Bark-Water Interactions Across Ecosystem States and Fluxes

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Abstract

Check out our video abstract: https://youtu.be/CGzFNU70yUg To date, the perspective of forest ecohydrologists has heavily focused on leaf-water interactions – leaving the ecohydrological roles of bark under-studied, oversimplified, or omitted from the forest water cycle. Of course, the lack of study, oversimplification, or omission of processes is not inherently problematic to advancing ecohydrological theory or operational practice. Thus, this perspective outlines the relevance of bark-water interactions to advancing ecohydrological theory and practice: (i) across scales (by briefly examining the geography of bark); (ii) across ecosystem compartments (i.e., living and dead bark on canopies, stems, and in litter layers); and, thereby, (iii) across all major hydrologic states and fluxes in forests (providing estimates and contexts where available in the scant literature). The relevance of bark-water interactions to biogeochemical aspects of forest ecosystems is also highlighted, like canopy-soil nutrient exchanges and soil properties. We conclude that a broad ecohydrological perspective of bark-water interactions is currently merited.

Bark-Water Interactions Across Ecosystem States & Fluxes

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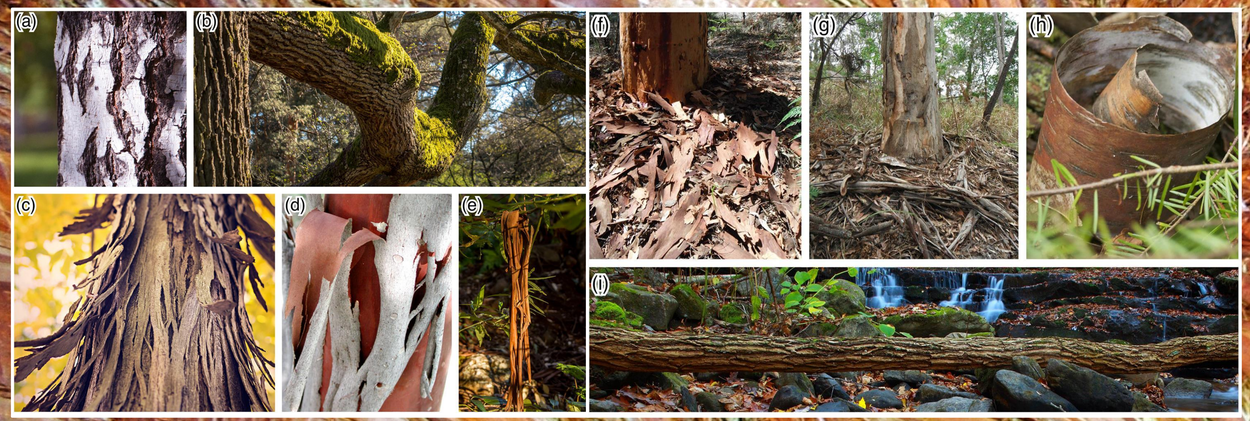
1. WELCOME TO THE BARK SIDE OF THE WATER CYCLE

To date, the perspective of forest ecohydrologists has heavily focused on leaf-water interactions – leaving the ecohydrological roles of bark under-studied, oversimplified, or omitted from the forest water cycle. This perspective outlines the relevance of bark-water interactions to advancing ecohydrological theory and practice:

(i) across scales (by briefly examining the geography of bark);
(ii) across ecosystem compartments (i.e., living and dead bark on canopies, stems, and in litter layers);
(iii)across all major hydrologic states and fluxes in forests; and
(iv)across various biogeochemical aspects of forest ecosystems.

We conclude that a broad ecohydrological perspective of bark-water interactions is merited.



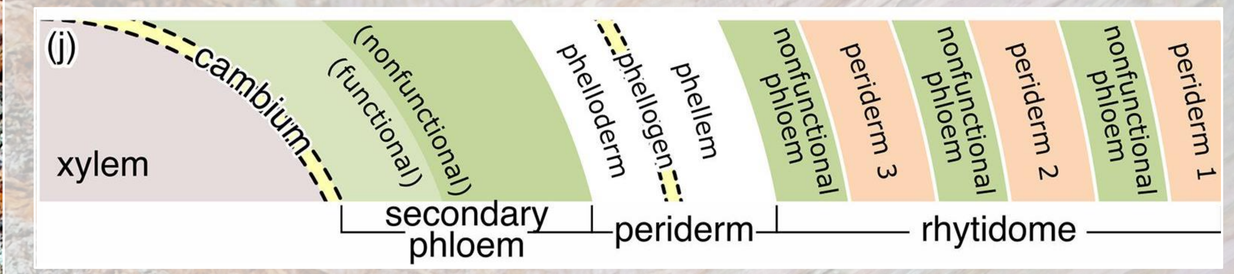
2. GEOGRAPHY OF THE BARK SIDE

Bark is almost everywhere in forests, spatially expansive and temporally persistent. Thus, its interactions with the hydrologic cycle may be as well.

- The bark surface is estimated to be nearly as large as the Asian continent, ~41 million km^2.
- (Plus the surface area due to bark's structural complexity or bark on fallen woody debris and so on)
- Unlike many leaves, the bark is present across all seasons.
- Bark shedding temporarily increasing surface area for bark-water interactions.
- Bark litter decomposes much slower than leaf litter.

Thus bark can be present all year round, on live and dead plants, from the canopy top to the litter below.

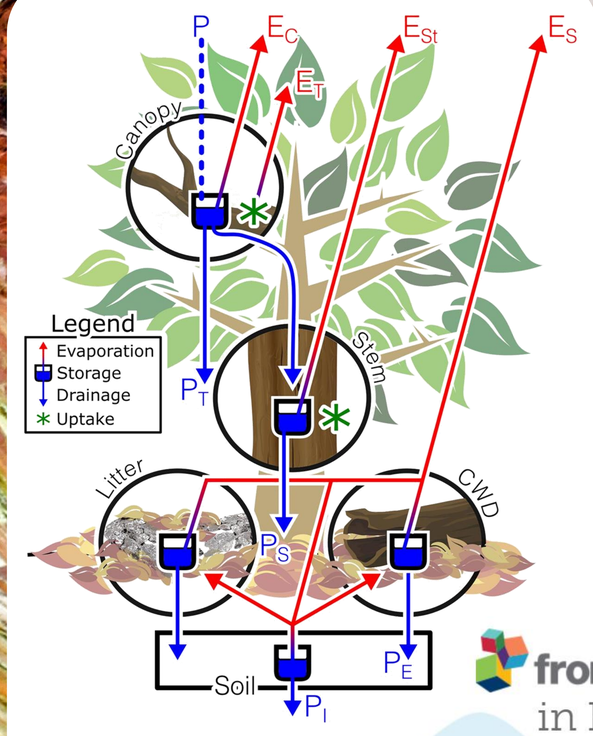
3. ANATOMY OF THE BARK SIDE



Bark can have several layers – all of which may interact with water. Starting from the outside-in:

- Outer bark intercepts liquid and solid water during precipitation and condensation.
- Between storms, outer bark can absorb water vapor, filling 10-60% of the bark water holding capacity before a storm.
- Some of the water stored in the outer bark can pass into the inner bark, be stored there, or be taken up.
- Water storage in the inner bark could represent a crucial buffer against daily-to-seasonal stresses during periods of decreased water availability.

4. BARK, WATER, AND BEYOND



Bark appears to couple water to other biogeochemical aspects of forest ecosystems, from canopy-to-soil nutrient exchanges to soil physicochemistry and microbial community structure. Some specific examples include:

- Chemically, solute uptake, leaching, wash-off and transformation occur during bark-water interactions.
- Physically, Bark surfaces can be excellent traps for coarse particles, including fungal spores, nutrient-rich pollen, and pollutants – all of which can be scoured and transported.
- Ecologically, vegetation residing on bark, like lichen and bryophytes, have strong relationships with bark water storage and the nutrient content of bark leachates.
- Physiologically, bark water uptake and carbohydrate storage may interact to enable embolism repair.
- After death, bark decomposition can influence the composition of nearby soil microbial communities.

Thus, bark-water interactions are connected to a wide spectrum of biogeochemical processes.

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TL:DR?
See our video abstract: