The 2005 Kyoto Prize Workshop : Symposium of Basic Sciences Category

Biosphere as a Complex Adaptive System

1:00 pm - 5:00 pm, November 12, 2005 (Sat.)
Kyoto International Conference Hall

Coordinator and Moderator
Yoh Iwasa (Chairman, Kyoto Prize Selection Committee; Professor, Faculty of Sciences, Kyushu University)

1:00 **Opening Address**
Toshitaka Hidaka (Chairman, Kyoto Prize Committee; Director-General, Research Institute for Humanity and Nature)
Introduction to Laureate
Yoh Iwasa

1:15 **Laureate Lecture**
Simon Asher Levin (the Laureate in Basic Science)
"Learning to Live in a Global Commons: Socioeconomic Challenges for a Sustainable Environment"

2:15 **Lecture**
Nanako Shigesada (Professor, Faculty of Culture and Information Science, Doshisha University)
"Spatial Dynamics in Ecology"

2:50 **Intermission**

3:10 **Lecture**
Norio Yamamura (Professor, Center for Ecological Research, Kyoto University)
"Evolution of Interspecific Interaction and Stability of Biological Community"

3:45 **Lecture**
Akio Takenaka (Team Leader, Biodiversity Conservation Research Project Group, National Institute for Environmental Studies)
"Patterns in Forest Ecosystems and Processes at the Tree Level"

4:20 **Lecture**
Mayuko Nakamaru (Associate Professor, Graduate School of Decision Science and Technology, Tokyo Institute of Technology)
"Social Sciences and Ecology"

4:55 **Closing**

Organized by Inamori Foundation
Supported by Kyoto Prefectural Government, Kyoto City Government, and NHK
Cooperated by The Ecological Society of Japan, Japan Ethological Society, The Japanese Society for Mathematical Biology, Society of Evolutionary Studies, Japan, The Society of Population Ecology, and The Society for the Study of Species Biology

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Professor Simon Asher Levin
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Learning to live in a Global Commons: Socioeconomic Challenges for a Sustainable Environment

Ecologists, economists and other social scientists have much incentive for interaction. First of all, ecological systems and socioeconomic systems are linked in their dynamics, and these linkages are key to coupling environmental protection and economic growth. Beyond this, however, are the obvious similarities in how ecological systems and socioeconomic systems function, and the common theoretical challenges in understanding their dynamics. This should not be surprising. Socioeconomic systems are in fact ecological systems, in which the familiar ecological phenomena of exploitation, cooperation and parasitism all can be identified as key features. Or, viewed from the opposite perspective, ecological systems are economic systems, in which competition for resources is key, and in which an evolutionary process shapes the individual agents to a distribution of specialization of function that leads to the emergence of flows and functionalities at higher levels of organization. Most fundamentally, ecological and socioeconomic systems alike are complex adaptive systems, in which patterns at the macroscopic level emerge from interactions and selection mechanisms mediated at many levels of organization, from individual agents to collectives to whole systems and even above. In such complex adaptive systems, robustness must be understood as emergent from selection processes operating at these many different levels, and the inherent nonlinearities can trigger sudden shifts in regimes that, in the case of the biosphere, can have major consequences for humanity. This lecture will explore the complex adaptive nature of ecosystems, and the implications for the robustness of ecosystem services on which we depend, and in particular examine the conditions under which cooperative behavior emerges. It will then turn attention to the socioeconomic systems in which environmental management is based, and ask what lessons can be learned from our examination of natural systems, and how we can modify social norms to achieve global cooperation in managing our common future. Of special interest will be issues of intragenerational and intergenerational equity, and the importance of various forms of discounting.

Lecture

Nanako Shigesada
Professor, Faculty of Culture and Information Science, Doshisha University

Spatial Dynamics in Ecology

In nature, almost every organism migrates or disperses to some extent leaving its natal site. The interplay of dispersal and local population dynamics in spatial mosaic can alter both the qualitative and quantitative dynamics, and hence ultimately determines the outcome of ecological processes, such as the stability, function and biodiversity of ecosystems. Thus the spatial ecology that explicitly accommodates spatial aspects has recently been drawing considerable attention of ecologists. Professor Levin has pioneered in bringing mathematical approaches to the spatial ecology and brilliantly resolved a number of fundamental themes in this field. As one of those having great influence from Prof. Levin, I will take up herein spatial dynamics of range expansion of biological invasions and introduce some mathematical models that explain characteristic features of expansion patterns. In particular, I will focus on the case that organisms extend their range by random diffusion as well as long-distance movements. The model is applied to the epidemic propagation of pine wilt disease that occurred in Ibaraki prefecture.

Lecture

Norio Yamamura
Professor, Center for Ecological Research, Kyoto University

Evolution of Interspecific Interaction and Stability of Biological Community

One of the greatest research achievements by Professor Levin is that he considered how the traits and interaction of individual organisms and their evolution effect on the dynamics of total ecosystems, and developed a research field connecting evolution and dynamics in ecology. Here, I explain how adaptive behavior or adaptive evolution effects on dynamics of the prey-predator system, especially its stability, in relation to my own researches. It is known that the prey-predator system sometimes shows a large cyclic oscillation. This pattern, however, drastically changes when the predator chooses prey menus adaptively (Optimal Foraging Strategy). This is explained in relation to Paradox of Enrichment that enrichment causes instability of aquatic systems theoretically while such phenomena are rare in nature. Furthermore, I explain the system where preys change defensive efforts depending on predation pressure (Optimal Defense Strategy).

Lecture

Akio Takenaka
Team Leader, Biodiversity Conservation Research Project Group
National Institute for Environmental Studies

Patterns in Forest Ecosystems and Processes at the Tree Level

"There is no single correct scale or level at which to describe a system" is a message Professor Levin repeatedly emphasized in his MacArthur Award Lecture (1992). If you look at forests from far distance, you will notice changing appearance of forests along the latitude. You may find smaller scale pattern along the altitude of mountains. At long time scale, the spatial patterns along latitudes and altitudes shift gradually responding to the climate change between glacial and interglacial periods. At closer look at forests, different species composition correlated with small topography will emerge. All these patterns of forests are related to the processes at individual tree levels: how and where they grow, mature and reproduce. In this presentation, I will introduce studies with simulation models of forest dynamics which connect the tree level processes to the forest level patterns. The main focus will be on the mechanisms of tree species coexistence in forest ecosystems, and how we can validate proposed hypotheses.

Lecture

Mayuko Nakamaru
Associate Professor, Graduate School of Decision Science and Technology,
Tokyo Institute of Technology

Social Sciences and Ecology

Which is more effective, a complicated model or a simple one? This is an important question in both ecological and social sciences that rely on mathematical models or computer simulations. In his 1999 book, Fragile Dominion, Professor Simon Levin points out that simple models have been very successful than complex ones in describing and analyzing ecological systems. Can simple models also succeed in the social sciences? Recently, the trend has been to use more complicated models to analyze and solve social problems arising in our society. However, it may be suitable to employ simple models, which often assume aspects of human behavior such as language ability, learning ability, cultural transmission and social norms, for studies on human society and behavior that take a more theoretical approach.
Here I will focus on two collaborations between Professor Simon Levin and myself—a study on the evolution of spite behavior in a lattice and an investigation of the spread of social norms in complex social networks—in order to show how simple models work in the field of social sciences.