STRUCTURE OF PHLOEM IN SOME PLANTS OF BENNETTITALES AND PENTOXYLALES COLLECTED FROM THE RAJMAHAL HILLS, INDIA

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ABSTRACT

The phloem of three species, *Ptilophyllum sahnii*, *Bucklandia dichotoma* and *Pentoxylon sahnii*, collected from Amarjola in the Rajmahal Hills, is described.

INTRODUCTION

Not much attention has been given to the study of phloem in the petrified plants found in the Rajmahal Hills (Bose & Kasat, 1971, 1972; Rao & Achuthan, 1968 ; Sharma, 1967, 1969). The material for the present paper was collected from Amarjola in the Amarapara region. It was boiled in canada balsam prior to sectioning. Slides were prepared by the usual grinding and polishing processes and mounted in canada balsam.

DESCRIPTION

Ptilophyllum sahnii Gupta & Sharma, 1968

It is a moderate sized, pinnate frond. The epidermal and anatomical structures of the leaf has been studied (Gupta & Sharma, 1968 ; Bose & Kasat, 1971). But the structure of the phloem was not fully known. The rachis is provided with a well-developed vascular system. The bundles are arranged in a double 'U' with the concavity facing adaxial side (Pl. 1, Fig. 1). A similar arrangement of bundles is seen in *Ptilophyllum guptai* Sharma (1967), *P. cutchense* (Rao & Achuthan, 1968) and *Dictyozamites* sp. Bose & Kasat (1972). The bundles are 20-30 or more, collateral, conjoint and endarch, each surrounded by a bundle sheath (Pl. 1, Fig. 2). The phloem lies on the outer side of the xylem and in comparison to the latter is more developed. The phloem cells, very distinct from tracheids, are narrower and placed irregularly (Pl. 1, Fig. 3). The phloem consists of sieve cells, phloem parenchyma and phloem fibres. The sieve elements are long, narrow with pointed ends. They measure 1.4-2.2 mm $\times$ 8-10 μ in size. They are circular or little angular in cross section (Pl. 1, Fig. 3). Their lateral walls are provided with distinct closely placed, circular sieve areas (Pl. 1, Fig. 4) with minute or not clearly visible perforations. The phloem parenchyma cells are narrower than the sieve cells, 40-50 $\times$ 6-8 μ in size, angular in cross section and have transverse end walls. They are irregularly intermingled with the sieve cells and their lateral walls are smooth. The phloem fibres are comparatively wider cells, 400-450 $\times$ 16-20 μ in size (Pl. 1, Fig. 3), arranged in 2-3 radial rows in a bundle. They are different from the sclereids (Rao & Achuthan, 1968) found in *Ptilophyllum cutchense* in the inner portion of cortex and adjacent with the outer part of phloem.

Bucklandia dichotoma Sharma, 1970

The stem is covered with rhomboid leaf bases. Cortex and pith are wide, parenchymatous with mucilage canals. Primary bundles are numerous, collateral, conjoint, endarch

and open (SHARMA, 1970). The phloem is well developed but does not form a continuous ring due to the flared secondary phloem rays (Pl. 1, Fig. 5), which are seen in radial, alternate bands. The primary phloem is present at the periphery of secondary phloem as crushed tissue. The phloem is made up of sieve cells, phloem parenchyma and phloem fibres. Sieve cells are 2-2.5 mm × 14-18 μ in size with blunt end walls. They are rectangular/squarish in cross section (Pl. 1, Fig. 5). Their lateral walls are provided with numerous, uniseriate, distinct, separate and circular sieve areas (Pl. 1, Fig. 7). Each sieve area is provided with many sieve pores (Pl. 1, Fig. 6). The phloem parenchyma are comparatively narrower, 60-80 × 8-10 μ in size, found intermingled with sieve cells. Their end walls are transverse. Phloem fibres occur in alternate, tangential bands with sieve elements (Pl. 1, Fig. 5). They are 600-700 × 18-24 μ in size, thick-walled cells with tapering end-walls. Phloem rays are made up of thin-walled cells. They are generally poorly preserved (BOSE, 1953).

Pentoxylon sahnii Srivastava, 1945

The stem is characterised by the presence of 5-8 (SHARMA, 1973) large bundles, each having its own secondary growth. The secondary xylem shows marked centripetal development. Alternating with the main bundles are present smaller bundles which are also provided with secondary growth (Pl. 2, Fig. 12). In *Pentoxylon sahnii* the branches are dimorphic, i.e. long shoots and the dwarf shoots (SRIVASTAVA, 1945 ; SAHNI, 1948) and they show anatomical differences (MITTRE, 1957 ; SHARMA, 1973a). A dwarf shoot with well preserved phloem is yet to be discovered. In the present paper the phloem of only long shoots has been described.

The secondary phloem forms a distinct zone surrounding the secondary xylem, particularly on the side facing the pith and primary medullary rays (Pl. 2, Fig. 8). It is produced from the cambium (2-3 cells thick) in regular rings (Pl. 2, Figs. 10, 11). The phloem is 10-15 cells thick and is made up of sieve cells and phloem parenchyma. Phloem cells lying near the cambium are less differentiated in comparison to the distant ones (Pl. 2, Fig. 9).

Sieve elements are 1.2-1.5 mm × 12-14 μ in size with tapering end-walls. They are rectangular in cross section and are arranged in radial rings (Pl. 2, Fig. 10). Indistinct, irregular and uniseriate sieve areas are present on the radial walls of sieve elements. The phloem parenchyma cells are comparatively narrower, 60-80 × 8-10 μ in size with horizontal end-walls.

Outside the smaller bundles and adjacent with the phloem there are patches of scleroids (SHARMA, 1973). But these cannot be considered as phloem tissue because neither they are found in association with the parent bundles nor they are present in symmetry unlike the other phloem cells.

Phloem rays are small, 1-8 cells high and uniseriate like the wood rays. They are made up of rectangular parenchyma which does not possess any kind of thickening on their walls.

In *Pentoxylon sahnii* the long shoots are also of two types, i.e. thick shoots and thin shoots (SHARMA, 1973). The latter produced distantly placed leaves (SHARMA, 1973a) and the secondary phloem is better developed in them (Pl. 2, Fig. 11) than in the thick shoots (Pl. 2, Fig. 8). The sieve cells here are wider and arranged in loose, indistinct rings (Pl, 2. Fig. 11).

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EXPLANATION OF PLATES

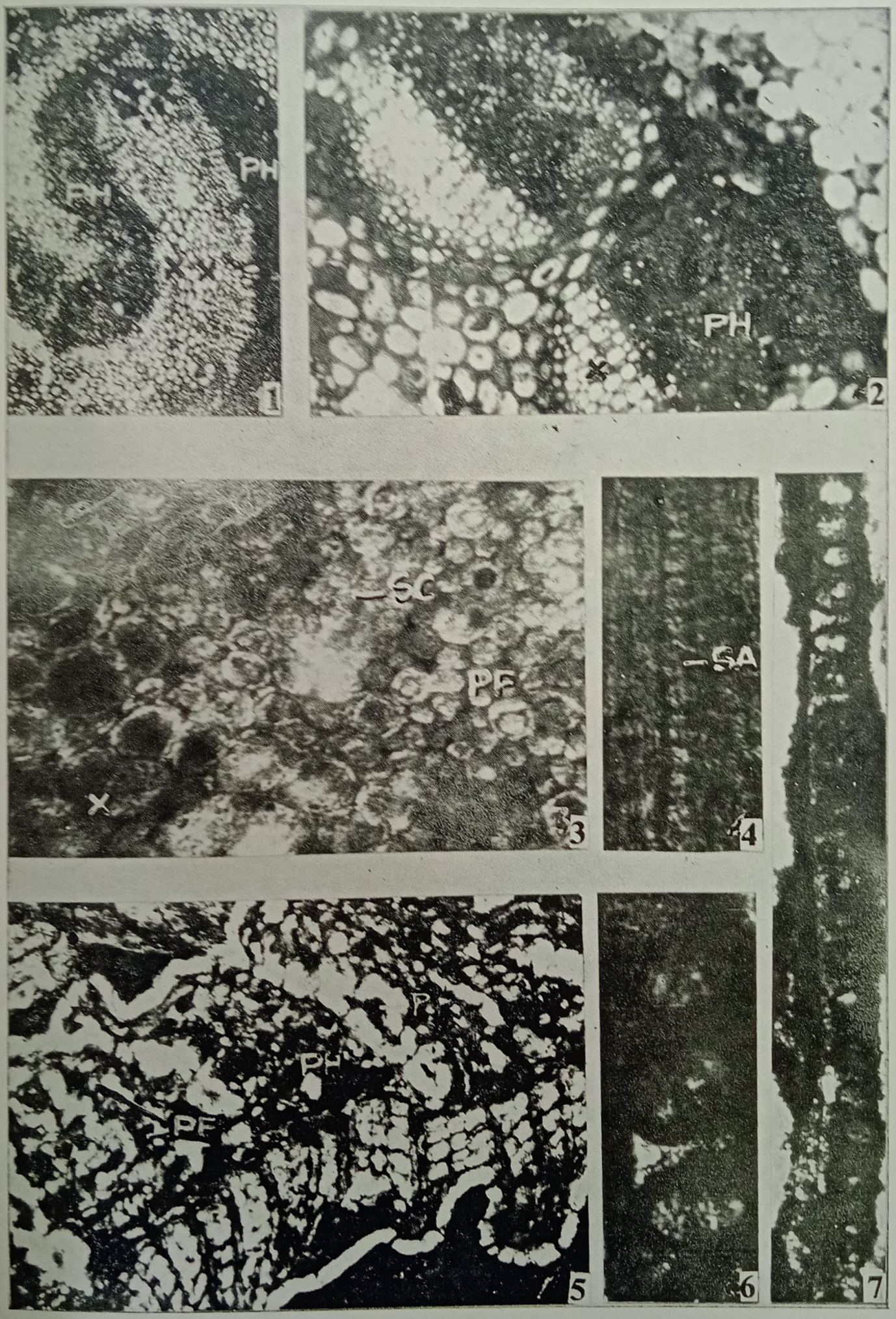
Plate 1—*Ptilophyllum Sahnii*

1. T. S. rachis, double row of bundles in the stele. ×60.
2. Two bundles enlarged. ×180.
3. Phloem portion enlarged. ×600.
4. L. S. sieve, *Bucklandia dichotoma*; cell with sieve areas. ×600.
5. T. S. stem. A portion of vascular zone, compact wood and secondary phloem in alternate bands ×60.
6. L. S. sieve cell with distinct sieve areas. Sieve pores visible. ×600.
7. A sieve cell with many, uniseriate sieve areas. ×180.

Plate 2—*Pentoxylon sahnii*

8. Stem T. S. portion of a bundle with distinct secondary phloem zone ×120.
9. Secondary phloem with rays. ×120.
10. Cambium zone (2-3 cells thick) between secondary xylem and secondary phloem. ×300.
11. Thin shoot. Secondry phloem in rings. ×300.
12. A cortical bundle with well developed secondary phloem. ×300.

(×-Secondry xylem, PH—Secondary phloem, SA-Sieve area, SC-Sieve cell, PF-Phloem fibre, PR-Phloem ray, CA-Cambium zone).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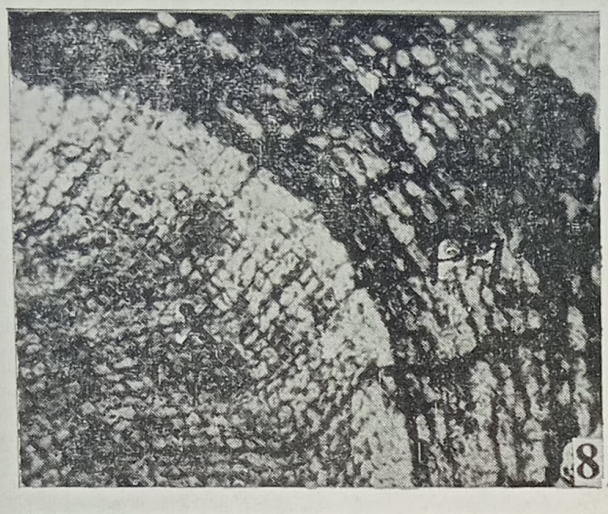

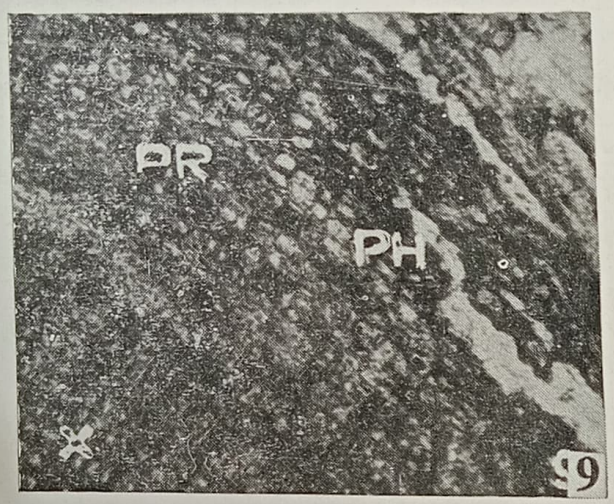

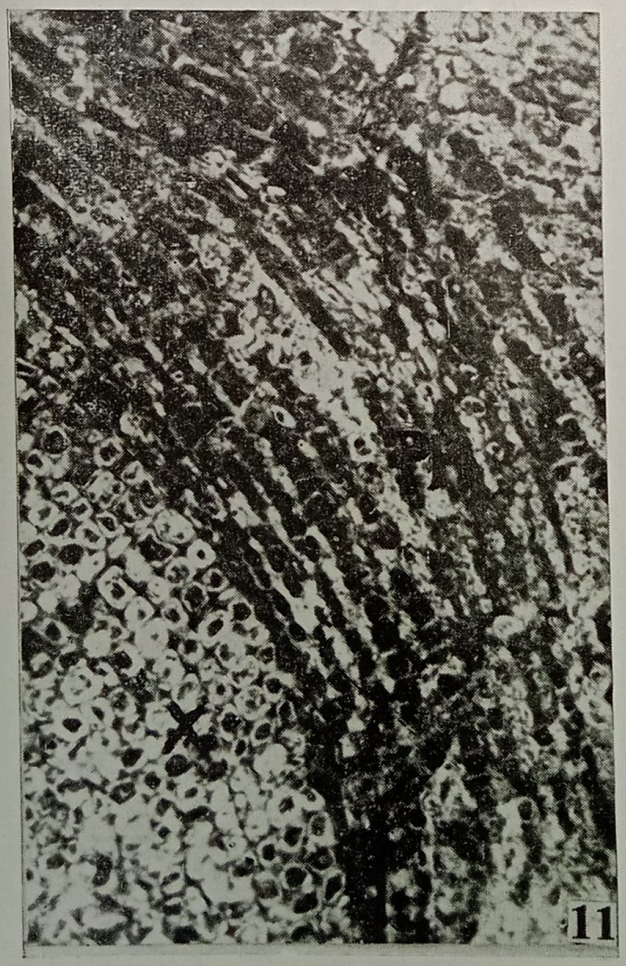

Sharma & Bohra—Plate 2