ARIZONA STATE UNIVERSITY

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M E M O R A N D U M

TO: Faculty and Students

FROM: Yang Kuang, Professor of Mathematics
Chair of Hao Wang's Dissertation for the Ph.D. in Mathematics

Hal Smith, Professor of Mathematics
Co-Chair of Hao Wang's Dissertation for the Ph.D. in Mathematics

I am writing to announce that Mr. Hao Wang will be defending his dissertation entitled:

Mathematical Analysis of Trophic Interactions: from Bacteria Competition to Lemming Cycles

on Thursday, November 30, at 12:15 P.M. The defense will be held in NUR 110.

Please share this information with colleagues and other students, especially those studying in a similar field. Both faculty and students are encouraged to attend. Mr. Wang will give a 40 minute talk, after which the committee members will ask questions. There may be time for one or two questions from the audience, but in general you are invited to attend as observers and will be excused when the committee begins its deliberations. Also, the committee may wish to question Mr. Wang further after the audience has left.

ABSTRACT

Mechanistic and phenomenological models and careful parameter estimations are presented through both aquatic and terrestrial ecosystems. The stoichiometric modeling of bacteria-algae lake system is relatively new, while the lemming population cycle has attracted the attention of several generations of theoretical and experimental biologists and continues to be an issue of controversy.

Bacteria-algae interaction in epilimnion is modeled with explicit consideration of carbon (energy) and phosphorus (nutrient). Global qualitative analysis and bifurcation diagrams of this model are presented. Competition of bacterial strains are modeled to examine Nishimura's hypothesis that in severely P-limited environments such as Lake Biwa, P limitation exerts more severe constraints on the growth of bacterial groups with higher nucleic acid contents, which allows low nucleic acid bacteria to be competitive.

Through a series of carefully derived models of the well documented high-amplitude, large-period fluctuations of lemming populations at Point Barrow, we argue that when appropriately formulated, autonomous differential equations may capture much of the desirable rich dynamics such as the existence of a periodic solution with period and amplitude close to that of approximately periodic solutions produced by the more natural but mathematically daunting non-autonomous models. This, together with our bifurcation analysis, indicates that neither seasonal factor, nor the moss growth rate and lemming death rate are the main culprits of the observed multi-year lemming cycles.

What ecological factors control population cycles? For some species — collared lemmings and snowshoe hares in particular—maturation delay of predators and the functional response of predation appear to be the primary determinants. Maturation delay almost completely determines the cycle period, whereas the functional response greatly affects its amplitude and even its existence. This result is obtained from sensitivity analysis of all the parameters and comparison of the lemming-stoat and hare-lynx systems.

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