Adaptive dynamics, fall 2010

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Lecturer

Stefan Geritz

News

- Tuesday, December 7, was the last lecture of this course.

Scope

10 cu.

Type

Advanced studies

Prerequisites

Some acquaintance with (systems of) ordinary differential equations would come in handy.

Lectures

Weeks 37-42 and 44-50, Tue 14-16 in room B321, Thursday 14-16 in room B322.

Lecture notes

Summary;

1 INTRODUCTION:

1.1 Introduction;

1.2 Introduction (recap);

1.3 Lotka-Volterra competition model;

1.4 Lotka-Volterra competition model (continued);

2 A MORE GENERAL THEORY OF ADAPTIVE DYNAMICS:

2.1 The ecological timescale:

2.1.1 Invasion and invasion fitness;

2.1.2 The outcome of an invasion event;

2.1.3 The outcome of an invasion event (continued);

2.2. The evolutionary timescale:

2.2.1 Classification of the local configuration of the pairwise invadability plot;

2.2.2 Evolution in a dimorphic population; First example; Second example;

2.2.3 Differential inclusions and total stability;

2.2.4 Master equation, canonical equation and diffusion approximation; Example;

2.2.5 Comparison of different stability concepts; Example;

3. FURTHER GENERALIZATIONS:

3.1 Invasion fitness for structured populations in continuous or discrete time;

4. SPECIAL TOPICS AND CASE STUDIES:

4.1 Evolution of seed size and seedling competitive ability;

4.2 Predator-prey coevolution and critical function analysis;

4.2.1 Invasion fitness for a variable resident environment;

4.2.1 Critical function analysis;

APPENDIX:

A.1 Local stability analysis of ODEs;

A.2 Elements of the theory of Poincare and Bendixon;

A.3 Example: the resource-consumer model of Gause;

A.4 The theorem of Perron and Frobenius;

REFERENCES:

Dieckmann & Law (1996) *Journal of Mathematical Biology* **34**: 579-612 (About: derivation of the 'canonical equation' of adaptive dynamics),

Geritz *et al.* (1998) *Evolutionary Ecology* **12**: 35-57 (About: the basic AD framework: classification of singularities and isoclines),

Geritz *et al.* (1999) *Theoretical Population Biology* **55**: 324-343 (About, in particular in the Appendix: the connection of the isoclines to the boundary of the coexistence set),

Geritz *et al.* (2002) *Journal of Mathematical Biology* **44**: 548-560 (About: resident-invader dynamics for similar strategies; the case of multiple resident population attractors),

Geritz (2005) *Journal of Mathematical Biology* **50**: 67-82 (About: resident-invader dynamics for similar strategies; four basic kinds of outcomes),

Gyllenberg & Parvinen (2001) *Bulletin of Mathematical Biology* **63**: 981-993 (About: evolutionary suicide),

Meszena *et al.* (2005) *Physical Review Letters* **95**: 078105 (About:resident-invader dynamics for similar strategies; the time-scale separation argument),

Exercises

Exercises 1-3 --> Solution 1-3 Solution 1-2

Exercises 4-7 --> Solution 4-7

Exercises 8-9 --> Solution 8 (Maple / *Mathematica*), Solution 9 (Maple / *Mathematica*)

Exercises 10-11 --> Solution 10 (Maple), Solution 11 (Maple / *Mathematica*)

Exercises 12-13 --> Solution 12-13 (MatLab & Maple / *Mathematica*)

These are all the exercises. The remaining time of the course you are supposed to work on one of projects listed see below (see under the heading "Projects").

Exam

The exam will be in the form of a project (= advanced exercise) or article reading plus discussion. Please, contact the lecturer to make your preference clear.

Projects

Predator-prey; Evolutionary cycles; Evolutionary arms-race; Cannibalism; Cooperation; Virulence 1; Virulence 2; Two-patch model; Prey evolution; Resistance; Resource use;

- Choose one project and hand in the completed project before the end of January 2011. When you hand in the project we make an appointment to discuss the results.

- We have reserved computer room C128 on Fridays from 14-16 for you to work on the projects. The assistant will be there for at least 15 minutes to help you if need be. If nobody shows up during that time, I can find him in his office B425.

- Here are some worked out examples (in Mathematica) to show what you are supposed to be able to do. We've seen these examples already during the lectures or the exercises:

Predator-prey (different from the project above); LV asymmetric competition (same as during the exercises); Cannibalism (same as during the lectures);

Exercise groups

Group	Day	Time	Place	Instructor

1.	Fri	14-16	B321	Jaakko Toivonen & Paolo Muratore Ginanneschi