UNIVERSIDAD ADOLFO IBAÑEZ

FACULTAD DE INGENIERIA Y CIENCIAS

PHD PROGRAM IN COMPLEX SYSTEMS ENGINEERING

COMPLEX EARLY SUCCESSIONAL NETWORK DYNAMICS OF BACTERIAL COMMUNITIES IN ENGINEERED MICROCOSMS

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November 2018

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This dissertation is submitted for the degree of Doctor of Philosophy

In the subject of Complex Systems Engineering

November 2018

Dedicado a la memoria de mi padre Gustavo Segundo y a mi amada familia.

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Declaration

This dissertation is the result of original work, done in collaboration, except where specifically indicated in the text. It has not been previously submitted, in part or whole, to any university of institution for any degree, diploma, or other qualification.

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Abstract

Complex systems are represented by a series of systems, including among others, ecosystems, the brain, the economy, organizations and society. These systems present emerging properties, stochastic and chaotic dynamics of difficult prediction and a network structure among the agents that make up the systems, which is a consequence of the interdependence between the elements that compose the complex systems. The engineering of complex systems provides a set of integrated methodologies for the description of complex systems and to address problems originated in this type of systems and Microbiology has not hesitated to incorporate the complex systems approach to characterize the dynamics of microbial assemblies. In this thesis, we study bacterial community dynamics at high early temporal resolution to reconstruct ecological interaction networks and to describe how bacterial networks reflect bacterial community dynamics. We will provide a detailed description of bacterial community network analysis in two different engineered ecosystems (soil microcosms and sea water submerged artificial surfaces), and demonstrate how it may be applied two evaluate bacterial ecosystem stability, contributing both to basic and applied Microbial Ecology.

Resumen

Los sistemas complejos están representados por una serie de sistemas, incluidos, entre otros, los ecosistemas, el cerebro, la economía, las organizaciones y la sociedad. Estos sistemas presentan propiedades emergentes, dinámicas estocásticas y caóticas de difícil predicción y una estructura de red entre los agentes que los componen, todo lo cual es consecuencia de la interdependencia entre los elementos que componen los sistemas complejos. La ingeniería de sistemas complejos proporciona un conjunto de metodologías integradas para la descripción de sistemas complejos y para abordar problemas originados en este tipo de sistemas y la Microbiología no ha dudado en incorporar el enfoque de sistemas complejos para caracterizar la dinámica de los ensamblajes microbianos. En esta tesis, estudiamos la dinámica de la comunidad bacteriana a una alta resolución temporal temprana para reconstruir las redes de interacción ecológica y para describir cómo las redes bacterianas reflejan la dinámica de la comunidad bacteriana. Ofreceremos una descripción detallada del análisis de redes de comunidades bacterianas en dos ecosistemas diferentes diseñados (microcosmos del suelo y superficies artificiales sumergidas en agua de mar) y demostraremos cómo se puede aplicar para evaluar la estabilidad del ecosistema bacteriano, contribuyendo tanto a la Ecología Microbiana básica como la aplicada.