Special Session 42: Modeling and analysis of predators-preys systems : stability, bifurcation, chaos and complexity

Aziz-Alaoui M.A., Applied Math. Lab., University of Le Havre , France
LI, Bai-Lian (Larry) , Ecological Complexity and Modeling Lab., Department of Botany and Plant Sciences, University of California, Riverside, USA

The 6th AIMS world's largest gathering of researchers in DYNAMICAL SYSTEMS will be held in Poitiers, France, on 25-28 June 2006. You are cordially invited to submit a paper to our Special Session in this conference, which is the second one following the one we organized in the 4th international conference of DCDIS in Guelph, Ontario, Canada in 2005.

Description : (see also : http://awal.univ-lehavre.fr/MAPPS2006/) : Renewal interest in ecological and biological modeling appears to have heightened in recent years due to their numerous adverse effects on ecosystems dynamics and biodiversity. The terms quasi-periodic, chaos and strange attractors are becoming familiar to ecologists. The main purpose of this special session is to bring together leading researchers and experts worldwide, to further promote and develop the cutting-edge research on complexity, chaos, bifurcation and stability in mathematical and computational modeling of ecological and biological systems, especially Predator-Prey Systems. Although a considerable progress has been made during the last decades in understanding basic scenarios of bio- and eco-systems, many important issues have not been properly addressed yet. Indeed, NONLINEAR DYNAMICS, CHAOTIC and COMPLEX systems constitute some of the most fascinating developments of late twentieth century mathematics and physics. The implications have changed our understanding of important phenomena in almost every field of science, including ecology. COMPLEXITY (or the science of complexity) is often used as a shorthand for the field that developed in the late 1980s around the use of mathematical and computational modeling of biological, economic and technological systems known as "complex systems". Therefore, this special session will certainly have broad interest. It will focus on equation-based, deterministic, stochastic ODE, PDE or mappings modelling of eco- or bio-systems analysis. But also on the study of eco- or bio-complexity and global emergent properties.

Main topics of interest (but not limited to) :
* Predator-Prey systems
* Mathematical and computational modeling of biological or ecological systems
* Multispecies interactions
* Marine ecosystems
* Complex modelling...

using tools borrowed from various areas:
* Nonlinear dynamics
* Stability
* Bifurcation
* Temporal or Spatio-Temporal Chaos
* Complexity

$\longrightarrow \infty \diamond \infty \longleftarrow$

Dynamics of Nonautonomous Delayed Predator-Prey Periodic Model

Nindjin Aka fulgence
Universite de Cocody, Ivory Coast
nindjinaka_fulgence@hotmail.com

Two-dimensional non-autonomous periodic delayed continuous time dynamical system modeling a predator-prey food chain, and based on a modified version of the Leslie-Gower scheme and on the Holling type-II is investigated. We establish conditions under which the system is persistence and admits a globally asymptotically stable positive periodic solution.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Statio-temporel dynamics of a modified michaelis-menten model

Baba issa Camara
Le Havre university, France
babaissa@yahoo.fr
Pr Aziz Alaoui

We numerically investigate the spatio-temporal dynamics and pattern formation of a predator-prey model of Michalaelis-Menten type. This study could be used for modeling cancer treatement by applying predator-prey equations in which body is a prey and a disease is a predator.

⟶ ∞◇∞ ⟵

On a dynamics of a non-smooth prey-predator model

Hassan Deai
University of le Havre, France
hassan.deai@laposte.net
M. Aziz-alaoui

In this work, the dynamics of a prey-predator discontinuous model of Holling-Tanner type is studied. We focus on boundedness, positivity of solutions and global asymptotic stability of the non-trivial equilibrium.

⟶ ∞◇∞ ⟵

Architectural Organization of Food Webs

Ernesto Estrada
University of Santiago de Compostela, Spain
estrada66@yahoo.com

Here we analyse several of architectural characteristics of food webs based on the analysis of a large dataset of networks. First, we analyse how much wired are the different species in a food web. Using subgraph centrality we rank the different species according to their implication in all the substructures forming the network. Then we explore the idea that the simplest picture of a food web can be represented as different "trophic" levels where species in one level predate species located at the level below, producing networks with a high bipartivity. Using a quantitative measure of bipartivity we show that with very few exceptions food webs show a very low bipartivity as a consequence of their larger number of trophic relations between species. We then study the existence of good expansion properties in food webs, which guarantee that no two major parts of the network can be disconnected by removal of a few bottleneck nodes/links. Using a spectral scaling method we show that most of food webs analysed show good expansion properties lacking bottlenecks in their structures. The consequences of these topological characteristics of food webs are finally considered for the understanding of important functional properties, such as robustness against node/link removal. We simulate the effects produced by the loss or isolation of species based on different strategies: removal of the most connected species, removal of bottlenecks, and removal of the most wired species.

⟶ ∞◇∞ ⟵

Nonlinear delay equations with nonautonomous past

Genni Fragnelli
University of Siena, Italy
fragnelli@dii.unisi.it
Dimitri Mugnai

Inspired by a biological model on genetic repression proposed by Nobel Laureates J. Monod and P. Jacob, I will present some results about a new class of delay equations with nonautonomous past with a non linear delay operator.

⟶ ∞◇∞ ⟵

First integral of chaotic dynamical systems

Jean-marc Ginoux
Universite du Sud Toulon Var, France
ginoux@univ-tln.fr
Bruno Rossetto

Slow-fast autonomous dynamical systems have been studied thanks to the *singular perturbation theory* which led to the zero-order approximation in ε of the *slow manifold*, i.e., the so-called *singular approximation* whose local invariance has been demonstrated . Starting from this seminal works, the aim of this article is to establish in the case where $\varepsilon \neq 0$ that the location of the points where Differential Geometry local metric properties of *curvature* and *torsion* of the trajectory curves of chaotic dynamical systems vanishes, provides the slow manifold analytical equation associated in this systems. Moreover, in the framework of the so-called *tangent linear system approximation*, it will be shown that both *curvature* and *torsion* are first integral of this dynamical systems. Applications to various predator-prey models such as Rosenzweig-MacArthur, Hastings-Powell and Volterra-Gause exemplify this new approach.

⟶ ∞◇∞ ⟵

Stability, bifurcation, chaos and complexity of predator-prey systems: an overview

Bai-lian L. Li
University of California at Riverside, USA
bai-lian.li@ucr.edu
M.A. Aziz Alaoui

In this overview, we will focus on the latest developments of research in stability, bifurcation, chaos and complexity of predator-prey systems and their ecological and evolutionary implications.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Allee Effect and Bistability in a Spatially Heterogeneous Predator-Prey Model

Junping Shi
College of William and Mary, USA
shij@math.wm.edu
Yihong Du

A diffusive predator-prey system of ecology is considered. Existence of multiple positive steady states and global bifurcation branch are examined as well as related dynamical behavior. It is found that while the predator population is not far from a constant level, the prey population could extinguish, persist or blow up depending on the initial population distributions, the various parameters in the system, and the heterogeneous environment. In particular, we examine a situation where the Allee effect is caused by the spatial heterogeneity of the environment. If time allows, a diffusive predator-prey system with a protection zone for prey will also be discussed. This is a joint work with Yihong Du of University of New England, Australia.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Periodic Orbits of Tritrophic Slow–Fast System and Double Homoclinic Bifurcations

Alexandre Vidal
Univ. Pierre et Marie Curie, Paris 6, France
alx.vidal@free.fr

The biological models - particularly the ecological ones - must be understood through the catastrophs they undergo as the parameters vary. However, the transition between two dynamical behaviours of a same system for diverse values of parameters is often obscure. For instance, the analysis of the non generic motions near the transition states is the first step to fully understand the catastrophs occuring in complex dynamics.

In this article, we adress the question to describe and explain a double bursting behaviour occuring for a tritrophic slow–fast system. We focus therefore on the appearance of a double homoclinic bifurcation of the fast subsystem as the predator death rate parameter evolves.

This article introduces the slow–fast system which extends Lotka–Volterra dynamics by adding a superpredator. Using the analysis of singular points and bifurcations undergone by fast dynamics, we study the flow near the homoclinic points. Finally, the main results concerns the existence of periodic orbits of different periods as the two homoclinic orbits are close enough to each other.

$\longrightarrow \infty \diamond \infty \longleftarrow$