Vardayani Ratti

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Academic Appointments

- Dartmouth College, Hanover, USA (July 2016-Present)
  John Wesley Young Research Instructor
- University of Guelph, Guelph, Canada (Feb 2016-July 2016)
  Postdoctoral Fellow, Natural Sciences and Engineering Research Council of Canada (NSERC-ENGAGE)

Education

- Ph.D. Mathematics University of Guelph, Guelph, 2015
  - Advisor: Dr. Hermann J. Eberl
  - Thesis: Predictive Modeling of the Disease Dynamics of Honeybee-Varroa destructor-Virus Systems
  - Funded by Natural Sciences and Engineering Research Council of Canada (NSERC)-Canadian Pollination Initiative (CANPOLIN) and Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).
- M.Sc. Mathematics, University of Guelph, Guelph, 2011
  - Advisor: Dr. Hermann J. Eberl
  - Thesis: Local Stability Analysis of the Honeybee-Varroa destructor-Acute Bee Paralysis Virus
  - Funded by OMAFRA
- M.Sc. Mathematics, Panjab University, India, 2009
  - Course Based Masters
- B.Sc., Sikh National College, India, 2007
  - Courses in Mathematics, Physics and Chemistry

Teaching Experience

- Instructor, Dartmouth College, Hanover, USA
  - Linear Algebra with Applications
  - Topics in Applied Mathematics (Senior Undergraduate and Graduate course)
  - Introduction to Calculus (Active learning course)
  - Multivariable Calculus

- Ordinary Differential Equations

- Teaching Assistant, University of Guelph, Guelph, Canada
  - Partial Differential Equations
  - Biomathematics
  - Matrix Algebra
  - Elements of Calculus I, II
  - Linear Algebra
  - Integrated Math Physics I
  - Differential Equations I
  - Applied Differential Equations II
  - Biomathematics

Scheduled to Teach

- Dartmouth College, Hanover, USA
  - Multivariable Calculus (S18)

Research Interests

My research interest is in Mathematical Biology, in particular applications in ecology, infectious diseases, pollination biology and agriculture using differential equations. I have been studying mathematical models of infestation of honeybee colonies by viruses and varroa mite. I have determined the conditions under which the disease together with forager loss leads to colony losses. I have developed a new model of within-host HIV dynamics that includes cells protected from infection by the action of a CRISPR/Cas intervention that disrupts the expression of CCR5 proteins in the protected cells. The model is used to predict the extent of the intervention required to offer a functional cure, and also determine parameters that must be measured in order to guide experiments underway currently in Dr. Alexandra Howell's laboratory. I recently completed a project that used a mosquito model to study the effect of spraying different treatments in the households of Kenya Highlands. I am currently developing a malaria model which includes partial immunity arising from re-inoculation, and that interfaces with a time varying mosquito model, in order to distinguish the malaria transmission patterns in two nearby towns with similar rainfall and temperature but different land use and topography. This project is in collaboration with Dr. Jonathan Chipman from Department of Geography. The connection between my seemingly disjoint research projects is the SIR type modeling approach and I employ both analytical and numerical methods in my research.

Awards, Grants & Honors

- Society of Mathematical Biology (SMB) Landahl Travel Grant ($750), 2016
- Queen Elizabeth II-Graduate Scholarship in Science and Technology ($5000), 2011
- Dean's Scholarship ($3350), 2011-13
- Dean's Scholarship ($1130), 2009-10

Publications (* indicates undergraduate student as co-author)

- Manuscripts
  - Ratti, V.; Rheingold, E.*; Wallace, D.I. Reduction of Mosquito Abundance Via Indoor Wall Treatments: A Mathematical Model. *Journal of Medical Entomology*. Doi: 10.1093/jme/tjy021. 2018
  - Ratti, V.; Kevan, P.G.; Eberl, H.J. A Mathematical Model of Forager Loss in Honeybee Colonies Infested with Varroa destructor and the Acute Bee Paralysis Virus. *Bulletin of Mathematical Biology*. 79(6): 1218-1253, 2017
  - Wallace, D.I.; Nanda, S.; Ratti, V.; Eszterhas, S. K.; Howell, A. Treating HIV with a Population of Gene Edited Hematopoietic Progenitor Cells: a Mathematical Model and Analysis. *Bulletin of Mathematical Biology*. Submitted. 2017.
  - Ratti, V.; Kevan, P.G.; Eberl, H.J. A Discrete-Continuous Modeling Framework to Study the Role of Swarming in a Honeybee-Varroa destructor-Virus System. *Mathematical and Computational Approaches in Advancing Modern Science and Engineering*. J.Belair (eds). Springer International Publishing, 299-308, 2016
  - Ratti, V.; Kevan, P.G.; Eberl, H.J. A Mathematical Model of the Honeybee-Varroa destructor-Acute Bee Paralysis Virus Complex with Seasonal Effects. *Bulletin of Mathematical Biology*. 77(8): 1493-1520, 2015
  - Eberl, H.J.; Kevan, P.G.; Ratti, V. Infectious disease modeling for honeybee colonies in J. Dellivers (ed). "In Silico Bees", p.87-134, CRC, Press Boca Raton, 2014
  - Ratti, V.; Kevan, P.G.; Eberl, H.J. A Mathematical Model of the Honeybee-varroa destructor-Acute Bee Paralysis Virus Complex. *Canadian Applied Math Quarterly*, 21(1): 63-93, 2013
- In Preparation
  - Wallace, D.I.; Kachalia, A.A.*; Ratti, V. Effect of habitat diversity on the population dynamics of *Anopheles gambiae*.
  - Ratti, V.; Wallace, D.I. A malaria model, combined with time varying mosquito model, to study the effect of land use and topography on disease transmission.
  - Ratti, V.; Nanda, S.; Eszterhas, S. K.; Howell, A.; Wallace, D.I. Threshold Phenomena and Sensitivity of a Mathematical Model of HIV dynamics Treated with a Population of Gene Edited Hematopoietic Progenitor Cells.
- Theses
  - Predictive Modeling of the Disease Dynamics of Honeybee-Varroa destructor-Virus Systems
  - Local Stability Analysis of the Honeybee-Varroa destructor-Acute Bee Paralysis Virus

Selected talks

- The Fields Institute for Research in Mathematical Sciences, Toronto, Canada. 2018 (Invited)
- Arizona State University, Arizona, USA, 2018 (Invited)
- Rochester Institute of Technology, Rochester, USA, 2018 (Invited)
- Bowdoin College, Maine, USA, 2018 (Invited)

- Joint Mathematics Meeting, San Diego, USA, 2018
- Minisymposium on Mathematical Biology, Dartmouth College, 2017
- Joint Mathematics Meeting, Atlanta, USA, 2017
- Society of Mathematical Biology (SMB) Annual Meeting and Conference, Nottingham, UK, 2016
- The 2015 AMMCS-CAIMS Congress, Waterloo, Canada, 2015
- The 2015 BIOMAT. International Symposium on Mathematical and Computational Biology, Indian Institute of Technology, Roorkee, India, 2015
- Canadian Association of Professional Apiculturists, Edmonton, Alberta, Canada, 2013
- Society of Mathematical Biology (SMB) Annual Meeting and Conference, Tempe, Arizona, USA, 2013
- 2013 Southwestern Ontario Graduate Mathematics and Statistics Conference, University of Guelph, Canada, 2013
- Missouri Botanical Garden (MBG), St. Louis, Missouri, USA, 2012
- The 5th Geoffrey J. Butler Memorial Conference on Differential Equations and Population Biology, University of Alberta, Canada, 2011
- CMS Winter Meeting, Toronto, Canada, 2011
- Emergency Management research expo, Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), University of Guelph, Canada, 2014
- Emergency Management research expo, Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), University of Guelph, Canada, 2013

Refereeing (By invitation)

- Grant proposal for Natural Sciences and Engineering Research Council of Canada (NSERC)
- Mathematical Bioscience and Engineering
- Journal of Behaviour

Other Research Experience

- Missouri Botanical Garden (MBG), St. Louis, USA
  - Hands on project on Associative Learning in Honeybees
  - Trained the bees using Proboscis Extension Reflex (PER)

Mentoring and Service

- Supervising an undergraduate student under James O. Freedman Presidential Scholars program at Dartmouth College
- Co-supervising an undergraduate student on senior thesis at Dartmouth College
- Organized a minisymposium on Honeybee modeling at the Annual meeting of Society of Mathematical Biology (SMB) held in Utah (2017)
- Organizing Applied Mathematics Seminars at Dartmouth College (2017-2018)
- Judge, poster session at Joint Mathematics Meeting, San Diego, 2018

- Assisted an undergraduate student at University of Guelph in a research project based on software implementation of a mathematical model on diseases in honeybee colonies
- Assisted a graduate student on a MSc project at University of Guelph
- Served on an award selection committee for Teaching Assistant Advisory Council (TAAC)
- Participated in various activities at the Honeybee Research Center (Guelph) as a member of the Apiculture Club

Society Memberships and Research Networks

- Society of Mathematical Biology (SMB)
- Society of Industrial and Applied Mathematics (SIAM)
- American Mathematical Society (AMS)
- NSERC Canadian Pollination Initiative

Computer Skills

- Technical Skills: MATLAB, MAPLE, XPPAUT, R
- General: MS Word, Excel, Power Point, LaTeX
- Teaching Management Systems: Canvas, Blackboard

Professional Development

- National Institutes of Health (NIH) Grant writing workshop
- Future Faculty Teaching Workshop Series
- Syllabus Design Workshop Series