

Editorial

Mathematical models have been increasingly used in more areas of biology, ecology, and medicine in the last 20-30 years, mostly because of an increased understanding of underlying interactions among species in ecological settings, substances at the metabolic level, epidemic classes in disease models. These developments are related in good part to technological advances, but also to better understanding and collaboration among many researchers from diverse backgrounds and disciplines, including statistics, social sciences, molecular biology, genetics, ecology, demography, biology, biochemistry, epidemiology, immunology, medicine, etc. A better appreciation of mathematics is evidenced by the increased value placed on mathematics by other disciplines and funding agencies and, for society at-large, it may be best exemplified by the appearance of mathematician, actuary and statistician as the top three jobs in the USA from 200 analyzed on a report released in late January 2009 by Adicio, Inc. based on five general categories inherent to every job, Work Environment, Income, Outlook, Stress and Physical Demands.

Some of these fruitful interactions across disciplinary boundaries begin through impromptu conversations between presenters and attendees in scientific conferences. The role of multidisciplinary conferences is important in several ways, the most obvious being the dissemination of state-of-the-art research results in areas that are of interest to several different audiences that may include other researchers in the disciplines, policy makers, students, government agencies, non-governmental organizations, and others. Other, perhaps, more subtle important roles include social and cultural. The former has an impact, for example, on establishing relations that may lead to future collaborations, joint projects that lead to research funding, student and researcher exchanges, etc. The latter are invaluable in creating an appreciation and sensitivity to other cultures and differences and commonalities with one's own. Such acquaintance and sensitivity is at the heart of our capacity as humans beings for tolerance, good will, enjoyment and appreciation of history, music, food, values, arts, handicrafts, etc.

CMPD2, The Second Conference on Computational and Mathematical Population Dynamics, took place in Campinas, Brazil, from July 16 to 20, 2007. The Conference was the second joint meeting of the Mathematical Population Dynamics (MPD) conferences and its counterpart, the Deterministic and Stochastic Models for Biological Interactions conference (DeStoBio), which have today a 23-year history of international meetings with ever-increasing participation and variety of settings, including Mississippi, New Jersey, Texas and Indiana in the USA, and France, Bulgaria, Poland, Italy, and now Brazil. CMPD had 160 participants from 16 countries in Africa, America, Asia and Europe. There were special sessions on Dynamics and Control of Infectious Diseases, Ecosystems Dynamics,

Mathematics of Physiology, Predator-Prey/Multi Systems, Meta-populations, Mathematics of Infectious Diseases, Computational Biology in Clinical and Ecological Trials, Stochastic and Numerical Approaches, Spatial Diffusion of Vectors & Infections, Dynamics and Genetics of Structured Populations, Mathematical Modeling of Fisheries Management, and Genetics.

We include in this volume a selection of fifteen articles of original research presented in Campinas on the areas of predator-prey interactions, agricultural ecology, demography, aquatic ecology, epidemiology of infectious diseases, cancer, molecular and cell biology, and genetics. Some of them are based on deterministic models, others on stochastic. The common thread, of course, is that they address issues of concern in the general areas of biology and ecology by using mathematical tools that lead to insights and possible answers to such concerns, some times beyond what is possible to observe or conclude without such tools.

Two papers on predator-prey interactions are included, one studying the impact on the long-term stability of food a web of prey preference by a predator species; the other —the effect of predator mortality on the predator-prey dynamics. The former shows that prey selection may alter significantly food web dynamics in terms of environmental heterogeneity, and also that predator mortality rate may impact both species similarly as the dynamics become more stable when the predator mortality rate increases. This may cast some doubt with respect to the robustness of some results in food web theory. The latter article uses aggregation methods by assuming a fast scale for predator disease and a slow scale for predator-prey interaction, and it shows that the equilibrium density of predator is always bigger in the endemic case than in the disease free case when mass action incidence is used but not when considering standard disease incidence. Ecologically speaking, this has the counterintuitive consequence that some degree of disease in the predator population may actually keep its size bigger than it would be in the absence of disease.

On agricultural ecology we also include two papers, one on the role of spiders as biological controllers in the agro-ecosystem, the other on the role of odor-mediated aggregation in enhancing colonization ability for a fruit fly. The first one introduces a model for the interactions between insects, pests and spiders in the typical ecosystem of a homogeneous rural landscape consisting of a continuous mosaic of cultivated land, a few small patches of grasslands, and small woods bounding the fields. The important role of spiders as biological controllers in the ecosystem is established and studied in combination with human intervention by means of pesticide spraying. Numerical simulations show that, when the inter-spraying time is increased, spider populations that would have gone to extinction can survive and recover. The second paper in this area concludes that odor-mediated aggregation is essential for fruit fly survival. Fruit flies not able to respond to chemical information could not successfully colonize their target area and

went extinct within four generations as a consequence of very high mortality due to the Allee effect. In contrast, when the flies had the ability to respond to chemical information, they successfully colonized the orchard and faster for stronger attraction to chemical information.

One article in demography is included that studies the impact of spatial migrations that happen on a different time-scale than the demographic processes. The two possible contrasting scenarios of migrations occurring on a faster or slower scale than demography are considered. When demography is faster than migration, the reduced system has multiple stable equilibria. In contrast, when migration is on a faster scale than demography, the reduction process extends some well-known discrete models allowing some new interpretations and justification of the resulting dynamics, including scenarios for the Allee effect that models a phenomenon characterized by a positive correlation between population density and per capita growth rate.

The article on aquatic ecology included deals with the toxic effect of a cyanobacterium on a cladoceran crustacean in a tropical Brazilian lagoon. The authors were able to compute the rate of change of the population as a function toxicant concentration and use this function to determine a confidence interval for the critical concentration that would lead to the extinction of the crustacean. Their results can serve as guidelines for aquatic life safety and environmental health policies.

Four articles are included in the general area of epidemiology. One deals with the impact of sexual abstinence on demography and disease propagation for sexually transmitted diseases. The authors consider a two-sex population that grows logistically with groups of individuals who avoid all sexual contact. When studying the spread of a sexually transmitted disease they show that the size of the sexually abstained class, which has an obvious negative correlation with total population size, can have a positive impact on reducing the size of the infected class. A second paper studies the spread of West Nile virus in the USA by a spatial model consisting of a system of partial differential reaction-diffusion equations for a mosquito-bird system. The authors determine the velocity of travelling wave solutions in terms of model parameters and show that random diffusion alone cannot account for the speed observed in reality (approximately 3-3.5 km/day) but rather than a preferential advection movement of approximately 1.6-2.1 km/day must be included in the observed advance from New York to California since 1999. Another article addresses optimal control strategies for malaria through the release of genetically modified mosquitoes, depending on the timing of their release. The authors do point out that there are environmental concerns about releasing any genetically engineered species into the natural environment and more studies are needed before advocating for the type of control their study analyzed. The last of the four articles uses reduction techniques offered by singular perturbations in order to analyze the spread of Bovine Viral Diarrhea Virus in a cattle herd structured into two age classes

and several epidemiological states, including two infectious states (transiently and permanently infected). The study establishes rigorously that transiently infected individuals can be ignored in a homogeneous population and not affect the long-term dynamics.

Two papers on cancer modeling are included in this volume. One focuses on the estimation of the hazard function that estimates the probability of dying for cancer patients, based on its dependence on the speed of proliferation of cancer cells. The authors propose a parametric model based on simple assumptions and carry out the parameter estimation using the kernel method. The second paper considers a recent model for tumor growth and combines it with immune response and chemotherapy to develop a treatment strategy that is adapted to each individual patient on the basis of response to current treatment (feedback). Under certain circumstances, the new control method leads to successful treatment with a large increase of the health indicators. When compared to classical formulations based on the minimization of the number of tumor cells, the new proposed formulation seems to be quite promising.

One article on cell physiology is included to study some of the main components of the mitochondrial energetic metabolism. The authors propose a simple dynamical system to model the relation between the tricarboxylic acid (TCA) cycle, the respiratory chain and the adenosine triphosphate (ATP) synthesis machinery. They find an equilibrium that seems to be globally stable and discuss its relevance to *in vivo* behavior. In particular, the importance of other ions not incorporated in the model is stressed to account for smaller variations in the electric field *in vivo* than in the model. The main advantage of the new model over other larger existing ones is that it lends itself to mathematical analysis, while the others do not because of their size and complexity.

Two papers on genetics are included, one modeling the emergence and loss of assortative mating in sympatric speciation and one on conditions for extinction of Y-linked genes. The first one attempts to shed some light on the possible impact of assortative mating (i.e. tendency to mate with individuals that are similar to itself in some respect, or dissimilar) as a cause for sympatric speciation (i.e. genetic divergence of several populations from a single parent species in the same geographic region, resulting in them becoming different species). The authors consider the solutions of their dynamical system that correspond to many different values of the parameters representing adaptive difference, carrying capacity and recombination probability, and they identify three different outcomes: assortative mating, extinction of one of the alleles in the locus that triggers an adaptive difference, and Hardy-Weinberg equilibrium. The authors note that assortative mating can be gained or lost with changes that preserve hysteresis, showing the resulting equilibrium to have partial memory of the initial state. The last paper studies the problem of extinction and survival of

the two alleles of a Y-linked gene in a two-sex monogamous population in which all males are of a single phenotype, via a two-type bisexual branching process. The authors assume that females pick their mates randomly and prove that the survival of each genotype depends on the mean number of female and male offspring of the given genotype per couple. They also observe in numerical simulations that the time to extinction can be extremely long, probably arbitrarily so.

It is interesting to note that three of the articles included use the same mathematical technique in three different areas of application, under three different names. The technique is called aggregation of variables in the article on predator-prey interaction; it is called model reduction in the paper on demography, and singular perturbation in the one on Bovine Viral Diarrhea Virus. This "duality and a half" in the name of the technique employed may symbolize the difference in vocabulary that scientists from different fields working on the very same problem—or even together—utilize and the resulting miscommunication that sometimes ensues. This multi-disciplinary work most applied mathematicians and mathematical biologists frequently conduct is very exciting and stimulating from the professional standpoint. Equally valuable aspects of such collaborations are the necessary growth in communication skills in all parties involved, as well as the parties or celebrations with an exhilarating feeling of "mission accomplished" that sometimes culminate a research project or conference, as was the case for CMPD2 in Campinas. We look forward to CMPD3 in Bordeaux, France, in the spring of 2010.

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