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Introduction

Interfaces between plants and their environment extract and exchange resources on a prodigious scale. Indeed, plants provide a chemically concentrated biomass which supports heterotrophic life. Accruing organic matter through photosynthesis is fundamental to all life but should not overshadow the ability of plants to harvest inorganic resources and especially water. Roots are the primary interface for nutrient and water acquisition.

Concentration of inorganic resources by roots is as impressive as the concentration of organic resources in shoot photosynthesis. Phosphate is concentrated by a factor of thousands during absorption. Water is sucked from seemingly dry soils to maintain biological function. At the other extreme, soils are often richer in inorganic solutes than is ideal for cell function and roots must act as a screen to prevent ingress of toxic ions such as aluminium and sodium. Few soils provide a uniformly benign substrate for root growth and function. Not only are ratios of solutes in bulk soil often incompatible with metabolism but concentrations also vary through space and time to confound extraction processes further.

Variability and scarcity of inorganic resources impose intense selective pressure on roots. Root architecture is discussed in Section 3.1 with reference to important selective pressures in our environment such as low fertility. Proteoid roots are highlighted as a special adaptation to ancient and nutrient-poor soils. The physical basis of water and nutrient flow to roots is discussed in Section 3.2, emphasising limits to water extraction. Section 3.3 describes the interface between roots and soil (rhizosphere) where roots interact with other organisms in a unique chemical and physical environment. Sections 3.4 and 3.5 cover two of the most productive biological interactions, formation of mycorrhizal roots and ?xation of atmospheric nitrogen. Finally, Section 3.6 gives an overall account of how water and ions ?nd a path to the long-distance transport system in roots. Tight regulation of developmental events in roots and genotype × environment interactions recur as themes for biological success. Roots can adapt to such a variety of soil conditions that few places exclude plant life.

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