Acta Bot. Neerl. 31 (4), August 1982, p. 275–279.

BARK ANATOMY OF TAMBOURISSA (MONIMIACEAE) FROM MADAGASCAR

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SUMMARY

Bark stucture of a mature tree of *Tambourissa hildebrandtii* Perk. and some other *Tambourissa* species (Monimiaceae) is described. The axial system of the conducting secondary phloem is composed for 40 percent of sieve elements and for about 60 percent of parenchyma cells of which many contain a granular oil-like substance. Storied structure and phloem fibres are absent. The bulk of the ray tissue is composed of wide multiseriate rays. Precocious sclerosis, at first horse-shoe shaped thickened sclereids, of parts of these rays is of common occurrence. Also the innermost phelloderm layers of the periderm are composed of such sclereids.

1. INTRODUCTION

The Monimiaceae s.l. is a family of usually trees and shrubs, rarely climbers, generally divided into two subfamilies viz. Monimioideae and Atherospermoideae (PAX 1894; METCALFE & CHALK 1950; HUTCHINSON 1964).

The Mascarene islands harbour three (GARRATT 1934; HUTCHINSON 1964) or four (CAVACO 1959) endemic genera. Of these *Tambourissa* Sonn. is the largest with 25 species (HUTCHINSON 1964). CAVACO (1959) on the other hand distinguishes 26 species; one (*T. ficus* (Tul.) DC.) from Java (Indonesia), the other 25 from the Mascarene islands. Of these 25 species, 19 are endemic to Madagascar.

Investigations on the anatomy of the secondary phloem of the family are scarce (METCALFE & CHALK 1950; MONEY et al. 1950) as far as we know, especially on adequately preserved specimens of stems. So in addition to the wood anatomy of *Tambourissa hildebrandtii* Perk. (DEN OUTER & VAN VEENENDAAL 1982) a description is given of its secondary phloem.

2. MATERIALS AND METHODS

Bark samples of *Tambourissa* used in this study, were collected by W. L. H. van Veenendaal and the author in Madagascar (1978) and by D. H. Lorence in Mauritius, Mascarene islands. The samples were immediately fixed in FAA.

Anatomical features were studied in transverse, radial and tangential sections and macerations. All sections were embedded in Kaiser's gelatin-glycerin. Means and ranges of the length of sieve-tube members, parenchyma strands, ray height and width, and the number of rays per mm in tangential direction are based on at least twenty-five individual measurements. The sieve-tube type, sieve-area type and companion-cell type were classified according to ZAHUR (1959).

A list of investigated samples is given below.

Tambourissa amplifolia (Bak. ex Tul.) A. DC. (Pl 3187; Lorence 2259; Mauritius, Mascarene islands; diameter 1.5 cm);
Tambourissa hildebrandtii Perk. (Pl 2866; Van Veenendaal and Den Outer 994; 10 km south-east of Ambalavao, Madagascar, in a vestigial forest about 800 m above sea-level; tree, height 4 m, diameter 40 cm);
Tambourissa tetragona (Tul.) A. DC. (Pl 3188; Lorence 2286; Mauritius, Mascarene islands; diameter 1.5 cm);
Tambourissa trichophylla Bak. (Pl 3189; Lorence 1879; Mascarene islands; diameter 1 cm);
Tambourissa Sonn. (Pl 3009; Van Veenendaal and Den Outer 1136; 10 km north of Fort Dauphin, Madagascar, in a rainforst about 100 m above sea-level; tree, height 4 m, diameter 6 cm).

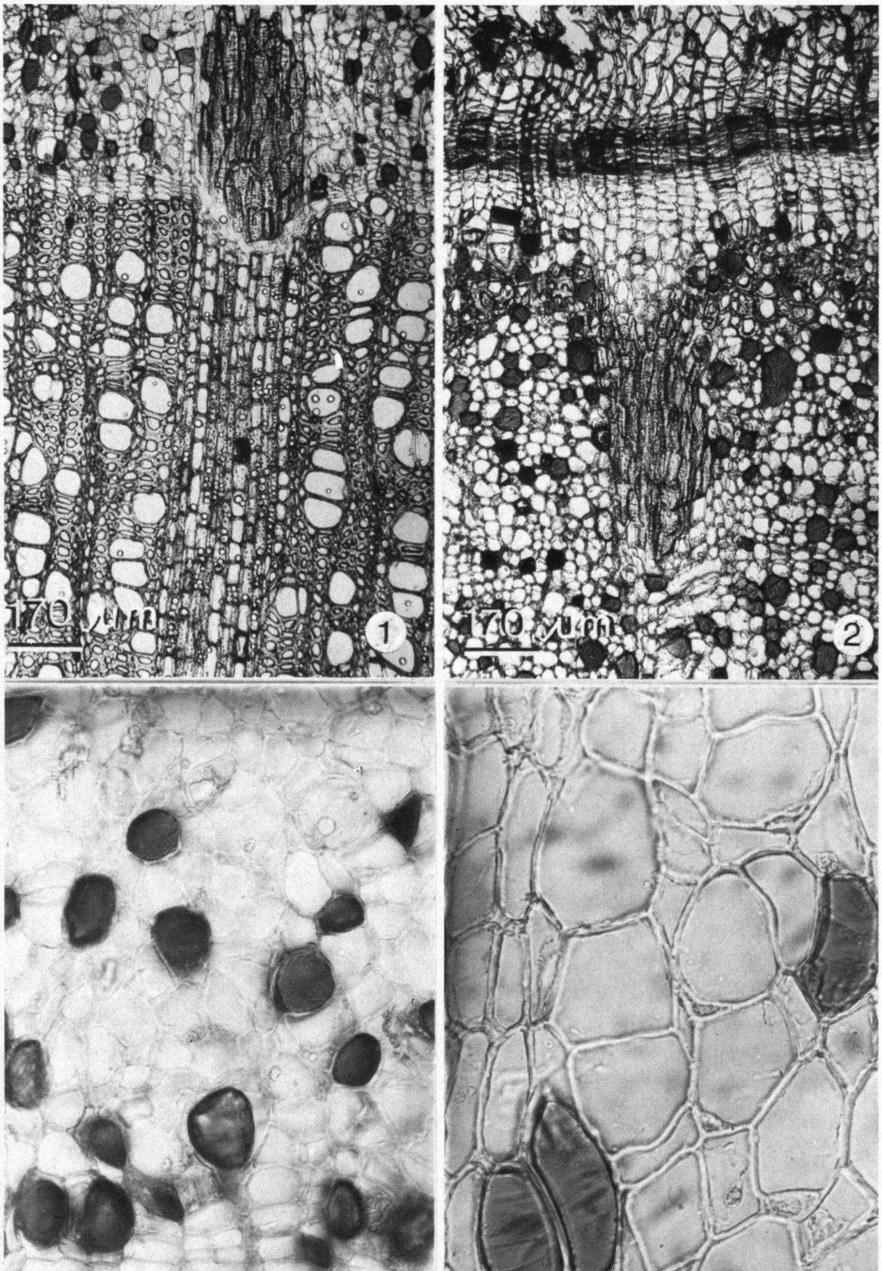
3. RESULTS

The bark of *Tambourissa hildebrandtii* Perk. is about 5 mm thick. It can be divided into three zones: a zone in which sieve tubes and companion cells are not collapsed (1675 μm), at least for a smaller or larger part consisting of the conducting secondary phloem immediately outside the cambium; the non-conducting secondary phloem (1160 μm) in which sieve tubes and companion cells are collapsed; a rhytidome (2165 μm) consisting of some more or less tangential periderm layers of about 630 μm thickness, alternated with dead bark tissue (see also *figures 1–4*).

The *axial system* of the conducting secondary phloem is composed for about 40 percent of sieve tubes and companion cells arranged in small groups or scattered and for about 60 percent of parenchyma cells. About half of these parenchyma cells are relatively large in cross section containing rather often red-brown deposits or less frequent a grey, granular oil-like substance. In the non-conducting secondary phloem in which the sieve tubes and companion cells are collapsed, all parenchyma cells are somewhat larger in cross section and rounded off. Storied structure and phloem fibres are absent; stone cells or sclereids are only present in multiseriate rays and in the inner part of the phelloderm.

Sieve-tube members are oval to angular in cross section, tangential and radial diameters 32 and 45 μm respectively; length (315–)435(–590) μm, type II. Sieve plates simple, slighty oblique to horizontal. Sieve areas mainly in the radial walls, well developed (type I rd).

Fig. 1–4. Secondary phloem of *Tambourissa hildebrandtii* Perk., transverse sections.
1. The upper one-third of the photomicrograph is secondary phloem, the rest secondary xylem. The multiseriate phloem ray immediately starts with a part composed of sclereids. These parts are very extended in longitudinal direction, almost as wide as the ray and about 500 μm in radial direction. Many large axial parenchyma cells with red-brown or oil-like contents.
2. The upper two-fifth of the photomicrograph consists of the last formed periderm layer of which the innermost 4–6 phelloderm layers are composed of horse-shoe shaped sclereids (tangential outer wall is usually not yet thickened); the remaining three-fifth is non-conducting secondary phloem. In the middle of the photomicrograph an area of a multiseriate ray composed of sclereids.
3. From top to bottom: conducting secondary phloem with many large axial parenchyma cells with red-brown contents, cambial zone and a small part of the secondary xylem.
4. Conducting secondary phloem. Right from the middle of the photomicrograph three sieve tubes with companion cells in the bottom left hand corner.


170 µm
1
170 µm
2
50 µm
3
25 µm
4

Companion cells as long as the sieve-tube members they accompany (type B) or shorter (type A), tangential diameter 13 μm, usually in the corners or along one of the tangential walls of the sieve-tube member.

Parenchyma cells small, more or less rectangular in cross section, tangential and radial diameters 25 and 15 μm respectively; or large, more or less oval, tangential and radial diameters 40 and 60 μm, respectively. Strands of 2–4 cells (cells with red-brown or oil-like contents, large) or more (cells without such contents, small), length about 720 μm.

Rays about 5 per tangential mm; 2(–3) of these rays are multiseriate, three are uni- or partly biseriate, low and inconspicuous. So the bulk of the ray tissue is composed of multiseriate rays without tails or with tails of only three cells; composed of erect and square cells and some slightly procumbent ones; (6–)10(–15) seriate, average width 200 μm; height usually 5–10 mm. Precocious sclerosis of parts of the multiseriate rays is of common occurrence. These parts are very extended in longitudinal direction, almost as wide as the ray and about 450–500 μm in radial direction; they are regularly alternated by slightly smaller areas without sclerotic ray-parenchyma cells. The sclereids are at first horse-shoe shaped (one of the radial walls is not thickened) and contain usually one or more simple crystals. Later they often become thick-walled all around.

Periderm consists of phellem (300 μm), phellogen and a phelloderm layer of about 320 μm wide. All cells are thin-walled except the innermost 4–6 phelloderm layers, which are composed of horse-shoe shaped sclereids (tangential outer wall is not thickened), or later also sclereids with all walls thickened. Some thin-walled parenchyma cells of the phelloderm and parenchyma cells in some tangential layers of the phellem, contain brown substances. Precocious flaring of the rays does not occur.

Since the other *Tambourissa* species collected by Lorence are twigs with a diameter of 1.5 cm, the bark production is limited. Usually one periderm layer is present, a cortex, the pericyclic region with a composite cylinder of fibres and hippocrepiform (shaped like a horse-shoe) sclereids, crushed primary phloem and secondary phloem. This last mentioned tissue shows some differences with that described for *T. hildebrandtii*. Sieve-tube members are shorter, 230 μm on the average, with horizontal simple sieve plates, type III. Sieve areas on the side walls usually poor developed (type III). Companion cells often type A. Several axial parenchym cells in *T. tetragona* are sclerotic. Rays (1–)4(–8) seriate, in *T. amplifolia* no precocious sclerosis.

4. DISCUSSION

Our findings on the anatomy of the secondary phloem of *Tambourissa* could not be compared with those of other investigators. Usually, freshly collected and adequately preserved specimens are not available. So dried herbarium material was used, and investigations remained confined to sclerenchymatous elements of twigs from herbarium species. The following could be found in literature. The young stems are characterized by forming a composite cylinder of sclerenchyma in the pericyclic region (MONEY et al. 1950). This cylinder is composed of strands of common septate fibres, alternating with strands of hippocrepiform sclereids. During subsequent enlargement of the stem, the sclereids tend to have uniformly thickened walls (MONEY et al. 1950). Early sclerosis and precocious flaring of the multiseriate rays of the secondary phloem in the Monimiaceae, is of common occurrence. Stratification of the secondary phloem by true phloem fibres does not occur in any of the Monimiaceae (MONEY et al. 1950). Secretory cells similar to those in the leaf, are generally present in the phloem (METCALFE & CHALK 1950).

ACKNOWLEDGEMENTS

Our sincere thanks for Mrs. M. H. van den Bergh, who prepared the slides used for this study. We also wish to express our appreciation to D. H. Lorence of the Department of Botany, Missouri Botanical Garden, St. Louis, Missouri 63110, U.S.A., for providing valuable bark samples.

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