

Distribution of *Quercus agrifolia* Mycorrhizae Deep within Weathered Bedrock: A Potential Mechanism for Transport of Stored Water¹

M. Bornyasz,² R. Graham,² and M. Allen²

In southwestern California, *Quercus agrifolia* distribution closely matches regions of granitic regolith. High annual evapotranspiration demand and inherent shallow soil conditions lead to a dependence on a deep rooting system and an ability to access water from deep within the regolith. Most of the plant available water in weathered granitic rock is held within micropores, which are generally too small for roots to access. It is not clear how water held in the rock matrix reaches the roots, which are confined to the fractures. Hyphae are narrow and able to explore a greater substrate volume for resources. Our study addresses the vertical composition of both endo- and ecto-mycorrhizae in weathered granitic rock in an effort to determine if mycorrhizae are available to act as conduits to transport water from rock matrix to roots. Water status, morphology, nutrients, root and mycorrhizae distribution of three *Q. agrifolia* trees were characterized from a 15-meter-wide by 4-meter-deep profile consisting of 30 to 70 cm of soil and 330 to 370 cm of weathered bedrock. Plant available water within the soil fraction was depleted by the end of June; therefore plants must rely on water available within the fractured bedrock for the remainder of the growing season and during the dry season. Roots greater than 1 mm are present throughout the entire 4-meter deep profile. Fine roots <1 mm are also present in the weathered bedrock and commonly occur in root mats consisting of live and dead roots. Percent infected tips and morphotype abundance in samples collected from the soil fraction (0-10, 10-20, 20-30 cm) decreased with depth from 65 percent to 30 percent and 12 to 2, respectively. This is a similar trend to what is generally reported in the literature. However, samples collected from fractures within the weathered bedrock at and below a one-meter depth also contained infected root tips. Percent infected tips ranged from 0-64 percent and morphotype abundance ranged from 0-10. Percent-infected tips from a 3.7 m deep rock sample closely matched that of a surface soil sample (63 percent rock; 65 percent soil), however morphotype abundance was substantially lower.

Morphotypes varied with depth and across substrates, but *Cenococcum* sp. was dominant in most samples that contained mycorrhizal roots and occurred throughout the entire profile. Presence or absence of mycorrhizae deep within the regolith may

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² University of California, Riverside, Center for Conservation Biology and Soil and Water Program, Environmental Sciences (e-mail: maborn@cirrus.ucr.edu)

be a function of substrate and not a function of depth. Live roots and infected tips were absent in samples that contained clay dominated fracture-fill material. Percent soil moisture is highest in this fracture-fill material, but the water is held tightly by the material and is less available to plants and fungi. Exploration by hyphae and persistence of mycorrhizae is also prohibited by the presence of discontinuous pore spaces created by shrink-swell behavior inherent in smectitic clays. In conclusion, mycorrhizae exist deep within the weathered granitic regolith. Nutrient acquisition may not be the primary function of this relationship. The primary function is more likely water acquisition.