

### Observations on the Phloem in Three Species of *Mimosa*

In *Mimosa* spp. where the leaves are sensitive to external stimuli, the phloem, in addition to its usual function of conduction of nutrients, constitutes the primary excitation channel of electric impulse through the protoplasmic continuity of its cells<sup>1,2</sup>. With an electric probe device, BOSE<sup>1</sup> recorded on either side of the xylem of the petiole in *Mimosa pudica* 2 groups of cells indicating an electrical conductivity. These strands containing distinct 'tube cells' were described by him as outer and inner phloem tissues. This internal phloem has often been described as a part of pith<sup>3</sup> or of protoxylem<sup>2,4</sup>. The cyto-histological details of the external and internal phloem in *M. pudica* Linn., *M. himalayana* Gamble and *M. pigra* Linn. have been studied from ontogenetic and histological points of view.

The transverse section of the vascular bundle in the petiole of leaf in the 3 species consists of a band of outer phloem, a well developed xylem and a small group of cells forming the inner phloem (Figure 1). Upon iodine-KI treatment<sup>5</sup>, both the outer and inner strands of phloem tissues appeared greenish yellow almost identically, the intermediate xylem and other neighbouring cells did not indicate any such reaction. With aniline blue<sup>6</sup> also, they were stained blue in a comparable fashion.

General structure of outer phloem. The sieve tubes in the outer phloem constitute 2 different types: (1) a much wider and shorter type, where the nucleus disintegrates early during ontogenetic differentiation, and (2) a narrower and longer type having each a spindle-shaped persistent nucleus with 1 or 2 nucleoli (Figure 2). The ontogenetic study of the sieve tubes in *M. pudica* indicates that the initials of the 2 types appear to be comparable, both having dense cytoplasm and being associated by

thin-walled companion cells. In the wider one with the rapid expansion and elongation of sieve tube initial, the vacuolation of the element and the disintegration of the nucleus occur very early, but in the narrower type the cytoplasm and nucleus persist almost throughout the life of the cell. Two nuclei have occasionally been observed in the middle of a wider sieve tube element; they are spindle-shaped and placed laterally side by side or in a linear series (Figure 3). Occurrence of more than 1 nucleus in sieve-tube elements appears to be rare and was previously reported in the secondary sieve tubes in tobacco<sup>7</sup>.

General structure of inner phloem. The inner phloem tissue in the 3 species consists of a small group of cells located just against the xylem and appears to be less complex being composed of comparatively thin-walled elongated sieve-tube elements and parenchyma (Figure 1). The sieve-tube elements form a number of vertical rows along the longitudinal axis of the rachis and are sharply distinguishable from the neighbouring parenchyma and pith cells. They possess each a conspicuous spindle-shaped persistent nucleus, occasionally associated with a definite companion cell (Figure 4).

<sup>1</sup> J. C. BOSE, *The Nervous Mechanism of Plants* (Longmans Green & Co., London 1926).

<sup>2</sup> T. SIBAOKA, *Science* 137, 226 (1962).

<sup>3</sup> N. G. BALL, *New Phytol.* 26, 148 (1927).

<sup>4</sup> H. TORIYAMA, *Cytologia* 27, 431 (1962).

<sup>5</sup> D. A. JOHANSEN, *Plant Microtechnique* (McGraw-Hill Book Co., New York 1940).

<sup>6</sup> A. S. FOSTER, *Practical Plant Anatomy* (D. Van Nostrand Co., New York 1949).

<sup>7</sup> A. S. CRAFTS, *Bot. Gaz.* 95, 592 (1934).

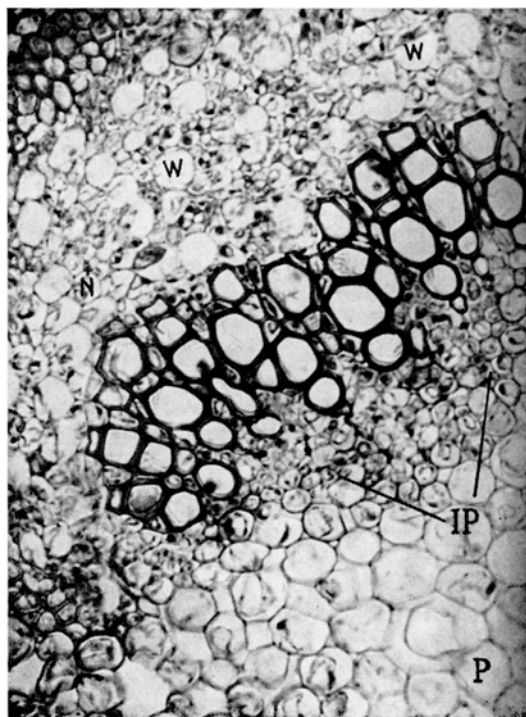


Fig. 1. Transverse section of a vascular strand in the petiole of *Mimosa pudica* showing wider (W) and narrower (N) sieve tubes in the outer phloem, xylem tissue and inner phloem (IP) against pith (P).  $\times 650$ .

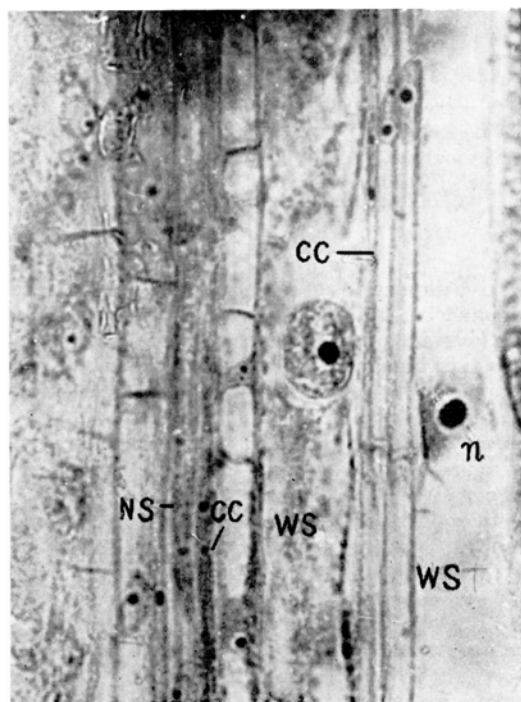


Fig. 2. *M. pudica*. Longitudinal section through the outer phloem showing companion cell (CC) being associated with the wider sieve-tube (WS) and narrow sieve-tube (NS) elements and degenerating nucleus (n) in the wider one.  $\times 850$ .

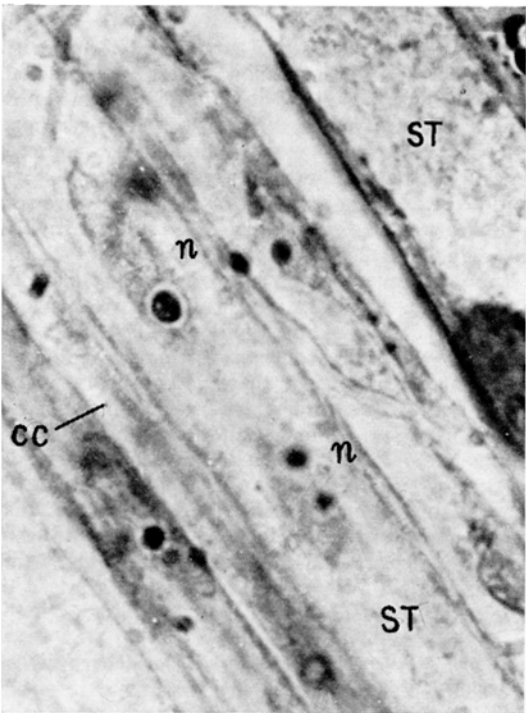


Fig. 3. *M. pudica*. Sieve-tube elements (ST) and companion cell (CC) of the outer phloem showing 2 nuclei (n) being placed in a linear row in the longitudinal direction.  $\times 1500$ .

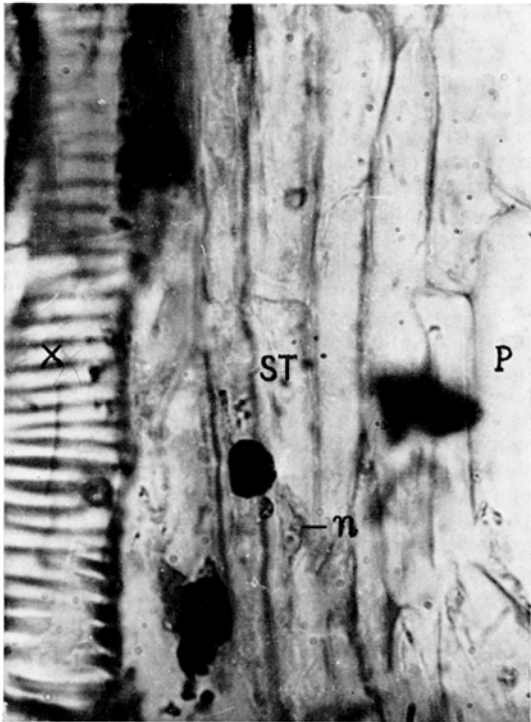


Fig. 4. *M. pudica*. Longitudinal section through the inner phloem showing sieve tubes with xylem vessel (X) on one side and pith cells (P) on the other. The nucleus (n) in the sieve tube is clearly seen.  $\times 850$ .

Mean values of measurements of sieve-tube elements in *Mimosa* (in  $\mu$ )

Name of plant	Outer phloem				Inner phloem	
	Wider sieve element		Narrower sieve element		Inner sieve element	
	Length	Breadth	Length	Breadth	Length	Breadth
<i>Mimosa pudica</i>	73	21	100	13	106	10
<i>M. himalayana</i>	112	25	129	13	91	11
<i>M. pigra</i>	87	21	118	15	81	8

Relative dimensions of sieve-tube elements. The relative lengths and breadths of the sieve-tube elements in the 3 species (average of 15 readings for each) indicate a comparable cyto-histological similarity between the narrower sieve tubes of the outer phloem and the sieve tubes of the inner phloem (Table).

Recently an almost similar membrane potential (mv) of the phloem cells corresponding to the outer narrower and inner sieve-tube elements has been reported<sup>2</sup>; and this shows their comparable electro-conducting property of stimulus. The inner sieve elements may thus be morpho-histologically and physiologically equivalent to the narrower sieve elements of the outer phloem in these sensitive plants.

The occurrence of 2 types of sieve tubes in the outer phloem may indicate differential systems of conducting channels in relation to the special physiological property. In *M. pudica*, in the larger wider elements of the outer phloem, a much lower resting potential of about  $-50$  mv and in the small elements a higher potential of about  $-160$  mv were recorded<sup>2</sup>.

The persistence of nucleus in the mature sieve elements of narrower sieve tubes of the outer phloem and of the inner phloem may refer to a longer and greater functional life of the phloem. The presence of nucleus in mature sieve tube was previously reported in *Strychnos*<sup>8</sup>. ESAU<sup>9</sup>, however, states that 'the enucleate condition is normal for mature sieve-tube elements'.

The cyto-histological features of the sieve-tube elements along with their conducting properties of electric impulse in *Mimosa* may indicate certain similarities with those in the neuron cells in animals.

The special features of the phloem in *Mimosa* spp. may be stated as follows: (1) occurrence of internal phloem, (2) occurrence of 2 types of sieve tubes in the outer phloem, (3) persistence of nucleus in the mature narrower sieve tubes and (4) occasional presence of more than 1 nucleus in the sieve elements<sup>10</sup>.

*Zusammenfassung.* Anatomische Untersuchungen am Phloem von *Mimosa* ergaben eine histologische Übereinstimmung der engen Siebröhren des Aussenphloems mit den Siebröhren des Innenphloems. In den engen Siebröhren bleibt der Zellkern erhalten.

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<sup>8</sup> D. H. SCOTT and G. BREBNER, Ann. Bot. 3, 275 (1889).  
<sup>9</sup> K. ESAU, Bot. Rev. 5, 373 (1939).  
<sup>10</sup> The authors are thankful to Dr. D. M. BOSE, Ex-Director, Bose Institute, for his interest in this work.