Preface

Ecosystems are subject to significant environmental changes such as global warming, and our most important measures to cope with these changes should include maintenance of multifold ecosystem functions and services. Industrial technology alone is insufficient to cope with such changes not only because of the difficulties involved in timely innovation, but also because of limited and unpredictable resources and/or energy sources. Organisms and ecosystems possess inherent properties to maintain and adjust themselves in response to environmental fluctuation. For instance, movement flexibility, adaptive plastic responses and evolution of organisms may all help reduce loss of biodiversity. Adequate space and land also confer robustness. Furthermore, ecosystems have the innate ability to clean and decompose pollutants; so more effective management schemes for maintaining such abilities is essential. In support of current thinking (e.g., Levin, 1999) we propose a novel research domain, “ecosystem adaptability science”, covering a wide range of disciplines and academic fields (biology, ecology, ecosystem technology, and socioeconomics) to maintain and better harness the multiple functions and services of ecosystems. Robustness and stability are required not only for ecosystems themselves, but also for the technologies and social systems that affect them. Thus, our new ecosystem adaptability science will include a wide range of natural, economic and social scientific disciplines.

In this first International Forum, we focus on what makes ecosystems robust, including diversity, network structures of biotic and abiotic interactions, and the types and linkages of component habitats, and evolutionary potentials. We are hoping to provide a comprehensive understanding of these aspects of ecosystems that make ecosystems robust, and integrate them into a conceptual framework to guide future ecosystem management under changing environments.

Organizing Committee
Masakado Kawata, Tohru Nakashizuka, Jotaro Urabe, Takehiro Sasaki, Hiroko Kurokawa, and Hiroshi Tomimatsu
Sunday, February 21

Opening Remarks
13:00–13:05  Tohru Nakashizuka (GCOE Program Leader)

Special Guest Talk
13:20–14:10  Hiroaki Kitano – Biological robustness

Session 1. Evolutionary Response and Robustness
(Chairpersons: J. Bridle & J. Kitano)
14:10–14:50  Elizabeth Hadly – Mammalian responses to Cenozoic climate change
14:50–15:30  Jon Bridle – Evolution in response to ecological change: how easy, and how slow?

Tea Break

15:50–16:30  Roman Biek – Life in the evolutionary fast lane: viruses as ecological players and indicators
16:30–17:10  Jun Kitano – Genetic basis for rapid evolution in human-altered environments
17:10–17:50  Nathan Kraft – Functional traits, evolutionary history, and the dynamics of plant communities

Poster Session 18:00–19:00
Welcome Reception 19:00–21:00

Monday, February 22

Key Note Session
9:00–9:50  Mark Vellend – Landscape history and plant biodiversity
9:50–10:40  Katharine Suding – New models of ecosystems dynamics: the application of thresholds and feedbacks to management
10:40–11:30  Kevin McCann – Food webs as complex adaptive systems

Lunch
Session 2. Diversity and Robustness  
(Chairpersons: O. Petchey & T. Fukami)

13:00–13:40  **Shigeo Yachi** – Insurance effects of biodiversity on ecosystem functionings: its basic idea and recent development

13:40–14:20  **Owen Petchey** – By how much do extinctions reduce functional diversity?

Tea Break

14:40–15:20  **Thomas Valone** – Diversity–stability relationships in annual plant communities

15:20–16:00  **Martijn Bezemer** – Diversity and stability of plant and soil communities in semi-natural grasslands

16:00–16:40  **Gregory Crutsinger** – Insect diversity and stability is driven by plant genetic and species diversity

Tea Break

17:00–17:40  **Marcel van der Heijden** – Symbiont diversity as a driver of plant diversity and ecosystem functioning

17:40–18:20  **Tadashi Fukami** – Alternative transient states in community assembly

**Tuesday, February 23**

Session 3. Network Structure and Robustness  
(Chairpersons: T. Romanuk & M. Kondoh)

9:00–9:40  **Daniel Stouffer** – Understanding food-web persistence from local to global scales

9:40–10:20  **Colin Fontaine** – Structure and stability of mutualistic and trophic networks

Tea Break

10:40–11:20  **Tamara Romanuk** – Robustness of food webs to species invasions

11:20–12:00  **Michio Kondoh** – Food-web structure, community dynamics and population-level adaptation

Lunch

13:30–14:10  **José Montoya** – How robust is the structure and functioning of complex ecosystems to environmental warming?
14:10–14:50  **Christopher Wilmers** – Can predators reduce atmospheric CO$_2$ through trophic cascade?

**Session 4. Spatial Structure and Robustness**  
(Chairpersons: K. With & G. Takimoto)

14:50–15:30  **Peter Mumby** – Physical and ecological perspectives on the robustness of coral reefs

**Tea Break**

15:50–16:30  **Debra Peters** – Connectivity in resources across heterogeneous landscapes and robustness of arid and semiarid systems

16:30–17:10  **Gaku Takimoto** – The time dimension of spatial food webs

17:10–17:50  **Kimberly With** – Does order beget order? Self-organization and critical biodiversity in heterogeneous landscapes

**Wednesday, February 24**

**Presentation by Organizers**

9:00–9:40  **Organizers** – Ecological robustness: a capacity of ecosystems to continue functioning under global environmental changes

**General Discussion**

9:40–11:00

**Closing Remarks**

11:00  **Masakado Kawata**
Invited Presentations
**Biological robustness**

Hiroaki Kitano\(^1, 2\)

\(^1\) Sony Computer Science Laboratories, Inc., Tokyo, 141-0022, Japan;  
\(^2\) The Systems Biology Institute, Tokyo, 108-0071, Japan

Robustness is a ubiquitously observed property of biological systems. It is considered to be a fundamental feature of complex evolvable systems. It is attained by several underlying principles that are universal to both biological organisms and sophisticated engineering systems. Robustness facilitates evolvability and robust traits are often selected by evolution. Such a mutually beneficial process is made possible by specific architectural features observed in robust systems. But there are trade-offs between robustness, fragility, performance and resource demands, which explain system behaviour, including the patterns of failure. Insights into inherent properties of robust systems will provide us with a better understanding of complex diseases and a guiding principle for therapy design.


**Hiroaki Kitano** (E-mail: h.kitano@csl.sony.co.jp; kitano@sbi.jp)  
Understanding biological systems at the system-level has been my long standing research agenda. I have been working on systems biology since mid 90s. For systems-approach to be successful, one must integrate theory, computational infrastructure, and experiments in a coordinated manner. On the theory front, I have been trying to develop a "theory of biological robustness" which sheds lights on robustness and its trade-offs in biological systems.
Mammalian responses to Cenozoic climatic change

Elizabeth A. Hadly

Department of Biology, Stanford University, Stanford, CA 94305-5020

Environmental change has always impacted the Earth’s biota. Extracting the responses of populations, species and communities to perturbations of the past is one of the best ways of unraveling how they will respond to perturbations of the future. Historic data from large environmental events such as the Pleistocene-Holocene transition and the Medieval Warm Period (MWP) provide unique opportunities for insights into resilience of mammalian communities. The transition from the cold, arid Late Pleistocene (LP) to the warm, mesic Holocene interglacial witnessed extinction of many mammals in North America: 70 of ~220 of the largest species (32%) disappeared due to climatic and human stressors. The smaller mammalian survivors of the extinction (e.g., voles, gophers, ground squirrels, etc.) persisted but showed range changes, species turnover, diversity decline and significant alteration of population structure. For example, genetic data and serial coalescent modeling reveal a turnover in gopher species during the rapid warming of the LP Bølling-Allerød event, where one species (*Thomomys mazama*) retracted its southern range northward and the other species (*T. bottae*) increased in abundance. Consistent with these results, another gopher (*T. talpoides*) showed low genetic variation and low gene flow between populations during the last 3000 years, regardless of climate. Voles (*Microtus* spp.), which generally prefer mesic grasslands, declined dramatically during the MWP, but genetic responses differed between sympatric species. Population size reduction of voles was accompanied by gene flow in one species (*M. montanus*) and an increase in abundance of another (*M. longicaudus*). A more xeric specialist, the Uinta ground squirrel (*Spermophilus armatus*), increased in abundance during the MWP, and genotypes prevalent before the MWP declined, finally disappearing completely in present landscapes. Study of historic responses to past climatic change has fostered a richer understanding of how populations and species will interact with their environments to persist: by reshuffling individuals, increasing or decreasing population size, and favoring particular genotypes, all of which will leave a mark on our future communities.

Elizabeth A. Hadly (E-mail: hadly@stanford.edu)

Elizabeth Hadly works to understand the dynamics of vertebrate response to environmental change using fossils and modern data using genetics, isotopes, morphology, and modeling.
Evolution in response to ecological change: how easy, and how slow?

Jon Bridle

School of Biological Sciences, University of Bristol BS8 1UD, UK

Predicting ecological resilience depends on understanding what limits adaptation to ecological change both at geographical margins and within ecological networks. At present it is unclear to what extent the potential for evolutionary change confers ecological resilience on ecosystems and their associated outputs. I will briefly review theoretical models and empirical data concerning what determines maximum rates of adaptation in time or in space. The key issues for both types of model are the amount of additive genetic variation available in the direction demanded by selection, which may be low even if variation in single traits is high, and the demographic costs incurred by populations while they adapt to changing optima. Not only is measurement of these parameters difficult, they are also likely to vary from population to population and generation to generation, even for a single species. Although general principles associated with evolutionary responses can be established, it remains difficult to predict how easily, or how rapidly, evolution will occur in response to ecological change in a given situation.

Jon Bridle (E-mail: jon.bridle@bristol.ac.uk)

BSc (Manchester 1993), PhD (Leeds 1998). Postdoctoral research was at UCL, and the Zoological Society of London. My work focuses on maximum rates of evolution to ecological change. I am also interested in speciation and the evolution of biotic communities.
Life in the evolutionary fast lane: viruses as ecological players and indicators

Roman Biek

Division of Ecology and Evolutionary Biology and Boyd Orr Centre for Population and Ecosystem Health, University of Glasgow, Glasgow G12 8QQ, Scotland, UK

Viruses are responsible for many important infectious diseases of humans, animals and plants. Viruses are also among the most rapidly mutating organisms, providing them with exceptional potential for adaptive evolution that may facilitate the expansion into new host populations or species. Using case examples, I will examine the role this evolutionary potential, as compared to ecological factors, has played in the recent emergence of viral diseases. I will also illustrate how the rapid accumulation of neutral genetic variation in these pathogens can be used to track their ecological dynamics in time and space, such as during disease invasions. Throughout the talk, I will draw on examples from my own research on rabies and Ebola virus as well as work carried out by other research groups.


Roman Biek (E-mail: r.biek@bio.gla.ac.uk)

Since 2007 Lecturer/Kelvin-Smith Fellow at University of Glasgow
2004 PhD Wildlife Biology, University of Montana
1999 Diploma (Biology), Marburg Universität, Germany

My research aims to understand how infectious organisms spread through animal populations, and how their ecological and evolutionary dynamics are linked to those of their hosts. This research program developed out of a strong training background in animal population ecology and field based investigations but over the years has increasingly involved the use of molecular markers and genetic inference. The systems I have worked on range from diseases strictly maintained by wildlife to parasites that are shared between wild and domestic species or that are transmissible to humans.
Genetic basis for rapid evolution in human-altered environments

Jun Kitano

Graduate School of Life Sciences, Tohoku University, Sendai 980-8578, Japan

Faced with sudden environmental changes, animals must adapt to novel environments or go extinct. Although phenotypic plasticity can contribute to population persistence in an altered environment, it cannot always bring up a population perfectly to a new adaptive peak. Therefore, evolutionary changes are usually required for population persistence. Theoretical models predict that genetic architectures underlying adaptive traits can influence the speed and trajectory of adaptive evolution. Therefore, information about genetic architectures of adaptive traits will provide us a great insight into animal conservation and ecological management. Recently, great progress has been made in elucidation of the genetic architectures underlying adaptive traits in the threespine stickleback fish. Therefore, we are now able to empirically study how stickleback populations adapt to disturbed environments by changing the genetic structures. Our work revealed that standing genetic variations facilitate rapid adaptive evolution. In addition, migrants can supply genetic variations, suggesting that moderate gene flows between populations may increase the robustness of subdivided populations. These results suggest that ecological management plans should be designed to maintain genetic variations not only in a single population, but also in a meta-population. Further investigation into genetic architectures underlying adaptive traits is required for a better understanding of the factors that determine the robustness of animal populations in disturbed environments.

Jun Kitano (E-mail: jkitano@m.tains.tohoku.ac.jp)
2009-present: Assistant Professor (Tohoku University, Japan)
2003-2009: Postdoctoral Researcher (Fred Hutchinson Cancer Research Center, Seattle, USA)
2002: Ph.D. Medical physiology (Kyoto University, Japan)

I am interested in genetic mechanisms underlying adaptive radiations. Primarily, I am working on the genetics of behavioral evolution and speciation in the threespine stickleback fish. I also aim at applying the knowledge of evolutionary genetics to animal conservation and ecological management.

Selected Publications
Functional traits, evolutionary history, and the dynamics of plant communities

Nathan J. B. Kraft

Biodiversity Research Centre, University of British Columbia, 6270 University Blvd.
Vancouver, BC V6T 1Z4, Canada

Our ability to predict the responses of taxa to future climate scenarios depends upon an accurate understanding how species distributions are shaped by the abiotic environment and the community context in which they are found. Functional trait-based approaches, which consider the distribution of ecological strategies found within a community, offer a powerful means of making inferences about the importance of ecological processes such as habitat associations, niche differentiation and dispersal assembly. Functional traits also can provide a useful “common currency” for both understanding and predicting species responses to variation in the environment.

Here I first present analyses linking variation in functional traits to variation in performance across tropical tree species. I then use functional traits and a null model approach to test for the signatures of niche-based community assembly processes in a high-diversity neotropical forest. I contrast these results with an analysis based on phylogenetic relatedness, which many have suggested may be a useful proxy for ecological similarity. Finally, I’ll consider the distribution of plant functional variation at broader geographic scales in the context of plant responses to climate change.

Nathan Kraft (E-mail: nkraft@biodiversity.ubc.ca)
Nathan is a Biodiversity Postdoctoral Fellow in the Biodiversity Research Centre at the University of British Columbia. His research focuses on the ecological processes shaping plant community assembly and species coexistence, with a particular emphasis on functional trait and phylogenetic approaches.
Landscape history and plant biodiversity

Mark Vellend

Department of Botany, University of British Columbia, Vancouver, BC V6T 1Z4, Canada

Spatial patterns in biodiversity may result not only from factors observable in contemporary studies, such as environmental gradients or species interactions, but also from events in the past that require an explicitly historical approach to uncover. Patterns of human land use in particular have changed considerably over the past few centuries, with potentially profound consequences for ecological patterns and processes. Here I discuss the legacies of human land use, which in some cases have persisted for a century or more following the cessation of a particular land use practice, such as agriculture. In forests of eastern North America and Europe, understory plants show extended time lags in their responses to the creation or destruction of forest patches, with local extinction following fragmentation and colonization following forest creation continuing for well over a century. For oak savannas on Vancouver Island, it appears that conversion to closed coniferous forest was prevented by the use of prescribed fire by native peoples historically (<1850). Vegetation patterns in this region are still changing in response to the systematic suppression of fires, which began over 100 years ago. In sum, an historical perspective appears in many cases to be critical to understanding the important processes and patterns that shape ecosystems.

Mark Vellend (E-mail: mvellend@interchange.ubc.ca)
Mark Vellend is an Assistant Professor and Canada Research Chair in Conservation Biology at the University of British Columbia (UBC), where he conducts research on the ecological consequences of genetic diversity, and historical landscape ecology on Vancouver Island. He received Bachelor’s and Master’s degrees from McGill University (Montreal, Canada), and a Ph.D. from Cornell University (Ithaca, New York, USA), and he spent one year as a postdoctoral fellow at the National Center for Ecological Analysis and Synthesis (Santa Barbara, California, USA) before moving to UBC.
New models of ecosystem dynamics: the application of thresholds and feedbacks to management

Katharine N. Suding

Department of Ecosystem Science, Policy, and Management, University of California, Berkeley CA 94720

The recognition that a system can appear resilient to changes in the environment, only to reach a critical threshold of rapid and unexpected change, is spurring work to apply threshold models in conservation and restoration. How do we manage systems for resilience to environmental change? How do we rebuild degraded systems that may be resilient to our management efforts? While evidence indicates that human impacts can widen the range of habitats where threshold dynamics occur and shift communities into new states that are difficult to reverse, many managed systems don’t easily fit theoretical expectations on which these models are based. Thus, in many applied settings, threshold concepts are being adopted without evaluation of evidence and uncertainty. I present initial work for incorporating threshold models that reflects an emphasis on applicability to decision making on relatively short timescales and in human impacted systems.

Katharine Suding (E-mail: suding@berkeley.edu)

I am an associate professor in restoration ecology at UC Berkeley in the Department of Environmental Science, Policy, and Management. I received my undergraduate degree from Williams College, my PhD degree from University of Michigan, and spent six years at University California Irvine before joining the Berkeley faculty last year. Questions at the interface between community and ecosystem ecology particularly fascinate me. Recently, my work has focused on the mechanisms regulating plant-soil interactions and their relationship to ecosystem management, invasion success, and global change issues. In addition, I am interested in larger conceptual questions about how species (and their functional traits) may affect ecosystem dynamics and the ramifications of these dynamics for land management. Most of my research group focuses on grasslands, alpine tundra, and oak woodlands, but we are a wide-ranging bunch. I have published over 50 research articles, serve as an editor for Ecology Letters, and my research is supported by NSF, USDA, the Mellon Foundation, and US DOE. Recent work applicable to this Forum includes the paper Threshold models in restoration and conservation: a developing framework (TREE 2009) and a book I edited with Richard Hobbs New Models for Ecosystem Dynamics and Restoration (Island Press, 2008).
Food webs as complex adaptive systems

Kevin McCann

Department of Integrative Biology, University of Guelph, Guelph, Ontario, Canada

Here, I synthesize a number of recent empirical and theoretical papers to argue that food web dynamics are characterized by high amounts of spatial and temporal variability and that organisms respond predictably, via behavior, to these changing conditions. Such behavioral responses on the landscape drives a highly adaptive food web structure in space and time. Empirical evidence suggests that underlying attributes of food webs are potentially scale-invariant such that food webs are characterized by "hump-shaped" trophic structures with fast and slow pathways that repeat at different resolutions within the food web. I then place these empirically-motivated patterns within the context of recent food web theory to show that adaptable food web structure confers stability to an assemblage of interacting organisms in a variable world. Finally, I show that recent food web analyses agree with two of the major predictions of this theory.

Kevin McCann (E-mail: ksmccann@uoguelph.ca)

Kevin McCann is a mathematically-trained ecologist interested in unraveling the mysteries behind nature's diverse ecosystems. The approach combines theory, field and lab research in order to address how food webs are structured, and the functional implications of this structure. This research necessarily considers a broad range of ecosystems, both terrestrial and aquatic, although McCann's lab places special emphasis on aquatic ecosystems. http://www.uoguelph.ca/~mccannlb/Home.html
When we recognize that the primary objective to conserve biodiversity is to sustain ecosystem services for human well-being, stabilizing effects of biodiversity on ecosystem functioning become the major focus of biodiversity study. In the long-term perspective, all ecosystems are bound to experience environmental changes, such as stochastic fluctuations, climatic changes. The insurance hypothesis is an idea that biodiversity insures ecosystems against declines in their functionings caused by environmental changes. This hypothesis assumes functional redundancy and that different species respond differently to environmental changes (functional response diversity), hence the contribution of some species may decrease while that of others may increase when the environment changes. Thus greater biodiversity should lead to a decreased temporal variability in ecosystem processes because of compensatory dynamics among species.

Recent empirical studies of biodiversity effects on the stability (e.g., temporal stability) of ecosystem functioning, especially conducted at grassland and microcosms have made fruitful progress. They showed that increase of species richness reduces the temporal stability of ecosystem functioning (e.g., community biomass), however, still debates continue on the underlying mechanisms of biodiversity effects. In this paper, I review the basic ideas centered on the insurance hypothesis, recent advances in theory and empirical findings, and future directions.

Shigeo YACHI (E-mail: yachi@ecology.kyoto-u.ac.jp)
Theoretical Ecologist. I have worked on theoretical studies, e.g., spatial dynamics of infectious disease, evolution of animal signaling, biodiversity-ecosystem functioning research, and interdisciplinary project on sustainable watershed management. In this symposium, I am expecting transdisciplinary discussions about the relationships between diversity, resilience, robustness and evolvability.
By how much do extinctions reduce functional diversity?

Owen L. Petchey

Department of Animal and Plant Sciences, University of Sheffield, Sheffield, S10 2TN, United Kingdom

Understanding the consequences of extinctions for biodiversity must include how functional diversity is impacted. The last decade has seen a revolution in how ecologists estimate the consequences of extinctions for functional diversity. Early studies focused on counting the number of functional groups lost as species went extinct. This approach was replaced by ones that use continuous measures of functional diversity to quantify the effects of extinctions. These studies have revealed how factors such as species richness, community composition, trait correlations, intra-specific variation, regional pools, non-random extinctions, trait choice, and measurement methods affect the consequences of extinctions for functional diversity. The most recent advances include methods to identify the contributions to functional diversity made by individual species, and attempts to connect the research to concepts such as redundancy and resilience.

Owen Petchey (E-mail: o.petchey@sheffield.ac.uk)

Owen’s research is driven by the overarching question of ‘What are the causes and consequences of extinctions?’ Laboratory-based microbial communities are my ‘pet’ research system. Building model communities, altering their structure, changing their environment, and observing the consequences provide answers to questions that would be very difficult to obtain at larger scales. The approach has limitations, however. To overcome these I couple findings with theoretical modelling and analysis of large scale datasets, and study taxa such as plants, birds, mice, and their parasites.

Owen studied at Cambridge University and also the Centre for Population Biology, Silwood Park, Imperial College London. He has worked at Rutgers University, New Jersey and the University of Sheffield. He has received two prestigious fellowship awards, one from NERC and one from the Royal Society.
Diversity-stability relationships in annual plant communities

Thomas J. Valone

Department of Biology, Saint Louis University, St. Louis, Missouri, United States

In this talk, I summarize diversity-stability relationships we have identified in natural annual plant communities at a long-term research site in Arizona. More diverse communities exhibit greater temporal stability in abundance. Of the three theoretical mechanisms that might explain this pattern (overyielding, portfolio and covariance effects), we find support only for overyielding: more diverse communities contained more individuals. The temporal stability of individual populations also increased with community diversity. This pattern was not generally explained by mean-variance scaling. Instead, mean population size increased with diversity and this likely promoted stability. Our recent work has shown that population stability is also affected by granivore manipulation. Populations of small seeded annuals on experimental plots which removed rodent granivores, exhibited significantly greater variability (lower temporal stability) than populations on control plots with the full complement of granivores. We show that the removal of granivores results in an increase in the abundance of large-seeded species that competitively suppress the abundance (and stability) of small-seeded species. Diversity-stability relationships in these natural communities are complex and provide important tests of theory.

Thomas Valone (E-mail: valone@slu.edu)

My research interests include community ecology, desertification and animal behavior. My community work has been centered at a long-term research site near Portal, Arizona where I have examined plant-animal interactions, effects of competition on diversity, diversity-stability relationships and impacts of invasive species. My desertification research is conducted at a nearby site that is exhibiting a reversal of desertification. Here, I examine soil property mechanisms that affect the dynamics of perennial grasses in arid systems. With respect to behavior, I am interested in how animals make decisions. My primary focus has been on how individuals use public information, obtained from observing the performance or activities of others, to estimate the quality of environmental parameters. My research involves a variety of taxa, including plants, ants, rodents and birds.
Diversity and stability of plant and soil communities in semi-natural grasslands

T. Martijn Bezemer\textsuperscript{1,2}

\textsuperscript{1}Department of Terrestrial Ecology, Netherlands Institute of Ecology, Heteren, The Netherlands; \textsuperscript{2}Laboratory of Nematology, Wageningen University, Wageningen, The Netherlands

The relationship between biodiversity and ecosystem functioning remains highly debated. A number of biodiversity experiments carried out in grassland communities have shown that there is a positive relationship between plant species diversity and ecosystem stability. In these studies plant community diversity has been maintained by hand weeding, and stability has been based on temporal changes in plant biomass. How changes in plant diversity will affect the temporal stability of other organisms remains poorly understood. I will show how the stability of plants and nematode populations is influenced by plant diversity in a long-term biodiversity experiment with sown and unsown plant communities. In contrast with other biodiversity experiments, the plant communities were not weeded. However, the sowing diversity treatments resulted in remarkably different plant communities. In sown plant communities, diversity had a positive effect on biomass stability and productivity. However, unsown plant communities had the highest diversity but were least productive and unstable. The mechanism behind these effects is that sowing reduced the spatial heterogeneity of the plant communities. Subsequently I will present data on the relationship between plant species diversity and the long-term population dynamics and temporal stability of soil nematodes. Nematodes are ideal organisms to study plant diversity effects on other organisms since they inhabit a range of trophic positions within the soil food web. The results show that plant diversity does not necessarily lead to stability in natural communities, and that diverse communities can be both stable and unstable.

Martijn Bezemer (E-mail: m.bezemer@nioo.knaw.nl)
In my research I aim to disentangle how aboveground and belowground multitrophic communities interact. We study these interactions in individual plants and in microcosms, but most of my work focuses on above-belowground interactions in natural systems. In old-fields, I study how plant diversity affects above- and belowground communities, and how community composition influences these interactions on individual plants growing in those communities.
Insect diversity and stability is driven by plant genetic and species diversity

Gregory Crutsinger¹ & Nick Haddad²

¹ Department of Integrative Biology, University of California, Berkeley, USA;
² Department of Biology, North Carolina State University, Raleigh, NC, USA

A key, unresolved issue in understanding the role of biodiversity in the functioning of ecosystems is whether the stabilizing effects of plant biodiversity propagate up food chains to influence the community structure of higher trophic levels. We sampled arthropods for over a decade in an experiment that manipulated the number of grassland plant species. We found that herbivore and predator species richness were strongly, positively related to plant species richness. Moreover, the richness and abundance of arthropods at both herbivore and predator trophic levels was more stable (i.e. lower variability over time) with increasing plant diversity. We find similar increases in arthropod diversity with the number of plant genotypes in a separate experimental manipulation within a dominant plant population. Taken together, these findings demonstrate the far-reaching consequences of plant diversity both at the genetic and species level for dependent animal communities. We conclude that even small losses of biodiversity at one trophic level may cause considerable long-term losses throughout the food chain.

Gregory Crutsinger (E-mail: crutsinger@berkeley.edu)
I finished my PhD in the Dept. of Ecology and Evolutionary Biology at the University of Tennessee, Knoxville in 2009 and am currently a Miller postdoctoral fellow hosted by the Dept. of Integrative Biology at UC Berkeley. My research focuses on the links between genetic variation in key traits within dominant plant species, species diversity of associated above- and belowground community members, and ecosystem processes such as primary production, nutrient cycling, and invasion resistance. My ecological hero is Tadashi Fukami.
Symbiont diversity as a driver of plant diversity and ecosystem functioning

Marcel G.A. van der Heijden¹,²

¹ Ecological Farming Systems, Research Station ART, Agroscope Reckenholz Tänikon, 8046 Zurich, Switzerland; ² Plant–Microbe Interactions, Institute of Environmental Biology, Faculty of Science, Utrecht University, 3508 TB, Utrecht, the Netherlands

The 450-million-year-old symbiosis between the majority of land plants and arbuscular mycorrhizal (AM) fungi is one of the most ancient, abundant, and ecologically important mutualisms on Earth. About 150,000 plant species associate with AM fungi and these underground soil fungi are present in almost any ecosystem investigated. AM fungi supply a range of limiting nutrients to plants and receive plant assimilates in return. Our latest results show that AM fungi can enhance the sustainability of ecosystems by promoting a closed phosphorus cycle and reducing nutrient leaching losses after heavy rain (van der Heijden 2010).

AM fungi interact with a wide range of other microbes, including nitrogen fixing rhizobia bacteria. The interaction of AM fungi with rhizobia is of particular interest because, both symbionts facilitate plant uptake of the two elements (phosphorus and nitrogen) that most strongly limits plant growth. In microcosm experiments, we observed that nitrogen fixation is highest when both AM fungi and rhizobia are simultaneously present. Legumes even appear to require both symbionts to be able to coexist with other plants in nutrient poor grassland. These results thus point to the significance of symbiont diversity for ecosystem functioning, legume growth & survival. Finally, in some soils, including those of biological farms, a higher AM fungal diversity has been observed. The ecological implications of differences in AM fungal diversity and its impact on ecosystem processes will be highlighted.

Marcel van der Heijden (E-mail: marcel.vanderheijden@art.admin.ch) is a plant ecologist & agronomist. His research showed that soil microbes and plant symbionts play a key role in ecosystems by stimulating biological diversity, plant community structure, plant productivity and soil structure. His current research interests include: (1) the impact of soil biodiversity on plant productivity and ecosystem functioning, (2) the importance of mycorrhizal fungi for sustainable agriculture, and (3) to develop farming practices that enhance ecosystem sustainability.
Alternative transient states in community assembly

Tadashi Fukami & Mifuyu Nakajima

Department of Biology, Stanford University, Stanford, CA 94305, USA

Since Richard Lewontin’s seminal work in 1969, ecologists have sought to understand conditions that give rise to the alternative stable states of community structure (such as species diversity and composition). Alternative stable states arise when final community structure depends on the history of community assembly (the sequence of species arrival during community assembly) even given the same species pool and environmental conditions. Understanding conditions for alternative states is essential to explaining the predictability of community structure, an aspect of ecosystem robustness. Indeed, alternative stable states are recently receiving considerable interest as a theoretical framework for ecological restoration. Few ecologists disagree, however, that most real communities are in transient, not stable, states, because disturbance keeps communities from reaching a stable state. In this talk, we will use the results of computer simulation of plant community assembly to show that predictions regarding the importance of community assembly history can be fundamentally different depending on whether the focus is transient or stable states. Our results suggest that ecologists may need to shift their focus from alternative stable states to alternative transient states to better understand the dynamics and robustness of ecological communities.

References

Tadashi Fukami (E-mail: fukamit@stanford.edu)
I study ecological and evolutionary community assembly, with emphasis on historical contingency in community structure, ecosystem functioning, biological invasion and ecological restoration, using experimental, theoretical and comparative methods involving bacteria, protists, fungi, plants and animals. For more information, visit: www.stanford.edu/~fukamit
Understanding food-web persistence from local to global scales

Daniel B. Stouffer & Jordi Bascompte

Integrative Ecology Group, Estación Biológica de Doñana – CSIC
c/ Américo Vespucio s/n, 41092 Sevilla, Spain

A better understanding of the features that contribute to the stability and persistence of an ecological community is critical for efforts to maintain biodiversity. The study of food webs, the network of trophic interactions in an ecosystem, provides a representational manner to investigate many questions regarding whole ecosystem behavior. In the past decades, scientists have begun to develop a clear picture of the key components which explain empirical food-web structure. Nevertheless, the dynamic implications of many of the structural features remain to be examined.

We combine recently-developed models for food-web structure and a bioenergetic consumer-resource model for food-web dynamics to understand the role of food-web structure in a community's ability to respond to perturbations, such as species extinctions. Throughout our investigations we find an intriguing pattern. The architecture of empirical food webs significantly increases their persistence, helping to reconcile the simultaneous complexity and stability of natural communities.

Daniel B. Stouffer (E-mail: stouffer@ebd.csic.es)

I attempt to follow a common approach in all of my research. First, utilizing tools from disciplines beyond ecology, such as engineering and physics, to search for robust patterns within empirical data. Second, developing intuitive models which are able to explain these empirical patterns while remaining simple enough to provide genuine insight into the systems under study. Although I am interested in a wide variety of topics, such as human communication patterns, my primary research focus is on ecological networks and food webs in particular.
Structure and stability of mutualistic and trophic networks

Colin Fontaine¹ & Elisa Thébault²

¹ CERSP UMR 7204, Muséum National d'Histoire Naturelle, Paris, France;
² Biometris, Wageningen University, Wageningen, Netherland

The architecture of ecological interaction networks is recognized to be strongly linked with community dynamic and stability. However, most of the work on ecological networks has focused on prey-predator interactions while species interact in many other ways, including for example mutualistic and parasitic interactions; only recently have these other types of interaction networks been studied in the same way as food webs. Recent studies suggest that their architecture differ from trophic networks, but the effect of the type of interaction on the relationship between network architecture and stability is unknown. We show using a theoretical approach that the architecture favoring stability fundamentally differs between trophic and mutualistic networks. A highly connected and nested architecture promotes stability in mutualistic networks while the stability of trophic networks is enhanced in compartmented and weakly connected architectures. Our predictions are supported by a meta-analysis on the architecture of a large series of real pollination (mutualistic) and herbivory (trophic) networks. Each of these two kinds of networks exhibits the architectural features that are predicted to favor their stability. We conclude that different types of interaction induce different stability constraints resulting in different network architectures.

Colin Fontaine (E-mail: colin.fontaine@mnhn.fr)

Ecological communities, whether they are forests, lakes or coral reefs, consist of a diverse range of species that interact with each other in many ways. As an ecologist, I try to understand how these complex systems function as a whole and how they respond to perturbations. To do so, I develop network approaches – a distilled version of this complexity – that allow reducing the complexity of a community to a form that can be studied systematically.

I am currently working on two main projects. The first one deals with the importance of the past evolutionary history of species in determining network architecture. In the second one, I aim at combining network approaches and participatory science to develop indicators of pollination systems across large scale.
Robustness of food webs to species invasions

Tamara N. Romanuk

Department of Biology, Dalhousie University, Halifax, NS, Canada

Maintenance of biodiversity is one of the most important ecosystem services and species invasions are widely considered to be one of the greatest threats to biodiversity maintenance after habitat loss. Given limited theoretical and empirical understanding of ecological robustness to such perturbations, I simulated species invasions in complex ecological networks by integrating a trophic “niche model” of food-web structure and a nonlinear bioenergetic model of population dynamics to determine how connectance and invaders’ trophic traits affect the robustness of communities to invasion. Low connectance webs and webs invaded by omnivores lost species most frequently. While high connectance webs were less likely to lose species, those that experienced extinctions were least robust to invasions, especially by carnivores. These and earlier simulation results suggest how community structure and invader properties interact and involve tradeoffs, for example, between the likelihood and magnitude of extinctions due to invasion. Such extinctions appear unlikely in more complex communities which are typically highly resistant and robust to invasion. However, the few complex communities in which extinction cascades occurred experienced more extinctions than simpler communities that are typically less resistant and robust.

Tamara Romanuk (E-mail: tromanuk@gmail.com)

Tamara Romanuk's research focuses on the potential consequences of biodiversity loss to the continued functioning of ecological systems. She is particularly interested in how species loss affects energy flows in food-webs and how changes in the structure of food-webs affect the stability of ecological systems.
Food-web structure, community dynamics and population-level adaptation

KONDOH Michio$^{1,2}$

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$^2$ PRESTO, Japanese Science & Technology Agency, 4-1-8 Honcho, Kawaguchi, Japan

The field of food-web ecology has been developing under the working hypothesis that population dynamics and community structure are interrelated. With this hypothesis, the population-related pattern, such as multi-species coexistence and interspecific population effects, has been attributed to food-web structure, while food-web structure has been understood as being constrained by population dynamics. Modeling approach, which allows linking food-web structure to population dynamics in an explicit way, has contributed to our understanding of biological communities. Those studies often assume a static food-web structure characterised by fixed topology or constant interaction strengths. However, food-web structure can actually be more dynamic. Recent study suggests that prey and predator species may temporally change their behaviour via adaptive process, such as evolution, learning and phenotypic plasticity, which may provide a potential driving force for introduction of temporal variability in food web structure. In this talk I show how strongly population-level adaptation may affect food-web structure, population dynamics and their relationships and discuss the potential role of ‘adaptation’ in shaping biological communities and maintaining biodiversity.

References

KONDOH Michio (E-mail: mkondoh@rins.ryukoku.ac.jp)  
Associate Professor of theoretical ecology at Ryukoku University, Japan. I have research interests in mechanisms of multi-species coexistence, food web structure and its relationship with population dynamics and ecosystem process.
How robust is the structure and functioning of complex ecosystems to environmental warming?

José M. Montoya$^1$ & Gabriel Yvon-Durocher$^2$

$^1$ Institute of Marine Sciences-CSIC, Barcelona, Spain;  
$^2$ School of Biological Sciences, Queen Mary University, London, UK

Most studies to date have concentrated on the effects of climatic warming on individuals and species, with particular emphasis placed on its effects on the phenology and physiology of organisms and on the range and distribution of species. However, it is difficult, and of questionable validity, to extrapolate from studies of individuals and populations to the community or ecosystem level, because of the potential indeterminacy of responses generated in these complex ecological networks, within which multiple species are connected to one another (e.g. via trophic links in food webs). Key ecosystem functions as biogeochemical cycling might well be affected by increasing temperatures.

I will present results that combine whole-system manipulative experiments with ecological theory to address the effects of expected warming for the end of the present century on two key aspects of ecological networks and ecosystems: the metabolic balance of ecosystems (i.e. the balance between the photosynthetic fixation and respiratory release of carbon at the ecosystem scale), and the allometric relationships between species numerical abundance and body mass (NM relationships). Our experimental results in freshwater mesocosms support our theoretical predictions based on the metabolic theory of ecology, and show that warming will reduce the capacity of ecosystems to absorb carbon dioxide. We accurately quantify the precise magnitude of the reduction in carbon sequestration rates observed experimentally. We also observe shifts in NM relationships, suggesting instabilities in network dynamics might occur under future warming scenarios.

José M. Montoya (E-mail: montoya@icm.csic.es) is a theoretical ecologist interested in how biodiversity has evolved, is organized and maintained within ecological networks. He uses models, analysis of existing datasets and experiments to address his research questions. Four major questions vertebrate his research. First, which structural patterns can be observed in these networks. Second, which ecological and coevolutionary processes give raise to these patterns. Third, how the structure of the interaction network can be responsible of ecosystem stability and its responses to disturbances – climate change and habitat loss mostly. And fourth, how changes in biotic interactions affect ecosystem functioning.
Can predators reduce atmospheric CO₂ through trophic cascade?

Christopher C. Wilmers¹, James A. Estes², Kristin L. Laidre³ & Matthew Edwards⁴

¹Environmental Studies Department, 1156 High Street, University of California, Santa Cruz, CA, 95064; ²Ecology and Evolutionary Biology Department, 100 Shaffer Road, University of California, Santa Cruz, CA, 95064; ³Polar Science Center, Applied Physics Laboratory, University of Washington, 1013 NE 40th Street, Seattle, WA 98105; ⁴Department of Biology, San Diego State University, San Diego, CA 92182

Top predators, by suppressing herbivores, often have positive indirect effects on plant biomass. Plants utilize CO₂ in photosynthesis and store most of the earth’s non-fossilized organic carbon in their living tissues, detritus, and in the tissues of their consumers. This suggests that predators can ultimately increase NPP, thereby decreasing atmospheric carbon. Here we analyze the impacts of sea otters on carbon NPP and sequestration. We find that sea otters, by suppressing herbivorous sea urchins, increase kelp biomass 100-fold, resulting in a 31 to 50 TgC yr⁻¹ increase in NPP and a 10 TgC increase in carbon sequestered by living kelps. These increases represent 34-55% (NPP) and 11.4% (living kelp) of the carbon contained in the atmosphere above the North American sea otter range or 136-220% (NPP) and 44% (living kelp) of the increase in atmospheric carbon since pre-industrial times, and the sea otter-induced increment in just the living kelps has a present day value of over $700 million on the European Carbon Exchange. Populations of large predators have been extensively depleted or lost throughout much of the globe. These losses probably substantially altered the rates of carbon flux through global ecosystems. The conservation and restoration of large predators might thus have indirect ecological effects that will figure prominently in the future trajectories of atmospheric CO₂ concentration and global climate change.

Christopher C. Wilmers (E-mail: cwilmers@ucsc.edu)
I am an assistant professor in the Environmental Studies Department at UC Santa Cruz. I’m generally interested in the effects of global change on food web interactions and population persistence.
Physical and ecological perspectives on the robustness of coral reefs

Peter J. Mumby$^{1,2}$

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Coral reefs are acutely threatened by climate change yet hundreds of millions of people depend on their ecosystem services including the provision of protein and coastal defence from storms. Understanding the factors controlling the robustness of reef ecosystems is challenging but important if managers are to identify opportunities to mitigate and adapt to rising climatic threats and increased local pressures from a burgeoning human population. Using a combination of field studies and spatially-explicit ecological models, the factors governing the robustness of coral reefs are examined. First are physical drivers that influence community structure, the functioning of individual organisms, the disturbance regime, and, in part, the acclimation of individuals to stress. Second are ecological drivers such as trophic cascades, some of which transcend the seascape through the migration of organisms from neighbouring mangrove habitats. Ecological processes create a number of positive and negative feedback mechanisms that can drive the ecosystem towards alternate stable states. Interestingly, biodiversity is able to exert a direct ecological impact on the resilience of reef ecosystems. Third are biological drivers that govern the response of individuals to stress and their capacity to adapt to new physical conditions. Such biological processes are perhaps the least understood yet have the potential to exert a profound effect on the ecosystem response to climate change.

Peter Mumby (E-mail: p.j.mumby@ex.ac.uk)

Professor Peter Mumby obtained his PhD in 1997 from the University of Sheffield (UK) looking at the remote sensing of coral reefs. He was then awarded a NERC Fellowship and moved to the University of Newcastle where he began to study ecological processes on reefs. In 2002 he moved to the University of Exeter on a Royal Society University Research Fellowship where he became permanent faculty and incorporated spatial modelling into his research. In April 2010 he moves to the University of Queensland to take up an ARC Laureate Fellowship. Peter is a Pew Fellow in Marine Conservation.
Connectivity in resources across heterogeneous landscapes and robustness of arid and semiarid systems

Debra Peters

USDA ARS, Jornada Experimental Range and Jornada Basin Long Term Ecological Research Program, Las Cruces, NM 88003-0003, USA

State changes in arid and semiarid systems have occurred globally that result in broad-scale conversion of perennial grasslands to woody plant dominance. However, at finer scales within a site, state change dynamics are spatially and temporally variable such that remnant grasslands remain within a predominantly shrub-dominated landscape. Explanations for the robustness of these remnant grasslands in the face of changing climate and management history are related to interactions among processes across multiple scales, from plant to patches and landscape units. Connectivity in resources (water, nitrogen) links spatial and temporal scales to result in these heterogeneous landscapes. Long-term studies were used to examine the relative importance of processes at each scale to patterns in remnant grasslands. Spatially contagious processes at fine scales (erosion-deposition) and patch scales (seed dispersal) were more important than broad-scale drivers (drought, grazing) to remnant grassland dynamics. By contrast, historic grasslands that are currently shrublands responded to multi-year patterns in rainfall via plant-soil water feedbacks at fine scales. These results indicate that different scales of pattern-process relationships are important in the robustness of current grasslands compared to historic grasslands that have converted to shrublands.

Debra Peters (debpeter@nmsu.edu) is a landscape ecologist with interests in ecosystem state changes, and the role of pattern-process relationships interacting across scales to generate system dynamics. She is also interested in comparative analyses of long-term studies across ecosystem types. She leads the EcoTrends Project that is synthesizing long-term data from a large number of research sites in the US (http://www.ecotrends.info).

The time dimension of spatial food webs

Gaku Takimoto

Department of Biology, Faculty of Science
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The past decade has seen an ever greater appreciation that food webs are open systems with resources and consumers moving across presumed habitat boundaries and causing potentially strong impacts on local dynamics. To understand how spatial openness affects food-web dynamics, many field studies were conducted to test whether across-habitat inputs of resource subsidies increase or decrease in situ resources indirectly through the generalist consumers of these two resources. Outcomes from these studies were diversified; some studies found positive indirect effects, and others observed negative or insignificant effects. Yet there is no unified answer about what determines the direction of the indirect effects of spatial subsidies. To address this question, I developed a theoretical framework based on a mathematical model. The framework incorporates temporal fluctuation in the inputs of resource subsidies, and also explicitly formulates the timescale difference between reproductive and aggregative numerical responses by generalist consumers. The framework generates case-by-case predictions depending on the timescales of consumer’s reproductive and aggregative numerical responses relative to the frequency of resource subsidy inputs. I then collected 23 empirical case examples from marine, freshwater, terrestrial, and agricultural ecosystems including microbial to mammalian consumers and seasonal to decadal fluctuations in subsidy inputs. Although theory was not applicable to seven out of the 23 examples due to the lack of clear timescale difference between consumer responses and subsidy fluctuations, the direction of observed indirect effects in 14 out of 16 applicable examples matched theoretical predictions. Model assumptions were not satisfied in the two examples that were inconsistent with predictions. These results suggest that the relative timescales of ecological processes is fundamentally important for understanding and predicting indirect effects in spatial food webs.

Gaku Takimoto (E-mail: gaku@bio.sci.toho-u.ac.jp)

I am interested in ecological and evolutionary theories, and mathematical/simulation modeling. The central question of my research asks how biodiversity at different levels of biological organization from genes to ecosystems has evolved, is currently maintained, and will evolve in future. I finished my PhD in Kyoto University, worked as a postdoctoral fellow in Hokkaido University and Yale University, and am currently a lecturer at Toho University. I enjoy Sunday morning running.
Does order beget order?  
Self-organization and critical biodiversity in heterogeneous landscapes

Kimberly A. With1 & Anthony W. King2

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2 Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37763, USA

The formation, structure and dynamics of communities may all be influenced by the underlying structure of the landscape, which in turn may affect system resilience to local perturbations (the introduction or extinction of species). We adopted a complex systems approach to modeling the effect of landscape structure (spatial contagion) on the evolution of diversity and subsequent stability of communities in heterogeneous landscapes in which habitat was randomly or fractally distributed. Stability was assessed in terms of susceptibility to extinction (the average extinction size as a function of diversity), which increased up to some critical level of diversity on the landscape—the critical biodiversity threshold. Communities on randomly organized landscape were themselves highly disordered and susceptible to extremely variable dynamics that sometimes resulted in complete system collapse. In contrast, communities that formed on fractal landscapes (higher spatial contagion = more ordered landscapes) had less variable dynamics and achieved a high degree of organization, especially in landscapes with an intermediate degree of contagion. The critical biodiversity threshold was highest for fractal landscapes, however, because local extinctions could more easily propagate within habitats owing to the greater spatial contagion, thus requiring a greater level of diversity for stability. Higher levels of diversity were inevitably attained in these landscapes, however, and the resulting self-organization (compartmentalization) and lower connectance among communities on the landscape (metacommunity structure) buffered the system from mass extinctions and contributed to greater global stability. Landscape order may thus beget order, stability and increased resilience in communities.

Kimberly A. With (E-mail: kwith@ksu.edu)  
Dr. With is a landscape ecologist, whose primary research interests have focused on theoretical and experimental investigations into the effects of landscape structure (especially habitat loss and fragmentation) on ecological processes. Her work has variously explored the effects of landscape structure on movement patterns and dispersal, population viability and extinction risk, invasive and disease spread, and community structure and dynamics.
What do spatial patterns tell us about ecosystem resilience and fragility? 
Insights from arid ecosystems

Sonia Kéfi

Darmstadt University of Technology, Germany

Most ecosystems exhibit a degree of spatial patterning, some patterns being more obvious to the human eye than others. A striking example is the patchiness of the vegetation cover in arid ecosystems. These ecosystems are fragile and likely to collapse to deserts under external changes. This has motivated extensive research efforts to search for indicators of degradation levels in arid ecosystems. It has recently been suggested that the characteristics of the vegetation patterns may be used to assess the vulnerability of arid ecosystems to increased human pressure or ongoing climate change. In this presentation, I will discuss the kinds of information that the spatial organization of the vegetation in arid ecosystems gives us about the ecological processes generating these patterns and about the “health” of the ecosystem (i.e. likelihood to switch to a desert). I will show that different spatial patterns emerge from different mechanisms of facilitation. These patterns can be interpreted differently in terms of resilience and stability. In particular, some specific patterns are associated with an approaching desertification threshold and may be used as early-warning signals for the onset of desertification.

Sonia Kefi (E-mail: kefi@bio.tu-darmstadt.de)
My Ph.D. at Utrecht University (The Netherlands) focused on the dynamics of arid ecosystems and their response to external changes. I was especially interested in the search for early-warning indicators of desertification. My current research at Darmstadt University (Germany) addresses the functioning and stability of full networks of interactions, embedding trophic and non-trophic interactions.
Ecological robustness: a capacity of ecosystems to continue functioning under global environmental changes

Takehiro Sasaki, Hiroko Kurokawa, Hiroshi Tomimatsu & Masakado Kawata

Graduate School of Life Sciences, Tohoku University, Sendai 980-8578, Japan

Robustness is an intrinsic property of systems that enables them to continue functioning despite external and internal perturbations. Here we argue that understanding the principles of robustness in ecosystems is the key for successful ecosystem management under highly stochastic environments. Global environmental changes caused by human activities have considerable impacts on ecosystems and therefore on the functions and services that they provide. Considering that human societies generally depend on the maintenance of ecosystem functions, our research priorities should be to elucidate what components of ecosystems enhance robustness against various perturbations. In this talk, we first describe the concept of 'ecological robustness', with particular reference to the concept of resilience and research on biodiversity effects on ecosystem function (BDEF). The current research on resilience rarely addresses ecosystem functions, while BDEF research needs to account for the uncertainty of ecosystems that may have multiple stable states as presumed in the resilience concept. We suggest merging the frameworks of these two research streams under the concept of ecological robustness. Next, we briefly summarize, by reviewing related publications, the components ensuring ecological robustness, including species and genetic diversity, the topology of food webs and spatial structure across a range of scales. We also discuss a possible role of evolutionary changes as well as suggest future research perspectives.

Key References

See pages 60–61 for the organizers’ biosketches.
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P14. Tsujino, M. – Interaction network structure in rocky intertidal sessile assemblages at the Pacific coast of Japan

P15. Sakamoto, Y. – Diversity of orchid symbiosis with mycorrhizal fungi

P16. Tomita, M. – Predicting future genetic variability of a small population of long-living tree from current genetic and demographic data: an example from an isolated, small population of Sakhalin spruce (*Picea glehnii* Mast.)

P17. Tabata, M. – Plasmids for gamma-Hexachlorocyclohexane degradation in a bacterial strain *Sphingomonas* sp. MM-1

P18. Kimura, M. R. – Hemiclonal reproduction prevents introgression between species in a hybrid zone of three species of *Hexagrammos*

P20. Shimano, S. – Inventorial databases of protists in Japan and local endemic species of ancient Lake Biwa

P21. Hasegawa, M. – Evolution of heat tolerance by nocturnal katydid grasshopper *Mecopoda niponensis* along urban to rural thermal gradient

P22. Bacosa, H. – Preferential utilization of benzene and *p*-xylene over octane by *Burkholderia cepacia* B5
Response of plant functional traits to crop abandonment and soil nutrients in rangelands

Aki Hoshino¹, Takehiro Sasaki², Tomoo Okayasu¹, Undarmaa Jamsran³, Toshiya Okuro¹ & Kazuhiko Takeuchi¹

¹ Graduate School of Agricultural and Life Sciences, The University of Tokyo, Bunkyo-ku 113-8657, Japan; ² Graduate School of Life Sciences, Tohoku University, Sendai 980-8578, Japan; ³ Centre for Ecosystem Study, Mongolian State University of Agriculture, 210153 Ulaanbaatar, Mongolia

Present study has two questions: Is the composition of plant functional traits in an abandoned agricultural field, which is not historical disturbance, different from that in rangeland? Can any difference in functional traits be explained by soil differences?

Study sites were fields abandoned in 1990, 1999 and 2006, grazed natural grassland and a grazing gradient (10, 50, 100, 200 and 500 m from center) in semi-arid grassland, Mongolia. Vegetation (species and percentage cover) and soil sampling from 0 to 15 cm were conducted at each site. Soil N, organic C, available P and particle size distribution were analyzed. Plant coverage at each quadrat was analyzed by detrended correspondence analysis. Quadrats were divided into 7 branches by multivariate regression tree, which explained value is site score of each quadrat by detrended correspondence analysis and explanatory variable is the appearance times of each traits. Soil properties of each quadrat were identified with branches, were divided by regression tree. The composition of plant functional traits was differed from those of rangeland in early-stage abandoned fields. In these abandoned fields, N and organic C contents were lower, and available P contents and fraction of coarse sand were higher than those of rangeland. An increase in zoochorous species indicates the transition of species composition from that of abandoned fields to that of rangelands. On the other hand, frequent existence of perennial species except for zoochorous trait was appeared at later stage abandoned fields. In these quadrats, fraction of fine sand was lower than rangeland.

Aki Hoshino (E-mail: aa077132@mail.ecc.u-tokyo.ac.jp)
Interest: Effects of land use history on plant species composition and soil hydraulic properties, hydrological process in the soil-plant-atmosphere continuum
Keywords: Ecohydrology, grassland ecology, plants tolerances for drought and salinity stresses, plant functional traits
The effect of coevolutionary changes of prey-predators interaction on the relationship between food web complexity and stability

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The relationship between food web complexity and stability has been the subject of a long-standing debate in ecology. Theoretically, the changes in the pattern and strength of prey-predator interactions have been indicated to affect the dynamics and stability of community. Many of those studies assumed that the changes in interaction links are caused by adaptive changes in the traits of predator food intake or/and prey defense. Kondoh (2003) showed that rapid changes in the food web structure through adaptive foraging behavior can confer stability to complex food webs. However, the evolutionary changes in interaction links would be not necessarily adaptive since evolution occurs through not only natural selection, but also various constraints on adaptive changes. Thus, in a previous study, we constructed individual-based models of the evolution of prey use by predators assuming explicit population genetics processes. The results showed that the evolution of prey use destabilized food webs with increasing complexity. However, this study did not consider the evolution of prey defense, or coevolutionary processes. In the present study, we extend our previous models by incorporating coevolutionary processes in multispecies prey-predatory systems. We will report the effect of prey-predator coevolution on the relationship between food web complexity and stability.

Wakako Yamaguchi (E-mail: wakako-y@mail.tains.tohoku.ac.jp)  
I am a Ph.D. student in Graduate School of Life Sciences at Tohoku University. I am interested in evolutionary effects on species diversity and food web architecture. To approach the problems, I use individual-based models for evolving food webs in metacommunity systems.
Expanded home range of pollinator birds facilitates greater pollen flow of *Camellia japonica* in a forest heavily damaged by volcanic activity

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Single-pollen genotyping enables us to track pollen flow that is mediated by animal vectors. By applying this innovative technique to a *Camellia japonica* and pollinator bird system on Miyake-jima, a volcanic island of the Izu Islands, Japan, we evaluated pollen flow mediated by the pollinator *Zosterops japonica* under different *C. japonica* flower densities. These flower densities were affected by a volcanic eruption in 2000 and subsequent large emissions of volcanic gases. The genetic diversity of pollen grains adhering to pollinators in areas with low flower density was greater than in an area with high flower density. This result was consistent with bird pollinator movement elucidated by radio tracking. In areas with low flower density, resulting from volcanic activity, pollinator birds ranged over larger areas to satisfy their energy demands rather than moving to areas with higher flower density. Low flower density also enhanced the efficiency of maternal reproductive success (i.e. pollination rate and seed set rate) (Abe and Hasegawa 2008). These results indicate that compensation mechanisms ensure better reproductive success at sites that are more affected by volcanic activities.

Harue Abe (E-mail: harue.abe@bios.tohoku.ac.jp)
From 2002-2007, I focused on plant-animal interactions in the Izu Islands in Japan, especially pollination and seed dispersal systems of *Camellia japonica*. I carried out my thesis work at Toho University and received a PhD (Science) in March 2007. After working as a museum curator at the Japan Monkey Centre, from June 2009, I have conducted for post-doc project aiming for the conservation of endangered alpine plants based on genetic approaches at Tohoku University.
The ecological and evolutionary stability of the plastic prey

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It has been increasingly recognized that rapid adaptive changes of traits can affect population dynamics. While the rapid adaptive changes result from two different mechanisms: rapid contemporary evolution and phenotypic plasticity, their effects on population dynamics are seldom compared explicitly. Here we theoretically examine the impacts of rapid evolution and phenotypic plasticity in predator-prey systems. Our analysis of the model revealed that phenotypic plasticity tends to stabilize population dynamics more strongly than does rapid evolution. In addition, if the phenotypically plastic genotype of prey, which exhibits a defensive phenotype when exposed to predators, and the two specialist genotypes of prey (undefended and defended ones) compete with each other, the plastic genotype cannot coexist with the specialists unless the system shows limit cycles. Also, the plastic genotype cannot beat the specialists without a forced environmental fluctuation. In conclusion, it is hard to predict the dynamics of rapidly adapting populations without knowing a mechanism by which phenotypic variation is generated. Our study also reveals that an environmental fluctuation is crucial for the evolution and maintenance of plasticity.

Masato Yamamichi (E-mail: yamamichi_masato@soken.ac.jp)

I am a Ph.D. candidate at SOKENDAI, Hayama. My main research interest is eco-evolutionary dynamics with theoretical approaches including mathematical ecology and population genetics. I am collaborating plankton (population dynamics) study with Prof. Yoshida at Univ. of Tokyo and snake-snail (ecological speciation) study with Dr. Hoso at Tohoku Univ.
Rapid phenotypic shift in a crater lake stickleback population

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Exotic species are causing many environmental problems. For exotic species to colonize novel environments, they should change a suite of phenotypic traits to adapt to novel environments. Accidental human release of threespine stickleback fish has occurred in many crater (caldera) lakes in Japan and independently gave rise to crater lake populations. These crater lake sticklebacks will provide us a great opportunity to investigate ecological and genetic mechanisms underlying rapid adaptation of exotic species in novel environments. In the present study, we investigated rapid phenotypic shift of a crater lake stickleback population from Lake Towada, Japan. We found that the body size and other morphological traits, such as armor traits and foraging traits, changed significantly during the last 30 years. However, we found that different traits exhibited different temporal trajectories of phenotypic shift, suggesting that genetic correlation between different adaptive traits may be relatively weak. We are currently making crosses within the lake population as well as crosses within the ancestral population (Aisaka stream, Japan) to investigate genetic contributions to the rapid phenotypic shifts. We are also collecting historical lake data to infer the ecological forces that drove the phenotypic shifts. Because threespine stickleback has recently emerged as a new model for evolutionary genetics, further studies on crater lake sticklebacks will give us a great insight into the genetic mechanisms underlying colonization of invasive species.

Tatsuya Adachi (E-mail: a-tatsuya@m.tains.tohoku.ac.jp)  
2005-present: Undergraduate Course of Biological Institute, Tohoku University, Japan  
2010 April-: Master Course of Department of Environmental Life Sciences, Graduate School of Life Sciences, Tohoku University, Japan

I am interested in conservation biology, ecological management, and environmental sustainability. I am entering Graduate School of Life Sciences at Tohoku University, in April 2010. My goal is to absorb the knowledge of ecology, evolution, and genetics at the graduate school and apply it to conservation and ecological management.
Ontogenetic niche shift, food-web coupling, and alternative stable states

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It has been suggested that food-web coupling by ontogenetic niche shift would generate alternative stable states (ASS). However, only the simplest situation, where the juveniles and adults of the primary consumer exploit different resources, has been considered previously, despite the structural diversity of coupled food webs in reality. Here, I investigated relationships between the occurrence of ASS and food-web configurations, specifically focusing on the influence of food-chain lengths and trophic levels in juvenile and adult habitats. Comprehensive model analysis showed that ASS could occur if either of the following conditions was satisfied for both juveniles and adults: (i) they are top predators or (ii) they have a (intermediate) predator attacked by a top predator. These mechanisms involve (i) overcompensation in reproduction and maturation due to strong density dependence and (ii) top-down cascade that intensifies the intrastage food competition, respectively. Furthermore, the environmental conditions under which ASS occurred varied in complex ways with the local food-chain length and stage-specific trophic level. These results suggest a novel hypothesis that anthropogenic changes in local community structure (e.g., species extinction and invasion) propagate through space and may cause regime shifts in regional community structure by altering the resilience to environmental perturbations.

Takefumi Nakazawa (E-mail: tknkzw@ntu.edu.tw)

I am interested in the interplay between individual behavior and community dynamics mediated by population structure, phenotypic plasticity, and evolution.
Resource subsidies increase the impact of invasive ecosystem engineers

Shota Nishijima¹, Gaku Takimoto² & Tadashi Miyashita¹

¹ School of Agriculture and Life Sciences, University of Tokyo, Tokyo 113-8656, Japan; ² Department of Biology, Faculty of Science, Toho University, Funabashi, Chiba 274-8510, Japan

Growing evidence suggests that invasive species can have strong impacts on biological communities or ecosystems, particularly when they are ecosystem engineers. Invasive ecosystem engineers can cause a positive feedback that promotes their own population growth by modifying the physical environment. Moreover, they are often sustained by resource subsidies. Here we theoretically demonstrate that resource subsidies can lead to a community regime shift through a positive feedback induced by invasive ecosystem engineers. Alien crayfish are known to reduce macrophytes that are refuges for aquatic animals, thereby strengthening their predation pressure on their prey, such as dragonfly larvae. The macrophyte loss by crayfish can in turn create a positive feedback that promotes their growth by enhancing their foraging efficiency on their prey because these prey are important energy sources for crayfish. At the same time, previous studies have shown that crayfish increase their densities by consuming leaf litter of terrestrial plants, which are allochthonous resource subsidies. By using a mathematical model comprised of crayfish, prey and litter, we found that this system exhibits various responses to varying amount of litter input. In addition, this model revealed conditions for the occurrence of each response. When crayfish effect of losing macrophytes and macrophyte effect of mitigating crayfish predation on prey are large, the increase in litter input is likely to cause a regime shift, leading to a crayfish outbreak and a large reduction of prey. Finally, our model showed that control of litter input lowers the threshold of crayfish loss rate above which crayfish become extinct. These results highlight the general importance of resource subsidies that trigger regime shifts by invasive ecosystem engineers, and control of resource subsidies may be a key to successful restoration of ecosystems deteriorated by invasive engineers.

Shota Nishijima (E-mail: nishijim@es.a.u-tokyo.ac.jp)
My field in study is community or invasion ecology. By theoretical and empirical approaches, I will try to elucidate a mechanism by which invasive species can cause large impacts in light of interspecific interaction. Now, my subject is freshwater system, in which numerous alien species, such as crayfish or predatory fish, are established.
Drosophila species distributions correlate with their genomic structure

Takashi Makino & Masakado Kawata

Graduate School of Life Sciences, Tohoku University, Sendai 980-8578, Japan

Environmental factors such as environmental gradient and/or geographical barriers could determine species distributions and the ranges. In addition, the expansion of species ranges might depend on whether or not species can adapt to new environments. Therefore, evolvability, which is an organism's ability to evolve, would be a key factor for extent of species distributions. Although it has been thought that genetic architectures creating and maintaining genetic variations is related to the evolvability, the details remain unclear. The purpose of this study is to investigate genetic factors related to the evolvability contributing to extent of species distributions.

We focused on duplicated genes because gene duplication is one of major sources for genetic variation. We identified duplicated genes for 12 drosophila species by homology search (BLAST), since whole genome sequences for the Drosophila species are available. For each 12 species, habitat diversity was measured as an index showing what variety of habitats was included in the species range. We found that habitat diversity was correlated with the proportion of duplicated genes on a genome significantly even after removal of phylogenetic constraint. This indicates that duplicated genes on a genome are a major factor to determine an ability to adapt different habitats. The attainment/maintenance of higher proportion of duplicated genes on a genome (e.g. widely distributed species Drosophila melanogaster genome) would contribute to higher ability to diverse environmental conditions during evolution. The results will be important for considering how species can shift their ranges responding to environmental change as global climate changes.

Takashi Makino (E-mail: tamakino@m.tains.tohoku.ac.jp)
Aug 2009–present (Assistant Professor): Graduate School of Life Sciences, Tohoku University, Japan
Apr 2006–Sep 2006 (Postdoc): Immunotherapy Division, Shizuoka Cancer Center Research Institute, Japan
Apr 2005–Mar 2006 (Postdoc): National Institute of Genetics, Japan

My backgrounds are molecular evolution and comparative genomics. I would like to contribute to fusion research between genomics and evolutionary ecology through computational science.
Trait-based differences of grassland plant species responses to historical landscape changes

Tomoyo Koyanagi¹, Yoshinobu Kusumoto², Shori Yamamoto² & Kazuhiko Takeuchi¹

¹ Graduate School of Agricultural and Life Sciences, The University of Tokyo, Tokyo 113-0032, Japan; ² Biodiversity Division, National Institute for Agro-Environmental Sciences, Tsukuba 305-8604, Japan

The effect of landscape changes may strongly differ among species, some species decline shortly, while some species persist longer after habitat fragmentation and degradation. Recent studies showed significant impacts of the past landscapes on the present grassland species richness, and discussed the existence of ‘extinction debt’ in the landscapes. However, few have examined trait-based differences of grassland species responses to historical landscape changes, thus the relative importance of the past landscapes for species groups with different functional traits is rarely known. In this study, we investigated whether the present distributions of functional groups of grassland plant species is related to the past surrounding landscapes at different time periods and spatial scales by focusing on the traits associated with reproductive and dispersal ability. Our model selection procedures showed that the relative importance of the effects of the past surrounding habitat proportions significantly varied among the groups. The present richness of tall summer flowering long-distance dispersal herbs showed significant positive relationships with the surrounding habitat proportions in the oldest time period (the 1880s) and at the widest spatial scale (1km radius), while the richness of short spring flowering species (SS) and tall summer flowering short-distance dispersal herbs (TS) were significantly correlated with those in the recent time periods (the 1980s and 2000s, respectively) and at the smaller spatial scales (100m and 250m radius, respectively). The richness of the other species groups (tall grasses and woody species) showed no significant relationships with the surrounding habitat proportions. Grassland species with short dispersal ranges (i.e., SS and TS) would be the most sensitive to the historical processes of habitat loss, thus have higher indicator values for targeting and prioritizing future conservation and restoration sites within highly fragmented satoyama landscapes.

Tomoyo Koyanagi (E-mail: aa077131@mail.ecc.u-tokyo.ac.jp)
Main interest: historical landscape changes in agricultural landscapes, past and future distributions of species in a landscape
Key words: diversity, plant community, time-lag, satoyama landscape, semi-natural grassland, conservation, restoration
(Photo in Brisbane, INTECOL 2009)
Bacterial community succession in contaminated soil by using culture-independent approaches

Hiromi Kato¹, Atsushi Toyoda², Yoshiyuki Ohtsubo¹, Fumito Maruyama³, Genki Fuchu¹, Ryo Endo¹, Hiroshi Mori³, Ayumi Dozono³, Masatoshi Miyakoshi¹, Yuji Nagata¹, Asao Fujiyama⁴, Ken Kurokawa³ & Masataka Tsuda¹

¹ Tohoku University, Sendai 980-8577, Japan; ² National Institute of Genetics, Shizuoka 411-8540, Japan; ³ Tokyo Institute of Technology, Kanagawa 226-8501, Japan; ⁴ National Institute of Informatics, Tokyo 101-8403, Japan

Disturbances in soil environments by, for example, drying-rewetting, temperature shift and chemical pollution, are known to drastically influence structures and functions of microbial community. Microbial community is a suitable example to observe effect of the environmental stress on the biodiversity. We investigated the soil bacterial community succession induced by contamination of polycyclic aromatic hydrocarbons (PAHs). For measuring bacterial biodiversity, culture-independent approaches were employed because less than one percent of microorganisms in natural environments are culturable under laboratory conditions. Metagenomic DNA samples extracted from contaminated or non-contaminated soils were analyzed for bacterial taxonomic composition on the basis of 16S rRNA genes. Our results indicated immediate domination of particular bacterial groups including Proteobacteria was observed in the contaminated soil, suggesting the important role of these bacterial groups to catabolize the contaminants. The community structures of the contaminated soils tended to return to those of the non-contaminated soils. However, domination of some groups was still observed after 24 weeks from the contamination even though the initial PAHs disappeared within 12 weeks. These results indicate that there was time-lag between the microbial remediation of the soil environment and the succession of microbial community structures.

Hiromi Kato (E-mail: katee@ige.tohoku.ac.jp)

Research area:
Microbiology of soil environments and their functions in the ecosystem including bioremediation and global cycle of greenhouse gases. If you are interested in using Mt. Fuji as a study site, please contact me.
Right-handed snakes and left-handed snails: predator-prey coevolution drives single-gene speciation

Masaki Hoso

Graduate School of Life Sciences, Tohoku University, Sendai 980-8578, Japan

The origin of species generally remains obscure because one can rarely identify both the genetic basis and evolutionary forces that initiated speciation. A gene for left-right reversal may generate a new species in snails, because of genital and behavioral mismatches between dextral (clockwise-coiled) and sinistral (counterclockwise-coiled) snails. However, this speciation process would be suppressed by a mating disadvantage for the reversal. Thus, the accelerated evolution of reversed snails on land has been a puzzle questioning how they have achieved the reversal so frequently. I show that sinistral snails repeatedly speciate as a coevolutionary response to specialized snake predation of the vast majority of dextrals. Experiments demonstrate that sinistral snails survive snake predation superiorly to dextrals. Biogeography reveals that sinistral snail species have recurrently evolved, where the snakes continue to prey on the remaining dextral majority of snails. This study illuminates the crucial role of coevolutionary dynamics in speciation.

Figure. The foraging sequence of a Japanese pareatid snake, *Pareas iwasakii*, on a dextral snail. *P. iwasakii* approaches a snail from behind following the snail’s mucus track, tilts the head leftward, grabs the basal foot near the aperture and swallows by pulling the snail body out of the shell with alternate retraction of left and right mandibles. Scale bars, 10 mm.

Masaki Hoso (E-mail: hoso@m.tains.tohoku.ac.jp)
A postdoctoral fellow. My interest is in evolutionary biology and community ecology, especially in speciation and coevolution. I am beginning to extend my research objective to understanding of relationships between human well-being and biodiversity.
Effect of ecosystem retrogression on stable nitrogen and carbon isotopes of plants, soils and consumer organisms in boreal forest islands

Fujio Hyodo¹ & David A. Wardle²

¹ Research Core for Interdisciplinary Sciences, Okayama University, Okayama 700-8530, Japan; ² Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, S901 83, Umeå, Sweden

In the prolonged absence of catastrophic disturbance, ecosystem retrogression occurs, and this involves increased nutrient limitation, and reduced aboveground and belowground ecosystem processes rates. Little is known about how the nitrogen and carbon stable isotope ratios (δ¹⁵N and δ¹³C) of plants, soils and consumer organisms respond to retrogression in boreal forests. We investigated a 5000 year chronosequence of forested islands in the boreal zone of northern Sweden, for which time since lightning-induced wildfire increases with decreasing island size, leading to ecosystem retrogression. For this system, tissue δ¹⁵N of three abundant plant species (Betula pubescens, Vaccinium myrtillus and Pleurozium schreberi) and humus all increased as retrogression proceeded. This is likely to be due to enhanced ecosystem inputs of N by biological fixation, and greater dependency of the plants on organic N during retrogression. The δ¹³C of B. pubescens and plant-derived humus also increased during retrogression, probably through nutrient limitation increasing plant physiological stress. Unlike the plants, δ¹⁵N of invertebrates (lycosid spiders and ants) did not increase during retrogression, probably because of their partial dependence on aquatic-derived prey that had a variable δ¹⁵N signature. The δ¹³C of the invertebrates increased as retrogression proceeded and converged towards that of an aquatic prey source (chironomid flies), suggesting increased dependence on aquatic-derived prey during retrogression. These results show that measurement of δ¹⁵N and δ¹³C of plants, soils, and consumers across the same environmental gradient can provide insights into environmental factors that drive both the aboveground and belowground subsystems, as well as the linkages between them.

Fujio Hyodo (E-mail: fhyodo@cc.okayama-u.ac.jp)
I am interested in how natural gradient and anthropogenic factors affect nutrient cyclings and food web structures in terrestrial ecosystems. To examine this, I am currently using several isotopes, such as δ¹³C, δ¹⁵N, and Δ¹⁴C.
Effects of grazing on plants and pollinators in a forest-steppe area, northern Mongolia

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¹ Azabu University, Sagamihara 229-8501, Japan;
² Obihiro University of Agriculture and Veterinary Medicine, Obihiro 080-8555, Hokkaido, Japan

Plant communities and visiting pollinators at lightly grazed (LG), moderately grazed (MG), and heavily grazed (HG) places were studied at Bulgan, northern Mongolia. Numbers of plants appearing in 1 m by 1 m plots were 35.2, 31.8, and 21.5 at LG, MG, and HG, respectively. Biomass was 11.8 g/m², 7.1 g/m², and 4.2 g/m², respectively in the same order. Almost all the plants decreased by grazing, but the reduction was particularly marked in erect, branched, and tall tussock forms (Gimingham, 1951), while it was slight in short growing tussock and rosette forms. In terms of pollination, reduction of entomophilous forbs was prominent. Numbers of pollinators in 2 m by 100 m transect were 621, 299, and 46, respectively in this order. LG was characterized by abundant *Sanguisorba* and *Geranium*, and by many insects including shield bugs (Pentatomoidea), butterflies, bees and flies. MG was characterized by relatively abundant butterflies and fewer shield bugs. LG was poorly vegetated by entomophilous forbs and only a few flies were recorded. Grazing reduces plants but the reduction was biased to entomophilous plants, and consequently destroys flower-pollinator link.

Seiki Takatsuki (E-mail: takatuki@azabu-u.ac.jp)
I have been studying the interrelations between ungulates and plant communities in Japan. Since 2002, I began studies in Mongolia, including migration of Mongolian gazelle, effects of Siberian marmot on vegetation. Recently I am studying the effects of grazing on the biodiversity of the Mongolian steppe.
Interaction network structure in rocky intertidal sessile assemblages at the Pacific coast of Japan

Masahiro Tsujino\textsuperscript{1,2} & Takashi Noda\textsuperscript{1}

\textsuperscript{1}Faculty of Environmental Earth Science, Hokkaido University, Sapporo 060-0810, Japan; \textsuperscript{2}Research Core for Interdisciplinary Sciences, Okayama 700-8530, Japan

Major goals in community ecology are to elucidate the causal and maintenance mechanisms of ecological community. It is a key that describe network structure of species interaction to understand the community. This is because component species of community do not exist independently but interact with the other species in various manners (e.g. competition, facilitation). In this context, the relationship between complexity and stability is at the center of interests. May (1972) asserted that communities will become unstable with large number of species, high connectance, or strong interaction. This prediction has seldom been evaluated by empirical data, owing to the difficulty of quantitative measure of interaction strength.

In this study, we examined the relationship between interaction network structure and community structure by using quantitative interaction strength data obtained at rocky intertidal sessile assemblages. Long term repeated observation was conducted along the Pacific coast of Japan. Transition probability matrices were calculated by using observed frequency of species replacement. Species interaction strengths were estimated from the transition probability matrices.

Results showed that (1) Link density increased along with number of species. (2) Average interaction strength decreased along with number of species. (3) Most communities were detected to be stable, in accordance with May's (1972) criterion. These facts suggest that biological constraints that restrict the number of species interaction may be weak among intertidal sessile organisms. Species interaction network structure in real ecosystems must possess special features that allow them to persist in nature.

Reference
May RM (1972) Will a large complex system be stable. Nature 238: 413-414

Masahiro Tsujino (E-mail: tsujino@ees.hokudai.ac.jp)
Education: Ph.D. Environmental science, supervisor: Dr. T. Noda, Hokkaido University, September 2009
Diversity of orchid symbiosis with mycorrhizal fungi

Yuki Sakamoto¹, Jun Yokoyama² & Masayuki Maki¹

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² Department of Science, Yamagata University, Kojirakawa, Yamagata 990-8560, Japan

The Orchidaceae is one of the largest plant families with estimates of more than 24,000 species. All of orchid species form mycorrhiza by fungal hyphae infection. Mycorrhizal fungi associated with most autotrophic orchid helps the orchid accumulation of N, P and water, vice versa, autotrophic orchids supply photosynthetic carbon to mycorrhizal fungi. Thus, relationships of mature autotrophic orchids and mycorrhizal fungi are mutualism.

However, a portion of Orchidaceae, mycoheterotrophic species depend on mycorrhizal fungi. They degenerate their leaves, lose photosynthetic performance, and depending their nutritional supplies fully on mycobionts through the life history. These mycoheterotrophic orchids are almost associated with ectomycorrhizal (ECM) fungi that linked to co-existing trees; this links provides orchid with photosynthetic carbon gained by trees to ECM fungi. Recent studies revealed hemi-heterotrophic nutrient type termed mixotrophy in orchids, which can also perform photosynthesis with their green leaves and they also utilizes carbon supply from ECM fungi. Mixotrophic species is considered to be an evolutionary step from autotrophy to mycoheterotrophy.

The aim of this study is to discuss about coevolution between mycobiont and mixotrophic Cephalanthera longibracteata by molecular phylogenetic techniques.

References

Yuki Sakamoto (E-mail: s-nappa@mail.tains.tohoku.ac.jp)
I am a doctoral student. I am curious about symbiosis of orchids and fungus. Orchids are very interesting plants. I’d like you to visit.
Predicting future genetic variability of a small population of long-living tree from current genetic and demographic data: an example from an isolated, small population of Sakhalin spruce (*Picea glehnii* Mast.)

Motoshi Tomita¹, Yoshihisa Suyama¹ & Hisashi Sugita²

¹ Graduate School of Agricultural Sciences, Tohoku University, Osaki 989-6711, Japan; ² Tohoku Branch, Forestry and Forest Products Research Institute, Morioka 020-0123 Japan

Maintenance of genetic variability is crucial to adapt to future environmental changes, especially in a small population. Because of difficulties in collecting genetic data for multiple generations, mating system often used to discuss future genetic variability of long-living trees. A possible problem in mating system approach is that it ignores the impact of demography and late-acting inbreeding depression, which also affects genetic variability of future generations. In this study, we aimed to predict future genetic variability of small population by combining genetic and demographic data.

As a result, inbreeding lead to approximately 30% decline in size of selfed saplings compared to sapling from unrelated parents. This would affect to survival of inbred saplings, and would lead to changes in effective population size and genetic variability of next generation. However, result from simulations based on those data indicated that the impact of late-acting inbreeding depression on future genetic variability is small. Rather, the decline of genetic viability was negligibly small as far as we considered life cycle duration of Sakhalin spruce.

Motoshi Tomita (E-mail: motoshi727@gmail.com)

I am a PhD student in forest science at Tohoku University. I am interested in conservation of tree species in the era of environmental changes.
Plasmids for gamma-Hexachlorocyclohexane degradation in a bacterial strain *Sphingomonas* sp. MM-1

Michiro Tabata, Yoshiyuki Ohtsubo, Yuji Nagata & Masataka Tsuda

Graduate School of Life Sciences, Tohoku University, Sendai 980-8577, Japan

Gamma-Hexachlorocyclohexane (gamma-HCH or lindane) is a man-made chlorinated organic insecticide that has caused serious environmental problems. A bacterial strain *Sphingobium japonicum* UT26, which was isolated from an experimental field in Japan, utilizes gamma-HCH as a sole source of carbon and energy. In UT26, *lin* genes for the degradation of gamma-HCH are dispersed on two chromosomes and a plasmid. On the other hand, several other gamma-HCH-degrading bacteria isolated from HCH-contaminated soils in India, France, and China also possess the *lin* genes, but their *lin* genes appear to be located only on plasmids. Furthermore, insertion sequence, IS6100, has been frequently found near the *lin* genes. These facts strongly suggest that the mobile genetic elements, *i.e.* plasmids and the insertion sequence, greatly contribute to the distribution of *lin* genes in the environment. However, features of the plasmids carrying *lin* genes remain unclear. Recently, we newly isolated a gamma-HCH-degrading strain, *Sphingomonas* sp. MM-1, from an HCH-contaminated soil in India. This strain had *lin* genes and at least four plasmids, named pISP1, pISP2, pISP3, and pISP4, with sizes of 200, 50, 40, and 30 kb, respectively. Southern blot analyses of MM-1 revealed that (i) all the six *lin* genes (*linA* to *linF*) are located on the plasmids: *linA* on pISP1; *linB* on pISP4; *linC* on pISP1 and pISP4; *linD* and *linE* on pISP3; and *linF* on pISP1 and pISP4, and (ii) several copies of IS6100 are dispersed on all the plasmids. Shotgun sequence analysis of these plasmids demonstrated that (i) pISP1 has a putative gene cluster for plasmid transfer, (ii) various putative genes highly homologous to those of *Sphingomonas* species are dispersed on pISP2, pISP3, and pISP4, (iii) pISP3 carries a *linDE* cluster that is almost identical to that of UT26, and (iv) IS6100 copies are located to most *lin* genes. These results strongly supported the above mentioned hypothesis that the plasmids and IS6100 play an important role in the distribution of *lin* genes. Further analysis of these plasmids will provide us more insights into the mechanism for the bacterial adaptation in the environment.

Michiro Tabata (E-mail: t-michiro@ige.tohoku.ac.jp)
Graduated from the Faculty of Sciences, Tohoku University. Graduated from the Graduate School of Life Sciences, Tohoku University. (M.D.) Ph.D. course at the Graduate School of Life Sciences, Tohoku University.
Hemiclonal reproduction prevents introgression between species in a hybrid zone of three species of Hexagrammos

Motoko R. Kimura¹, Masakado Kawata², Syuichi Abe³, Katsutoshi Arai³ & Hiroyuki Munehara¹

¹ Field Science Center for Northern Biosphere, Hokkaido University, Hakodate 041-1613, Japan;  
² Graduate School of Life Sciences, Tohoku University, Sendai 980-8578, Japan;  
³ Graduate School of Fisheries Sciences, Hokkaido University, Hakodate 041-8611, Japan

Hybrid zones are often observed between species distributed in higher and lower latitude/altitude. Climatic change such as global warming might cause the changes in distribution and size of the hybrid zones. It is important to examine factors maintaining hybrid zones of these species for predicting the effects of climatic change on the hybrid zones.

The Hexagrammos generic species are common coastal benthic fish in the North Pacific. A hybrid zone between a boreal species (H. octogrammus) and two temperate species (H. agrammus and H. otakii) is formed in the north of Japan, and hybrids between boreal and temperate species are frequently observed. Our research found that the hybrids show hemiclonal reproduction called hybridogenesis, in which hybrids transfer only the genome of the boreal species into germ line but exclude the genome of the temperate species during gametogenesis. Owing to the hemiclonal reproduction, backcross between the hybrids and the parent species always produced offspring with the same genotypes of the hybrids. Therefore, the introgression of genes from one species to other species cannot occur. These mechanisms prevent temperate species from moving northward nor genes relating to temperature-dependent traits from introgressing from temperate species to the boreal species. These results first showed that hemiclonal reproduction is an important factor maintaining hybrid zones. We expect that this reproductive mode might not be uncommon in other species.

Motoko R. Kimura (E-mail: m.kimura79@gmail.com)
I received a PhD in environmental science at Hokkaido University last year. I have studied about reproductive isolation in coastal marine fishes by field observation and genetic analysis, to understand mechanisms generating biodiversity. Now I am thinking about how the evolutionary ecology can contribute to conservation of biodiversity.
Stoichiometric effects of temperature on growth rate of a herbivore zooplankton, *Daphnia pulicaria*: an experimental study

Qi Gong, Wataru Makino & Jotaro Urabe

Graduate School of Life Sciences, Tohoku University, Sendai 980-8578, Japan

Global warming is expected to affect biological/ecological processes in various scales. One of putative effects of increased temperature is stimulation of primary production, which in turn likely increases herbivore production. However, responses of consumer growth to global warming may be complex, because under a limited nutrient supply increased growth of producers often accompanies decreases in their nutrient content, which may in turn stoichiometrically reduce consumer growth. To examine this possibility, therefore, we investigated whether strength of warming effects on growth of herbivore plankton, *Daphnia pulicaria* change depending on phosphorus (P) supply level and overall algal mortality rates. Green algae, *Scenedesmus obliquus*, were semi-batch cultured at four different P concentrations with the same dilution rate or at four different dilution rates with the same P concentration. Once the semi-batch culture became steady state level, these algae were daily harvested and fed to juvenile *D. pulicaria* for five days to measure their growth (as change rate of dry mass). This procedure was repeated at 12, 16, 20 and 24°C. The experiments revealed that warming effects on *Daphnia* growth, assessed by coefficients of variation in growth rates across temperatures, increased with increases in P supply and overall algal mortality through changes in algal P content and biomass. These results suggest that effects of warming on consumers are pronounced in eutrophic lakes and those lacking planktivorous fish.

Wataru Makino (E-mail: wmakino@mail.tains.tohoku.ac.jp)

We study producer-consumer interactions from the standpoint of Ecological Stoichiometry, the balance of multiple chemical substances in ecological interactions and processes.
Inventorial databases of protists in Japan and local endemic species of ancient Lake Biwa

Satoshi Shimano

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The protozoa (protists) is a minimum organism to which morphospecies concept is applied. For instance, the ciliate is widely distributed from deep sea, coast, brackish water, fresh water, lake and eventually into forest soils. From last year 2009, a protist research group started a project of inventory study of infrastructure development on protozoa in all habitats of Japan to monitor the effect of global warming. In this context, Shimano and Miyoshi (2009) reported a literature database of testate amoeba and ciliate in Japan area. Until five years ago, it was not clear yet if restricted distribution applies to free living micro-organisms (e.g. Finlay, 2002). Recently, distinguished protozoan morphospecies of some local endemic species became known as "flagship species (e.g. Foissner, 2009)". The endemic ciliate Leviceoleps biwae Foissner, Kusuoka and Shimano, 2008 was described as a new genus from Lake Biwa (below) and hence a flagship species with information on its molecular genetics. Indeed, the third oldest ancient in the world, fresh water Lake Biwa is experiencing a reduction in turn over (also called “Deep breath”) by global warming. This phenomenon involves colder, denser, surface water sinking to the bottom of the lake, partly due to colder surface temperatures and melting mountain snow flowing downhill. Turn over provides dissolved oxygen to the deepest parts of a body of water. For instance, Lake Biwa Environmental Research Institute has been investigating the planktonic fauna/ flora every month for more than 40 years. Difflugia biwae Kawamura, 1918, formerly considered as a local endemic species of Lake Biwa. In Lake Biwa 40 years ago, it had been reported as the dominant species in the investigation. In 2007, about 20 individuals were rediscovered, but they are not living cells, only tests. D. biwae, has became first endangered protozoan species in Japan to our knowledge. Kawamura (1918) described this species in Japanese, so Ichise et al. (2009) represented the detail of this species.

Shimano, Satoshi (E-mail: satoshis@staff.miyakyo-u.ac.jp)
Ph.D., Associate Professor, Miyagi University of Education
Microbial Ecology, Protistology, Systematics
Evolution of heat tolerance by nocturnal katydid grasshopper
*Mecopoda niponensis* along urban to rural thermal gradient

Masami Hasegawa, Misato Nagumo, Yuki Takeda & Yuki Kiyoshima

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Rapid urbanization of rural landscapes around large cities provides us opportunity to study rapid evolutionary response by organisms to microclimate changes and habitat fragmentation. We have studied combined impacts of habitat fragmentation and urban heat stress to the forest dwelling large katydid grasshopper *Mecopoda niponensis*. Major question we address is to know if rapid evolution of heat tolerance could compensate local extinction due to habitat fragmentation and heat stress to singing activities by male katydids. *Mecopoda niponensis* is a nocturnally active katydid, and adult male produce large sound probably to attract females to copulate at night from mid August to early October. Continuous production of large sound made by high pitch rubbing movements of forewing for over 20 min inevitably produce heat, and the male katydids stop sound production when their thorax temperature exceed ca. 32 C. Laboratory experiment was done to measure time duration the male katydid can produce sound, and the katydid produced sound maximally at air temperature of 24 C and stop singing over 28-30 C. This strict thermal dependence of sound production suggest that increased nighttime temperature associated with urban heat island would preclude mating activities and ultimately cause local extinction. In order to test above idea, we surveyed *M. niponensis* at 442 fragmented woodlands with area from 0.01 to 40.81 ha along large scale transect (25 km x 10 km) located in the east of Tokyo metropolis in the summer of 2005, 2007 and 2009. Temperature data loggers were sat in the forest floor at height of 50 cm to monitor air temperature the katydid experienced. We then predict nighttime forest floor temperature of 442 woodlands by considering forest size (ha) and distance from Tokyo. We found that several local populations of *M. niponensis* in the fragmented forests where nighttime air temperatures are too high to sing maximally. We are currently examining if thermal tolerance evolved to compensate local extinction in highly stressful fragmented forest independently at several forest patches along urban to rural landscape gradient.

Masami Hasegawa (E-mail: mhase@bio.sci.toho-u.ac.jp)
Primarily engaging in long-term ecological study of prey-predator systems in oceanic island system to explore micro geographic evolution of morphological, life historical and behavioral traits. Katydid project is a product of biodiversity conservation practices at Satoyama in Chiba.
Preferential utilization of benzene and \( p \)-xylene over octane by \textit{Burkholderia cepacia} B5

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Contamination of the environment by petroleum hydrocarbons is a widespread problem requiring clean-up efforts. The effective and economical way to remove them is microbial degradation. However, the major hindrance to use microorganisms for bioremediation is their preference to utilize the aliphatic hydrocarbon compounds than the more toxic and more persistent aromatic components of petroleum oil. We obtained a microbial consortium from petroleum-contaminated sediments that degraded aromatic hydrocarbon fractions faster than aliphatic hydrocarbons when incubated in kerosene as a sole carbon and energy source. Plating of the microbial consortium resulted in the isolation of various microbial strains identified using the 16S rRNA gene. Each isolate was grown on dual carbon source containing benzene or \( p \)-xylene, as representative aromatic compounds and octane, as a representative aliphatic compound. Degradation experiments were performed in aerobic batch experiment using sealed vials containing liquid medium with 100 mg/L each of hydrocarbon substrate. Among the tested isolates, only \textit{Burkholderia cepacia} B5 degraded benzene and \( p \)-xylene faster than octane. Changing the concentrations of the hydrocarbon substrates produced similar trends of degradation. The isolates were further investigated in their ability to degrade polycyclic aromatic hydrocarbons, and only \textit{Burkholderia cepacia} B5 exhibited favorable growth in the presence of fluorene, phenanthrene, anthracene, and pyrene. These results suggest that B5 isolate maybe considered for bioremediation applications. The findings of this study are an indispensable contribution detailing the role of microbial activity towards risk-based degradation of complex hydrocarbon pollutants.

\textbf{Hernando Bacosa} (E-mail: bacosa@er.kankyo.tohoku.ac.jp) holds an MS in Environmental Studies from Tohoku University where he is pursuing a doctoral degree. His current research focuses on microbial consortia and bacterial isolates that preferably degrade aromatic hydrocarbons in mineral oil. He obtained his BS Biology major in Ecology from Mindanao State University, Philippines. Previously, he worked on the effects of oil pollution on meiofauna populations inhabiting the mangrove sediments in Southern Philippines and investigated the heavy oil and hydrocarbon-degrading microbial populations in the mangroves of Okinawa, Japan.
Organizing Committee

Masakado Kawata (E-mail: kawata@mail.tains.tohoku.ac.jp)
Professor.  My research focuses on evolutionary mechanisms creating biodiversity and ecosystems. My research includes the evolutionary response of populations/communities to environmental change, evolution of species range and distribution, evolvability and robustness of organisms and ecosystems in response to various factors such as infectious disease, global climate change and human-induced environmental change.

Tohru Nakashizuka (E-mail: toron@mail.tains.tohoku.ac.jp)
Professor.  We conduct a wide range of fundamental research on the forest ecosystem, from biodiversity through sustainable management. Topics include forest dynamics, natural & human disturbance, canopy ecology in tropical forest, plant-animal interaction, human-nature interaction, forest utilization and biodiversity. Field studies are conducted both in international and domestic research sites and explore both the basic and applied aspects of forest ecology.

Jotaro Urabe (E-mail: urabe@mail.tains.tohoku.ac.jp)
Professor.  We conduct a variety of laboratory and field studies to understand how local, regional and global environmental changes alter lake and stream ecosystems. Our research includes ecological stoichiometry of aquatic organisms, effects of warming and rising CO2 on biological interactions, mechanisms regulating the food web and functional roles of biodiversity in biogeochemical cycling and ecosystem stability.

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Takehiro is a Postdoctoral Fellow in the Ecosystem Adaptability Global COE program at Tohoku University. His research mainly focuses on nonlinear vegetation dynamics in arid and semi-arid ecosystems, including the patterns and processes of nonlinear vegetation responses to grazing, and the mechanisms how local extinctions in communities impact ecosystem functioning. For more information, please visit http://homepage3.nifty.com/landscape_ecology/.
Hiroko Kurokawa (E-mail: hiro@m.tains.tohoku.ac.jp)
Assistant Professor. Hiroko is a plant ecologist, generally interested in how plant functional diversity affects above- and belowground interactions, ecosystem functioning, and eventually feedbacks to plant community structure. She has worked at tropical rain forests in Borneo, an invaded flood plain in New Zealand, subtropical islands and subalpine forests in Japan.

Hiroshi Tomimatsu (E-mail: htomi@bios.tohoku.ac.jp)
Assistant Professor. Hiroshi has joined the GCOE program in April, 2009. His research primarily focuses on the dynamics of plant populations and communities, with a particular emphasis on the influence of human activities such as habitat loss and fragmentation and anthropogenic dispersal. He received a Ph.D. from Hokkaido University, and he was a JSPS postdoctoral fellow at Tokyo Metropolitan University and at the University of British Columbia.
Other Researchers in GCOE Program

Kouki Hikosaka (E-mail: hikosaka@mail.tains.tohoku.ac.jp)
Associate Professor. We study plant response to environmental change: analyzing the impact of warming and atmospheric CO₂ increase on photosynthesis, plus growth and reproduction on various spatial and temporal scales. We conduct research on the evolution of plants inhabiting CO₂ spring ecosystems, where they have been exposed to high CO₂ concentrations on an evolutionary time scale.

Satoshi Chiba (E-mail: schiba@biology.tohoku.ac.jp)
Associate Professor. We examine how various organisms exhibit evolutionary response, community-level response and interactions between organisms to direct or indirect human activity. Using the archipelago as a model we also analyze evolutionary processes, invasive species, the response of native species to invasion, and mitigation and ecosystem protection against radical environmental change.

Masataka Tsuda (E-mail: mtsuda@ige.tohoku.ac.jp)
Professor. Our goal is to understand the behavior and evolution of environmental bacteria from the standpoints of molecular genetics, molecular biology, structural and functional genomics and molecular ecology. Particular emphasis is placed on understanding bacteria able to degrade environmental pollutants.

Hideyuki Takahashi (E-mail: hideyuki@ige.tohoku.ac.jp)
Professor. We look at the way in which sessile land plants avoid stress and adapt to their surroundings in response to various environmental cues. For example, plants adjust their morphology and growth orientation in response to light, temperature, water, gravity, and mechanical stimuli, all of which helps them to obtain light energy and water for survival. Our research aims at elucidating the molecular and genetic bases of these adjustments.

Tatsushi Muta (E-mail: tmuta@biology.tohoku.ac.jp)
Professor. To understand ecological adaptability and robustness, it is necessary to understand host defense mechanisms against pathogenic microorganisms. We investigate the activation mechanisms and physiological functions of innate immunity present in all multicellular organisms from plants through mammals. Using human and mouse cells and genetically engineered mice we are currently analyzing the innate immune system with a variety of techniques including: biochemistry, molecular biology, cell biology, immunology, and developmental engineering.
Koji Tamura (E-mail: tam@biology.tohoku.ac.jp)
Professor. Adaptation and response to environmental change differ between species. We research the morphology of vertebrates in order to understand their flexibility and robustness as the basis of adaptivity. We use development/regeneration of tissues and organs in vertebrates as an experimental model to assess morphogenetic ability.

Shoichiro Kurata (E-mail: kurata@mail.pharm.tohoku.ac.jp)
Professor. We analyze the molecular mechanisms of “development and regeneration” and “innate immunity” to better understand how organisms adapt to environmental change. These studies utilize Drosophila as the model organism. We are also developing compounds that act on insect immunity to control vector-born diseases such as malaria and sleeping sickness, the transmission of which has expanded due to climate changes.

Akihiro Kijima (E-mail: a-kijima@mail.tains.tohoku.ac.jp)
Professor. We are interested in understanding the causes of change in distribution of organisms around the Sanriku coast. This represents a location in which warm and cold sea currents meet and is a north/south boundary for distribution of a number of species. We conduct research on changes in species distribution, adaptation, and the mechanism of recent climate change. We are also interested in evaluating future risk and strategies to mitigate risk.

Yoshinari Endo (E-mail: yendo@bios.tohoku.ac.jp)
Professor. Global warming is likely to increase ocean stability, diminish nutrient enrichment and reduce primary productivity. Increased CO₂ in the oceans renders them more acidic, making it more difficult for some plankton to build and maintain calcium carbonate shells. In addition to fundamental studies of marine plankton, we are interested in understanding the impact of such radical environmental changes on marine plankton and the physiological and ecological strategies that these organisms use to survive.

Yukio Agatsuma (E-mail: agatsuma@bios.tohoku.ac.jp)
Associate Professor. Global warming extends over the ocean and accelerates kelp deforestation in rocky subtidal communities, resulting in expansion of barren ground “Isoyake” dominated by crustose coralline red algae. Alternation from kelp forest to fucoid forest is also seen. Production of herbivorous sea urchin is reduced due to these changes, and our main area of study focuses on the systemic adaptations of primary consumer/altered producer through species interaction.

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Associate Professor. We study the molecular ecology of forest trees: in particular, genetic diversity, ecological adaptation, ecosystem function, and conservation as part of a forest ecosystem. We use a combination of molecular and ecological approaches for both domestic and international projects. In ongoing projects, we conduct large-scale field experiments using artificial wetlands and riparian forest to clarify the relationship between biodiversity and ecosystem function.
Junya Fukumoto (E-mail: fukumoto@plan.civil.tohoku.ac.jp)
Associate Professor. We research ecological governance, i.e. how social systems adapt to drastic changes in the ecological environment. We propose a novel mechanism that collates human ecological knowledge, coordinates the interests of different stakeholders, and tries to implement mutually beneficial eco-strategies. Our main concern is to apply ICT to ecological governance.

Nariaki Fujisaki (E-mail: fujisaki@mail.kankyo.ac.jp)
Professor. In order to shed light upon various aspects of water resource problems, we recently started an interdisciplinary research project focusing on a river basin in West Java, Indonesia. While the level of deterioration of the watershed ecosystem, changes in water flow and water quality degradation in the region will be assessed scientifically, several factors related to industrialization and urban development, such as access to water supply and sewerage, establishment of environment-related laws and ordinances, and provision of administrative and environmental management services, will be analyzed from a social science viewpoint.

Osamu Nishimura (E-mail: osamura@eco.civil.tohoku.ac.jp)
Professor. The restoration of rivers, lakes, wetlands, tidelands and seaweed beds damaged by human activity is a critical requirement of ecosystem conservation. To restore and sustain ecological services, we research and develop technologies using constructed wetlands and tidal flatlands to remove pollutants and enhance biodiversity.

Kazunori Nakano (E-mail: knakano@eco.civil.tohoku.ac.jp)
Associate Professor. Natural environments have effective purification systems that do not require external energy for their operation and maintenance. By strengthening the natural functions of constructed wetlands water purification is effected with minimum energy input. In this program, we conduct research on the experimental wetlands established at Kawatabi Field Center to investigate water purification in connection with rhizosphere microorganic activity enhanced by hydraulic manipulation.

Yasuhisa Hayashiyama (E-mail: yhaya@econ.tohoku.ac.jp)
Professor. Our social and economic activities are subject to the laws of nature, and our economic activities cause environmental problems. We research the interactions between socio-economic activity and the natural environment. More concretely, we try to quantify the impact of environmental policy on our social and economic systems, and measure environmental services in monetary term.

Atsushi Yoshimoto (E-mail: yoshimoa@ism.ac.jp)
Visiting Professor, The Institute of Statistical Mathematics. Our research focuses on mathematical models for predicting and controlling natural and socio-economic resource change within deterministic and stochastic frameworks. Through field survey, we conduct research on sustainable forest resource management as a socio-economic system. One of our current projects concerns risk evaluation and economic analysis of sustainable forest resource management.
Noriko Takemoto (E-mail: takemoto@m.tains.tohoku.ac.jp)

Professor by Special Appointment and Senior Business Adviser. After helping set up a company in direct marketing and founding another in IT education, I became involved in a citizens’ project to fund wind generator turbines in Hokkaido and, then, more generally, with CSR and the design of goods consonant with the philosophy and practice of environmental sustainability. I now serve on a couple of committees charged with looking at ecological sustainability with regard to business, and join this Center as its business liaison adviser.

Hiromi Kato (E-mail: katee@ige.tohoku.ac.jp)

Postdoctoral Fellow. Disturbances in environments are known to drastically influence structures and functions of microbial community. Microbial community is a suitable example to observe effect of the environmental stress on the biodiversity. Using molecular biological approaches, we investigate the succession of soil bacterial communities and functions induced by chemical pollution.

Tomokazu Yamazaki (E-mail: yamat@ige.tohoku.ac.jp)

Postdoctoral Fellow. My interest is how plants adapt to their surroundings changing various ranges of physicochemical stresses, which are caused by light strength, temperature, and water amount, and so on. Of the adaptation mechanisms, hydrotropism in plant roots is a system to avoid water shortage with sensing moisture gradient followed by altering growth direction to high-humidity region. In the project of GCOE, I aim at elucidating the molecular base of hydrotropism.

Seiji Ishida (E-mail: ishidaseiji@m.tains.tohoku.ac.jp)

Assistant Professor. My research interest is how quaternary glaciations and recent anthropogenic impact have altered biodiversity of freshwater species in the northern hemisphere. I conduct phylogeographic and taxonomic studies on freshwater zooplankton to reveal population history and invasion. I also conduct interdisciplinary research relating to paleolimnology and gene functions of freshwater zooplankton, *Daphnia*.

Takashi Makino (E-mail: tamakino@m.tains.tohoku.ac.jp)

Assistant Professor. We are interested in genetic factors related to evolvability contributing to extent of species distributions, and focus on genome structures of Drosophila species for the issue by comparative genome analysis. Our point of view is important for considering how ecological system shifts by change in environment such as global warming. We also expect that the research outcomes are applicable to species conservatory.

Hai-Liang Song (E-mail: shl@eco.civil.tohoku.ac.jp)

Assistant Professor. Aquatic ecosystems are increasingly being affected by human-derived emerging organic micro-pollutants such as pharmaceutically active compounds, personal care products, hormonally active agents. In addition to fundamental researches concerning the fate of the above human-derived micro-pollutants in natural aquatic ecosystems, we are particular interested in developing engineered wetland ecosystems to reduce the potential ecological risk caused by the human-derived micro-pollutants.
Yasuyoshi Kanari (E-mail: kanari@life.biology.tohoku.ac.jp)  
Assistant Professor: Several host genes control retroviral replication and pathogenesis. I have conducted association study about Italian cohort to reveal HIV resistant host genetic factors focusing on immune response. The understanding of the mechanisms of natural protection from or spontaneous resistance to viral infections may contribute to the development of treatment of infectious disease based on Ecosystem Adaptation. Now, I am researching how the cells recognize the pathogen and respond for exclusion of pathogen at molecular level to understand the mechanism of natural protection more deeply.

Akira Goto (E-mail: agoto@mail.pharm.tohoku.ac.jp)  
Assistant Professor: Damaging ecosystems could trigger emergence or re-emergence of pathogens and concomitant high utilization of antibiotics also causes drug resistances. One of the alternative solutions to this vicious cycle problem is to make use of the potential powers of innate immunity which is the pillar of immune system for both vertebrates and invertebrates. To understand how organisms adapt to environmental changes including infections, I am currently investigating the molecular mechanisms of innate immune responses using Drosophila melanogaster (fruit fly) as model organism and further looking for alternative solutions to infectious diseases and pest control.

Kazunori Nakajima (E-mail: nakajima@econ.tohoku.ac.jp)  
Assistant Professor: We conduct research on economic evaluations of impacts of environmental policies, biodiversity conservation policies and climate stabilization policies on our socio-economic systems from view points of efficiency, equity as well as sustainability, through developing/using economic models such as a dynamic optimization model and a computable general equilibrium model.

Masashi Konoshima (E-mail: konoshima@m.tains.tohoku.ac.jp)  
Assistant Professor: My research interest lies in examining natural resource, especially forest resource, management decisions over space and time. In order to examine the complex tradeoffs associated with natural resource management decisions, I have developed integrated models that combine ecological/biological/physical models and economic models. I have applied GIS and optimization models for spatial natural resource economic analysis, which is one of the emerging areas of natural resource and environmental economics. The current research topics include: management of natural disturbances, wildlife habitat protection, and invasive species.

Masakazu Inagaki (E-mail: m-inagaki@m.tains.tohoku.ac.jp)  
Assistant Professor: We are interested in the relation between consideration to environment and economic activity. Especially, we analyze the economic effect of environmental education by attitude behavior change model. We also research the market of environment-conscious type products by using statistical methods.
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Map

期間中、東北大学川内キャンパス内の食堂も利用出来ます。
春休み期間のため、昼食時ののみの営業です。

Cafeterias at the Tohoku University Kawauchi Campus are also available for lunch.
International Forum for Ecosystem Management Applying to Ecosystem Adaptability Science

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