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**Ecological-evolutionary feedback in evolved
lineages of *Pseudomonas fluorescens***

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Abstract

Multicellularity cannot proceed to subsequent stages without the evolution of collectives. Thus, it becomes essential to understand the evolution of cooperation before the evolution of multicellularity. However, understanding the evolution of cooperation presents a problem. This is because natural selection rewards selfish behavior; yet, in nature, cooperation is apparently common. Here arises a conflict between individual and collective interest and thus raises questions concerning the evolution of cooperative behavior. Assortment between cooperating types has been identified as the underlying mechanism behind theories for the evolution of cooperation. However, these theories assume the environment to be stable and fail to acknowledge interactions are density and frequency dependent (two components of the environment), capable of generating co-evolutionary interactions. In this regard the feedback between ecology and evolution (eco-evo feedback) is of likely importance.

In a previous experiment, a rudimentary life cycle was established in model bacterial populations where lineages were repeatedly cycled between a cellulose producing, group living cooperator type, termed WS, and solitary, free living cheater types, termed SM. The results of the experiment showed that collective level fitness increased in evolved lineages compared to baseline lineages. I believe that the eco-evo feedback is likely to have occurred on the WS-SM interactions and that this is responsible for the increased fitness of the evolved lineages.

The aim of this thesis was to identify the presence of the feedback in evolved lineages. I compared the *evolutionary dynamics* of frequency dependent interactions between WS and SM, and *population dynamics* due to density dependent factors on the interactions between WS and SM. I also report the joint influence of evolutionary and population dynamic patterns via *eco-space diagrams* of the ancestor and evolved lineages.

The results showed that the interactions between WS and SM are both frequency and density dependent and the joint influence of the above two factors reveals the presence of an eco-evo feedback. The nature of the feedback is suggested to be a reduced transition capacity of SM to switch to WS in evolved lineages. The tendency of evolved SM to produce few WS suggest a strategy on the part of the SM to save the metabolic cost of production of cellulose, by WS, and to trade-off this cost with an increase in fitness of the evolved lineages.

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Table of Contents

| | | |
|--------------------------------|---|-------------|
| ABSTRACT | | II |
| ACKNOWLEDGEMENTS | | IV |
| LIST OF FIGURES | | XII |
| LIST OF TABLES | | XIII |
| | | |
| CHAPTER 1. INTRODUCTION | | 1-26 |
| 1.1 | EVOLUTION OF MULTICELLULARITY | 1 |
| 1.2 | EVOLUTION OF COOPERATION | 2 |
| | 1.2.1 Defining cooperation | 3 |
| 1.3 | THEORIES EXPLAINING THE MAINTENANCE OF COOPERATION..... | 5 |
| | 1.3.1 Theories based on direct fitness gains | 5 |
| | a) Non enforced by-product benefits | 5 |
| | b) Enforced benefits | 6 |
| | 1.3.2 Theories of cooperation based on indirect fitness gains | 7 |
| | a) Kin selection theory | 7 |
| | b) Group selection | 8 |
| | c) Indirect reciprocity (IDR)..... | 8 |
| | d) Limited dispersal..... | 9 |
| | e) Spatial structure | 9 |
| | f) Assortment—a general mechanism for the evolution of cooperation | 10 |
| | g) Environment dependent cooperation..... | 11 |
| 1.4 | FREQUENCY AND DENSITY DEPENDENT EFFECTS ON COOPERATION | 12 |
| | 1.4.1 Frequency dependence..... | 12 |
| | 1.4.1.1 Possible outcomes of frequency dependence | 12 |
| | a) Cooperator dominance..... | 13 |
| | b) Cheater dominance | 13 |
| | c) Coexistence | 13 |
| | d) Bistability | 14 |
| | 1.4.2 Density dependence..... | 14 |
| | a) High density leads to high cooperation | 14 |

| | | |
|--|---|--------------|
| b) | Quorum sensing leads to high density and high cooperation | 15 |
| c) | High population density leads to lower levels of cooperation | 16 |
| 1.5 | ENVIRONMENT DEPENDENT COOPERATION IN <i>P. fluorescens</i> | 17 |
| 1.5.1 | Environment-1, nature of interaction: cheat as an invader (invasion) | 17 |
| 1.5.2 | Environment-2, nature of interaction: cheat as a propagule (coexistence)..... | 18 |
| 1.6 | DEVELOPMENT OF INTERACTIONS BETWEEN WS-SM IN A LONG TERM EVOLUTION EXPERIMENT WITH <i>P. fluorescens</i> | 21 |
| 1.7 | MOTIVATION | 23 |
| 1.7.1 | Impact of ecology on evolution..... | 23 |
| 1.7.2 | Impact of evolution on ecology..... | 23 |
| 1.8 | HYPOTHESIS | 24 |
| 1.9 | AIM OF THE STUDY | 25 |
| 1.10 | THESIS STRUCTURE | 26 |
| CHAPTER 2. MATERIAL AND METHODS | | 27-39 |
| 2.1 | LIFE CYCLE EXPERIMENT..... | 27 |
| 2.1.1 | Transition Capacity (TC) | 28 |
| 2.2 | EVOLUTIONARY HISTORY OF LINEAGES | 30 |
| 2.2.1 | WS and SM of ancestral lineage – SBW25 | 30 |
| 2.2.2 | WS and SM of evolved lineages – Line 17 and Line 43 | 30 |
| 2.2.3 | WS and SM of baselines lineages-Line 70 and Line 71 | 32 |
| 2.3 | EXPERIMENTAL SET-UP | 33 |
| 2.3.1 | Experimental set-up to study frequency dependent interactions..... | 33 |
| 2.3.2 | Experimental set-up to study density dependent interactions | 34 |
| 2.4 | APPROACH TAKEN TO STUDY INTERACTIONS | 35 |
| 2.4.1 | Approach taken to study frequency dependent interactions | 36 |
| 2.4.2 | Approach taken to study density dependent interactions..... | 36 |
| 2.4.2.1 | Log transformation and normalisation of density dependent data | 36 |
| 2.4.3 | Approach taken to study joint effect of frequency and density – eco-space diagrams..... | 37 |

| | | |
|--|--|----|
| 2.4.4 | Effect of transition capacity on the trajectory of the plots..... | 38 |
| 2.5 | MEDIA, GROWTH CONDITIONS AND OTHER METHODS..... | 38 |
| 2.5.1 | Growth in shaken conditions..... | 39 |
| 2.5.2 | Growth in static culture..... | 39 |
| 2.5.3 | Revival of freezer stocks..... | 39 |
| 2.5.4 | Preparation of stock cultures..... | 39 |
| | | |
| CHAPTER 3. FREQUENCY DEPENDENT INTERACTIONS | | |
| BETWEEN WS AND SM..... 40-61 | | |
| 3.1 | INTRODUCTION | 40 |
| 3.2 | RESULTS | 42 |
| 3.2.1 | Frequency dependent interactions in ancestral SBW25 | 42 |
| a) | Effect of WS on SM..... | 46 |
| b) | Effect of SM on WS..... | 47 |
| 3.2.2 | Frequency dependent interactions in baseline lineages | 48 |
| 3.2.2.1 | Frequency dependent interactions in baseline lineage – Line 71..... | 50 |
| a) | Effect of WS on SM | 50 |
| b) | Effect of SM on WS | 51 |
| 3.2.2.2 | Frequency dependent interactions in baseline lineage – Line 70..... | 51 |
| a) | Effect of WS on SM | 51 |
| b) | Effect of SM on WS | 55 |
| 3.2.3 | Frequency dependent interactions in evolved lineages | 55 |
| 3.2.3.1 | Frequency dependent interactions in evolved lineage – Line 17..... | 55 |
| a) | Effect of WS on SM | 55 |
| b) | Effect of SM on WS | 56 |
| 3.2.3.2 | Frequency dependent interactions in evolved lineage – Line 43 | 56 |
| a) | Effect of WS on SM | 56 |
| b) | Effect of SM on WS | 57 |
| 3.3 | DISCUSSION | 57 |
| 3.3.1 | Summary of the frequency dependent interactions lineage-wise..... | 57 |

| | | |
|-------|--|----|
| a) | Ancestral SBW25..... | 57 |
| b) | Baseline lineage – Line 71 | 57 |
| c) | Baseline lineage – Line 70 | 58 |
| d) | Evolved lineage – Line 17..... | 58 |
| e) | Evolved lineage – Line 43..... | 59 |
| 3.3.2 | Comparison of frequency dependent interactions between baseline and evolved lineages..... | 60 |
| 3.3.3 | Interactions seem to be density dependent..... | 61 |

CHAPTER 4. DENSITY DEPENDENT INTERACTIONS

BETWEEN WS AND SM..... 62-75

| | | |
|-------|--|----|
| 4.1 | INTRODUCTION | 62 |
| 4.2 | RESULTS | 62 |
| 4.2.1 | Density dependent interactions in ancestral SBW25..... | 62 |
| a) | Effect of WS on SM..... | 62 |
| b) | Effect of SM on WS..... | 62 |
| 4.2.2 | Density dependent interactions in baseline lineage – Line 71 | 68 |
| a) | Effect of WS on SM..... | 68 |
| b) | Effect of SM on WS..... | 68 |
| 4.2.3 | Density dependent interactions in baseline lineage – Line 70 | 68 |
| a) | Effect of WS on SM..... | 68 |
| b) | Effect of SM on WS..... | 68 |
| 4.2.4 | Density dependent interactions in evolved lineage – Line 17 | 69 |
| a) | Effect of WS on SM..... | 69 |
| b) | Effect of SM on WS..... | 69 |
| 4.2.5 | Density dependent interactions in evolved lineage – Line 43 | 69 |
| a) | Effect of WS on SM..... | 69 |
| b) | Effect of SM on WS..... | 69 |
| 4.3 | DISCUSSION | 70 |
| 4.3.1 | Summary of the density dependent interactions lineage-wise..... | 70 |
| a) | Ancestral SBW25..... | 70 |
| b) | Baseline lineage – Line 71 | 71 |
| c) | Baseline lineage – Line 70 | 71 |

| | | |
|--|--|--------------|
| d) | Evolved lineage – Line 17 | 72 |
| e) | Evolved lineage – Line 43 | 72 |
| 4.3.2 | Comparison of density dependent interactions between baseline and evolved lineages | 73 |
| 4.3.2.1 | Effect of WS on SM | 74 |
| a) | Baseline lineages | 74 |
| b) | Evolved lineages | 74 |
| 4.3.2.2 | Effect of SM on WS | 74 |
| a) | Baseline lineages | 74 |
| b) | Evolved lineages | 74 |
| CHAPTER 5. ECO-SPACE DIAGRAMS | | 76-99 |
| 5.1 | INTRODUCTION | 76 |
| 5.2 | RESULTS | 77 |
| 5.2.1 | Lineage-wise eco-space trajectories | 77 |
| a) | Ancestral Lineage – SBW25 | 79 |
| b) | Baseline lineage – Line 71 | 80 |
| c) | Baseline lineage – Line 70 | 80 |
| d) | Evolved lineage – Line 17 | 81 |
| e) | Evolved lineage – Line 43 | 82 |
| 5.2.2 | Combination-wise eco-space diagrams: for populations founded with different combinations of frequency and density. | 84 |
| 5.2.2.1 | Eco-space diagram for pure WS population founded at different densities | 86 |
| 5.2.2.2 | Eco-space diagram for mixed (1:1 WS: SM) population founded at different densities | 90 |
| 5.2.2.3 | Eco-space diagram for pure SM population founded at different densities | 94 |
| 5.3 | DISCUSSION | 97 |
| 5.3.1 | Summary and comparison of strategies between baseline and evolved lineages | 97 |
| 5.3.2 | Eco-evo feedback indicates evolution on the part of the cheater | 98 |

| | |
|---|----------------|
| CHAPTER 6. CONCLUSION | 100-109 |
| 6.1 FREQUENCY DEPENDENT INTERACTIONS..... | 102 |
| 6.1.1 Increased transition rate from WS to SM | 103 |
| 6.2 DENSITY DEPENDENT INTERACTIONS..... | 103 |
| 6.3 JOINT INFLUENCE OF FREQUENCY AND DENSITY REVEAL PRESENCE OF AN ECO-EVO FEEDBACK..... | 105 |
| 6.3.1 Common strategy in evolved lineages | 105 |
| 6.3.2 Reduced transition rate of SM of evolved lineages..... | 106 |
| 6.4 FUTURE WORK..... | 107 |
| CHAPTER 7. REFERENCES..... | 110-119 |
| CHAPTER 8. APPENDIX..... | 120-121 |

List of Figures

| | | |
|------------|---|----|
| Figure 1.1 | Three stages in the evolution of multicellularity | 2 |
| Figure 1.2 | Maintenance of cooperation by different mechanisms | 4 |
| Figure 1.3 | Schematic view of the life cycle | 18 |
| Figure 1.4 | Feedback between environment and genotype | 19 |
| Figure 1.5 | A representation of ‘generation 1’ of the life cycle experiment | 21 |
| Figure 1.6 | Steps in the development of an eco-evo feedback | 25 |
| Figure 2.1 | Experimental design for frequency and density dependent interactions | 31 |
| Figure 3.1 | Interactions between ancestral SBW25 (SM) and WS. | 43 |
| Figure 3.2 | Frequency dependent interactions in Line SBW25. | 44 |
| Figure 3.3 | Frequency dependent interactions in Line 71 | 49 |
| Figure 3.4 | Frequency dependent interactions in Line 70 | 52 |
| Figure 3.5 | Frequency dependent interactions in Line 17 | 53 |
| Figure 3.6 | Frequency dependent interactions in Line 43 | 54 |
| Figure 4.1 | Density dependent interactions in Line SBW25 | 63 |
| Figure 4.2 | Density dependent interactions in Line 71 | 64 |
| Figure 4.3 | Density dependent interactions in Line 70 | 65 |
| Figure 4.4 | Density dependent interactions in Line 17 | 66 |
| Figure 4.5 | Density dependent interactions in Line 43 | 67 |
| Figure 5.1 | Lineage-wise plots of population density versus frequency. | 78 |
| Figure 5.2 | Eco-space trajectories of pure WS populations | 85 |
| Figure 5.3 | Eco-space trajectories of mixed populations | 89 |
| Figure 5.4 | Eco-space trajectories of pure SM populations | 93 |

List of Tables

| | | |
|-----------|--|----|
| Table 2.1 | Evolutionary history and transition profiles for all the WS-SM pairs (used in this study)..... | 29 |
| Table 3.1 | Summary of the frequency dependent interactions | 59 |
| Table 4.1 | Summary of the density dependent interactions | 73 |
| Table 5.1 | Transition Capacity (TC) | 83 |