

***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 drying out process, while some xylem vessels were cavitated, cavitation did not propagate to the upper vessels of upright plant due to the hydraulic valve features of vessel end. During refilling process, similar flow pattern repeats in each xylem vessel. Water front stops at a vessel end for a while, thereafter it restarts rising in the next vessel with a higher velocity than the normal refilling speed. Vapor bubbles are removed when water front stops at the vessel end and xylem lumens are pressurized. These observations demonstrate that intervessel pits act as a valve to pressurize the xylem vessel for gas removal. The bordered pits seem to be architected to manage embolism occurred frequently in conducting vessels under tension and to control water supply into a vascular plant. 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.

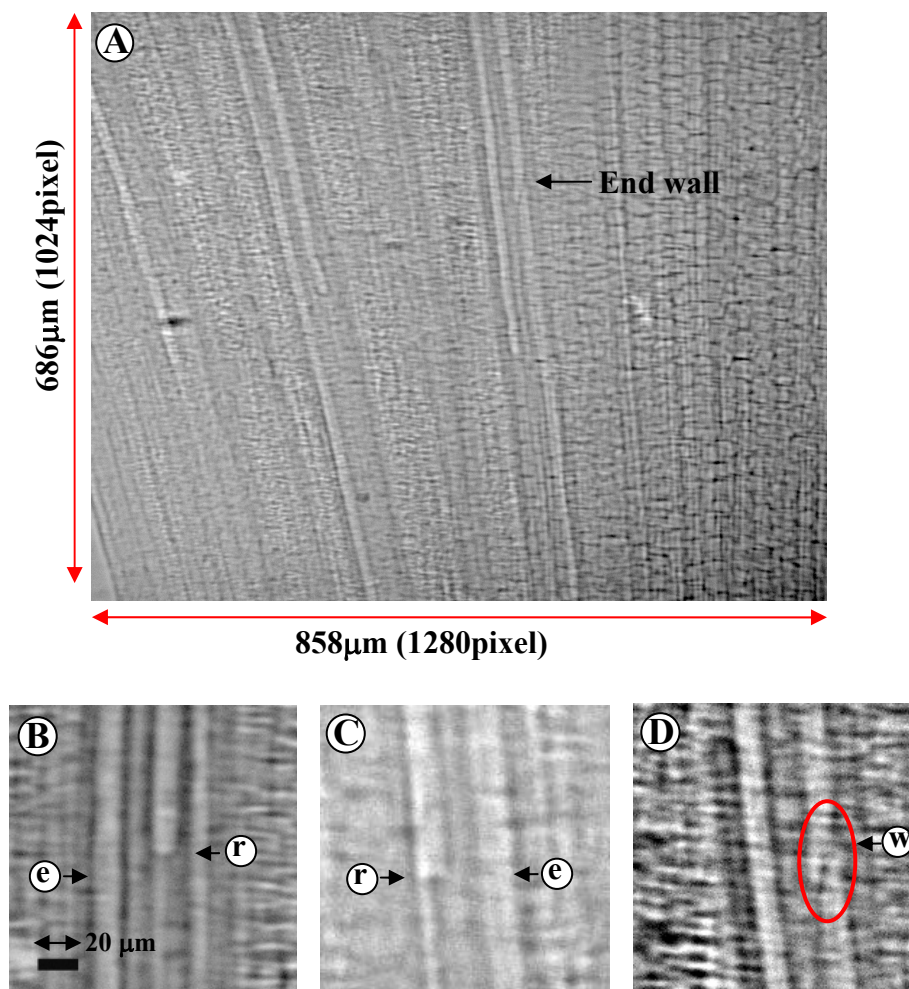


Figure 1. A typical X-ray image of bamboo leaf showing xylem vessels

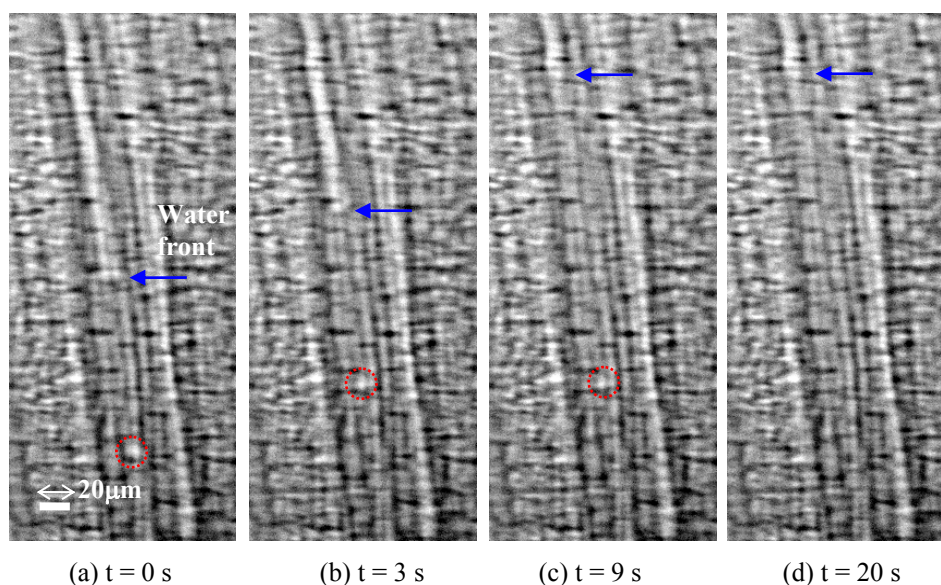


Figure 2. Removal process of vapor bubble in a xylem vessel

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