NOISY INTERACTIONS:

Understanding the emergence of context–dependent interactions in ecological and evolutionary dynamics

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A thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

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Different abstractions from the same wholes capture different aspects of the reality but also leave us with different blindnesses. Therefore it is always necessary to recognize that our abstractions are intellectual constructs, that an "object" kicks and screams when it is abstracted from its context and may take its revenge in leading us astray.

– Richard Levins

ABSTRACT

Species interactions have non random consequences in natural communities, thus they have a central role in our explanations of diversity maintenance. However,the magnitude, sign and outcome of species interactions have shown repeatedly to be context dependent. In order to disentangle the role of contingency in nature, we must first explore the noise that arises from the way we study species interactions. This thesis is focused in exploring with theoretical and empirical approaches how model formulation, parametrization and reductionism alter our ecological predictions. Chapter one explores the structural sensitivity of species coexistence to alternative models and a Bayesian parametrization. Chapter two analyses via data simulation how an interaction chain between three species changes the coexistence outcome of a focal pair. Chapter three examines how the interaction between plants and pollinators is altered through pollination interference. The uncertainty surrounding species interactions might be intrinsic to how natural communities operate, however our theories and predictions should be robust enough to consider the noise that comes from our study of nature.

PREFACE

This thesis is a collection of three stand alone scientific articles. Each chapter is a standalone piece of research and, therefore, I only provide a general Introduction and Conclusion chapters linking the three chapters together. In I focus on describing how my three chapters are connected. In Discussion, I focus on summarising the results from each of my thesis chapters, their combined implications both in invasion ecology and data science and finally I further expand on new ideas beyond those presented in the different chapters to discuss about the future steps moving forward.

At the time of submission, each of these three articles are in different stages of the publication process and are formatted in the style of a journal article. This chapter is in preparation for submission to *Journal of Applied Ecology*. This chapter was published in the *Journal of Applied Ecology* April 2021: Volume 58, no. 4, pages 777–788. This chapter is in preparation for submission to the *Journal of the Royal Society Interface*. Canterbury.

Part I

GENERAL INTRODUCTION

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INTRODUCTION

The reciprocal forces organism exert one another create emergent properties in natural communities. Indeed, a large body of work has shown that the way species affect one another determinde key properies such as stability, resilience, productivity, and the coexistence of multiple species. This is because

Species interactions do not present themselves to us. We often choose to represent them as parameters in a model, and so they become abstractions. Our abstractions always reflect choices.

Ecological and evolutionary research has begun to incorporate the complexity in our the study of species interactions, I am part of that research. Through out this thesis I explored different ecological systems, with different types of interactions and species in them. However, the fundamental questions remains : what happens when add biological, environmental and mathematical complexity to the study of species interactions? Do they change our predictions?

Part II

DISCUSSION

COLOPHON

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