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In Vivo Visualization of the Water Refilling Process in Xylem Vessels Using Synchrotron X-Ray Micro-Imaging

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Synchrotron X-ray micro-imaging was employed to non-invasively monitor the refilling process of water inside the xylem vessels in bamboo leaves. The consecutive phase-contrast X-ray images clearly showed both plant anatomy and the transport of water within the xylem vessels. Traces of water-rise, vapor bubbles and variations in contact angle between the water front and the xylem wall were all measured in real time. During the refilling process, air bubbles are removed when the rising water front halts at a vessel end for a while; subsequently, it starts rising again at a higher velocity than the normal refilling speed. Repeated cavitation was found to lessen the refilling ability in xylem vessels. In the absence of light, the water refilling process in xylem vessels was facilitated more effectively than in bright illuminated conditions. Finally, X-ray micro-imaging was deemed to be a powerful, high resolution, real time imaging tool to investigate the water refilling process in xylem vessels.

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