IAWA BULLETIN

Contents

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

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The Netherlands

continued on page 39

TRAUMATIC RESIN CANALS IN WESTERN HEMLOCK, TSUGA HETEROPHYLLA (RAF.) SARG.

by

Lawrence Leney and Larry D. Moore
College of Forest Resources, University of Washington, Seattle, U.S.A.
Simpson Timber Company, Arcata, California, U.S.A.

Summary

In this study of *Tsuga heterophylla* the large number of samples of wound tissue regions examined showed no evidence of formation of traumatic transverse resin canals. Therefore, the absence of fusiform rays with transverse resin canals can be used with confidence as a characteristic to separate western hemlock from those woods with normal resin canals.

Biseriate rays were common in traumatic zones, but did not persist in the normal wood formed to the outside of the wound area.

Introduction

The absence of fusiform rays with transverse resin canals has been used as an identification feature to separate hemlock, *Tsuga* (Endl.) Carr. from those genera which have normal resin canals of both the longitudinal and transverse type. Although transverse resin canals have not been reported for *Tsuga*, traumatic longitudinal canals are frequently formed in the wood as the result of injury stimuli in the cambial zone.

This frequency of occurrence and often abundance of traumatic longitudinal canals causes some doubt whether occasionally traumatic transverse resin canals may also be formed in the wood of *Tsuga* (Panshin and de Zeeuw, 1970). Traumatic transverse canals have been reported in the wood of Sitka spruce, *Picea sitchensis* (Bong) Carr., which also has normal longitudinal and transverse canals (Gerry, 1942). Traumatic transverse canals are found in *Cedrus* Trew., as first reported by Jeffrey (1905). These findings and the fact that traumatic longitudinal canals are readily formed in *Tsuga* have lead to the expectation that under traumatic conditions fusiform rays with resin canals may occur in this wood. This throws doubt on the identification feature discussed above.

The objective of this study was to develop a high degree of confidence as to whether or not fusiform rays with transverse resin canals occur in the wood of western hemlock, *Tsuga heterophylla* (Raf.) Sarg., as a result of traumatic stimuli.

Procedure

Samples of western hemlock wood were collected from three widely separated areas within Washington State. In two of the collection areas, a number of sample pieces were obtained from sawmill trimmings or reject lumber. In the third area, whole stem sections were cut from different logs. The objective was to collect a fairly large number of sample pieces which showed a traumatic condition and which came from different trees. From these sample pieces, 600 small sample blocks were cut (200 for each area), each containing evidence of injury. The blocks were cut to produce a tangential surface approximately 12 mm square and a radial dimension of 25 mm or more. The injury was located toward one end of the block such that when cut with the sliding microtome a series of sections would pass from the bark side to the pith side of the traumatic region.

Rather than prepare sections to determine the presence of transverse resin canals, a stereoscopic microscope with incident illumination was used to examine the tangential surface of the block at each level after one or two 40 μm sections had been removed. Stain was used to accentuate the ray tissue in contrast to the surrounding tracheids. Magnification was adequate to observe the presence or absence of fusiform rays.

If a traumatic transverse resin canal were formed due to injury there would first have to be a fusiform ray formed in the cambial zone as a result of the injury stimuli. The development and continuation of such a traumatic transverse canal would then extend from the injury outward to the cambium as the tree continued to grow. By starting the series of sections at a distance of at least one years growth on the bark side of the traumatic zone and proceeding toward the pith until passing through the traumatic zone, any fusiform rays, if present, would be observed within the series.

During the course of the serial sectioning a number of thinner sections were taken for more detailed examination by the transmitted light microscope to substantiate observations made with incident light.

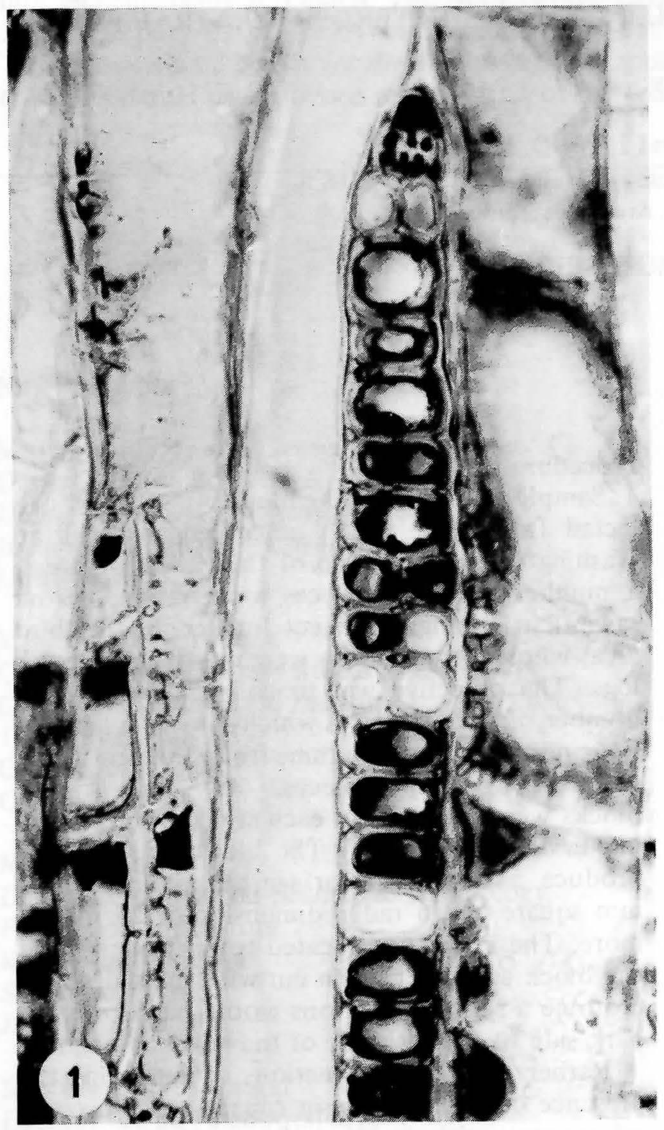

Figure 1. Tangential section of western hemlock showing a biseriate ray adjacent to wound parenchyma in a traumatic zone. The cells of the ray are widened tangentially compared to normal ray cells in this species.

Results and Discussion

No fusiform rays with transverse canals were found in any of the samples of hemlock studied. There were, however, some interesting differences in ray structure in the traumatic areas. In all the traumatic zones, some biseriate rays were present. A few of the rays were biseriate up to 80 percent of their height. A triseriate condition was observed in one ray. The parenchyma cells in the rays of the traumatic zone were enlarged in width approaching twice the cell height, while the cells in normal rays tend to be higher than they are wide.

Where the traumatic ray was biseriate the adjacent two cells were about circular in tangential sections and together were slightly wider than the uniseriate condition above or below them in the ray (Fig. 1). This widening of rays was also observed in aphid injured true fir, *Abies spec.* (Doerksen and Mitchell, 1965; Mitchell, 1967). Kučera and Bosshard (1975) report biseriate-triseriate ray condition in *Abies alba* Mill. but did not indicate any connection with traumatic condition.

This broadening of the rays is necessary if a fusiform ray is to be formed. However, the mechanism which caused the broadening of the rays does not necessarily have anything to do with the formation of transverse resin canals. Or if it does, the causal mechanism in this case did not persist for sufficient time to generate a multiseriate ray and then form a resin canal. There was no evidence of a canal formation, although there is the potential for schizogenous separation where four cells are in contact in the biseriate portion of some rays. The biseriate condition, however, did not persist for more than a short distance from the traumatic zone toward the bark.

Within the traumatic zones, there was considerable disruption of the wood structure with a profuse amount of parenchyma tissue formed. Within this traumatic tissue there were intercellular spaces, some of which might be considered to be resin cavities adjacent to traumatic longitudinal canals. A detailed study of these possible resin cavities, which were not a part of the ray tissue, was not undertaken at the time. There was no evidence, however, of a traumatic transverse resin canal formed within a fusiform ray tissue as has been reported for *Cedrus.*

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THE PECULIAR WOOD STRUCTURE OF LEPTOSPERMUM CRASSIPES LEHM. (MYRTACEAE)

by

P. Baas

Rijksherbarium, Leiden, The Netherlands

Summary

The swollen stem of *Leptospermum crassipes* Lehm. shows a normal juvenile secondary xylem composed of vessels, thick-walled fibre-tracheids, 'normal' heterogeneous rays, and scanty axial parenchyma. The later-formed wood, however, is characterized by a homogeneous ground tissue of wide, thin-walled, 'vessel members' and 'vascular tracheids' traversed by extremely low rays of strongly procumbent cells. Axial parenchyma is absent, except in wound tissue. The resulting histology as well as the morphology of the perforate and imperforate axial elements is more or less unique and differs markedly from the wood of other *Leptospermum* species. This peculiar wood anatomy and the deviating length-on-age curves for the axial elements are discussed with reference to current ideas on xylem evolution.

Introduction

Leptospermum crassipes Lehm. is a woody species of curious habit (Fig. 3). The plant is characterized by a swollen stem continuing into the upper part of the tap root. This swollen stem may dichotomize into two swollen branches in some plants, the remaining twigs being slender. The plants seen by me do not exceed 17 cm in total height, measured from the tip of the taproot to the top of the branch system. According to Bentham (1866) they may be up to nearly 30 cm high. The swollen stem does not exceed 1 cm in thickness (J.W. Green, Perth, personal communication). The species is common on swamp flats of South West Australia along the south coast between Augusta and Albany. The ground is waterlogged in winter, but dries out considerably during the hot summer months. Diels (1906) commented on the swollen stems of this species and their 'massenhafte Entwicklung dünnwandiger Holzelemente'. The locally abundant occurrence of the species led Diels to contemplate that, although he could not explain how the peculiar wood formation of *Leptospermum crassipes* was related to its ecology, it certainly 'functions well'.

During preparatory work for a detailed survey of the vegetative anatomy of the genus *Leptospermum*, now carried out by Mr. Colin Johnson from the University of Western Cape, at the Rijksherbarium, my attention became focused on this species. Its curious habit invited a wood anatomical study, to test generalized ideas relating habit and/or habitat with wood structure (Carlquist, 1975; Baas, 1976). In order to place the results in a broader perspective, comparisons were made with some other *Leptospermum* species (mainly based on data from the literature) and another Myrtaceous species with a swollen stem: *Verticordia grandiflora* Endl., also from West Australia.

The structure of the secondary xylem of *Leptospermum crassipes* revealed some, to my knowledge, unique features, so that the publication of a special note seemed justified.

Materials and Methods

Transverse, radial, and tangential sections of taproots (diameter 1 mm), swollen stems (diameter 4 & 8 mm) and slender branches (diameter 1 mm) were prepared using standard techniques. Surfaces of swollen stem parts were gold-coated and studied with a Cambridge Scanning Electron Microscope. Measurements of cell lengths were carried out on macerated material. Average and extreme values are based on at least 25 measurements (usually 50). The material studied was derived from herbarium specimens of entire plants at the Rijksherbarium.

Leptospermum crassipes Lehm. West Australia: Preiss 155, on peaty soil in dense lowland shrubbery in vicinity of Albany, diameter of swollen stem 8 mm; Pritzel 248, in rather humid shrubbery on hills of S.W. Plantagenet not far from the sea, diameter of swollen stem 4 mm.

Verticordia grandiflora Endl. West Australia: Pritzel 603, in shrubbery on sandy soil between the rivers Murchison and Moore, diameter of swollen stem 6 mm.

Results

General wood structure

Near the centre of the stem the secondary xylem appears quite normal (Fig. 1 and 2). It is composed of narrow, simply perforated vessels embedded in a ground tissue of thick-walled fibre-tracheids with conspicuously bordered pits. Axial parenchyma occurs as scanty isolated cells, and the rays are narrow, uniseriate, and composed of erect, square, and occasionally also procumbent cells. The wood anatomy of slender twigs and the narrow part of the tap root is more or less identical with this narrow core of 'normal' juvenile stem wood.

Towards the periphery, about 100 to 200 μm from the intraxylary phloem, the structure of the wood changes drastically into a more or less homogeneous tissue. This is composed of morphologically similar perforate and imperforate elements of large diameter and short length. This ground tissue is traversed by extremely narrow and low uniseriate rays. The ray cells are strongly procumbent, and the rays are usually only one, rarely up to 6 cells high. At the points of new formation of rays they usually also contain some square to erect cells. Axial parenchyma is totally absent, except in some patches of wound tissue observed adjacent to growth ring boundaries. The 'axial elements' of the ground tissue can be referred to as vessel members and vascular tracheids, depending on the presence of small oval perforations (Fig. 8–11). Although many vessel members with 2 perforations occur it is impossible to identify vessels in transverse or longitudinal sections, because of the similarity in shape with the imperforate elements. All axial elements are connected by diffuse, non-crowded, bordered, vestured pits, which are circular (3–4 μm) and have included slit-like apertures. The pits from ray cells to axial elements are similar but half-bordered and more crowded. Growth ring boundaries occur and are marked by radially narrower 'late wood' elements. In Preiss 155 five growth ring boundaries could be identified, in Pritzel 248 only two.

The transition from the normally differentiated juvenile wood to the poorly differentiated (i.e. homogeneous) more mature wood is effectuated over a very short radial distance (c. 100-200 μm). It is characterized by an increase in diameter of all axial elements in such a way that vessel members and imperforate elements become indistinguishable. The axial elements strongly decrease in length (see below) and lose their narrow fusiform shape. The ray cells become highly procumbent (Fig. 1, 2, 4–6).

Additional features of the axial elements

The morphology of the individual axial elements varies greatly in the thin-walled portion of the wood of *L. crassipes* (Fig. 8–11), and is not correlated with presence or absence of perforations. Most frequently the elements are rectangular to polygonal, often slightly elongated radially, as seen in transverse section; in radial sections they appear upright rectangular, and in tangential sections they are irregularly-shaped with a tendency towards barrel-, diamond-, or spindle-shaped. Deviations from this generalized morphology are frequent. This is, presumably, caused by intrusive growth of one element between or 'into' others. Elements often have pointed 'outgrowths' in a lateral position corresponding with 'invaginations' in the adjacent elements (Fig. 9–11). This presumed intrusive growth does not affect the element length to any great extent, it only accounts for the irregularity of the element morphology. Although our material was not very suitable for studying the cambial cells, it appeared that the fusiform initials only differed from the axial cells in radial dimensions and in lacking the irregular outgrowths or invaginations.

Length-on-age graphs for element length are plotted in Fig. 13. The abrupt decline in perforate and imperforate element length is based on observations of radial sections, the points of the graph are based on measurements of macerated material. Note that in the juvenile wood there is a normal difference in fiber-tracheid and vessel member length indicative of intrusive growth of the former. In the more mature wood the length of perforate and imperforate elements is virtually identical. Vessel member length is given for elements with two perforations. Elements with one perforation are also rather frequent and have similar lengths as vessel members and imperforate vascular tracheids. The abrupt decline in element length must be the result of reduced intrusive longitudinal growth of fusiform initials following pseudotransverse divisions. This is supported by the observation of radial rows of axial elements divided into two as seen in radial sections (Fig. 2) and by the changing morphology of axial elements as seen in tangential sections at different distances from the pith. Dilatation is chiefly achieved through increase in tangential cell size. From the periphery of the juvenile wood to the periphery of the stem in Preiss 155 there is a 17-fold increase in circumference, but the number of axial cells increases only from 90 to 320 (c. x 3.5). The tangential diameter of the axial cells increases from about 20 μm at the periphery of the juvenile core to (40–)70(–100) μm at the periphery of the 'mature' wood.

The perforations which measure about 20 μm in diameter, have vestured to non-vestured rims. Fig. 12 illustrates a maximum development of vestures, comparable to the situation in *Leptospermum ericoides* reported by Kučera *et al.* (1977). The latter authors also noted that vestur-

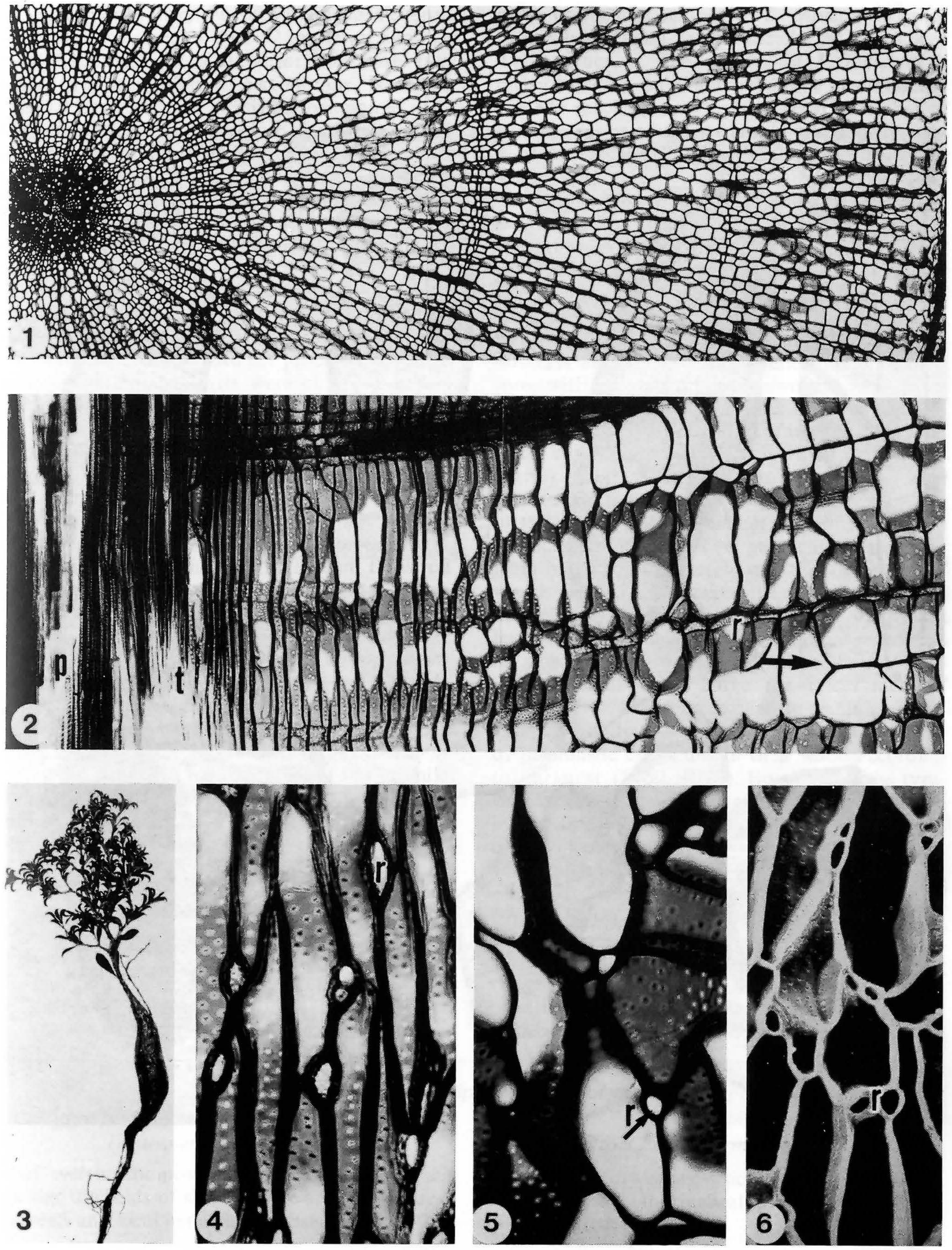

Figure 1–6. *Leptospermum crassipes* Lehm. — 1: Transverse section (Preiss 155), x 42. — 2: Radial section (Pritzel 248); arrow indicates subdivision in radial row of axial elements, x 105. — 3: Habit (Preiss 155), x 0.7. — 4: Tangential section of transition zone near pith (Preiss 155), x 260. — 5: Tangential section of later formed wood (Preiss 155), x 260. — 6: Tangential surface (Preiss 155), SEM x 250. p = pith and intraxylary phloem; t = transition zone; r = ray.

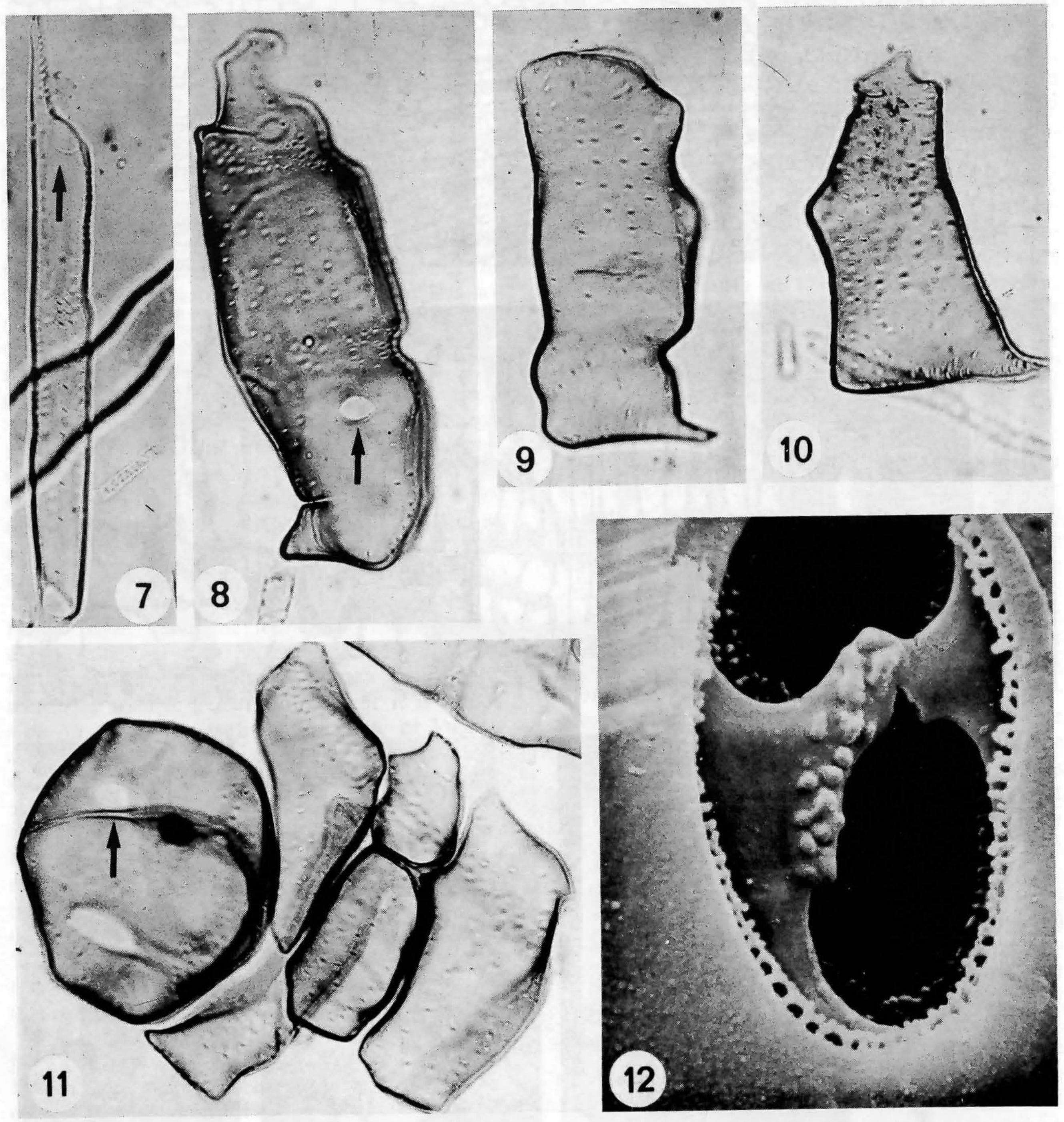

Figure 7–11. Macerated elements of *Leptospermum crassipes* Lehm., all x 325. — 7–10: Preiss 155. — 11: Pritzel 248. — 7: 'Normal' vessel element from transition zone. — 8: Vessel element from later formed wood. — 9 and 10: Imperforate elements ('vascular tracheids') from later formed wood. — 11: Cluster of perforate and imperforate elements.
Figure 12. SEM micrograph of vestured perforation (Preiss 155), x 6000.
Arrows in fig. 7–11 indicate perforations.

ed perforations may be of variable occurrence within a single species. Fig. 12 moreover shows a combination of an oval perforation with two more irregularly shaped perforations. Near the cambial zone frequent persisting compound middle lamellas were observed in 'perforations' of otherwise fully differentiated cells. This confirms reports in the literature (e.g. Meylan and Butterfield, 1972) that the perforation plates are dissolved after the deposition of secondary wall material in other parts of the cell has been completed.

The bordered pits show a modest degree of vesturing consisting of short little branched filaments protruding from the pit aperture and ceiling of the pit chamber into the pit cavity. In some elements infrequent warts were observed; others had smooth walls.

Discussion

The quite unusual, if not unique, wood anatomy of *L. crassipes* immediately invites comparisons with data on other *Leptospermum* species. The most detailed account of *Leptospermum* wood anatomy is that of Ingle and Dadswell (1953) who studied 7 species. Their data agree very closely with my own, very limited, observations on *L. laevigatum*. The differences in 'mature' wood structure with the other *Leptospermum* species (shrubs or small trees) are listed in Table 1.

The differences listed could easily induce the systematic wood anatomist to assign *L. crassipes* to an entirely different order than the other *Leptospermum* species, were it not that the juvenile secondary xylem in *L. crassipes* is more or less identical to that of *L. laevigatum* and probably to that of all other *Leptospermum* species. The peculiar structure of the later formed wood of *L. crassipes* can therefore not be used to argue in favour of a highly isolated systematic position of this species. In fact Bentham (1866) and Diels (1906) commented on the close similarities in all characters except habit of *L. crassipes* with *L. ellipticum.*

It seemed therefore of interest to consider the habit or perhaps ecology of *L. crassipes* in order to account at least hypothetically for its peculiar wood structure. The ecology of *L. crassipes* is rather unusual as pointed out in the introduction, but the species grows together with a number of woody species of normal shrubby habit. The habit of *L. crassipes* is slightly reminiscent of another small woody representative of the Myrtaceae: *Verticordia grandiflora.* On comparison of the swollen and unswollen parts of the stem of this species the secondary xylem appeared to be basically similar throughout. It is similar to the juvenile wood of *L. crassipes* with its ground tissue of thick-walled fibre-tracheids interspersed with clearly differentiated vessels, narrow heterogeneous rays and scanty axial parenchyma. Comparisons with other taxa with swollen stem bases would be interesting, but this has to await the availability of more material. Van Steenis (1955) listed a number of taxa which would be interesting for comparison. As far as I am familiar with literature accounts of the wood anatomy of some of these taxa, I would expect most of them to be characterized by massive parenchyma development and also by a clear distinction of fibres and vessels. This is for instance the case in flask-, barrel-, or bottle-shaped trees belonging to Sterculiaceae and Bombacaceae. In those species the rays are moreover well developed and large.

The length-on-age curve for vessel member length of *L. crassipes* is slightly reminiscent of that for woody species showing 'paedomorphosis' or juvenilistic characters in their wood according to Carlquist (1962, 1975). However, in the typical cases these deviating length-on-age curves have been found to be correlated with the (presumed) retention of other primitive primary xylem characters such as large vessel pits, tall rays of mainly erect cells. In *L. crassipes* the pattern is quite in contrast with these trends: the extremely low homogeneous rays and similar morphology of perforate and imperforate elements, as well as the pitting all deviate strongly from the juvenile condition and must be interpreted as highly specialized character states. The controversial dictum

Table 1. Comparison of the wood of *L. crassipes* with that of other *Leptospermum* species

Leptospermum crassipes	Other *Leptospermum* species
Axial system composed of vessel members and vascular tracheids of similar shape and size. Fibre-tracheids and axial parenchyma absent.	Axial system of vessels, vasicentric tracheids, fibre-tracheids, and apotracheal parenchyma clearly differentiated.
Mean length of perforate and imperforate elements 190–220 μm.	Mean vessel member length 440–630 μm. Mean fibre-tracheid length 800-1100 μm.
Rays uniseriate, usually only one (rarely up to 6) cells high, composed of strongly procumbent cells except for first-formed cells.	Rays (1–)2–3(–4) seriate, weakly to markedly heterogeneous, of 'normal' height.

that ontogeny recapitulates phylogeny certainly applies to *L. crassipes*: the normal first-formed xylem is the only wood anatomical witness of the ancestral type from which the peculiar later-formed wood must be derived.

With its comparatively massive development of thin-walled xylem elements one could call the swollen stems of *L. crassipes* succulent. Stem succulents often show length-on-age curves for axial elements typical of paedomorphosis (see Carlquist, 1975 and literature cited there). Here the parallel ends, however, because these stem succulents tend to be characterized by other juvenilistic characters reviewed above, which are lacking in *L. crassipes.*

If one wishes to explain the strange length-on-age curves for the xylem elements of *L. crassipes* functionally, Carlquist's theory (1975) of a release-from-mechanical-strength, because long fibres are not needed for the modest habit of this species, seems plausible but remains speculative. The controversial interpretation by Mabberley (1974) of Philipson and Butterfield's theory (1967) explaining normal length-on-age curves does certainly not apply here, because the pith in *L. crassipes* is very narrow (see also Koek-Noorman, 1976, and Baas, 1976 for an elaborate discussion).

In conclusion we have to leave the problems indicated in the introduction unsolved. Obviously Diels (1906) was right when he reflected that the xylem of *L. crassipes* apparently functions well. This, however, does not imply that we should interpret the peculiar wood structure as the result of directing forces caused by ecological or other adaptive strategies in evolution. With the present state of our knowledge, *L. crassipes* appears to be an isolated case in which generalized wood anatomical trends are defied. This strengthens me in my unprovable belief of an important role of *'patio-ludens'* evolution (*sensu* Van Steenis, 1977), rather than in ecological strategies in this case.

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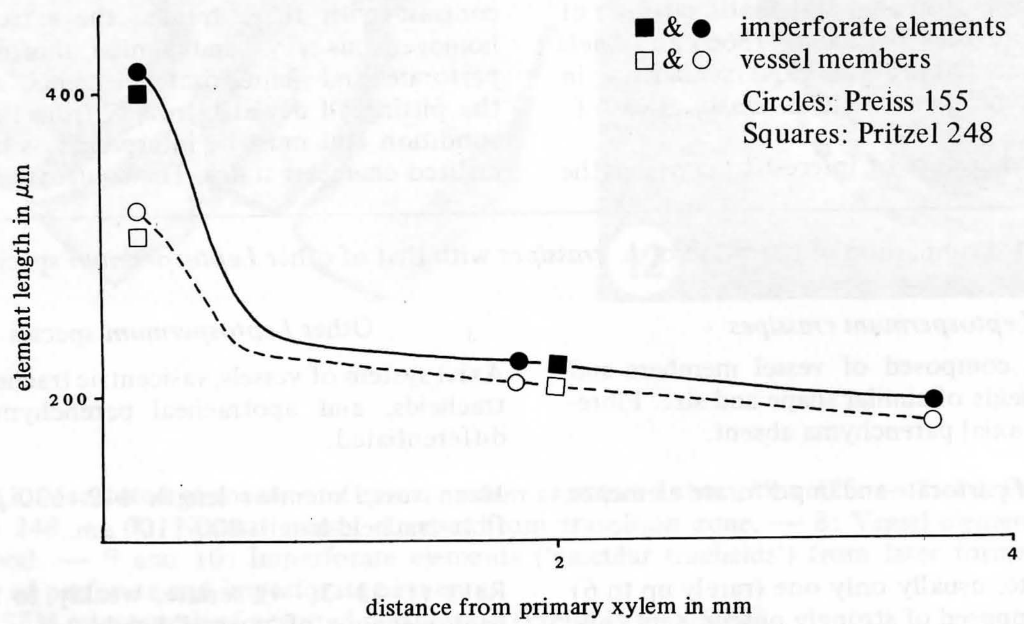

Figure 13

ON THE PRESENCE OF LARGE STYLOIDS IN THE SECONDARY XYLEM OF THE GENUS HENRIETTEA (MELASTOMATACEAE)

by

B.J.H. ter Welle and A.M.W. Mennega

Institute for Systematic Botany, Utrecht, The Netherlands

Summary

Unusually large styloid crystals were noticed in the secondary xylem of a few species of *Henriettea* (Melastomataceae). Because of their size the name mega-styloids is proposed. Shape, chemical composition, and distribution pattern are described. The crystals occur in idioblasts with an extremely thin cell wall. These crystals in the wood were compared to those in the leaves and other plant parts of the same and other species. The taxonomic value of the occurrence of the mega-styloids in some *Henriettea* species is discussed.

Introduction

Crystals are of common occurrence in the secondary xylem of a great diversity of plants. A considerable variation exists in the form of these crystals, their quantity and the tissues in which they are found. The type of crystal and distribution pattern are often of diagnostic and taxonomic value (Solereder, 1899, 1908; Metcalfe and Chalk, 1950; Chattaway, 1955, 1956). This is particularly true for other types than the most common rhombic crystals.

When investigating the wood of neotropical Melastomataceae we noticed the presence of elongated crystals of an uncommonly large size in the wood of some species of *Henriettea*. As far as we know, such crystals were never described before from secondary xylem and for this reason we studied them more thoroughly.

Materials and Methods

The genus *Henriettea* comprises about 20 species. All are trees or shrubs restricted to the northern part of S. America, C. America and the West Indies (Krasser, 1893). Our study is based on 25 wood samples belonging to 9 species as indicated in Table 1. All these samples are backed by herbarium vouchers. Though the greater part of the wood samples are from trunks or branches, some twigs taken from herbarium sheets were also included in our study in order to evaluate the diagnostic value of this crystal type, and to be able to include also a few species which were not represented by wood samples.

Radial sections about 30 μm thick were prepared from all samples, whereas transverse and tangential sections were made from a more restricted number of specimens. Observations were made using normal and polarized light microscopy, supplemented with Scanning Electron Microscope studies. The chemical composition of the crystals was investigated with the aid of an Energy Dispersive X–ray Analyzer (EDXA) and also with the method of Pizzolato (1964).

Results and Discussion

In Table 1 the dimensions of the crystals in the wood of *Henriettea* are listed. The crystals are elongated and therefore belong clearly to the category of elongated crystals or styloids. The definition of this type of crystals is not very strict. In wood anatomical descriptions generally Chattaway's (1955) concept of the elongated crystal, *viz.* that such a crystal is about four times longer than wide is followed. We prefer to use the term styloid because it is the oldest one: introduced by Radlkofer in 1890, it was subsequently used by e.g. Solereder (1899, 1908), Metcalfe and Chalk (1950) and Fahn (1974). The crystals in *Henriettea* having a length/width ratio of 6 to 13, though mostly of 8 to 11, are not only much longer than is usual in this kind of crystals but at the same time wider. In cross section they measure from 24 to 80 μm, and in length they range from 240 to 560 μm.

Of some of the woody genera with elongated crystals listed by Chattaway (1955) we measured the dimensions of these crystals in sections of material in our collection. The results are shown below:

Euphorbiaceae	
Glochidion capitatum (Uw 10902)	75 x 10 to 95 x 18 μm
Glochidion obscurum (Uw 10906)	75 x 10 to 118 x 18 μm
Lauraceae	
Cryptocarya parinarioides (Uw 9800)	13 x 3 to 18 x 4 μm
Celastraceae	
Siphonodon peltatus (Jacobs 9177)	40 x 10 to 63 x 10 μm
Siphonodon peltatus (Uw 21726)	30 x 10 to 40 x 15 μm

A comparison of these values with those of the styloids from *Henriettea* as shown in the table demonstrates how much larger the crystals of the latter are. Even though the length/width ratio in *Glochidion capitatum* approaches the lowest value found in *Henriettea*, the dimensions of the crystals are much smaller. Therefore we propose for the unusually large crystals occurring in the wood of some species of *Henriettea* the new name: '*mega-styloids*'.

In transverse sections these crystals are nearly square or rectangular (Fig. 1) sometimes more or less diamond-shaped. The deviations from the nearly square form may, at least in part, be due to a non-axial position of the crystal. The longitudinal axes of the crystals and the wood fibres are at an angle with each other varying from 0 to 55° (Fig. 3, Table 1). This oblique position is more pronounced in the radial plane than in the tangential plane (Fig. 2). In the SEM micrographs (Fig. 5 and 6) we see that the crystals consist of an elongated body, terminated at both ends by pyramid-like structures or wedge-like structures with trapezoid lateral faces. In polarized light the prismatic part of the crystal remains white and opaque whereas the sloping terminal parts show a number of bands exhibiting bright interference colours. The same was described by Rothert & Zalenski (1899) for their 'Liliaceenform' crystals, i.e. for the large elongated crystals present in the leaves of various Liliaceae, a type of crystals matching in form exactly the mega-styloids of *Henriettea.*

Crystals of the styloid type are considered to consist of calcium oxalate. With the aid of an EDXA apparatus we could establish that at least the bulk of the crystal is made up of a calcium compound. In view of the studies of e.g. Pobeguin (1943) and Scurfield *et al.* (1973) it seems justified to regard them as consisting of calcium oxalate. This mineral exists in the form of monohydrates and of di- or trihydrates. The square form seen in the cross sections of the crystals of *Henriettea* is an indication for the dihydrate form or an even higher class (personal communication by Dr. W. van Tongeren). However, a more thorough crystallographic examination would be necessary to establish the exact nature of these crystals. This was, however, beyond the scope of our study.

In trying to demonstrate the presence of calcium oxalate using Pizzolato's method (1964), which is based on the blackening of the crystals when treated with a mixture of hydrogen peroxide and 5 % silver nitrate followed by an exposure to fluorescent light, we did not observe any blackening, but this may be due to the large size of the crystals, because Scurfield *et al.* (1973) were not successful either when probing this method on the large solitary crystals found in sections of *Terminalia belerica*. The latter are even much smaller than those found by us in some of the *Henriettea* species.

The most striking feature of the mega-styloids, apart from their large size, is the position they occupy in the wood. Normally a crystal is included in a cell: most often in the cells of rays or of axial parenchyma, less frequently in the fibres. In *Henriettea*, however, it was not possible with light- or scanning electron microscopy, to detect the walls of the cell in which the crystal must have been produced. By treating a section with strongly diluted sulphuric acid, a method used by Rothert (1900) for demonstrating the existence of a cell wall around the large solitary styloids occurring in the diaphragms which are found in the petioles of *Eichornia*, we succeeded in demonstrating a flimsy cell wall in *Henriettea*. Perhaps the small rough patches on the slanting ends of the crystals seen in Fig. 6 may be considered to be remains of the cell wall. In one of the SEM photographs in Scurfield *et al.*'s paper (1973) similar structures are visible and these authors consider them to be possible remains of a vacuolar membrane.

We failed to make such a membrane visible by applying strongly diluted hydrochloric acid to the sections, i.e. by means of the method advocated by Rothert in his above mentioned analysis of the formation of the *Eichornia* crystals.

The distribution of the crystals seems haphazard, though in some samples a tendency to an axial alignment was evident in the radial sections. Fig. 1 and 3 show how the elongated parenchyma cells bordering on the crystals are often distorted. These cells may belong either to the rays or to the axial parenchyma. They are usually filled with a dark-coloured substance, which is also present, though less abundant, in the normal parenchyma cells.

The wood of *Henriettea* possesses numerous uniseriate rays, few parenchyma strands in contact with the vessels, and a fibre tissue composed of intermingled non-septate and septate fibres. In the latter type of fibres a yellowish substance, probably the same as that seen in the parenchyma cells, is present. Such fibres are often also found round a crystal.

In *Calycogonium squamulosum* (Uw 22049) belonging to the same tribe (Miconieae) of the Melastomataceae styloids of a smaller type occur. As they are shorter and narrower, they fit in the normal type of elongated parenchyma cells and in the septate fibres with one partition. With respect to the more or less identical wood structure of the two genera we felt at first inclined to associate the mega-styloids of *Henriettea* also with the parenchyma and the septate fibres. The very thin cell wall, the extraordinary size and the often diagonal and irregular position within the wood induced us, however, to consider the crystals and their cells to be true idioblasts, which probably

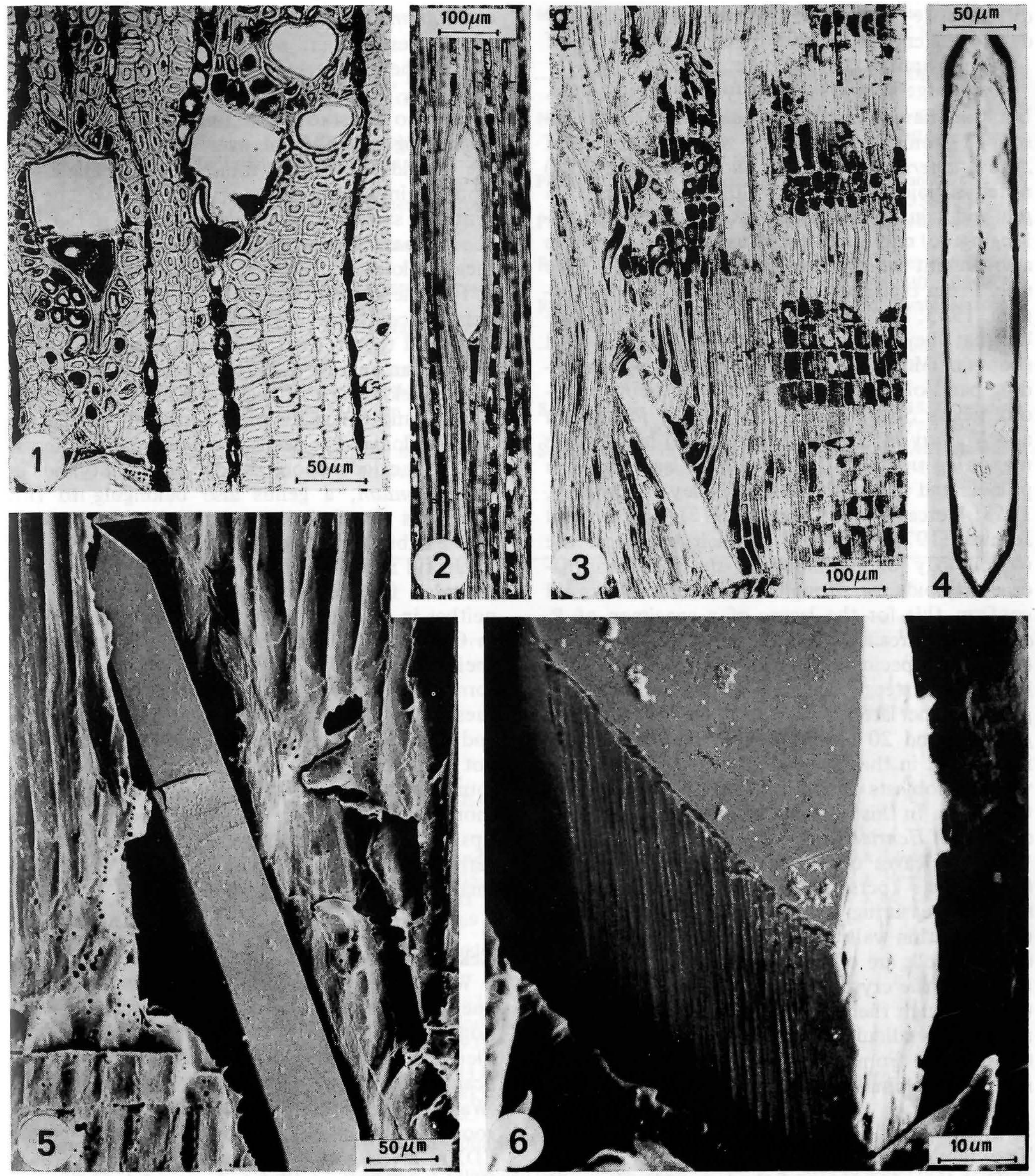

Fig. 1. Transverse section of *Henriettea maroniensis* (Uw 1315), showing two mega-styloids surrounded by irregular cells with dark contents. –– Fig. 2. Tangential section of *H. succosa* (Uw 1301). –– Fig. 3. Radial section of *H. succosa* (Uw 1301) showing different positions of the crystals (axial and oblique). –– Fig. 4. Mega-styloid of macerated wood of *H. succosa* (Uw 4196). –– Fig. 5 and 6. SEM micrographs of mega-styloids and surrounding tissue in *H. succosa* (Uw 4129).

differentiate very close to the cambium; fully developed crystals were noticed at a distance of 150 μm from the cambial zone.

Very large styloids are not unknown in plants, but they have so far as we know, never been described from the secondary wood. In leaves of *Agave americana* Rothert and Zalenski (1899) noted styloids which were 500 μm long and 25 μm wide; in the leaves of several other taxa belonging to monocotyledonous families they are also present though they are not of the same large size. From the literature (Netolitzky, 1929; Pobeguin, 1943; Frey-Wyssling, 1959) it seems probable that they are more common in the leaves and shoots of Monocotyledons than in the corresponding parts of the Dicotyledons. The dicotyledonous genus *Sphenostemon* (including *Idenburgia* and *Nouhuysia*; Sphenostemonaceae) has styloids measuring up to 350 x 30 μm in leaves, and in phloem and pith of the shoots (Bailey and Swamy, 1953; Metcalfe, 1956; Baas, 1975). Jackson and Jethwa (1973) illustrate in their paper on the morphology of *Bersama abyssinica* (Melianthaceae) styloids measuring 220 x 20 μm. We could confirm this for the leaves of a specimen of *B. abyssinica* Fres. ssp. *paullinioides* Verdc. and in the wood specimen pertaining to the same collection (Versteegh & Outer 11) styloids are also present. The latter, which are about 300 to 360 μm long and 20 μm wide, are found amidst the fibres (not in the fibres themselves) in very thin-walled idioblasts of the same width and length as the fibres. In this respect they resemble the mega-styloids of *Henriettea.*

In the leaves of *Henriettea succosa* DC. (Ule 6049) Baas (personal communication) noticed styloids measuring 160–250 μm x 10–35 μm situated in thin-walled cells. In sections the walls of these cells are often difficult to see. Here as in the wood the crystals are usually irregularly scattered, though there is a tendency for an arrangement perpendicular to the leaf surface. Usually they extend from the lower to the upper epidermis of the lamina.

Taxonomic implications

That the occurrence of the large styloids is not an accidental phenomenon due to an injury of some kind, but a characteristic feature of at least one and perhaps two more species of *Henriettea* is shown in Table 1. In all sections of trunk, branch or twig xylem of *H. succosa* the crystals proved to be present, though they are usually scarce. Of the nine species of the genus *Henriettea* investigated by us five were represented by two or more samples. In the best represented species, i.e. *H. succosa*, all specimens contained the mega-styloids. In *H. multiflora* on the contrary, no crystals were found. In the species *H. maroniensis* and *H. ramiflora*, both closely related to *H. succosa*, the results were not uniform. The identification of the vouchers is nevertheless beyond doubt. However, the deviating sections, i.e. those in which no crystals were found, were obtained from twig material not over 4 mm in diameter. We should also bear in mind that in a single section the invariably scarce crystals may well be absent. We saw the crystals none the less in twigs of *H. succosa*, the species which always contains mega-styloids.

For the present we have to conclude that the occurrence of the mega-styloids is a variable character and therefore of restricted diagnostic value. Now it can only be used for recognizing some species as belonging to the genus *Henriettea*. In *Henrietella*, another genus of the tribe Miconieae, no mega-styloids were seen. The presence of a shorter and decidedly more slender type of styloids in *Calycogonium*, a genus also belonging to this tribe, has already been mentioned. Other genera of the tribe still have to be studied.

Up till now the occurrence of crystals was not recorded for the wood of the Melastomataceae, neither in the 'Anatomy of the Dicotyledons' nor in Chattaway's lists of families having crystals in their wood (1955, 1956). Crystals of a different form are, however, known to occur in other tissues. It may be mentioned here that in the pith and bark of the species investigated, also in those not containing the mega-styloids, styloids are found of more usual dimensions, i.e. thinner and shorter and with more gradually tapering, slender tips. Being thinner these styloids showed the many bright colours in polarized light, typical for smaller crystals.

Acknowledgements

We wish to thank the following persons, who in one way or another have assisted in this investigation. Dr. W. Berendsen (Utrecht, Institute for Electron Microscopy) for his assistance with the Scanning Electron Microscope, ing. S. Henstra (Wageningen, Stichting Techn. en Fys. Dienst voor de Landbouw) for his co-operation in the EDXA investigation of the crystals, Dr. P. Baas (Leiden, Rijksherbarium) for useful comments and the loan of leaf sections, Dr. R.W. den Outer (Wageningen, Institute of Botany) for loan of a wood sample of *Bersema*, Prof. W. van Tongeren (Amsterdam, Laboratory of Analytical Chemistry) for extensive crystallographic information, Drs. J.J. Wurdack and H. Eyde (Washington, Smithsonian Institution) for the identification of herbarium vouchers and for the loan of material. To Prof. C.E.B. Bremekamp we are greatly indebted for the correction of the English text. Messrs A. Kuiper and T. Schipper are thanked for preparing the plate.

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Table 1. Material studied and occurrence, size and orientation of mega-styloids

SPECIES	Uw-No.	COLLECTION	LOCALITY	M.S.[1]	DIMENSIONS[2]	ANGLE[3]
Henriettea						
granulata Berg	8176	Krukoff 7099	Amazonas	–		
prob. *granulata* Berg	21614	A.C. Smith 3054	Guyana	–		
horridula Pilg.	twig	Maas 518	Manaus	–		
maroniensis Sagot	1315	Lanjouw & Lindeman 744	Suriname	+	384–480 x 32–68	20– 5
maroniensis Sagot	3132	Lindeman 4505	Suriname	+	432–512 x 36–48	20– 0
maroniensis Sagot	twig	Florschütz 645	Suriname	+	480 x 80	
maroniensis Sagot	twig	Lindeman 5069	Suriname	–		
martiusii (DC.) Naud.	22328	Wurdack & Adderley 42740	Venezuela	–		
multiflora Naud.	337	Stahel 337	Suriname	–		
multiflora Naud.	929	For. Dept. 3293	Guyana	–		
multiflora Naud.	1300	Lanjouw & Lindeman 689	Suriname	–		
multiflora Naud.	3188	Lindeman 4593	Suriname	–		
ramiflora DC.	twig	Boschwezen 4440	Suriname	+	300 x 24	40
ramiflora DC.	twig	Kramer & Hekking 2755	Suriname	–		
ramiflora DC.	twig	Proctor 26432	Jamaica	–		
spruceana Cogn.	22329	Wurdack & Adderley 42711	Venezuela	+	240–320 x 32–40	40– 5
succosa DC.	1301	Lanjouw & Lindeman 690	Suriname	+	368–548 x 36–48	55– 5
succosa DC.	1316	Lanjouw & Lindeman 744a	Suriname	+	416–480 x 36–68	15– 0
succosa DC.	3956	Lindeman 5802	Suriname	+	304–384 x 32–48	10– 0
succosa DC.	4067	Lindeman 5927	Suriname	+	272–560 x 28–48	40– 0
succosa DC.	4129	Lindeman 6058	Suriname	+	304–512 x 44–70	45– 0
succosa DC.	4196	Lindeman 6144	Suriname	+	336–448 x 36–52	45– 0
succosa DC.	twig	Prance & Pennington 1957	Amazonas	+	358–464 x 36–48	30– 5
succosa DC.	twig	Oldeman & Sastre 22	Fr. Guiana	+	248 x 24	10
stellaris Berg ex Triana	17485	Maguire et al. 55453	Suriname	–		

1: M.S. = mega-styloid; + = present; – = absent
2: minimum to maximum length x minimum to maximum width, as measured in radial sections
3: angle between the axis of the crystals and the fibres as observed in radial sections

BOOK REVIEWS

Manuel d'identification des Bois Commerciaux 2, Afrique guinéo-congolaise. D. Normand & J. Paquis, 335 pp, 61 plates. Centre Technique Forestier Tropical, 45bis Av. de la Belle-Gabrielle, 94 Nogent s/Marne, France, 1976. Price: Fr. Francs 60.00.

Everyone familiar with the excellent introduction to wood identification by Monsieur Normand published as volume 1 of this series in 1972, will welcome the appearance of this volume which contains accounts of not less than 248 commercial or potentially commercial timbers from tropical West and Central Africa. The wood anatomical details for these species are largely contained in codified descriptions to be used for making a perforated card key, and are illustrated with very high quality micrographs of transverse sections at x 14 magnification. The text of the book consists of descriptions and notes on the individual genera and families. This section is written in a more or less informal style and the amount of detail for each group varies. There are almost always notes on distribution, ecology, and general wood features of the genera, which are very often complemented by concise wood anatomical characterizations. For commercially very important groups (e.g. *Entandrophragma*) some species are treated individually. The entire text reflects the thorough botanical and wood anatomical knowledge as well as the vast experience of the senior author. Here is a book which is intended to facilitate identification of commercial woods, but which also enables the reader to see the trees from their microscopic structure, and to a certain extent also the wood from the trees. The title and professed aims of the book are far too modest I think, because besides the 248 species of commercial importance there are anatomical and botanical notes on a great number of non-commercial taxa of diverse habit (small trees and shrubs, and even palms and screw palms). This makes the book of considerable botanical interest, because some of the taxa treated are of controversial botanical affinity or have so far remained undescribed in the wood anatomical literature. The total number of genera dealt with amounts to not less than 350.

In a way it is a pity that the authors have not completely drawn the consequences of the great botanical importance of their book, by for instance adding a bibliography of the more relevant publications they occasionally cite, and by makking some of the anatomical descriptions more comprehensive.

The small format and lay-out are designed to facilitate frequent use, if necessary in the field. A transparent square with scales and frames for measuring and counting with the aid of a hand lens is added.

The authors are to be congratulated on this major addition to the wood anatomical literature, which should not be ignored by wood scientists who are not very conversant with the French language. It is hoped that the volumes on timbers from French Guyana and Madagascar, tentatively promised in the preface to the first volume of this series, will follow soon. What a valuable addition to wood anatomy these would be, particularly the one on the remarkable woody flora of Madagascar!

Pieter Baas

Anatomy of more important Andaman commercial timbers (with notes on their supply, properties & uses). S.K. Purkayastha, K.B.S. Juneja & S.M. Husain Kazmi, 48 pp, 18 plates. Indian Forest Records (New Series) 2 (1). Controller of Publications, Delhi–6, 1976. Price: £ 0.73 or $ 2.25.

Timbers from the Andaman islands play an increasingly important role on the Indian timber market, and the authors have aimed at providing a publication which will enable microscopic and macroscopic identification of 36 of the more important commercial species. Several of the species included are wood anatomically poorly known or are here described for the first time. There are notes on tree size, ecology, general (macroscopic) features, and properties and uses. The gross and minute structure of the timbers is dealt with in great detail, and this makes this publication one of outstanding quality in the best tradition of classical wood anatomy. Besides comprehensive treatments of the usual features included in a wood anatomical description, the proportion of the tissues (vessels, parenchyma, fibres and rays) are given as percentages of the total volume of the wood. Card key features for hand lens identification are added. Photomicrographs of perfect transverse and tangential sections are added on satisfactorily reproduced half-tone plates.

Apart from the obvious use of the booklet for the identification of Andaman timbers, the descriptive data together with notes on tree size and forest type offer interesting information to students of diverse aspects of wood anatomy. The ecologically interested anatomist may be struck by the fact that for the species described from the evergreen forests and belonging to various families, mean vessel member length is significantly longer than for the species from the less wet deciduous forests. The tree physiologist may plot the vessel diameter against percentage of total wood volume occupied by the vessels and find that, although there is not a clear correlation, there is a trend for species with the widest vessels to have the lowest percentage of water conducting tissue. This fits nicely with the Hagen-Poiseuille formula for highly reduced resistance to flow in the individual (wider) vessels.

Although the format of this book is modest, the price is extremely low, so that financial reasons cannot prevent anyone from purchasing it.

Pieter Baas

WOOD ANATOMY ACTIVITIES AROUND THE WORLD

All-Union Coordinating Conference of Wood Specialists in Tbilisi (U.S.S.R.)

Our member Dr. E.D. Lobjanidze, Head of the department of Wood Anatomy and Technology of the Tbilisi Forestry Institute sent us an interesting report of the All-Union coordinating Conference of Wood Specialists held in Tbilisi from October 21 to 23, 1976 on the initiative of the Tbilisi Forestry Institute. Noted scientists from many centres of forest products research all over the U.S.S.R. discussed biological, technological, ecological and economical aspects of wood research. Of the numerous scientific papers read, we mention 'Thermodynamic analysis of Hygroscopicity of frozen wood' by Prof. Chudinov from Krasnoyarsk; 'Ultrasonic impulse method for controlling wood quality' by Dr. Ashkenazi from Leningrad; 'The use and technical properties of modified wood' by Dr. Darzninsh from Riga; and 'The influence of various felling methods on wood anatomical and technological properties' by Dr. Lobjanidze. In addition, excursions were organized to the laboratories, experimental forest managements, and the department of Wood Anatomy and Technology of the Tbilisi Forest Institute as well as to the dendrological museum of the agricultural Institute.

Pan American Regional Group of IAWA meets in 1978

In response to the proposal to establish regional groups within IAWA, which was passed at the 12th International Botanical Congress, the Pan American Regional Group is pleased to announce the formulation of their first meeting. The meeting will be a joint session(s) with the Structural Section of the Botanical Society of America to be held at Virginia Polytechnic Institute and State University, Blacksburg, Virginia on August 20-25, 1978. Details of this meeting and a call for contributed papers will be circulated at a later date. We would appreciate any suggestions you may have regarding the organization of a symposium or sessions dealing with specific topics. We hope this will be the first of many profitable regional meetings. Please make your plans to attend.

W.C. Dickison (Dept. of Botany, University of North Carolina, Chapel Hill)
J.G. Isebrands (Inst. of Forest Genetics, Rhinelander, Wisconsin)
Organizing Committee

Afro-European Regional Group news

Plans are presently elaborated to organize a meeting of the Afro-European Regional Group of the IAWA in the Netherlands in 1979, in close collaboration with the Anatomy and Morphology section of the Royal Dutch Botanical Society. The meeting will probably be in the form of a 3 or 4 day Symposium on diverse aspects of wood structural research. Any suggestions will be highly welcome and should be addressed to the Office of the Executive Secretary.

Request for Wood Samples

For his study of the comparative anatomy of *Leptospermum* (Myrtaceae), Mr. Colin Johnson requests authenticated wood and bark specimens of any species belonging to this genus. He is not only interested in the arborescent representatives but also in the majority of shrubby species. Offcuts of wood and bark samples should be sent to Mr. Johnson's temporary address: Rijksherbarium, Schelpenkade 6, Leiden, The Netherlands.

ASSOCIATION AFFAIRS

Financial Report 1976

Two separate financial surveys are given: one for Syracuse from January 1, 1976 until January 31, 1977, and one for Leiden from March 19, 1976 until December 31, 1976. The extra month for the Syracuse account is included because financial transactions during that month chiefly concerned payments for 1976 Bulletins and postage.

Syracuse

Debit		Credit	
Balance 1975	$ 1836.46		
Dues and subscriptions	$ 790.82	IAWA Bulletin & stationary	$ 2704.40
Glossary and reprint sales	$ 251.66	Postage	$ 367.00
Transfer from Leiden	$ 250.00	Balance	$ 57.54
	$ 3128.94		$ 3128.94

Leiden

Debit		Credit	
Dues and subscriptions	Dfl. 2796.50	Stationary	Dfl. 459.42
Reprint sales	Dfl. 395.00	Propaganda leaflets	Dfl. 269.21
Interest	Dfl. 6.22	Banking costs (extra)	Dfl. 18.25
		Transfer to Syracuse	Dfl. 572.94
		Balance	Dfl. 1877.90
	Dfl. 3197.72		Dfl. 3197.72

Statements of Account:
January 31, 1977. Unibank Account No. 102.042-603, Lincoln First National Bank-Central, Syracuse, New York 13201, USA. Checking Account: $ 57.54.
December 31, 1976. AMRO Bank, Account No. 45.13.20.352, Rapenburg, Leiden, The Netherlands. Checking Account: Dfl. 1877.90 (– c. $ 750).

Members should note that at the beginning of 1977 our working balance was less than half that on January 1, 1976. It is hoped that our precarious financial situation will soon be remedied by the receipt of 1977 or earlier dues of those members who did not yet pay.

continued from page 22

Change to retired status

Prof. Dr. E. Reinders
Prof. Dr. C.A. Reinders-Gouwentak
Sparrenhof, Flat 616
Stationsweg 92
Ede (Gld.)
The Netherlands

Changes of address

Dr. C.C. Amobi
Department of Botany
University of Nigeria
Nsukka
Nigeria

Dr. J.D. Boyd
Forest Products Laboratory
CSIRO, P.O. Box 56
Highett, Victoria 3190
Australia

Mr. Mark D. Gibson
2366 N.W. Green Circle
Corvallis, Oregon 97330
USA

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

Dr. rer. nat. R. Wagenführ
Forschungsinstitut für Holztechnologie
8020 Dresden
Zellescher Weg 24
DDR

Resignations

Dr. E.A. Anderson
S.U.N.Y. College of Environmental Science & Forestry
Syracuse, New York 13210
USA

Dr. S. Nemec
U.S. Horticulture Research Laboratory
2120 Camden Road
Orlando, Florida 32803
USA

The IAWA Constitution

Those members who did not yet return the ballot forms for the amended Constitution sent in November 1976, are urgently requested to do so as soon as possible. It would be very costly and troublesome to send out individual reminders. However, with the present number of returned forms it will be impossible to adjust our Constitution to current practice in for instance admission of new members.

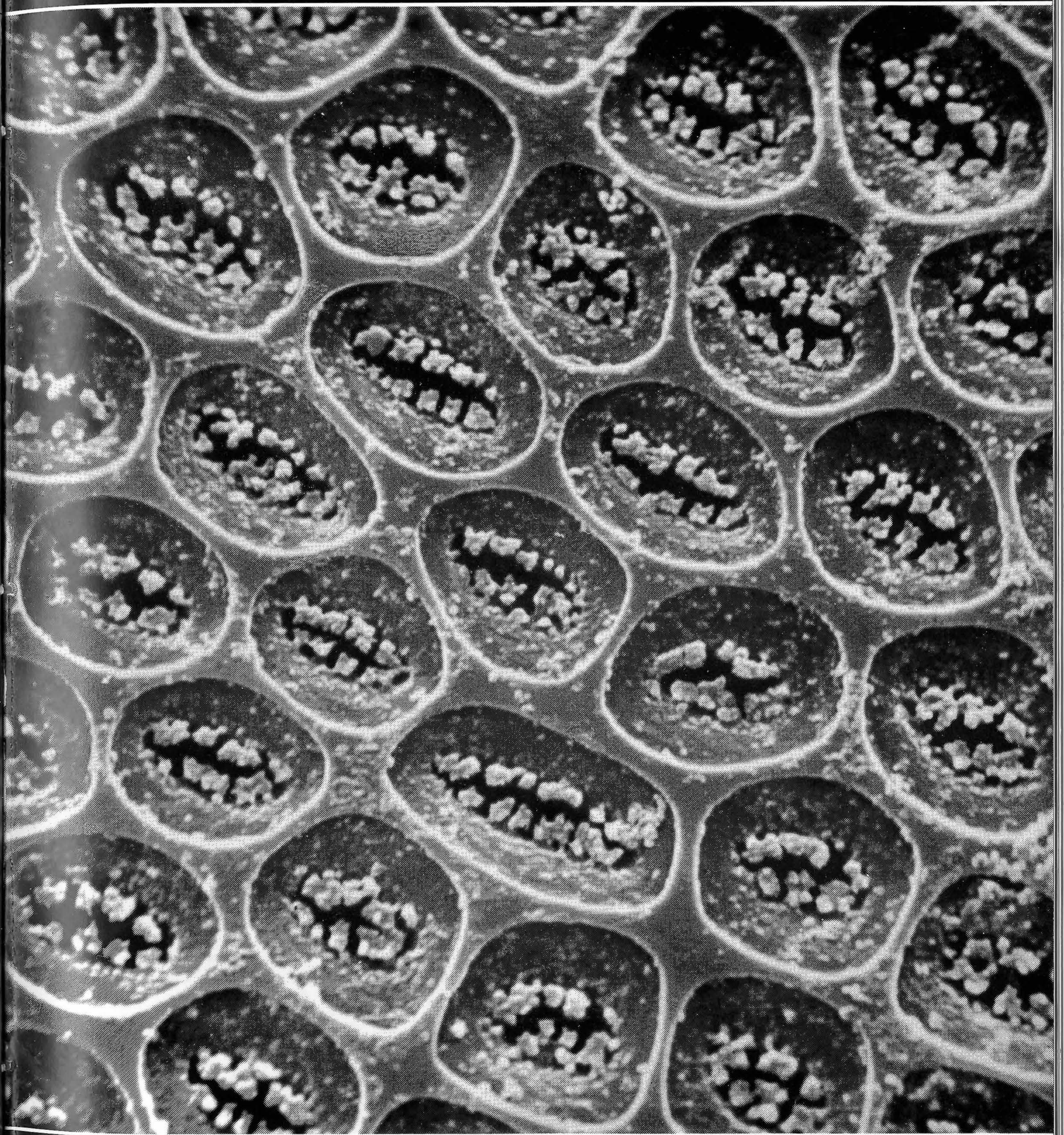
IAWA BULLETIN

Contents

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

OFFSETDRUK ADMINISTRATIEF CENTRUM DELFT

IAWA BULLETIN 1977/3



International Association of Wood Anatomists

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