Chapter 6
A Historic Perspective of Endophytes in Vascular Plants and Their Role in Environmental Sustainability

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ABSTRACT

The term "endophyte" comes from words "endo" meaning within and "phyton" meaning plant. In 1866, De Bary first defined an endophyte as any organism that resides in the tissues of plants but not causing any harm. Thus, endophytes can be a microorganism, usually fungi or bacteria, that colonizes plants parts. The plant tissues/parts where endophytes grow include healthy leaves, petioles, stems, twigs, bark, roots, fruits, flowers, and seeds. They are found virtually in every one of the 300,000 species of vascular plants. Many endophytes co-exist in a single plant host with their populations ranging from one to hundreds of bacterial/fungal species. This chapter outlines a historical perspective of endophytes including ethnobotanical approach to drug discovery. Also, this chapter provides upto date information on the emerging role of endophytes in the sustainability of pasture and economy of agriculture, thereby contributing to the environmental sustainability.

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INTRODUCTION

The term "endophyte" comes from the two words "endo" meaning 'within' and "phyton" meaning 'plant' (Staniek, Woerdenbag, and Kayser, 2008). In 1866, De Bary first defined an endophyte as any organism that inhabits the tissues of plants without causing apparent harm to the host (Nisa et al, 2015; Staniek et. al. 2008). The term now suggests that an endophyte is a microorganism, usually fungal or bacterial, that colonizes plants for part of its lifecycle (Hardoim et al. 2015). Endophytes can inhabit a variety of plant tissues and organs, including healthy leaves, petioles, stems, twigs, bark, roots, fruits, flowers and seeds, and are found in virtually every one of the 300,000 species of vascular plants (Fouda, Hassan, Eid and Ewais, 2015). Many endophyte species can even co-exist in a single host and their populations can range from one to hundreds of bacterial/fungal species, depending on the plant species (Christina, Christapher & Bhore, 2013; Tan & Zou, 2001).

During the 19th century it was widely accepted that healthy plants were sterile and, therefore, free of microorganisms as first postulated by Pasteur (Hardoim et al, 2015). However, in 1887, M. L. V. Galippe found microbes living in healthy vegetable plants and proposed that they were derived from the soil. Galippe was criticized because other scientists had demonstrated that microbes could not live within healthy plants (Compant, Sessitsch & Mathiew, 2012). Endophytes were officially discovered in 1904 in Darnel, Germany (Strobel et al, 2004). However, only recently has it been widely accepted that microorganisms do inhabit healthy plants (Compant et al. 2012).

When Galippe originally documented the colonization of microorganisms in the interior of plants, he proposed that they played a possible beneficial role to the plant (Compant et al. 2012). This, too, was criticized and contrasting studies soon arose (Hardoim et al, 2015). Today, scientists agree that the symbiotic relationship between endophytes and their host varies depending on a variety of factors, including plant and microbe genotype, environmental conditions, and interactions within the plant-microbe biome (Hardoim et al, 2015). The symbiosis ranges from mutualistic to pathogenic, but little is known about the pathogenicity of many endophytes. Some endophytes may lose their virulence under certain conditions; for example, the pathogenic fungus, *Colletotrichum magna*, lost its virulence due to a mutation and became a mutualistic endophyte (Redman, Ranson & Rodriguez, 1999). Different endophyte strains have different degrees of pathogenicity depending on their host; for example, the bacteria, *Klebsiella pneumoniae*, is a human pathogen but it is also a commensal endophyte in other hosts (van Overbeek et al, 2014). Some endophyte-plant symbioses change depending on the conditions; for example, *Pseudomonas* spp., normally found to be beneficial to plants, has been shown to be detrimental to Leatherleaf ferns, *Rumohra adiantiformis*, under specific conditions (Hardoim et al, 2015). Finally, endophyte symbiosis may change depending on the plant host. The fungus, *Verticillium dahliae,* causes a decrease in plant yield to strawberry and olive crops but has a commensal relationship with grapevines and some medicinal plant species. Thus, it is hard to distinguish between pathogenic and nonpathogenic endophytes and, therefore, an "endophyte" must be defined by habitat and not function (Hardoim et al, 2015).

This chapter covers various topics on endophytes such as their classification, diversity, plant-microbe interaction, mechanisms of colonization, transmission, roles of endophytes in plants, enthnobotanical approach to drug discovery and roles of endophytes in environmental sustainability.

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