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Root tensile strength assessment of Dryas octopetala L. and implications for its engineering mechanism on lateral moraine slopes (Turtmann Valley, Switzerland)

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Geomorphic processes and properties are influenced by vegetation. It has been shown that vegetation cover intercepts precipitation, enhances surface detention and storage, traps sediment and provides additional surface roughness. Plant roots impact the soil in a mechanical and hydrological manner and affect shear strength, infiltration capacity and moisture content. Simultaneously, geomorphic processes disturb the vegetation development. This strong coupling of the geomorphic and ecologic system is investigated in Biogeomorphology. Lateral moraine slopes are characterized by a variety of geomorphic processes, e. g. sheet wash, solifluction and linear erosion. However, some plant species, termed engineer species, possess specific functional traits which allow them to grow under these conditions and also enable them to influence the frequency, magnitude and even nature of geomorphic processes. For lateral moraine slopes, Dryas octopetala L., an alpine dwarf shrub, was identified as a potential engineer species. The engineering mechanism of D. octopetala, based on its morphological (e.g., growth form) and biomechanical (e.g., root strength) traits, yet remains unclear and only little research has been conducted on alpine plant species.

The objectives of this study are to fill this gap by (A) quantifying D. octopetala root tensile strength as an important trait considering anchorage in and stabilization of the slope and (B) linking plant traits to the geomorphic process they influence on lateral moraine slopes. D. octopetala traits were studied on a lateral moraine slope in Turtmann glacier forefield, Switzerland.

(A) Root strength of single root threads of Dryas octopetala L. were tested using the spring scale method (Schmidt et al., 2001; Hales et al., 2013). Measurement equipment was modified to enable field measurements of roots shortly after excavation. Tensile strength of individual root threads was calculated and statistically analyzed. First results show that Dryas roots appear to be quite strong compared to other alpine species with a mean tensile strength of 22,63 N mm $^{-2}$.

(B) On a micro scale, morphological and biomechanical features of above and below-ground biomass were qualitatively studied through field observations on D. octopetala individuals. Findings indicate that D. octopetala's dense cushions, covering many square meters of the moraines surface, traps fine sediment, stores moisture and significantly reduces erosion through wind and water. Furthermore, Dryas is well adapted to rock fall or burial by forming stabilized patches of ground despite steep slope inclinations and strong, episodic surface runoff and creep processes. Anchorage is provided by its strong root, which in all studied cases grew upslope parallel to the moraines surface.

Insights from this study allow to relate root tensile strength and other specific plant traits of Dryas octopetala to an engineering mechanism and effect on geomorphic processes on lateral moraine slopes. Knowledge about Dryas as an engineering species may help to understand its biotic influence on the geomorphic system of a lateral moraine and aid in the selection of species for erosion control or rehabilitation of ecosystems, where Dryas is native.