Mathematical Biology Newsletter

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ANNUAL MEETING

The SMB participated as a Guest Society at the Federation of American Societies for Experimental Biology (FASEB) in Las Vegas, May 1-5, 1988. Business and board meetings were held on May 2 and 3. The scientific sessions, organized by Hans Othmer and held on May 4, were arranged through the American Physiological Society, and sponsored jointly with the American Mathematical Society and the Society for Industrial and Applied Mathematics. The theme of this year's sessions was "The Dynamics of Excitable Media." These sessions also served as the twenty-second annual symposium on Some Mathematical Questions in Biology.

SCIENCE AT THE ANNUAL MEETING

(Communicated by Hans Othmer)

Six talks covering the mathematical and experimental aspects of current research in excitable media were presented. Professor J. Alexander of the University of Maryland spoke on "Forced Excitable Systems and Bursting." While much is known about the response of periodically-forced oscillatory systems, much less has been done on forced excitable systems, despite the fact that such systems occur very widely. Alexander showed that the analysis of a simple model can give insight into the resonance structure of forced excitable systems, and that some of the analytical results are very similar to what Jose Jalife and co-workers have observed experimentally in forced Purkinje fibers.

Professor Jose Jalife of the SUNY Health Sciences Center in Syracuse discussed his recent work on the mechanisms of sinoatrial pacemaker synchronization. He described computer simulations of a two-dimensional network of resistively-coupled cells that model SA node cells. The results show that the model can accurately simulate the activation sequence seen experimentally in the rabbit sinus node when the basic cycle length of the pacemakers and the intercellular resistances are chosen appropriately.

Two related talks were devoted to propagation in cardiac tissue. In the first talk, Fred Phelps of the University of Utah discussed his work with J. Keener on models for anisotropic cardiac tissue. These authors have studied a model for the effect of a premature stimulus on the myocardium, and make certain predictions about the role of intercellular coupling in the onset of tachycardia or fibrillation. In the second talk, Professor Robert Plonsey of Duke University discussed the bidomain model of excitable media. In this model, excitable tissue is treated as two coupled, interpenetrating continua comprising the intracellular and interstitial spaces. A number of results on wave propagation in one-and two-dimensional media were presented which show that there are features of propagation that are simulated in the bidomain model but which cannot be reproduced in single-phase continuum models.

Other aspects of excitable media were discussed in the lectures given by Professor Peter Monk of the University of Delaware and by Dr. Roger Traub from IBM Research. The cellular slime mold Dictyostelium discoideum is a widely-studied developmental system that exhibits many of the fundamental morphogenetic processes found in other systems. In the aggregation phase, randomly-located cells begin periodic emission of the chemoattractant cyclic adenosine monophosphate. Other cells respond to super threshold levels of the signal by amplifying and relaying it, and move toward the source. The net result of this process is a compact aggregate of cells that undergoes further developmental changes, but in the process of aggregation, a variety of striking wave patterns are observed. In his lecture, Monk described a mathematical model, based on laboratory measurements of relay and adaptation, that accurately reproduces the experimental results under clamped conditions. This model provides an input-output model for the response of individual cells to extracellular cyclic adenosine monophosphate, and was used to simulate the wave patterns in aggregation. Monk presented a number of examples of single and double spiral waves, generated using a variety of initial conditions, that demonstrate how well the model agrees with the observed waves.

Dr. Traub discussed his recent numerical simulations of a model for the longitudinal CA3 slice. Each cell is described using a number of dendritic compartments and voltage-and calcium-dependent conductances. The model enables one to understand a number of experimental observations, including the production of slowly propagating waves when inhibition is fully blocked, and the existence of oscillations in population activity at periods faster than the interburst intervals of individual cells. The latter result is in contrast with, e.g., the SA node, where the observed frequency of a synchronized network of coupled cells is usually, but not inevitably, lower than the frequency of the fastest cells in the network.

More details about any of the talks can be found in the papers to appear in the proceedings of the symposium. The proceedings will be edited by Hans Othmer and will be published by the American Mathematical Society in 1989.

BUSINESS AT THE ANNUAL MEETING

(From minutes taken by Colleen S. Martin)

Simon Levin, in his President's Report, noted he would like to: 1) strengthen communication among members, especially through the Newsletter (Levin suggested newsletter coverage could be broadened by creating an editorial board); 2) expand membership; 3) increase the benefits of membership; 4) increase the national and international role of SMB; 5) strengthen the Bulletin; and 6) expand the meetings program.

SMB has been granted society membership status with the American Institute of Biological Sciences (AIBS), and Torcom Chorbajian has agreed to serve as the SMB representative to attend AIBS council meetings.

SMB will join SIAM and AMS in the joint AMS-SIAM-SMB Committee on Mathematics in the Life Sciences, and will co-sponsor, with SIAM and AMS, the yearly symposium on Mathematical Questions in Biology. The 1989 symposium will be organized by Marc Mangel on the topic of "Sex Allocation and Sex Change: Experiments and Models," and will be held at the annual AIBS meeting in Toronto, August 6-10, 1989.

Don Marsh reported on the possible establishment of a regular study section at NIH on mathematical biology and computers. This study section would consider funding requests and ensure that proposals in the area of mathematical biology receive fair consideration. The Board recommended that Levin send a letter to Mischa Friedman, Div. of Research Grants, NIH, Washington, D.C., noting that the SMB Board of Directors strongly supports such a group. SMB members also are urged to write to NIH expressing support of this effort. Note: Mischa Friedman has retired and has been replaced by Jeanne Ketley.

Torcom Chorbajian gave the Treasurer's Report and reported a balance of $66,461, of which about $35,000 is the Landahl Scholarship Fund. Expenses for the year totaled $22,725; total income was $23,350.

Chorbajian announced the SMB election results. Stuart Kauffman and Nancy Kopell were elected to serve on the Board of Directors for a two-year term, replacing Torcom Chorbajian and Paul Rapp, whose

terms expired in spring, 1988.

The current Landahl endowment is $35,000, plus interest. The Board voted to expend the interest on the endowment each year in support of travel awards to SMB-associated meetings. Only graduate students will be eligible for awards, and no individual award will exceed $500. There will be two deadlines each year for submitting requests for travel awards. The Board recommended the Landahl Scholarship Endowment Committee be established as a standing committee of SMB.

Michael Conrad filed a written Secretary's Report. Major points included a report on international cooperation efforts of the Society. The Board reaffirmed the president's authority to negotiate with counterpart societies or groups in other parts of the world. The international meeting report also described preliminary attempts by SMB to co-sponsor an international meeting. The report suggested that SMB might consider sponsoring and organizing its own international meeting. Also included in the report was a description of the current status and plans for the Newsletter.

Alan Perelson, chairman of the Publications Committee, noted important changes in the Bulletin, both in its physical appearance and in its content.

Brian Scanlan presented the Publisher's Report for Pergamon Press. Following discussion, the Board directed Levin to negotiate an agreement with Pergamon on: 1) the possible increase in Pergamon charges for publishing the Bulletin; 2) Pergamon's assistance in a membership campaign; 3) a possible $1,000 Pergamon Prize; and 4) sponsorship of the 50th Anniversary meeting. Details of the negotiations appear below.

Levin requested that the Treasurer work aggressively to get SMB members out of arrears with their dues. A suggestion was made that the Treasurer send the invoice for dues three months earlier than in the past. This will give members time to pay the dues before their membership expires.

The Board discussed whether advertisements should be accepted for publication in the Newsletter. It was agreed that ads will be accepted from equal opportunity employers only, and that the Treasurer will work up a rate structure proposal for consideration. Post-doctoral announcements submitted by SMB members will be printed in the Newsletter free of charge.

OTHER SMB NEWS

Capasso to organize European meeting. At the suggestion of S. Levin and with the approval of the Board, Professor Vincenzo Capasso of Bari has undertaken to organize an Italian section of the SMB and to use this initiative as a stimulus for bringing together similar chapters throughout Europe. Professor Capasso has also agreed to organize a European meeting of the Society in January or February, 1990. The SMB Board has officially endorsed this meeting.

Mimura to organize Japanese section. Also at the direction of the Board, Professor Mayan Mimura of Hiroshima University has undertaken to organize a Japanese section of the SMB. This is an important step in the Society's internationalization efforts.

Michael Reed to chair Landahl Scholarship Committee. The Society has about $35,000 in this fund, which was set up by former President Herbert Landahl. Each year, up to $2,500 (the interest earnings) can be awarded to graduate students attending SMB-affiliated meetings. Awards will not exceed $500 per individual. For further information, contact Dr. Michael C. Reed, Department of Mathematics, Duke University, Durham, NC 27701.

SMB Elections. A President-elect and two new members of the Board are to be elected this year. The chairman of the Nominations Committee is Alan Perelson (Los Alamos National Laboratory, T-10, MS-M710, Los Alamos, NM 87545). SMB members are encouraged to transmit suggestions to Alan.

Agreement with Pergamon; SMB Dues Increase. Negotiations between Simon Levin and Pergamon Press, referred to in the minutes of the business meeting, resulted in an agreement on the following items (each effective in 1989): 1) beginning in 1989, SMB will raise the amount it pays Pergamon for each member subscription from $20 to $25; 2) Pergamon will provide an annual prize of $1,000 for the best paper printed in the Newsletter; 3) Pergamon will provide $5,000 in travel expenses for the 1989 Anniversary Meeting in Oxford; and 4) Pergamon will provide assistance in our

membership drive, which would include such items as distributing leaflets at book exhibits and providing access to their mailing lists.

As a result of the agreement, the SMB Board has approved a dues increase from $30 to $35, effective with the 1989 membership year. Student dues will remain at $15.

SMB MEETINGS

(Communicated by Marc Mangel)

Last year, the SMB joined AMS and SIAM in sponsoring the series, "Mathematics in the Life Sciences." Details of the 1988 meeting are reported earlier in the Newsletter. The 1989 meeting will be held in conjunction with the American Institute of Biological Sciences (AIBS) meeting in Toronto during the week of August 6-10. The topic of the meeting is "Sex Allocation and Sex Change: Models and Experiments." The tentative line-up for the one-day symposium includes the following speakers: Maureen Stanton (UC, Davis); Paulette Bierzychudek (Pomona College); Sabin Lessard (Universite de Montreal); Robert Warner (UC, Santa Barbara); Peter Petraitis (University of Pennsylvania); and Donna Fernandes (University of Liverpool).

As an inauguration of the Special Issues of the Bulletin, the Society is sponsoring, in conjunction with the Institute for Mathematics and Applications (IMA, the British version of SIAM), a meeting entitled, "Classics of Theoretical Biology." The meeting will be held during the week of July 3, 1989, in Oxford, and the proceedings of the meeting will be published as a special issue of the Bulletin of Mathematical Biology and as a separate volume by Pergamon. The volume will contain reprints of classic papers in various areas of theoretical biology, each accompanied by a short discussion paper by an expert in the field explaining why the paper is a classic, how the field has developed, etc. The current line-up of speakers and topics is: John Rinzel and Jack Cowan (Neurophysiology); James Murray (Development); William Reed (Bioeconomics); Robert May (Ecology); Roy Anderson (Epidemiology); and William Provine (Population Genetics).

OTHER PERTINENT MEETINGS

4th Conference on Irreversible Processes and Self-Organization. (February 19-25, 1989, Rostock, GDR.) This meeting, organized by the Physical Society of the GDR, the Humboldt University of Berlin, and the Wilhelm-Pieck University at Rostock, will provide an opportunity for the presentation and discussion of results and trends in:

- stochastic and statistical theory of nonequilibrium processes
- dissipative structures, autowave processes, and nucleation
- models of evolutionary processes and strategies
- nonlinear networks, associative memory and pattern recognition

The scientific program will include plenary lectures, short papers, and posters. For further information, contact: Professor Werner Ebeling, Sektion Physik, Humboldt Universität zu Berlin, Bereich 04, 4th IPSO, Invalidenstr. 42, DDR-1040, Berlin G.D.R.

International Symposium on Mathematical Models of Cellular Processes. (November 19-23, 1989, Holzhau (near Dresden), GDR.) This symposium is being organized by the Society for Physical and Mathematical Biology of the GDR in collaboration with the Biochemical Society of the GDR, the Humboldt University, and the Academy of Sciences of the GDR.

Organizing Committee: R. Heinrich (Secretary, Berlin); H.G. Holzhütter (Berlin); J. Reich (Berlin); and L. Pratsch (Berlin).

Scientific Advisory Committee: R. Bohnensack (Magdeburg); A. Colosimo (Rome); M. Conrad (Detroit); A. Cornish-Bowden (Marseille); A. Goldbeter (Brussels); H.P. Herzel (Berlin); A. Holden (Leeds); W. Knorre (Jena); P. Kuchel (Sydney); M. Markus (Dortmund); J.P. Mazat (Bordeaux); D. Mikulecky (Richmond); S.M. Rapoport (Berlin); A. Schiewagen (Leipzig); H.V. Westerhoff (Bethesda); and H. Willer (Berlin).

The main topics of the symposium are:

- New theoretical approaches to biomathematical modeling
- Models of various cellular processes

(biochemical networks, membrane transport, gene expression, morphogenesis, immunological processes, neurobiological processes, etc.)
- Application of mathematical models in medicine and biotechnology.

The symposium will comprise invited papers. Posters and short communications in round-table discussions will be welcomed from all participants. Preliminary registration fee: 180 Marks; full board for 5 days: 200 Marks. All requests should be sent to the organizing committee at the following address (before April 10, 1989): International Symposium on Mathematical Models of Cellular Processes, Gesellshaft für Physikalische und Mathematische Biologie der DDR, Am Kupfergraben 7, Berlin, 1080, German Democratic Republic.

American Association for the Advancement of Science. The 1989 Annual Meeting of the AAAS, January 14-19 in San Francisco, will feature many outstanding expository talks by prominent mathematicians. These include the following symposia (3-hour sessions) sponsored by Section A (Mathematics) of AAAS:

- Chaos and Dynamical Systems, organized by Jerrold E. Marsden. (Robert Devany, Philip Holmes, James Yorke, Stephen Smale.)
- Monte Carlo Methods, Statistical Mechanics, and Combinatorial Optimization, organized by Nicholas C. Metropolis and Lawrence Goldstein. (J.D. Doll, Steward Geman, Brosl Hasslacher, Lawrence Goldstein, G.S. Guralnik.)
- The Next Generation of Neural Nets, organized by David H. Sharp. (Dana Ballard, Eric Mjolsness, David H. Rumelhart, John S. Denker, David Haussler.)
- Mathematics and Molecular Biology, organized by Michael S. Waterman. (Michael S. Waterman, Eric Lander, Samuel Karlin, James White.)

This year's AAAS Annual Meeting will be held in tandem with the Joint Annual Meeting of the American Association of Physics Teachers and the American Physical Society. The AAAS program will also feature various symposia honoring the sesquicentennial of the American Statistical Association. In view of this rich interplay, Section A of AAAS is also co-sponsoring various symposia that will be of interest to mathematicians and mathematics educators. These include:

- Chaos in Neural Networks
- Chaos in Biological Systems: Physiology, Medicine and Ecology
- Chaos in Physical Systems: Studies of Turbulence
- Chaos in Physical Systems: Studies of Quantum Systems
- Chaos in Physical Systems: Astronomy and Celestial Mechanics
- Chaos in Global Affairs: Economics and the Arms Race
- Spatial Statistics

Symposia proposals for future AAAS meetings should be sent to Warren Page, Secretary (Section A), New York City Technical College, CUNY, 300 Jay Street, Brooklyn, New York 11201.

AWARD TO SMB PRESIDENT

The Newsletter Editor has learned (but not from Simon Levin) that the current SMB president has received the Ecological Society of America MacArthur Award for 1988. The award is in memory of the outstanding mathematical ecologist, Robert H. MacArthur. It has been awarded annually since 1983 "for meritorious contributions to ecology with the expectation of continuing outstanding ecological research." Levin received the award on August 16 during the annual meeting of the Ecological Society, and will give the MacArthur Address at the annual meeting of the Ecological Society in Toronto in 1989.

LITERARY EVENTS

The Society for Industrial and Applied Mathematics has inaugurated its Classics series with Mathematics Applied to Deterministic Problems in the Natural Sciences, by C.C. Lin, Lee Segel, and George Handelman. Lee Segel is editor of the Bulletin of Mathematical Biology, the

official journal of the SMB. The book was noted for its success in showing how mathematics can be effectively applied in the physical sciences.

A new rapid publications journal, Applied Mathematics Letters, is being published by Pergamon Press. The purpose is "to provide a means of very rapid publication for important but brief applied mathematical papers...." All applications are welcome. For further information, contact the managing editor, Ervin Y. Rodin (Department of Systems Science and Mathematics, Box 1040, Washington University, St. Louis, MO 63130, USA).

The Universal Turing Machine: a Half-Century Survey, edited by Rolf Herken, Oxford University Press, 1988, 661 pp. Twenty-seven authors write on either the historical ideas leading to Turing's computational concepts or on their present-day implications. Several of the papers touch on biological issues or on ideas of biological relevance.

Kinetics of Biochemical Processes, V.L. Gatchok, Kiev Scientific Publishers (Kiev, USSR), 1988, 219 pp. (in Russian) A general monograph with specific focus on polyenzymatic systems under gene control, metabolic regulation and membrane potential stability, preturbulent regimes, steroid metabolism, and reaction-diffusion kinetics in the presence of immobilized enzymes.

Introduction to Theoretical Ecology, Peter Yodzis, Harper & Row, 1988. An introduction to ecological theory for upper-level undergraduate or graduate students with a year of ecology and calculus. The text covers growth of single populations in both continuous and discrete time; population interactions, including consumer-resource, competitive, predator, and whole-community; and the evolution of life-history strategies, featuring the theory of optimal resource allocation and reproductive value.

ART AND THEORETICAL BIOLOGY

(by Michael Conrad)

In this period, when we are moving towards internationalization of the mathematical and theoretical biology community, and towards putting biological and complex systems theory on the agenda of world science, we must work hard to ensure that our exhibition galleries--the journals and conferences--are fully ready to accommodate all the genres of discovery. The image of exhibition galleries can perhaps be of some use. The methodological styles of theoretical biology and the methodological categories used by the art critics have elements in common.

Realism in art, for example, has its analog in the attempt to map nature in detail in science. Abstraction becomes the attempt to delineate the essential patterns of nature. Impressionism corresponds to an attempt to perceive the essential elements of a reality too complex to map in detail. Expressionism is the attempt to give form to one's otherwise inchoate conception of reality. The art of fantasy and imagination has its equivalent in de novo invention and design, just of the type that the hopefully not too mad biotechnologist might contemplate.

In art, elements of each of the above styles enter into each piece of work. How can we really separate perception and impression from conception and expression? Who can map the elements of reality without abstraction, and what is the sense of doing so? What painting of a tiger is so realistic that we should go to the gallery with the hope of learning about its intermediary metabolism?

Theories and models in science also seem to be admixtures of elements. This feature was masked in the Newtonian model of science, where the concentration on simple systems led to the view that in an ideal scientific theory, a mathematical map should map nature in a one-to-one manner, and that there is no in-principle limit on how close the scientist could approach this ideal. Discoveries of limits to computation and limits to measurement have led to a more realistic conception. What is the sense of having a mathematical map of nature if one cannot compute that map with a programmable machine? But it is clear that a single benzene molecule vastly outpaces the most powerful supercomputer when it comes to behaving like benzene. And what is the sense of talking about a unique map for a unique system if the investigator himself becomes a causal agent in altering

critical organizational features of that system? We will always create something like the artifact that inevitably occurs in a work of art when the model is reactive (such as a human model) and the artist works at close range.

These limits mean that the scientist using the tools of mathematics and computer science must make choices, must focus on particular aspects or domains, just like the experimentalist working with a microscope. He may choose to focus on one or another particular cross-section of a circumscribed domain of nature in detail, at the expense of limiting the range of conditions under which the description is valid; or he may choose to focus with less resolution on more aspects of a broader domain. The map may be an impression of the territory, an expression of our conception of it, a detail of selected features of a particular part, an architectonic of highly abstracted features, or a plan for restructuring. The objective at hand determines which of these genres dominates, and which media should be used (oils or differential equations, mosaic tiles or cellular automata, calligraphy or formal languages...). The important point is that all involve abstraction and simplification. If the map could be as real and complicated as the territory, it would not be suitable as a tool of discovery.

It may be objected that our analogy is flawed since art wheels and deals in beauty, while science wheels and deals in truth. Truth, at least in the empirical sciences, is a more difficult matter than beauty. Testing a model against experience in a public manner through inductive and deductive methodologies is essential. In a universe in which every map bears the mark of the investigator's choices, discovery may be the more "realistic ideal." We can practically describe it as the recognition, using publically available tools, of a phenomenon or relationship that is surprising and significant to the individual and the community. Wilhelm Roentgen, for example, knew that he had discovered something important when he saw the bones of his hand displayed on a screen. A primal cave scientist might have thought the observation no more noteworthy than a thunderclap. Roentgen had the advantage of having a well developed framework at his disposal that could be wrong and that therefore could serve to reveal an important "x" in the structure of science. The discovery of x-rays required not only a territory, but a pre-existing map.

If limits of computation and measurement considerations are correct, there must, in general, be many different but equally valid maps for any territory, and indeed many ways of choosing the territory in the first place. Admitting all of these into the gallery increases the possibilities for discovery, just as admitting all the genres of art increases the possibilities for experiencing beauty. It is here that the analogy between science and art is instructive for theoretical biology and possibly for physics and other traditional domains of science as well.

THE LANDAHL TRAVEL AWARDS

The Society for Mathematical Biology has funds to partially support the travel of graduate students to meetings co-sponsored by the Society including the IMA meeting in Oxford, England (July 3-8, 1989), the Fortieth Annual Meeting of the AIBS in Toronto, Canada (August 6-10, 1989), and the Second Annual Meeting of the INNS (September 5-9, 1989). Graduate students who wish support may apply to:

Michael C. Reed
Department of Mathematics
Duke Univeristy
Durham, NC 27706

The application, which should be received by April 1, 1989, should include a one page research summary and one letter from a faculty sponsor.
