

**Interdisciplinary Opportunities Mini-Grants
Proposal Cover Sheet**

Project Title: Developing a laboratory manual and Lecture Notes for
Mathematical models in life sciences

Institution:

Faculty/Staff Name: Dr. Saber Elaydi, Dr. David Ribble

Faculty/Staff Department: Mathematics/Biology

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Student(s) Name(s): To be determined.

Year Classification:

Phone:

E-mail:

Amount requested: \$8,500

Please check the appropriate boxes: curricular proposal co-curricular proposal
 planning & implementation planning only

Date grant submitted: 16 February

Proposed grant period: 1 June 2007 - 1 Oct. 2007

Type of project: Planning & Implementation

Signature of faculty/staff submitting proposal Saber Elaydi Date 2/16/07

Signature of student submitting proposal _____ Date _____

Dr. David Ribble

Dr. Diane Smith

Name of appropriate dept./div. chair

Name of Chief Academic Officer:

Or chief student affairs officer

David Ribble

D Smith for Michael Fischer

Signature of above chair or officer

Signature of Chief Academic Officer

Date 2/16/2007

Date 2/15/07

Evidence of institutional support is required for each curricular mini-grant proposal in the form of a letter of support from the proposal author's Department/Division Chair. For co-curricular proposals institutional support is required in the form of a letter of support from the faculty/staff mentor/sponsor and a letter from the chief student affairs officer. All proposals must be signed by the chief academic office.

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Date received _____ By _____

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Action _____ Notification sent _____

Title: Developing a Laboratory Manual and Lecture Notes for Mathematical Models in Life Sciences

Submitted by:

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Summary

The PIs plan to write two manuscripts during the summer and part of the fall of 2007. The first manuscript is a laboratory manual that includes 12 laboratory experiments in biology and the second manuscript will be lecture notes on mathematical modeling in biology. Both manuscripts will be used in co-teaching the new developed course (Mathematical models in life sciences) which is a core course in the multidisciplinary minor titled Scientific Computing. The PIs, Elaydi from mathematics and Ribble in biology, have jointly developed the course and team-taught in fall of 2006. Mathematical models in life sciences embodies all the ingredients of a true and successful interdisciplinary collaboration. Its novelty is the introduction of laboratory experiments in a mathematically-oriented course and the team-teaching of it by a biologist and a mathematician.

Project Description

The PIs Elaydi and Ribble will be co-teaching a new course titled “Mathematical Models in Life Sciences” in the fall of 2007. This is one of the core courses in the new minor in Scientific Computing. This course is novel because it will include a laboratory component in which students will set up, follow, and count real organisms that are modeled as part of the lecture/modeling component. The second PI, Ribble, will be developing the laboratory experiments for the course. We propose to work on two manuscripts between June, and October, 2007.

I. A laboratory manual to be used in the course in fall 2007.

II. Lecture Notes to be used in the course in fall 2007.

During the year, Elaydi will develop deeper understanding of biology through doing the experiments himself as well as attending Biol 1311 (Integrative Biology) in the fall and Biol 3434 (Ecology) in the spring. Moreover, he will be attending some selected seminars in the biology department throughout the year. This will be of tremendous value in writing the lab manual and the textbook. On the other hand, the second PI will gain greater insight into the mathematics behind the biological models while teaching Biol 3434. He will be holding regular meetings with the first PI to discuss the mathematical models and their validity vis-à-vis experimental data.

We now discuss, in details, the narratives of each manuscript.

Laboratory Manual

We will develop 12 laboratory experiments. The instructors of the course can select from five to seven experiments during the semester. Since one of our objectives is to disseminate this course to all colleges and universities, we are giving prospective instructors greater flexibility in the selection of laboratory experiments.

We will conduct these experiments our selves with the help of one Trinity student in the summer of 2007. The collected data will then be used to verify and modify, if necessary, the mathematical models in the Mathematical Models in Life Sciences course. During the summer we will employ an undergraduate student to maintain the experimental organisms and carry out sample experiments. The PIs have requested Trinity support for summer housing for the employed student.

Lecture Notes

The Lecture Notes will incorporate the new knowledge and experience gained by the two PIs during the year. Moreover, the notes will incorporate the results of the new laboratory experiments that will be developed in the summer of 2007.

The book will include a supplement on the Maple programs needed for the course. Maple is a computer algebra system that is used widely in scientific computing. It is the computer algebra system that has been used in the Geosciences-Math-Physics laboratory at Trinity University in the last 15 years. Though the Maple supplementary will be designed for the Mathematical Models in Life Sciences course, it may, however, be used in courses in the natural sciences , psychology, social sciences, business, economics, engineering and mathematics. It is a great tool to be learned by all students, particularly those in the natural sciences.

Evaluation, dissemination, and sustainability

Success will be measured in several quantifiable ways. First, enrollments in this course will be tracked through time. In our initial offering of this course there were only 2 “official” students (there were 2 others sitting in on the course including one Biology laboratory assistant and a Howard Hughes Medical Institute postdoctoral fellow), and we plan to get these number up to at least 6 per year. This will be accomplished by advertising the course as well as cross-listing it as a Biology course within the Biology Department.

We will also monitor how Biology students perform on their Major Field Test (MFT) which is part of their requirements for graduation in the Biology Department. A part of the assessment on this examination is characterized as “Analytical Skills”. If we are successful with this interdisciplinary course we would expect Biology students that have taken this course to outperform their Biology peers at Trinity who have not taken this course.

Dissemination of our course will be accomplished through a unique textbook. We are not familiar with any other textbooks that cover this material in the way that we propose. We will also make presentations at the Trinity HHMI meetings and ACS meetings that are designed to disseminate interdisciplinary teaching models. We will consider publishing our course outline and assessment in journals such as *American Biology Teacher*.

This course will be sustained since it is an integral part of the Scientific Computing minor at Trinity University.

Budget

Item	Amount
Supplies for Summer Experiments	500.00
Student Stipend for June and July, 2007	3000.00
Faculty Stipends	5000.00
TOTAL REQUEST	8500.00

C.V. of Faculty Participants

David O. Ribble

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Education and Training:

- 1978 - 82 B.A. in Biology, Trinity University, TX
- 1982 - 85 M.S. in Wildlife Biology, Colorado State University
- 1985 - 90 Ph.D. in Zoology, University of California, Berkeley
- 1990 - 92 NATO Postdoctoral Fellow, University of Western Ontario, Canada

Faculty Positions:

- 1992 - 98 Assistant Professor, Department of Biology, Trinity University, San Antonio, TX
- 1998 - 01 Associate Professor (tenured), Department of Biology, Trinity University, San Antonio, TX
- 2000 Visiting Scholar, Department of Zoology, University of Natal, Pietermaritzburg, South Africa
- 2001 - 2004 Associate Professor & Chair, Department of Biology, Trinity University, San Antonio, TX
- 2004 - Current: Professor & Chair, Department of Biology, Trinity University, San Antonio, TX
- 2005 (fall) Sabbatical, Cuernavaca, Mexico
- 2006 (spring) Director of Associated Colleges of the Midwest "Nation Building and Development in Tanzania", University of Dar Es Salaam, Tanzania.

Recent Research and Fellowship Awards:

- 2006 Principal Investigator (M. Shubert, C. Schradin, N. Pillay, and D. von Holst Co-PIs). National Geographic Society Research Grant: Evolution of monogamy in the round-eared elephant shrew (*Macroscelides proboscideus*) (\$17,500).
- 2005 (fall) Academic Leave from Trinity University
- 2003 Principle Investigator (M. Brodl and J. B. King Co-PIs). NSF REU Supplement to Multi-User Equipment Grant: Image Acquisition and Analysis Facility to Enhance Faculty-Student Research (\$ 21,525)
- 2002 - 04 Principle Investigator (M. Brodl, L. Espey, N. Young, Co-PIs, and R. Blystone, J. King, D. Miller, B. Rushing contributors) NSF RUI DBI Multi-User Equipment Grant: Image Acquisition and Analysis Facility to Enhance Faculty -Student Research (\$102,149)
- 2002 - 03 Principle Investigator, National Park Service Contract to Survey the Terrestrial Mammals of the San Antonio Missions National Historic Park (\$12,982)
- 2000 (fall) Academic Leave from Trinity University

Institutional Initiatives

- 2005 Co-PI (with D. Pope, K. Lyons, J. Shinkle, and K. Livingstone). Associated Colleges of the South Science Reform Mini-grant (with Keck Foundation Support), Integrative Biology at Trinity University (funded at \$14,668).
- 2004 Contributor and Curriculum Director (with M. Brodl (PI), E. Clark, N. Mills, J. King, and J. Shinkle), Howard Hughes Medical Institute, Interdisciplinary Integrations in Teaching and Research (funded \$1,000,000).
- 2003 Contributor (with M. Brodl (PI), M. Bushey, J. King, W. Kurtin, K. Livingstone,

- N. Mills, J. Shinkle, and J. Spence), W. M. Keck Foundation, Research Collaborations Between Chemists and Biologists to Drive Interdisciplinary Curricular Innovations (funded \$500,000).
- 2003 Co-PI (with P. Kelleher (PI), E. Roy, F. Loxsom, and N. Mills), NSF Robert Noyce Scholarships at Trinity University (\$500,000).

Peer-Reviewed Publications: (*Denotes Trinity University Undergraduate)

- Ribble, D.O., and M.H. Smith. 1983. Relative intestine length and feeding ecology of freshwater fishes. *Growth* 47:292-300.
- Ribble, D.O., and F.B. Samson. 1987. Microhabitat associations of small mammals in southeastern Colorado, with special emphasis on *Peromyscus* (Rodentia). *Southwestern Naturalist* 32:291-303.
- Ribble, D.O., and M. Salvioni. 1990. Social organization and nest co-occupancy in *Peromyscus californicus*, a monogamous rodent. *Behavioral Ecology and Sociobiology* 26:9-15.
- Ribble, D.O. 1991. The monogamous mating system of *Peromyscus californicus* as revealed by DNA fingerprinting. *Behavioral Ecology and Sociobiology* 29:161-166.
- Ribble, D.O. 1992. Dispersal in a monogamous rodent, *Peromyscus californicus*. *Ecology* 73:859-866.
- Ribble, D.O. 1992. Lifetime reproductive success and its correlates in the monogamous rodent, *Peromyscus californicus*. *Journal of Animal Ecology* 61:457-468.
- Ribble, D.O., and J.S. Millar. 1992. Inbreeding effects among inbred and outbred laboratory colonies of *Peromyscus maniculatus*. *Canadian Journal of Zoology* 70:820-824.
- Ribble, D.O., and J.S. Millar. 1992. Intraspecific variation in testes size among northern populations of *Peromyscus*. *Functional Ecology* 6:455-459.
- Lechner, K.A.*, and D.O. Ribble. 1996. Behavioral interactions between red imported fire ants (*Solenopsis invicta*) and three rodent species of south Texas. *Southwestern Naturalist* 41:123-128.
- Ribble, D.O., and J.S. Millar. 1996. The mating system of northern populations of *Peromyscus maniculatus* as revealed by radiotelemetry and DNA fingerprinting. *Ecoscience* 3:423-428.
- Conditt, S.A.*, and D.O. Ribble. 1997. Social organization of *Neotoma micropus*, the Southern Plains woodrat. *American Midland Naturalist* 137:290-297.
- Ribble, D.O., and Stanley, S.* 1998. A comparison of the home ranges and social organization of syntopic *Peromyscus boylii* and *P. truei*. *Journal of Mammalogy* 79:932-941.
- Schnepf, K.A.*, J.A. Heselmeyer*, and D.O. Ribble. 1998. Effects of cutting Ashe juniper woodlands on small mammal populations in the Texas Hill Country. *Natural Areas Journal* 18:333-337.
- Peles, J.D., A.L. Bryan, Jr., C.T. Garten, Jr., D.O. Ribble, and M.H. Smith. 2000. Ecological half-life of ¹³⁷Cs in fish from a stream contaminated by nuclear reactor effluents. *Science of the Total Environment* 263:255-262.
- Ribble, D.O., A.E. Wurtz*, E.K. McConnell*, J.J. Buegge*, and K.C. Welch, Jr.*. 2002. A comparison of home ranges of two species of *Peromyscus* using trapping and radiotelemetry data. *Journal of Mammalogy* 83:260-266.
- Mzilikazi, N., B.G. Lovegrove, and D.O. Ribble. 2002. Exogenous passive heating during torpor arousal in free-ranging rock elephant-shrews, *Elephantulus myurus*. *Oecologia* 133:307-314.
- Farmer, N.A.*, D.O. Ribble, and D.G. Miller. 2004. Influence of familiarity on shoaling behaviour in Texas and blacktail shiner. *Journal of Fish Biology* 64:776-782.

Ribble, D.O., and M.R. Perrin. 2005. Social organization of the Eastern Rock Elephant-shrew (*Elephantulus myurus*): The evidence for mate guarding. *Belgian Journal of Zoology* 135(supplement):167-173.

Coster, S.*, and D.O. Ribble. 2005. Density and cover preferences of Black-and-rufous elephant-shrews (*Rhynchocyon petersi*) in Chome Forest Reserve, Tanzania. *Belgian Journal of Zoology* 135 (supplement):175-177.

Book Chapters:

Ribble, D.O. 2003. The evolution of social and reproductive monogamy in *Peromyscus*, evidence from *Peromyscus californicus* (the California Mouse). Pages 81-92 in U. Reichard and C. Boesh (eds), *Monogamy: Mating Strategies and Partnerships in Birds, Humans, and other Mammals*. Cambridge University Press.

M.C. Kalcounis-Rueppell, and D. O. Ribble. In press. Phylogenetic Analysis of the Socioecology of Neotomine-Peromyscine Rodents; in J.O. Wolff, and P.W. Sherman (eds), *Rodent Societies: An Ecological and Evolutionary Perspective*. University of Chicago Press.

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Education:

Ph.D. in Mathematics, University of Missouri, Columbia 1978.

Employment:

- Professor, Trinity University, 1991-.
- Chair, Trinity University, 1991-1999.
- Associate Professor, Trinity University, 1989-1991. Associate Professor, University of Colorado at Colorado Springs, 1984-1989. Assistant Professor, Kuwait University, 1978-1983.
- .Visiting Scholar: Howard University (2006), University of California-Berkeley (Spring 2001), University of Augsburg (Summer 2001), Birzeit University (Fall 2000), University of Florence (Fall 1994).

Recent Grants:

- NSF Grant, DMS 2006-2007
- REU-NSF Grants, DMS-9619837, 1997-2000, 2001-2004.
- Fulbright Grant, 2000.
- NSF Grant, DMS-9706954, 1997-2000.
- Trinity University Course Development Grant (with Ribble), summer 2007.

Synergetic Activities:

- Co-Editor-in-Chief, Journal of Difference Equations and Applications, Taylor & Francis-1994-
- Co-Editor-in-Chief, Journal of Biological Dynamics (JBD), Taylor & Francis, 2006-
- Editor-in-Chief, Journal of Education Quality (JEQ), International Society of Education, Kyoto, 2007-
- Member of the editorial board of Journal of Computational and Applied Analysis, 1998-
- Member of the editorial board of Journal of Computational and Applied Analysis, 1998-
- Member of the editorial board of the International Journal of Mathematics and Computer Science, 2005-
- President, The International Society of Difference Equations, 2005-
- *Director of the Minor in Scientific Computing, Trinity University, 2006-*

Research Interests:

Discrete Dynamical Systems, Difference Equations, and Mathematical Biology

Recent Books:

1. Discrete Chaos, Chapman &Hall / CRC 2000.
2. An Introduction to Difference Equations, Third Edition, Springer, 2005.
3. (Editor) Mathematics Research at the leading edge, NOVA 2006.

4. (Editor) *Difference Equations and Discrete Dynamical Systems*, Proceedings of the 9th International Conference, University of Southern California, World Scientific, 2005
5. (Editor) *Difference and Differential Equations*, Fields Institute Communications, American Mathematical Society, Providence, 2004.
6. (Editor) *New Progress in Difference Equations*, Chapman & Hall/CRC, Boca Raton, 2004.
7. (Editor) *New Trends in Difference Equations*, Taylor & Francis, London, 2002.
8. (Editor) *Mathematics & Mathematics Education*, World Scientific, Singapore, 2002.
9. (Editor) *Proceedings of Mathematics Conference*, World Scientific, Singapore, 2000.
10. (Editor) *New Developments in Difference Equations and Applications*, Gordon and Breach, 1999.

Recent Refereed Papers:

1. Population Models in almost periodic environment, Accepted in *Journal of Difference Equations and Applications* (with Diagana, Yakubu).
2. Periodic difference equations, population biology and the Cushing-Henson conjecture, *Mathematical Biosciences* 201 (2006), 195-207 (with Sacker)
3. An extension of Sharkovsky's theorem to periodic difference equations, *J. Math Anal. Appl.* Vol. 316, pp. 128-141 (2006) (with AlSharawi, Angelos, Rakesh).
4. Nonautonomous Beverton-Holt models and the Cushing-Henson Conjectures, *J. Diff. Eq. Appl.* Vol. 11 (pp. 337-347), 2005.
5. Global stability of periodic orbits of nonautonomous difference equations in population biology and the Cushing-Henson conjectures. *Proceedings of the Eighth International Conference on Difference Equations and Applications*, 113--126, *Chapman & Hall/CRC, Boca Raton, FL*, 2005 (with Sacker).
6. Global stability of periodic orbits of nonautonomous difference equations and population biology, *Journal of Differential Equations*, Vol. 208, pp. 258-273 (2005) (with Sacker).
7. Difference Equations versus Differential Equations, a possible equivalence, *Physica D*, Vol. 195/ 1-2 (2004), pp. 29-49 (with Letellier et al).
8. Basin of attraction of periodic orbits and population biology, *J. Diff. Eq. Appl.*, Vol. 10(10), 881-888 (2004), (with Sacker).
9. Asymptotic stability of linear difference equations of advanced type, *J. Computational Anal. Appl.*, Vol. 6, No. 2, 423-428 (2004) (with Dannan).
10. Difference equations from discretization of continuous epidemic models with disease in the prey, *Canadian Applied Math Quarterly*, Vol. 11, pp. 93-101, 2003 (with Jang)
11. Stability of hyperbolic and non-hyperbolic fixed points of one-dimensional maps, *J. Diff. Eq. and Appl.* 9(2003), 449-457 (with Dannan, Ponomarenko)
12. Is the world evolving discretely? *Advances in Applied Math*, 31(2003), 1-9.
13. Poincaré-type solutions of systems of difference equations, *J. Math. Anal. Appl.* 275 (2002), 69-83 (with Abu-Saris, Jang).

Disclosure Statement

David Ribble and Saber Elaydi will be supported in part by a stipend from Trinity University (total of \$4000) to support this work in June 2007. David Ribble will also be collaborating with a student during the summer months to work on genetic analyses of paternity. All of this work will be carried out on the Trinity University campus.