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# ORNL

# FOREIGN TRIP REPORT

ORNL/FTR-3747

DATE: September 25, 1990

SUBJECT: Joint Report of Foreign Travel of Donald L. DeAngelis, Charles T. Garten, Jr., and Monica G. Turner, Environmental Sciences Division

TO: Alvin W. Trivelpiece

FROM: D. L. DeAngelis, C. T. Garten, Jr., and M. G. Turner

PURPOSE: D. L. DeAngelis presented invited papers at the OJI International Seminar in Gifu; the Fifth International Congress of Ecology in Yokohama; and the Fukuoka Symposium on Theoretical Ecology in Fukuoka and chaired sessions at each of the three meetings. C. T. Garten attended the International Congress of Ecology in Yokohama. M. G. Turner chaired a symposium and presented a paper at the International Congress of Ecology in Yokohama.

SITES VISITED:

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|---|---|---|---|
| 8/18-22/90 (DeAngelis) | OJI International Seminar | Gifu | H. Kawanabe |
| 8/23-30/90 (DeAngelis, Garten, Turner) | Fifth International Congress of Ecology | Yokohama | F. B. Golley |
| 8/31-9/2/90 (DeAngelis) | Fukuoka Symposium on Theoretical Ecology | Fukuoka | H. Matsuda |

**ABSTRACT:** The travelers attended the Fifth International Congress of Ecology (INTECOL) in Yokohama, Japan, August 23-30, and two presented invited papers and chaired symposia. One traveler also attended the OJI International Seminar in Gifu, Japan (August 18-22), and the Fukuoka Symposium on Theoretical Ecology in Fukuoka, Japan (August 31-September 2) and presented invited papers. At these scientific gatherings, a large number of symposia and specific presentations were relevant to current research at ORNL, especially in the areas of landscape dynamics, plant physiology, and aquatic ecosystems.



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The travelers were able to discuss plans for collaborative research. In particular, D. L. DeAngelis has submitted a proposal for U.S.-Japanese collaborative research on ecosystem dynamics that will be relevant to DOE-funded work on stream ecosystems. M. G. Turner contacted small mammal ecologists whose work may help to test ideas in landscape theory being developed at Oak Ridge under DOE sponsorship. C. T. Garten spoke to a number of foreign researchers about work at ORNL on the Walker Branch Watershed Project.

## PURPOSE

The main purpose of the trip for the three travelers (D. L. DeAngelis, C. T. Garten, Jr., and M. G. Turner) was to attend the Fifth International Congress of Ecology (INTECOL), organized by the International Association for Ecology, held in Yokohama, Japan, August 23-30. The theme of the meeting was "Development of Ecological Perspectives for the 21st Century," and over 2500 ecologists from more than 70 countries attended. INTECOL congresses are held every 4 years and provide the primary mechanism for ecologists from around the world to share results of current ecological research. D. L. DeAngelis and M. G. Turner were each co-organizers of different symposia at this meeting, and D. L. DeAngelis and M. G. Turner presented invited papers in three different symposia. In addition, D. L. DeAngelis presented invited papers at two satellite meetings of the INTECOL meeting: the OJI International Seminar in Gifu, Japan (August 18-22) and the Fukuoka Symposium on Theoretical Ecology in Fukuoka, Japan (August 31-September 2).

## PARTICIPATION BY TRAVELERS

1. Fifth International Congress of Ecology

D. L. DeAngelis was co-organizer of a symposium, "Food Webs: Regularities and Their Causes," along with H. Nakajima (Japan). The purpose of the symposium was to assess the current understanding of food web structure and dynamics. Profs. S. L. Pimm and J. E. Cohen reviewed data on a large number of food webs, pointing out the types of general patterns that can be observed and discussing the dynamic explanations that have been offered. Prof. G. A. Polis presented detailed data on a specific desert food web, indicating that such intensively studied food webs defy easy identification of patterns. P. H. Neinhuis presented data on long-term trends in coastal food webs under pollutant stress. D. L. DeAngelis compared model and experimental results concerning the effects of nutrient limitation on stream food web structure and stability. Four additional papers discussed mathematical approaches to understanding food webs.

M. G. Turner organized a symposium, "Methodology in Landscape Ecology," with Prof. T. Katsuno (Japan). This symposium was one of three landscape ecology sessions that were invited by the Japanese Organizing Committee. A symposium organized by Z. Naveh (Israel) and M. Numata (Japan) focused on "Landscape Ecology: Theory and Applied Aspects in Human Society," and a symposium organized by R. T. T. Forman (United States) and H. Ide (Japan) addressed "Theory and Principles in Landscape Ecology."

In the methodology symposium, M. G. Turner presented a paper, "The Effect of Landscape Pattern on Ecological Processes: Theory and Testing." Recent research in theoretical ecology by Turner, R. H. Gardner, and R. V. O'Neill was reviewed with an emphasis on testable hypotheses that have been derived from theory. This work has been funded by DOE through the Ecological Research Division of the Office of Health and Environmental Research. The next presentation, "Landscape Management in Europe," was by K.-F. Schreiber (Federal Republic of Germany). Schreiber emphasized the broad-scale environmental problems, such as high nutrient loadings, faced in Central Europe and offered suggestions for landscape management practices that would help provide solutions. In another presentation, D. M. Sharpe (United States) described a combination of field studies and geographic information system (GIS) analyses that were used to examine deforestation in the central United States and the resultant species diversity in the fragmented landscape. Sharpe found that most forest fragments in the study area contained <10 species but that 25% of all patches studied contained a species unique to that patch. No single forest patch contained the entire regional flora, and the number and spatial arrangement of patches required to preserve the species richness of the region must be determined. J. Schaller (Federal Republic of Germany) reported on research that also makes extensive use of GIS analyses. Schaller has studied high mountain landscapes in Germany, focusing on the fluxes of water and energy between the different habitat types. A dynamic flow model was linked with a spatial data base stored in a GIS to predict the effects of alternative land use conditions and patterns on water transport. The final paper in the symposium focused on scaling issues in landscape studies and was presented by V. Meentemeyer (United States). Meentemeyer reviewed a variety of scale-related concepts and provided examples of ecologically important processes, such as precipitation patterns and decomposition, that appear to have different controls operating at different spatial and temporal scales.

## 2. OJI International Seminar

This seminar was titled "Mutualism, Cooperation, and Organization in Natural Communities" and was organized by Prof. H. Kawanabe of Kyoto University, President of the Japanese Ecological Society. The meeting brought together about 60 scientists from Japan, the United States, and several other countries who are studying complex ecological systems, both through field studies and theoretical models. D. L. DeAngelis presented a paper, "The Role of Size Variations within Fish Cohorts in Competition, Responses to Predation, and Apparent Mutualism," which showed results of

a complex model of first-year dynamics of a smallmouth bass cohort. D. L. DeAngelis also chaired one of the sessions. The meeting was extremely effective in demonstrating the basic similarities in the types of organization underlying different ecological systems.

3. Fukuoka Symposium on Theoretical Ecology

More than 50 scientists from Japan and other countries attended this meeting, which addressed a variety of topics in theoretical ecology and evolutionary theory. Particularly interesting results were presented on the dynamics of very rare species (S. L. Pimm) and on factual descriptions of landscapes (Y. Cohen). D. L. DeAngelis presented a poster, "Model Investigations of Where Density-Dependent Regulation Occurs in Fish Life Cycles."

## OTHER INTECOL SYMPOSIA OF INTEREST

Several presentations of new work at the Congress were especially relevant to ongoing DOE-sponsored work in landscape and theoretical ecology that focuses on the effects of spatial heterogeneity on ecological processes. Three papers presented in the symposium "Relation Between Spatial Heterogeneity, Behavioral Ecology, Genetics and Population Dynamics" were particularly noteworthy. Rolf Ims (Norway) described a field experiment in which population-level responses of small rodents to habitat fragmentation were studied. The size, shape, and connectivity of habitat patches were manipulated, and the responses of two genetically different Microtus populations from different locations in Norway were studied. The populations differed in their behavioral characteristics, one being very aggressive and the other more docile. The populations responded differently to habitat fragmentation. The aggressive, more territorial population exhibited a rapid reduction in population size (Ims termed this "fission") because animals expelled other animals from their territories on small patches. In contrast, the more docile, less territorial population exhibited increased congregation of individuals on small patches (Ims termed this "fusion"). Thus, the docile population did not decline in the short term, but longer-term consequences might include overexploitation of resources and social dysfunction. His presentation concluded by asking the question, "Can we extrapolate results from model systems to larger landscapes or from one species to another?" The study suggested that it is necessary to study different species on different scales to define the limits to extrapolation.

A study by M. Gaines (Kansas) also examined the effects of habitat fragmentation on small mammal populations. However, this study examined the responses of three species ranging in mass from 18 g (Peromyscus) to 36 g (Microtus) to 160 g (Sigmodon) to habitat patches of three different sizes. The following hypotheses were tested: (1) population densities will be lower in fragmented habitats than in continuous habitat;

(2) species will sort according to body size, with larger animals more prevalent in larger patches; and (3) turnover rates will be higher on smaller habitat patches because habitat quality is hypothesized generally to be worse on small patches. The most interesting result of this study was that the species did indeed sort according to body size, with Peromyscus densities highest in small patches, Microtus highest in moderate patches, and Sigmodon in large patches. In addition, the average persistence of an individual on a patch increased with patch size, and turnover rates were highest on small patches. Discussions with both Ims and Gaines indicated a keen interest in the landscape theory being developed at ORNL.

A paper presented by Peter Kareiva (United States) nicely demonstrated important ecological effects of habitat heterogeneity. In manipulated patches of fireweed on Mt. St. Helens, early data showed that aphids were most abundant on large patches and least abundant on small patches. During later years, however, this trend was reversed - aphids became most abundant on small, isolated patches. Predators were then sampled, and results demonstrated that predation pressure was 61% on large patches but only 38% on small patches. Thus, habitat fragmentation altered predation pressure and reversed the trend in population abundance observed in the absence of predators. Kareiva concluded by suggesting that it is necessary to address multispecies responses and multiple trophic levels to assess the effects of habitat fragmentation.

In a symposium on "Spruce Forests and Other Boreal Forests in Global Perspective," E. A. Johnson (Canada) presented a paper addressing the fire regime, mortality, and recruitment patterns in subalpine forests. Results were relevant both to global climate change studies and to Turner's ongoing studies of fire in Yellowstone National Park. In four large (>200,000-ha) study areas, the fire return interval between 1600 and 1730 was approximately 50 years, whereas the return interval since 1730 has been approximately 90 years. The climate during the earlier period was warmer and drier than the current climate. Fire history studies also provide no indication that fire suppression has had any effect on natural fires. Large-scale fires appear to be controlled by the frequencies in synoptic weather patterns. Forest reestablishment following extensive fires occurs in two phases. A cohort of seedlings becomes established in the first several years following fire. An additional cohort can become established after canopy formation, but mortality is greater and these individuals have little opportunity to get into the canopy. These data are particularly relevant to the studies of plant reestablishment following fire in Yellowstone National Park.

Sessions on plant physiology, ecosystem modeling, and biogeochemical cycling in terrestrial ecosystems at this congress were of direct benefit to C. T. Garten because of their relationship to his work for DOE. The first session of interest was entitled "Plant Behavior as the Integration of Physiological Responses to Environmental Factors." Two presentations in this session addressed questions relating to the long-term response of plants to increasing levels of atmospheric carbon dioxide ($CO_2$). George Koch (University of California, Davis) reported on carbon and

nitrogen relationships in plants (Ludwigia spp.) from habitats that have experienced naturally high levels of atmospheric $CO_2$ originating from $CO_2$-mineral springs along the west coast of North America. He reported on changes in carbon and nitrogen metabolism (increasing leaf mass, decreasing leaf N levels, and increasing leaf photosynthetic rates) in high-$CO_2$ environments. This was a novel approach to the study of plant responses to increasing atmospheric $CO_2$. Other studies have taken the approach exemplified by Dieter Overdieck (Federal Republic of Germany) who reported on increased growth and production of tree seedlings in response to exposure to elevated atmospheric $CO_2$ in a greenhouse setting. The implications of both sets of work are that increasing atmospheric $CO_2$ as a result of climate change will have some indirect effect on N cycling in terrestrial ecosystems. These findings argue for a careful integration of studies of carbon and nitrogen cycling such as those currently under way in the Environmental Sciences Division (ESD) on Walker Branch Watershed. A remaining problem in this field was identified by Hal Mooney. Plant physiological ecology and plant population biology have not been well integrated, mainly because of problems related to plant responses that occur over very different time scales in these two branches of ecology.

Several interesting papers on high-level symbolic simulation languages were presented in this session entitled "Microcomputers in Ecological Modelling: Novel Approaches in Interactive Research." William Mitsch (Ohio State University) described the application of $STELLA_R$ on the Macintosh for modeling a major oil spill on the Ohio River in 1988. This modelling technique has also been applied to efficiency of wetlands in removing iron from acid mine drainage. The simplicity of $STELLA_R$ and similar high-level symbolic simulation languages and their speed of implementation makes them potentially powerful tools for predicting response to ecological disasters. We have found applications for $STELLA_R$ in more basic research issues related to activities in ESD, including research on Walker Branch Watershed.

In a different, but interesting vein, Valerio Vendegna (Italy) presented one of the most stimulating papers in this session. He described a model for singling out the optimal solution of environmental reclamation projects. Dr. Vendegna has applied a cost-benefit model to answer the question of when continuing expenditures in environmental reclamation result in no further improvement in the environment. Beyond this point, tax dollars spent on reclamation are wasted on diminishing (and sometimes negligible) returns to environmental quality. This technique has been applied to the problem of waste water discharge from Italian cities to the Mediterranean Sea. It would be very interesting to apply this type of cost-benefit analysis to the problem of environmental restoration at DOE facilities in the United States. This would appear to be a cost-saving and more scientific initiative in approaching environmental problems than merely responding to political and public pressures for environmental cleanup.

Along these same lines, C. T. Garten attended another session entitled "Ecological Values and Environmental Benefit-Cost Analysis." It is a

matter of opinion whether our environmental problems (including those within the DOE community) can be managed efficiently without a good marriage between the fields of ecology and economics. To stimulate discussion in this general area, Ralf Buckley (Australia) conducted an afternoon discussion on ecological values and environmental accounting. The problem he posed was one of estimating the economic value of natural ecosystem processes. This session was beset by more problems than solutions because frequently the value of an item (including an ecosystem) depends on the circumstances of a particular setting. The value of ecosystems and choices in conservation are usually decided on the basis of noneconomic values. This can be a costly approach. One of the problems in applying economic principles to ecology is that economics is not good at valuing big, irreversible changes (such as the loss of all the world's oil or the loss of irreplaceable species), and methods used to determine what ecosystem processes are worth to human well being are not reliable or well developed. Many participants indicated that there is an absence of scientific methods to make decisions of environmental value and choice in conservation. The discussion during this session demonstrated that there will be many viewpoints and problems in building linkages between ecology and economics. Nonetheless, this is an emerging area of considerable importance in which ORNL might be positioned to make substantive contributions by virtue of its interdisciplinary nature.

A final session of most direct interest and bearing on C. T. Garten's work at ORNL was entitled "Biogeochemical Cycling of Elements in Terrestrial Ecosystems." Lennart Rasmussen (Denmark) reported on field experiments to manipulate water and nutrient inputs to forests by building large (400 to 1200 $m^2$) roofs below forest canopies. This work was interesting because of our current discussions within ESD about large-scale manipulations of hydrologic inputs to Walker Branch Watershed. The Europeans are building large roofs below forest canopies at six sites in Europe differing in nitrogen and sulfur deposition. This is certainly a novel approach. The acronym for this project is EXMAN (Experimental Manipulations of Forest Ecosystems in Europe). Although some technical problems are evident in this approach, the results so far from this 2-year-old study show that small changes in hydrologic inputs (10%) can result in a quick change in forest productivity and nutrient cycling. Timing of disruption in precipitation inputs appears to be a critical variable. A second presentation of interest in this session was given by Shigeo Katagiri (Japan). Katagiri is comparing nutrient cycling on upper and lower slopes in a natural deciduous broad-leaf forest in Japan. A number of findings in his study are similar to those of Garten's current studies on topographic variation in nitrogen cycling on Walker Branch Watershed. Based on Katagiri's report, we have similar topographic patterns in nitrogen cycling in two different ecosystems from two very different parts of the world. Garten was unaware of Katagiri's work until this meeting, and there could be some potential here for future collaborations.

In summary, this was a very useful trip from the standpoint of technical interests of C. T. Garten. Aside from the formal meeting presentations, this conference had a large number of poster presentations that provided

an effective forum for meeting researchers from other countries. A number of contacts were made by C. T. Garten through the poster sessions, and one accomplishment of these contacts was informing other people of our work at ORNL on the Walker Branch Watershed Research Project. Although there were sometimes difficulties in communicating with Japanese scientists, an exchange of business cards with a few well kept notes set the stage for future correspondence on matters of mutual interest. Because of the international nature and broad subject matter covered at this meeting, travelers had an opportunity to learn about a broader range of work from more foreign countries than is usually encountered at more technically specialized overseas meetings. Future participation by ESD staff members in the Sixth International Congress of Ecology in 1994 is recommended.

Symposia of special interest to D. L. DeAngelis included "Experimental Ecology of Aquatic Ecosystems" and "Role of Fish and/or Birds in the Regulation of Aquatic Ecosystems." The first of these provided an extremely good overview of the microcosm, mesocosm, and whole-system experimental work currently being done on aquatic systems in different countries. This topic was highly interesting in relation to the artificial stream studies being conducted at ORNL with which D. L. DeAngelis has been associated. The second of these symposia provided a large amount of evidence of the prevalence of top-down effects from predators in aquatic systems, which has implications for the food web dynamics of eastern Tennessee streams and reservoirs being studied at ORNL.

A complete listing of the INTECOL program, including plenary lectures, symposia, and poster sessions, is available from D. L. DeAngelis.

## SIGNIFICANT ACCOMPLISHMENTS, RESULTS, AND INFORMATION ACQUIRED

New experimental studies are being conducted by traditional small-mammal ecologists to examine the effects of spatial heterogeneity on population dynamics. Collaboration with these researchers could provide excellent opportunities to test landscape-level theory currently being developed at ORNL.

M. G. Turner was invited to participate in two upcoming international symposia: (1) a landscape ecology symposium to be held in Italy during the summer of 1992, organized by Dr. Frank B. Golley, President of INTECOL, and Dr. Almo Farina and (2) a landscape ecology symposium to be held in Tartu, Estonia, during the spring of 1992, organized by Dr. Ulo Mander.

D. L. DeAngelis was contacted by Prof. H. Kawanabe (President of the Japanese Ecological Society) and asked to write a letter of support for the establishment of a National Institute of Ecology in Japan. Details of this proposal are available from D. L. DeAngelis.

D. L. DeAngelis was invited to an International Symposium on the Nagara River on August 22 at Gifu, Japan. This symposium was held to discuss the future of the Nagara River, which is "the last major undammed river in Japan." The groundbreaking for a 150-billion-yen dam at the river mouth recently took place, leaving many questions about the adverse environmental impacts unresolved. Although DeAngelis was unable to attend the symposium, he discussed with Japanese scientists the environmental problems associated with the damming. Many Japanese citizens oppose the dam, but there are no easy mechanisms for challenging its construction.

D. L. DeAngelis met with Prof. J. R. Baylis (University of Wisconsin) and Prof. D. L. G. Noakes (University of Guelph) to discuss proposed collaborative work on a project for the Electric Power Research Institute, Compensatory Mechanisms in Fish Populations.

D. L. DeAngelis met with Prof. E. Teramoto and Drs. H. Nakajima, K. Kawasaki, and N. Shigesada (all of Japan), Prof. R. E. Ulanowicz (University of Maryland), and Prof. B. C. Patten (University of Georgia) to discuss plans for joint collaboration. This group has submitted a proposal to the National Science Foundation for U.S.-Japanese collaborative research.

## RECOMMENDATIONS

Because the INTECOL congresses are the primary forum for the international group of ecologists, DOE should ensure continued participation at future conferences from ecologists at the national laboratories. This provides two benefits to DOE: (1) opportunities for DOE-sponsored research to be presented to an international audience and (2) results from current research conducted around the world and of relevance to DOE-sponsored work can be made available to DOE scientists.

# APPENDIX A

## ITINERARY

Donald L. DeAngelis

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|---|---|
| August 16-18 | Travel from Oak Ridge, Tennessee to Gifu, Japan |
| August 18-22 | Attending OJI International Seminar, Gifu, Japan |
| August 23-30 | Attending the Fifth International Congress of Ecology, Yokohama, Japan |
| August 31-September 2 | Attending the Fukuoka Symposium on Theoretical Ecology, Fukuoka, Japan |
| September 3-4 | Travel from Fukuoka, Japan to Oak Ridge, Tennessee |

Charles T. Garten, Jr.

| | |
|---|---|
| August 21-23 | Travel from Oak Ridge, Tennessee to Yokohama, Japan |
| August 23-30 | Meetings of the Fifth International Congress of Ecology, Yokohama, Japan |
| August 30 | Travel from Yokohama, Japan to Oak Ridge, Tennessee |

Monica G. Turner

| | |
|---|---|
| August 21-22 | Travel from Oak Ridge, Tennessee to Yokohama, Japan |
| August 23-30 | Attending the V International Congress of Ecology, Yokohama, Japan |
| August 31-September 1 | Personal business in Kyoto, Japan |
| September 2 | Travel from Kyoto, Japan to Oak Ridge, Tennessee |

## APPENDIX B

## PERSONS CONTACTED TO A SIGNIFICANT DEGREE

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## APPENDIX C

## LITERATURE OBTAINED

Abstracts of the Plenary, Symposium Papers and Posters, International Congress of Ecology, Yokohama, Japan, August 23-30, 1990. 503 pp.

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Sato, T. 1988. Seasonal dynamics of leaf-shapt and leaf-size in plant foliage. Sci. Forum 3:73-77.

Sato, T., G. Grabherr, and K. Washio. 1989. Quantitative comparison of fern-leaf development and fertility with respect to altitude in the Tirol, Central European Alps, Austria. J. Biogeogr. 16:449-455.

Sieffermann, R. G. An ecosystem under acid rain at Merapi volcano in central Java, Indonesia (reprint of manuscript from unidentified journal).

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Yangnan, L., Z. Guizhi, and Z. Ji. The soil activity effect of the synthetically harnessed degenerative Aneurolepidium chinense grassland (reprint of manuscript from unidentified journal).

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C. E. T. A., Centro di Ecologia Teorica ed Applicata, The International Center for Theoretical and Applied Ecology, Gorizia, Italy.

Kawanabe, H., T. Ohgushi, and M. Higashi (eds.). 1990. Ecology for Tomorrow. Physiol. Ecol. Japan 27 (Special Number).

# END

# DATE FILMED

10/31/90