Polar Auxin Transport in Leaves of Monocotyledons

ALMOST nothing is known about the establishment of cellular polarity underlying the polar auxin transport system of higher plants. Osborne[1] has suggested that the apical ends of cells derived from an apical meristem by sequential divisions are younger than the basal ends: their polarity and the basipetal transport of auxin are due to this age difference. Sachs[2] in his work on regenerating vascular strands has found that gradients of auxin may be responsible for establishing the cellular polarity and the subsequent transport of auxin in the direction of the initial gradient. Shoot tips and expanding dicot leaves contain relatively high levels of auxin. The basipetal polarity of auxin transport in petioles and stems is therefore associated with basipetal auxin gradients. In grass coleoptiles the greatest amounts of auxin are found at the tip, where basipetal auxin transport is also associated with basipetal auxin gradients.

In monocot leaves which grow by a basal intercalary meristem, the pattern of cell division and of auxin distribution is more or less the reverse of that found in shoot tips. Sequential divisions of the basal meristem presumably make younger the basal ends of cells; and in growing monocot leaves the greatest amounts of auxin are found at the base[3,4]. The polarity of auxin transport in monocot leaves is therefore of considerable interest.

Hertel and Leopold[5] reported that in the primary leaf of *Zea mais*, auxin transport was basipetal. No other references to auxin transport in monocot leaves are available and I therefore tested the leaves of a number of species. In every case auxin transport was basipetal (Table 1).

Plant	C.p.m. in receiver blocks	
	Acropetal transport	Basipetal transport
Amaryllidaceae		
Galanthus nivalis L (8)	1	2,098
Narcissus sp (6)	0	4,616
Cyperaceae		
Carex pendula L (4)	6	553
Gramineae		
Hordeum vulgare L (6)	2	117
Iridaceae		
Crocus purpureus Weston (6)	0	142
Iris sp (4)	2	999
Liliaceae		
Chlorophytum comosum (Thunb.) Jacques (8)	2	51
Cordyline australis (Forst.) Hook. f. (4)	0	106
Orchidaceae		
Cymbidium lowianum Rchb. f. (4)	0	784
Palmae		
Erythea armata (Wats.) Wats. (6, leaflets)	1	52

Leaves were collected from plants growing outdoors and from tropical species in glasshouses. Sections (7 mm) were placed horizontally, supported by a strip of filter paper coated with petroleum jelly, on glass slides, and were supplied with agar (1% w/v) donor and receiver blocks. Donor blocks contained [1-^{14}C] indol-3-yl acetic acid (52 mCi/mM, Amersham) at a concentration of 3.0 μM. During the transport period (3.5 h) the sections were kept in the dark in Petri dishes lined with moistened filter paper. Receiver blocks were then placed in scintillation vials with liquid scintillator[6] (4 ml.) and counted for at least 10 min on a Packard TriCarb scintillation counter. Background counts (25–30 c.p.m.) were subtracted from the results. The numbers of leaf sections used are shown in parentheses.

In leaves of young plants of *Avena sativa*, basipetal auxin transport took place across the meristematic region at the base of the leaf and also in the leaf sheath (Table 2), which grows by a basal meristem[6]. Plants germinated and grown in darkness yielded similar results. Less auxin transport was found near the leaf tip than in the younger, more basal parts of the leaf and younger leaves had a greater ability to transport auxin than older leaves (Table 2). A decline in the ability of cells to transport auxin as they grow older has been observed in a number of other species and tissues[7-10].

The hypothesis that polarity is determined by the difference in age between the apical and basal ends of cells becomes more complicated if it is to explain how both apical and basal meristems give rise to cells with a basipetal polarity. Its greatest weakness is in explaining the basipetal polarity of cambial

Table 2 Auxin Transport in Primary Leaves

| Region of leaf | C.p.m. above background | | | |
| | 11-day-old plants | | 19-day-old plants | |
	Acropetal transport	Basipetal transport	Acropetal transport	Basipetal transport
Tip	1	28	1	1
Middle	1	670	0	49
Base	0	525	0	106
Leaf–leaf sheath junction	1	495	1	107
Leaf sheath	2	346	0	117

7 mm sections were taken from different regions of primary leaves of *Avena sativa* plants grown in daylight at 22° C. Procedure as in Table 1. 10 sections were used for each sample. Transport time 3.5 h.

derivatives[11] which arise not by transverse but by longitudinal divisions. The possibility that gradients of auxin determine the polarity of cells also seems at first sight unlikely to provide an explanation for the development of basipetal auxin transport in monocot leaves; but too little information is available about the anatomy of the basal meristems and the detailed pattern of auxin distribution in and around the meristematic region for any firm conclusions to be made.

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