

Dynamics of Plant-Herbivore Interaction with Chemical Defense and Spatial Diffusions

Abstract

The purpose of this dissertation is to investigate the dynamics of plant-herbivore interactions with plant defense by assuming the numerical response is not necessarily proportional to the functional response.

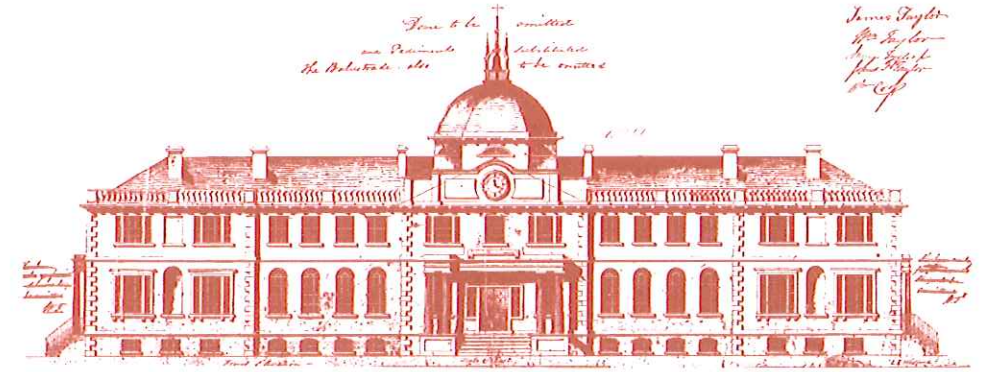
We first introduce basic background on plant chemical defense and concepts of functional response and numerical response, then consider a two dimensional system of autonomous differential equations, which models interaction between plant and herbivore. The existence, uniqueness and boundedness of the non-negative solution are proved. Local and global stability of equilibria, Hopf bifurcation, existence of limit cycle are addressed in Chapter 2.

In Chapter 3, a diffusive plant-herbivore system with Neumann boundary conditions is derived. Local and global stability of spatially homogeneous steady states are established. We derive the conditions for the occurrence of Hopf bifurcation and steady state bifurcation and provide geometrical methods to locate the bifurcation values. A large variety of different types of short-term behavior, including oscillations both in space and in time, or oscillations with different amplitudes, are observed.

In Chapter 4, we consider a diffusive plant-herbivore model subject to homogeneous and non-homogeneous Dirichlet boundary conditions. Stability of spatially homogeneous steady states is obtained. Through numerical simulations, we observe several types of transient spatio-temporal behavior including oscillations both in space and in time, or in one of them.

In Chapter 5, a system of two ordinary differential equations is proposed. The system models chemically-mediated interactions between plants and herbivores by incorporating a toxin-modified numerical response. This numerical response accounts for the reduction in the herbivore's growth and reproduction due to chemical defenses from plants. It is shown that the system exhibits very rich dynamics including multitype saddle-node bifurcations, Hopf bifurcation, homoclinic bifurcation and multitype bi-stability. Limit cycles, homoclinic orbits and heteroclinic orbits are numerically observed.

In Chapter 6, we discuss our main results and some possible future works.



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UNIVERSITY OF NEW BRUNSWICK SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Fang Yu

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

Ph.D. Candidate

Fang Yu

Graduate Academic Unit

Math & Stats

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**January 7, 2014**

**10:00 a.m.**

**Seminar Room (4<sup>th</sup> floor)  
Harriet Irving Library**

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Examining Board:

Dr. Lin Wang (Math & Stats)
Dr. James Watmough (Math & Stats)
Dr. Jack Gegenberg (Math & Stats)
Dr. Sanjeev Seahra (Math & Stats)
Dr. Robert Johns (HRA, Biology)

Supervisor
Supervisor

Chairperson

External Examiner:

Dr. Yuming Chen, Assoc. Prof.
Dept. of Mathematics
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The Oral Examination will be chaired by:
Dr. Ed Biden, Dean of Graduate Studies

BIOGRAPHY

Education:

1997-2001	Bachelor of Science, Hebei Normal University
2008-2014	PhD candidate, University of New Brunswick

Publications (to be submitted):

- Fang Yu, Lin Wang, James Watmough, Bifurcation analysis and transient spatio-temporal behavior for a diffusive plant-herbivore system with Neumann boundary conditions.
- Fang Yu, Lin Wang, James Watmough, Bifurcation analysis of a diffusive plant-herbivore system with Dirichlet boundary conditions.
- Fang Yu, Lin Wang, James Watmough, Dynamics of plant-herbivore model with a chemically-mediated numerical response.
- Fang Yu, James Watmough, Transition of hive bees to foragers in continuous system.

Awards:

- AARMS Poster Award, 2010, CMS Summer Meetings, Fredericton, NB, Canada.
- International Differential Scholarship, 2008-2010, University of New Brunswick.

Employment:

- Teaching and Research Assistant, Department of Mathematics & Statistics, University of New Brunswick, 2008-present
- Instructor, Teaching ‘College Algebra and Trigonometry’, University of New Brunswick, Jan. 2011-Apr. 2011
- High School Math Teacher, Handan No.1 High School, Hebei Province, China, 2001-2007