

## SHORT COMMUNICATIONS

### THE OCCURRENCE OF TRANSFER CELLS IN THE VASCULAR TISSUES OF THE COLEOPTILAR NODE OF WHEAT\*

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Wooding and Northcote (1965), Gunning, Pate, and Briarty (1968), Gunning and Pate (1969), and Pate and Gunning (1969) have drawn attention recently to the presence of cells with wall ingrowths in a number of sites in plants at which one might expect short-distance transport of considerable quantities of solutes. Gunning and Pate (1969) suggested that these cells be called "transfer cells" and surveyed their distribution in the leaves of a large sample of Angiosperms. These cells have not been found in the leaves of any grasses, and they have been demonstrated in the Gramineae only in the embryo sac of maize (Diboll 1968). In this paper, transfer cells are illustrated in the vascular tissue at the coleoptilar node in wheat, and the possible functions of these cells at this site are discussed.

#### *Materials and Methods*

Grains of wheat (*Triticum aestivum* L. cv. Heron) were surface-sterilized with silver nitrate (Davies 1935) and set to germinate in the dark on 1.2% agar at 25°C for 1–5 days. Specimens were fixed in a mixture of glutaraldehyde and acrolein for 12–16 hr at 0°C. Serial transverse sections 1–2  $\mu$ m thick were prepared from the appropriate regions of these specimens after embedding them in glycol methacrylate according to the procedures given in detail by Feder and O'Brien (1968).

#### *Results and Discussion*

Figure 1 shows the main features of the vascular system in a portion of a wheat seedling. Though the precise arrangement of the vascular tissues between the coleoptilar node and the root is much more complex than this diagram suggests, it is adequate for present purposes since the transfer cells are present in rather distinctive parts of the vascular network. These parts are shown black in Figure 1. The transfer cells are found in the horizontal extension of the main scutellar bundle and in its Y-shaped divergence that connects with the coleoptile bundles. They are absent from the vertical part of the scutellar bundle and extend only for about 600  $\mu$ m into the base of the coleoptile. Transfer cells are also present in the downward divergence of the scutellar trace that joins with the stele of the radicle. They have not been detected in the radicle or in any of the traces of the foliage leaves except for the basal part of the midrib of the first foliage leaf.

\* Manuscript received February 12, 1970.

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Figure 2 shows part of a transverse section taken at the level shown by A-B in Figure 1, and Figure 3 shows the transfer cells in more detail. The cells are characterized by the presence of flanges of thickened wall which commonly lie only on the side of the cell which abuts a tracheary element. The flanges are often Y-shaped when seen in transverse section, completely unlignified, and they stain intensely and metachromatically with toluidine blue O, suggesting that they are rich in polyuronides with free carboxyl groups. The position of the flanges and their shape and staining reactions serve to distinguish them from the thickenings of differentiating tracheary

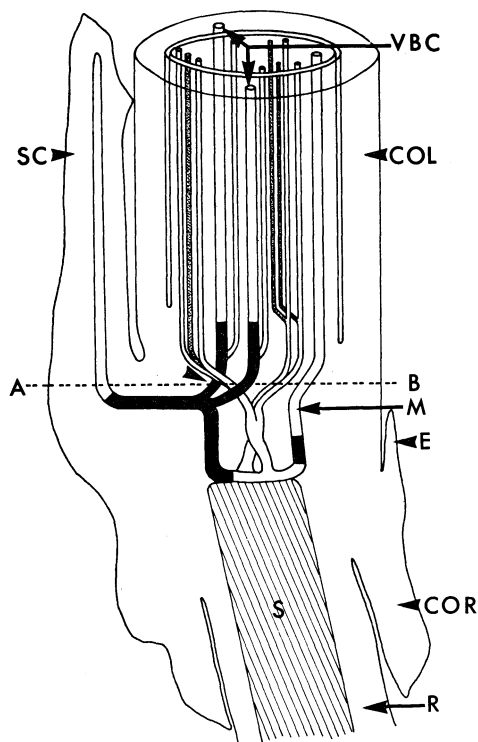


Fig. 1.—Diagram of part of a wheat seedling showing the major organs and their vascular interconnections (redrawn and modified from Boyd and Avery 1936). The distribution of transfer cells is shown in solid black. Vascular traces shown dotted are the midrib and two laterals of the second foliage leaf. The open bundles of the plumule are the midrib and six laterals of the first foliage leaf. The line A-B indicates the level from which Figures 2 and 3 are taken, the arrowhead indicating the vascular bundle of Figure 2. COL, coleoptile; COR, coleorhiza; E, epiblast; M, midrib of first foliage leaf; R, radicle; S, stele of radicle; SC, scutellum; VBC, vascular bundles of the coleoptile.

elements with which they can be readily confused at first sight. In this part of the seedling, transfer cells are associated exclusively with the tracheary elements and are probably best regarded as modified xylem parenchyma. Gunning (personal communication) has classified them as type C (see Gunning and Pate 1969).

Gunning and Pate (1969) suggest that these cells are present at the sites of intense solute transfer. In this case it is difficult to assess the direction of the transfer from the distribution of the cells for they could either secrete solutes to or accumulate them from the tracheary elements. We favour the second alternative and suggest that these cells are involved in accumulating organic nitrogen from the tracheary elements. First, the guttation fluid from young grass seedlings is known to be rich in organic nitrogen and especially in glutamine (Greenhill and Chibnall 1934; Curtis 1944; Goatley and Lewis 1966; Sheldrake and Northcote 1968). Second, preliminary observations suggest that the differentiation of these transfer cells from the pro-vascular tissues present in the mature embryo accompanies the differentiation of the

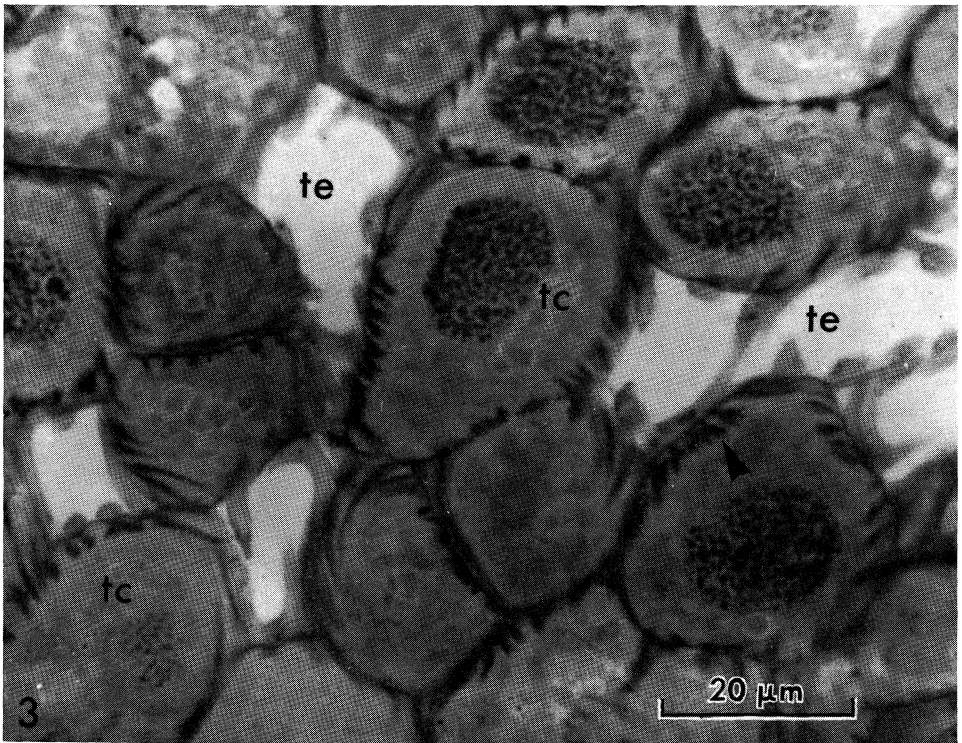
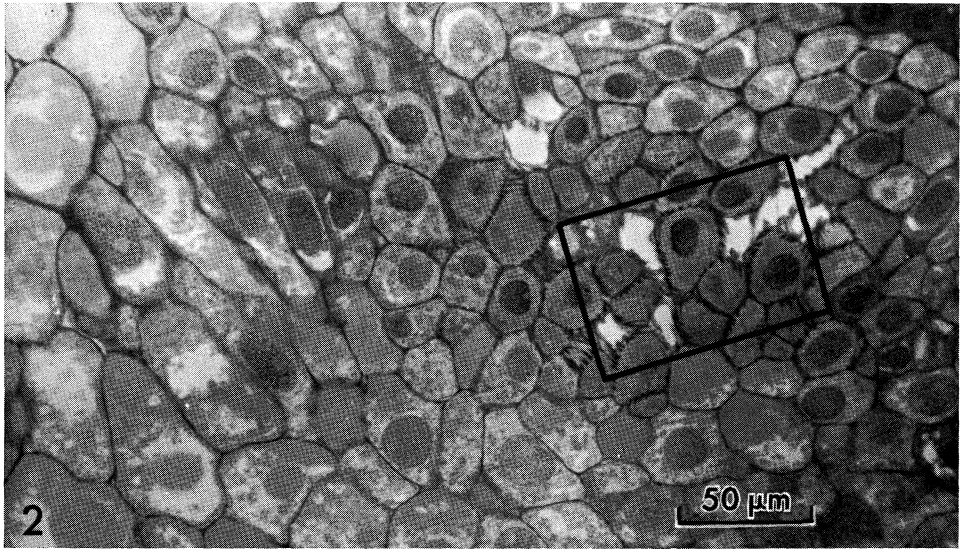


Fig. 2.—Transverse section of the seedling at a level corresponding to A–B on Figure 1. The area includes part of the vascular bundle of the coleoptile at the arrowhead shown on A–B. The area enclosed in the rectangle is shown at higher magnification in Figure 3. Acid fuchsin–toluidine blue O stain.

Fig. 3.—Type C (xylem parenchyma) transfer cells (*tc*) abutting tracheary elements (*te*). The flanges of wall thickening that characterize these cells are often Y-shaped when seen in transverse section (arrowhead). Acid fuchsin–toluidine blue O stain.

tracheary elements during germination. In wheat (but not in panicoid grasses), aleurone bodies are present in the coleorhiza, coleoptile, epiblast, and scutellum but are absent from the radicle, primary leaves, and shoot apex of the mature embryo (Swift, unpublished data). These protein-rich bodies disappear very rapidly from the coleorhiza, epiblast, and coleoptile during germination, and more slowly from the scutellum. These reserves must be moved to the developing tissues of plumule and root which lack aleurone bodies. The transfer cells are ideally situated to accumulate organic nitrogen from the differentiating xylem and transfer it via a symplastic route to the sieve tubes which supply the developing roots and plumule (see also McCall 1934).

This suggestion is based chiefly on the position of the cells. Direct physiological evidence that these cells function in this way must await a more detailed reconstruction of the path of the vascular tissues through these nodes, an understanding of the sequence of differentiation of xylem and phloem, and a study of tracer movement within and between the vascular bundles of these organs.

#### *Acknowledgments*

We wish to thank Dr. A. T. Pugsley for supplying the wheat grains, Mrs. Jane E. Lee for redrawing Figure 1, and Dr. B. E. S. Gunning and our colleagues for critical discussion. This work is supported by grants from the Australian Research Grants Committee and the Rural Credits Division of the Reserve Bank of Australia.

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