Chapter 2

Ecology of Extracellular Enzyme Activities and Organic Matter Degradation in Soil: A Complex Community-Driven Process

Matthew D. Wallenstein* and Richard G. Burns

2–1 INTRODUCTION

Microorganisms produce enzymes to perform many biogeochemical processes that include various inorganic and redox reactions. Another very important function is the production of hydrolytic enzymes for decomposition and mineralization of nutrients. This process is critical for the functioning of ecosystems and for industrial and environmental applications. A majority of enzyme assays in this book measure the rate of hydrolytic reactions. Therefore, the objective of this chapter is to present the functions and ecology of enzymes involved in decomposition to provide context and assistance for interpreting enzyme assay outcomes involved in decomposition.

In fertile soils, heterotrophic microorganisms are supplied with detritus from plant and other biomass that is rich in carbon and the nutrients that are required for cell maintenance and growth. However, microorganisms cannot directly transport these large macromolecules into the cytoplasm. Rather, they rely on the activities of the myriad of enzymes that they synthesize and release into their immediate environment. These extracellular enzymes depolymerize organic compounds and generate soluble, low-number oligomers and monomers that are then recognized by cell-wall receptors and transported across the outer membrane and into the cell.

Protein synthesis and enzyme production and secretion is energetically expensive and requires nitrogen (Schimel and Weintraub, 2003) and is ultimately debilitating unless there are equivalent nutritional rewards. Thus, the allocation of cell resources to enzyme synthesis and secretion must involve a dynamic balance between the investment of the precious resources allocated to the production of enzymes with the energy and nutrients gained as a result of their activity. However, soil is an inherently hostile environment for extracellular enzymes because once they leave the cell they are subject to denaturation, degradation, and inactivation.

*corresponding author;
Richard G. Burns, School of Agriculture and Food Sciences, University of Queensland, Brisbane, Australia (r.burns@uq.edu.au).
doi:10.2136/sssabookser9.c2

Copyright © 2011 Soil Science Society of America, 5585 Guilford Road, Madison, WI 53711-5801, USA. 