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Evolutionary game theory: ESS, convergence stability, and NIS

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ABSTRACT

Question: How are the three main stability concepts from evolutionary game theory – evolutionarily stable strategy (ESS), convergence stability, and neighbourhood invader strategy (NIS) – related to each other? Do they form a basis for the many other definitions proposed in the literature?

Mathematical methods: Ecological and evolutionary dynamics of population sizes and heritable strategies respectively, and adaptive and NIS landscapes.

Results: Only six of the eight combinations of ESS, convergence stability, and NIS are possible. An ESS that is NIS must also be convergence stable; and a non-ESS, non-NIS cannot be convergence stable. A simple example shows how a single model can easily generate solutions with all six combinations of stability properties and explains in part the proliferation of jargon, terminology, and apparent complexity that has appeared in the literature. A tabulation of most of the evolutionary stability acronyms, definitions, and terminologies is provided for comparison.

Key conclusions: The tabulated list of definitions related to evolutionary stability are variants or combinations of the three main stability concepts.

Keywords: adaptive landscape, convergence stability, Darwinian dynamics, evolutionary game stabilities, evolutionarily stable strategy, neighbourhood invader strategy, strategy dynamics.

INTRODUCTION

Evolutionary game theory has and continues to make great strides. Increasingly, evolution by natural selection is seen as a game, and the mathematics of game theory as the language of Darwinian evolution. Yet, it rarely receives a central position in textbooks on evolution or even evolutionary ecology. And, as we enter the twenty-first century, the promise and intricacies of evolutionary game theory still elude many evolutionists and evolutionary

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