



Newsletter

Volume 9, Numbers 3-4
May-June and July-August 1992

Editor's Note

As in nature, changing seasons at the Institute of Ecosystem Studies bring changing highlights. In fall the scientific seminar series begins, the Continuing Education Program attracts both new and returning students, and elementary school teachers collaborate with IES educators to introduce Eco-Inquiry to their classrooms. During the winter, scientists work in their Plant Science Building laboratories, analyzing and writing up the data collected during the warmer months. This is also the time when a major attraction for Arboretum visitors is the "tropical oasis" that is our Greenhouse. Spring marks the start of the field season, when ecologists return to their outdoor research sites, and it is the time of reawakening in the Perennial Garden and the Fern Glen.

And, in summer? ... Institute research and education programs interact most closely as scientists and students collaborate on both new and continuing studies. In order to present a more complete picture of this busy season at the Institute, we have consolidated the May-June and July-August issues of the IES NEWSLETTER.

The IES Newsletter is published by the Institute of Ecosystem Studies at the Mary Flagler Cary Arboretum. Located in Millbrook, New York, the Institute is a division of The New York Botanical Garden. All newsletter correspondence should be addressed to the Editor.

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Cary Fellows' Summer Research

Voles in Space

The curiosity of 100 high school students touring the Arboretum in July was aroused when they spotted someone apparently fishing in the meadows alongside West Flagler Drive. What on earth could he or she be doing?

It was, indeed, a fishing pole that Dr. Stephen R. Pugh was maneuvering over the tall grasses, and the object of his "fishing trip" was to record information about meadow vole populations. The scientist was working within the fenced enclosures constructed several years ago by IES animal ecologist Dr. Richard S. Ostfeld specifically for vole population studies, and attached to the end of the fishing pole was a radio antenna that Dr. Pugh was using to find voles.

family as rats and mice. They are most closely related to lemmings, and, like lemmings, demonstrate cyclical changes in population density. There are several factors that could affect how voles disperse themselves in their grassy meadow habitats, among them the vegetation type and other environmental characteristics of those habitats. Dr. Pugh, however, is most interested in whether or not "relatedness" — recognition of mother, siblings or other relatives — affects the animals' use of space. He hopes to learn how relatedness might have an impact on the voles' three-to-five year population cycles.

Dr. Pugh collected data on space use by meadow voles from trapping and with radiotelemetry. First, he laid traps in 11 grids. Each vole caught was given an identifying tag if it had not been tagged



TOM TRIFT

Wearing a receiver around his waist and holding a fishing pole with an antenna mounted on the end, IES Cary Summer Fellow Dr. Stephen Pugh tracked meadow voles to learn more about what contributes to space use by these small mammals.

During the academic year, vertebrate ecologist Dr. Pugh is an assistant professor at Boston University. This summer, under the auspices of a Cary Summer Research Fellowship*, he collaborated with Dr. Ostfeld and plant ecologist Dr. Charles D. Canham to learn more about the factors contributing to space use by meadow voles.

Meadow voles, *Microtus pennsylvanicus*, are small mammals that are in the same

previously, then released after its weight, reproductive condition and location on the grid had been recorded. In addition, in preparation for radiotelemetry, Dr. Pugh selected some of the larger animals (weighing over 35 grams, or 1.2 ounces) from six of the grids and fitted each with a small collar containing a radio transmitter. Each transmitter used a different frequency. Then, holding the antenna-equipped fishing pole, Dr. Pugh and his collaborator, REU student Kristel Price (see the article on the IES Research Experiences for Undergraduates program on pages 3 and 4) tracked each collared vole. Over a two-week period 45 locations were recorded for each animal, and at the end of the observation period the animals

* Cary Summer Research Fellowships are funded by the Mary Flagler Cary Charitable Trust and awarded by the Institute to scientists who typically have heavy teaching responsibilities but want the opportunity to do research.

Cary Fellows, *from page 1*

were retrapped and the collars removed. The locations were plotted on maps of the grids to show the individuals' home ranges.

At the time of first capture of each meadow vole, Dr. Pugh took a tissue sample. When he returns to Boston University, he will analyze DNA from these samples, comparing the DNA "fingerprints" (banding patterns determined by a process called electrophoresis) to develop a vole family tree for each of the grids. Then, armed with this information, he will refer back to data from the two tracking methods to learn if relatedness affects dispersal: Do offspring remain near their parents? Do siblings stick together? Do males and females reflect the same sorts of behavior? Do voles avoid breeding with close relatives? Does relatedness regulate population density? What drives the cyclical changes?

Results of the study will have other useful and interesting applications as well. Because voles can be hosts of the bacterium that causes Lyme disease, their fluctuating numbers could influence the prevalence of the disease. Also, apple growers are interested in learning more about vole populations because of the considerable impact that these non-hibernating animals have on apple orchards: during the winter when grass is not available they eat bark, frequently girdling — and consequently killing — apple trees. Finally, meadow voles are an important food source, especially for hawks and owls and carnivorous mammals, so their numbers will have an impact on raptor and other predator populations. This ecological relationship can be a cause for celebration by local bird watchers, because when the population of voles and lemmings in Canada is at the low point of its cycle, snowy owls tend to fly south of their usual range in order to feed, and often are spotted in the northeastern states.

At the Base of the Food Web ...

Organic matter in sediments is the source of almost all the nutrients, and energy, in streams, rivers and other bodies of water. In order for that trapped energy to become available for use by plants and animals of the aquatic ecosystem, the organic material must undergo decomposition. Microorganisms — bacteria and fungi — are the agents of decomposition, and to understand fully how ecosystems work it is important to know how fast these microbes accomplish the breakdown process.

This was a challenge taken on by Cary Summer Fellow Dr. Robert L. Sinsabaugh,

an assistant professor at Clarkson University in Potsdam, New York whose research involves microbial ecology and decomposition processes in soils and streams. From May through August at IES he studied sediments in both the East Branch of Wappinger Creek, which flows through the Arboretum, and the Hudson River.

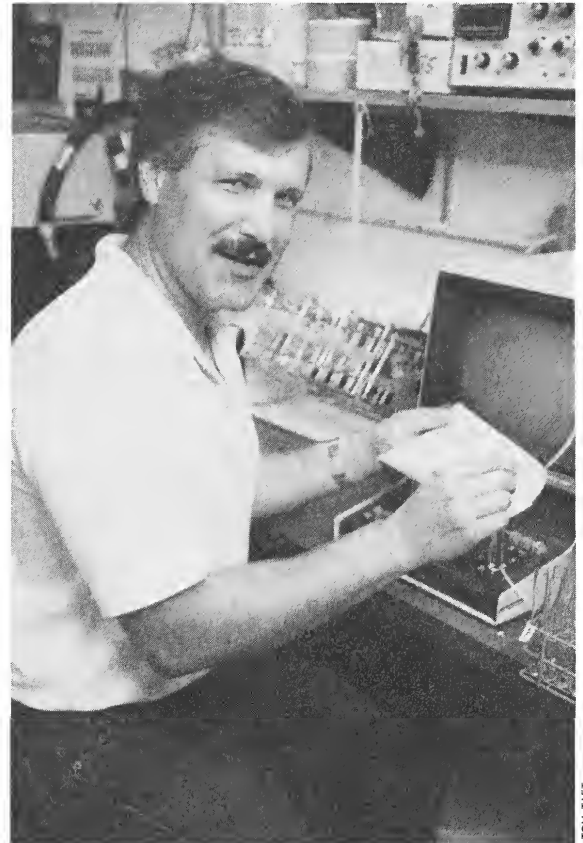
Near where the East Branch of Wappinger Creek passes under the bridge at the Fern Glen, Dr. Sinsabaugh collected sediment from the creek bottom, sieved the material to separate particles into three size categories, and sewed it into small nylon mesh bags. One hundred fifty of these bags were returned to the creek, attached to a submerged framework. Each month, Dr. Sinsabaugh retrieved several bags of each particle size. He weighed the material to determine how much organic matter had been lost, and used a spectrophotometer in the IES laboratory to analyze the enzymes that are used by microorganisms to break down lignin and cellulose (structural components of plants). He then compared the loss of mass to the enzyme activities of the microbes.

Dr. Sinsabaugh has used this type of analysis in his research on soils, studying decomposition of the leaves and sticks that comprise forest litter. The technique has not been used previously, however, to learn about the fine particulate matter of stream sediments, and the ecologist hopes that it will be useful in helping to understand the dynamics of aquatic ecosystems. Although he is now back at Clarkson, where he teaches general ecology during the academic year, he will be returning to retrieve bags of material each month to collect a full year of data on decomposition.

The Hudson River project, which was done in collaboration with IES aquatic ecologist Dr. Stuart E.G. Findlay and research assistant David Lints, concerned microbial biomass (the total weight of the organisms), production (the organisms' rate of reproduction) and enzyme activity in surface sediments at four sites in the river. Samples were collected with a coring device pushed 15 centimeters (6 inches) into the sediment. The top 2 cm were sliced off and saved for study in the laboratory, where samples were sieved to determine particle size and microbial analyses were done.

Bacteria were separated from the sediment and counted under a microscope for biomass calculations, while the biomass of fungi was determined using an instrument called an HPLC (high performance liquid chromatograph) to measure levels of ergosterol in the samples. (Ergosterol is unique to fungi, and acts on a cellular level the way cholesterol does in human cells). This method for measuring fungal biomass has been in use for only a few years — Dr. Sinsabaugh was among the first to use it — and has led to the development of ways to calculate fungal production rates as well. Also applying new techniques, Dr. Findlay measured bacterial production in the Hudson River sediments by determining replication rates of the cells' DNA.

Institute ecologists are studying many aspects of the Hudson River, including its algae and zooplankton, larval fish popula-



Dr. Robert Sinsabaugh uses a high performance liquid chromatograph (HPLC) in the Institute laboratories to determine the biomass of fungi in Hudson River sediments.

tions, benthic (bottom-dwelling) organisms, and physical and chemical properties. Results of the research by Dr. Sinsabaugh and his colleagues on energy-rich sediments and the microorganisms that break them down will help to complete the picture of the complex Hudson River ecosystem.

Research Experiences for Undergraduates, 1992

For the fifth consecutive year, the Institute of Ecosystem Studies hosted a summer Research Experiences for Undergraduates (REU) program. Fliers sent to approximately 675 undergraduate institutions in early January brought applications from 85 students, nine of whom were selected to do 12 weeks of independent research under the supervision of an IES mentor scientist. In addition to working in the field and laboratory, the students attended weekly seminars on research methods and on the role of science in society. Midway through the program they participated in the "IES Forum on Opportunities in Ecology", at which 12 professionals from a broad range of scientific and environmental fields spoke of their own career histories and adventures, as well as of the positives and negatives of their jobs. Finally, on August 18, each student presented her or his research methods and findings in a public symposium at the Plant Science Building.

The REU program is funded by the National Science Foundation (NSF) in its efforts to improve science education and to help assure an adequate supply of high quality scientists, mathematicians and engineers for the future. In 1991, after awarding individual grants to the Institute in 1988, 1989 and 1990, NSF approved three years of support for continuation of the IES REU program. Following are the Institute's 1992 REU students and their research projects:

- Obed M. Cepeda (Sullivan County Community College, N.Y.): *Comparison of the distribution and spirochaete infection rates of Ixodes dammini ticks within and among different habitat types.* Dr. R.S. Ostfeld, mentor.
- Valerie Eviner (Rutgers College, N.J.): *How leaf resource status of Populus deltoides modulates resistance to feeding by Plagioderia versicolora.* Dr. C.G. Jones, mentor.
- Eugénie S. Euskirchen (Marymount College, N.Y.): *The effect of phenolic glycoside concentrations and combinations on the feeding of Plagioderia versicolora and Chrysomela scripta.* Dr. C.G. Jones, mentor.
- Meadow Goldman (Bard College, N.Y.): *Methane consumption rates and nitrogen mineralization along an urban to rural gradient.* Dr. P.M. Groffman, mentor.
- Sharon L. Hausam (SUNY Albany): *Settlement and colonization preferences of mollusks in the Hudson River.* Dr. D.L. Strayer, mentor.

• Claire C. McGrath (Oberlin College, Ohio): *Competition for water and nitrogen between corn and a living mulch.* Dr. A. R. Berkowitz, mentor.

• Kristel A. Price (Unity College, Maine): *Ecological correlates of space use in meadow voles.* Dr. R.S. Ostfeld, mentor.

• Jaelyn Schnurr (SUNY New Paltz): *Predation on red maple seeds by small mammals in a transition oak-northern hardwood forest.* Dr. C.D. Canham, mentor.

• Jeralee Stalker (Colgate University, N.Y.): *Possible factors influencing oxygen consumption in shallow groundwater.* Dr. S.E.G. Findlay, mentor.

Two of the 1992 studies dealt with the ecology of animal species, some of which are recent arrivals in this region:

Hudson River Mollusks

Mollusks, often referred to as "shellfish", are represented in the Hudson River by a number of species of snails and mussels, among them the recently introduced zebra mussel. Because mollusks are important components of the river ecosystem as food for fish and waterfowl, as sediment mixers and feeders, as water quality indicators and — in the case of zebra mussels — as biofoulers, REU student Sharon Hausam wanted to learn more about the factors that affect where these animals settle and colonize. The information she gathered

would add to the baseline data against which future changes in Hudson River mollusk populations could be measured.

She chose a site at Cruger Island, about 25 miles north of Poughkeepsie near Bard College, where she compared the following: 1) snail and zebra mussel settlement on rocks with high vs. low wave and current exposure; 2) preferences for rock surfaces with algae and silt vs. those that were bare; and 3) colonization on the top surfaces vs. the under surfaces of rocks. She examined the site every other day at first, counting mollusks as algae grew back on rocks she had scraped clean at the start of the study, then recorded data weekly.

Ms. Hausam found that zebra mussels preferred bare rock surfaces, which provide a cleaner base for attachment by the animals' byssal threads. Among the snails, grazers preferred algae-covered rocks, while filter-feeders selected bare surfaces. Zebra mussels and all snails strongly preferred the undersides of rocks as sites for settlement and colonization, and, with the exception of one family (a taxonomic category) of snails, chose a sheltered site to one with high wave and current exposure. Such protected areas are selected because fragile juvenile stages anchor more successfully in quiet waters.

* * * * *

Sharon L. Hausam is a Poughkeepsie resident. She will return this fall to the State University of New York at Albany as a senior majoring in biology and art.

continued on page 4



REU student Sharon Hausam studied Hudson River snails and zebra mussels.

Ecology of the Deer Tick

Lyme disease is caused by a spirochete -- a type of bacterium -- transmitted by the bite of the deer tick. While the disease now has been reported in at least 45 states, the ecology of the deer tick and Lyme disease remains poorly understood. Obed Cepeda hoped to contribute to the body of existing knowledge in his REU study, asking the question: Do tick distribution and spirochete infection rates vary among and within habitat types?

stages of ticks: larvae and nymphs. Tick larvae were preserved in alcohol while the nymphs — the middle stage — were kept alive for subsequent study.

Mr. Cepeda found that the highest numbers of questing ticks were in the oak and maple sites. This suggests that the greatest risk to humans of tick encounters, at least during the summer*, may be in deciduous forests. There was an interesting paradox, however: when he examined small mammals at his research sites for attached ticks, he found

nymphal ticks to look for the disease-causing spirochetes. After removing the gut, where the spirochetes reside, he used 400x magnification and a technique called darkfield microscopy to identify infected ticks. While he did not find any correlation between tick abundance in a habitat type and spirochete infection rates, he identified bacteria in 19 of the 75 ticks he examined, or an infection rate of approximately 25%.

* * * * *



Tick dragging: REU student Obed Cepeda collected questing deer ticks by dragging a square of white cloth along transects at his research sites. To protect himself he wore special chaps with a flap that kept the ticks from continuing their upward climb. Inset: The dark-colored ticks, though tiny, were visible on the drag cloth. Mr. Cepeda counted and removed them for future study.

Mr. Cepeda selected five habitats on the Arboretum for his study — maple forest, oak forest, shrubby field (dominated by gray dogwood), hayfield and little bluestem meadow — and collected his tiny research subjects by “tick dragging”: walking along four transects at each of the sites, he dragged behind him a one meter square of white corduroy. Questing ticks (those that are searching for a host on which to feed) tend to cling to anything that brushes against them and thus were collected on the cloth. Each site was dragged several times over the summer, to make sure that data were gathered for both immature life

the highest numbers on animals in the little bluestem meadow. He proposed that this may be due to the nature of the habitat — ticks that are not attached may desiccate and die quickly in the dry, unshaded fields — and, in his presentation at the final symposium, he stressed the need for further investigation of this question.

Early in the REU program, Mr. Cepeda studied tick anatomy at New York Medical College in Valhalla, N.Y., working with Lyme disease experts Drs. Thomas Daniels, Richard Falco, Durland Fish and Denise Frank. He thus was ready to dissect

Obed M. Cepeda received an associates degree from Sullivan County Community College, Loch Sheldrake, N.Y. in May, and is continuing his undergraduate studies in biology at Cornell University this fall.

* **Note:** Much work remains to be done on the ecology of the deer tick. Nymphs molt to adults during the latter part of summer and adults quest for their blood meal during the autumn. The preferred habitat for deer tick adults is not yet known. Be in the habit of checking yourself for ticks whenever, and wherever, you have been outdoors.

Dr. Likens Receives Garden Club Citation

The Millbrook Garden Club has been a member of the Mary Flagler Cary Arboretum since 1980. Club members are particularly concerned about environmental issues, and, as such, have an on-going interest in the Institute of Ecosystem Studies' research, education and gardening programs, both individually and as an organization.

The Millbrook Garden Club is also a member of The Garden Club of America (GCA). During 1991, the local club nominated IES Director Dr. Gene E. Likens for recognition to the parent organization for his contributions to

ecological research and to a better environment. In December, Dr. Likens received a letter from the national chairman of the GCA's Medal Award Committee, informing him that he had been awarded The Garden Club of America Special Citation "for outstanding achievement in ecology and environmental education".

Dr. Likens, Mrs. Phyllis Likens and Dr. Likens' mother, Mrs. Josephine Likens, joined representatives of the Millbrook Garden Club at The Garden Club of America's Medal Award Dinner on May 13 in Baltimore. In Dr. Likens' acceptance speech, he said that it has become clear

during recent years that a strong economy is dependent upon a healthy environment. "The current challenge is to establish full and proper value, including economic value, for clean air, clean water, clean soil and clean and nourishing food -- that is, our basic life support system -- in the equations needed to develop and manage a sustainable biosphere for future generations," he told more than 500 garden club members in attendance from across the country. "Rigorous and sustained ecological research provides a critical information base needed to formulate these equations. I am proud that you have chosen to honor my field, ecology, with this special citation."

IES Environmental Science and Ecology Award

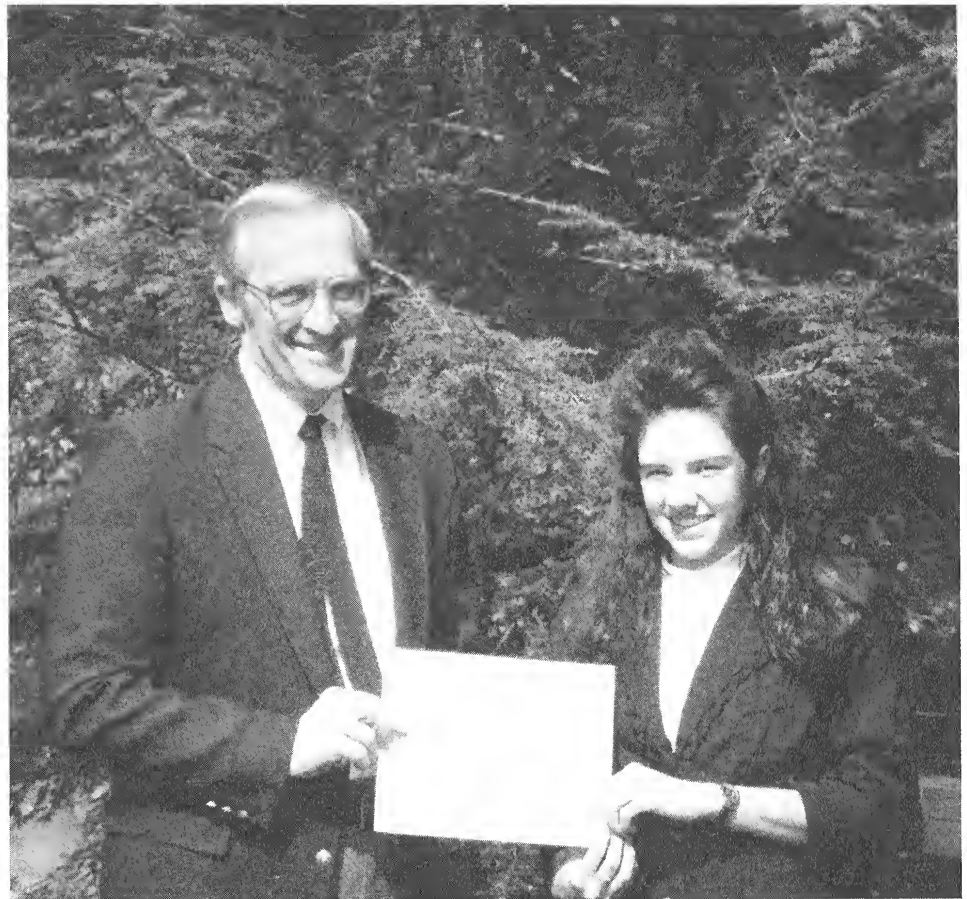
What are the effects of road salt on plants? This question interested Heather York when she read a newspaper editorial about road salt pollution in some local wells, and to find an answer she developed a series of experiments. The 10th grader at Roy C. Ketchum High School (Wappingers Falls, N.Y.) compared the effects of different salt solutions and of fresh water on the germination and growth of a number of types of seeds. She found that both processes were affected adversely by increasing concentrations of salt, and that some of the changes resulted from salt filling spaces in the soil and thereby slowing percolation of water.

Her project won first prize at the Wappinger Science Fair, and she went on to the 33rd Annual Dutchess County Science Fair, where she again took first place. Among the judges at that fair were Institute scientists Drs. Vera Krischik, Gary Lovett and Richard Ostfeld and Mr. Benjamin Peierls, and they selected Ms. York's project to receive the 1992 IES Best Project in Environmental Science and Ecology award. At a ceremony at IES, Institute Director Dr. Gene E. Likens presented Ms. York with a Certificate of Recognition and a \$25 award.

Postscript: As the winning project at the Dutchess County Science Fair, Ms. York's road salt study joined over 750 entries at the International Science and Engineering Fair held in May in Nashville. Ms. York competed with science fair winners from 47 states as well as from Canada, Germany, Ireland, Japan, the Republic of China, Sweden and the United Kingdom; the 800 judges were also international.

Although Ms. York did not win an award at the International Fair, her successes and challenges encouraged her to continue doing independent research. She reports

that she will maintain ties with the Institute of Ecosystem Studies, where she has made contacts with scientists and educators, in order to pursue new directions in science.



Institute of Ecosystem Studies Director Dr. Gene E. Likens presented a Certificate of Recognition to Heather York for her award-winning science fair project.

IES Notes



JILL CADWALLADER

On the evening of July 31, a portion of the Fern Glen was struck by a tornado. Hemlock and white pine trees were toppled, resulting in the formation of gaps in the forest canopy. Such gaps play an important role in forest regeneration, because the increased amount of light reaching the forest floor permits establishment and growth of plants that either could not have grown previously or were growing very slowly in the shade under the dense canopy. It is expected, therefore, that the vegetation in parts of the Fern Glen will change somewhat. Over the coming months, most of the fallen trees will be cleared away. However, the stump and root ball of a large white pine will remain as a public demonstration of ecosystem disturbance and of natural pit and mound formation in forest soils. (In the photograph above, the deck overlooking the East Branch of Wappinger Creek is on the left.)

- “Ecology, Eco-Inquiry and Earth Day” was the cover story for the April 1992 issue of *Teaching Pre-K-8*, a professional magazine for teachers. The article described the 5th and 6th grade science curriculum developed by IES educational research and development specialist Kathleen Hogan, and over 250 curious teachers from across the country contacted the Institute to learn more about Eco-Inquiry. Each was sent a packet of information that included a response form, and, based on a review of those forms that were returned, 14 teachers with appropriate grade levels and adequate classroom resources were selected to be provided with materials to teach Eco-Inquiry this academic year. Half of this group also will have the opportunity to be among the first of any classrooms to pilot the “Eco-INQUIRE” computer software developed by Bank Street College in collaboration with Ms. Hogan and project coordinator Lisa Morganstern. Eco-Inquiry dissemination thus is progressing as planned, with participation by elementary schools in at least 15 states this fall.

- Dr. Vera A. Krischik, at the Institute under the auspices of a two-year National Science Foundation Visiting Professorship for Women, studies natural plant resistance to insects and diseases. Since 1987, Dr. Krischik has been the consultant to the U.S. State Department, the U.S. Department of Agriculture and the Food for Peace Program on scientific matters relating to grain and food storage. An expert in techniques of Integrated Pest Management (IPM) — biological and other non-chemical means of pest control (see the following note)— she is called upon frequently to advise and act as liaison in both national and international situations dealing with pests and pesticides. Recently she was in Washington D.C. initiating a research exchange program with scientists from the Dominican Republic. The Dominican research team is learning about biological control, pheromone trapping and insect pest identification to improve their nation’s food storage facilities and quarantine programs, and will be collaborating with U.S. experts introduced to them by Dr. Krischik.

- Dr. Krischik has edited the first how-to guide for IPM, *Management of Grain, Bulk Commodities, and Bagged Products*, which was published in February 1992 by the University of Oklahoma. (For information on the Institute’s applications of IPM, see “The End of an Era in the Greenhouse” in the November-December 1991 issue of the IES NEWSLETTER.)

IES VOLUNTEERS WANTED

Current needs:

Visitor Reception • Gift and Plant Shop
Clerical • Library • Perennial Garden

Benefits include:

- The opportunity to be part of an excellent research and public education program
- Discounts on classes, workshops and excursions
- Discounts in the Gift and Plant Shop

Call Su Marcy at (914)677-5358

- At the Greenhouse: The genus *Hibiscus* (Malvaceae, or mallow family), comprises herbs and shrubs native to warm-temperate and tropic regions, and includes locally grown ornamentals such as Rose-of-Sharon and Rose Mallow. There are five *Hibiscus* sub-species in the IES Greenhouse, most of which came from Longwood Gardens (Kennett Square, Penn.) as cuttings in 1978. Greenhouse manager David Bulkeley predicts that these plants will be flowering, as below, on and off through spring.



JILL CROWWALLADER

- Tracy Ritchie, left, and Donna Mitchell spent the first week of August at Camp DeBruce in the Catskill Mountains, sponsored by the Institute of Ecosystem Studies. Ms. Ritchie, whose 6th grade class at Intermediate School 144 in the Bronx, N.Y. piloted Eco-Inquiry in fall 1991, was selected by her teacher, Mrs. Suzanne Posner, because of her keen interest in ecology. Donna Mitchell, a student at the Astor Home for Children in Rhinebeck, N.Y., was chosen because of her interest in and enjoyment of outdoor studies and camping. Camp DeBruce is one of the New York State Department of Environmental Conservation's (DEC) environmental education camps, where campers aged 12 - 14 practice outdoor skills and learn about ecological relationships and environmental issues. The DEC encourages sponsorship of campers by environmental organizations, civic groups and others, and the Institute has sent a pair of students to camp each summer since 1987.



JILL CROWWALLADER

- *The Ecology and Natural Resources of New York City: A Bibliography*, by IES ecologists Drs. Richard V. Pouyat and Mark J. McDonnell, was published in July 1991 as IES Occasional Publication #5. Written as a reference guide to literature for scientists, planners and natural resource managers, it is available by writing to Marjory Spoerri, Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545. The cost of this 121 page publication is \$5, which includes postage and handling.

- "Fundamentals of Ecosystem Ecology", a short, intensive course in ecosystem ecology, will be given at the Institute from January 4-18, 1993. The course is intended for graduate students in ecology, environmental studies or related fields. Advanced undergraduates with appropriate background will be accepted if space permits. Qualified students are invited to write to Dr. Gary M. Lovett, Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545 for application information. Completed applications must be received by Nov. 6.



SHARON M. OKADA

Fieldwork in Freshwater Ecology: The Institute of Ecosystem Studies offers opportunities for students in grades 5 - 8 to do programs in pond ecology at IES. A teacher may select a one-session pond exploration or an extended program that includes winter classroom activities and a second field trip in the spring, or may inquire about modified programs to suit his or her grade level and school's science curriculum. For information, call Diana Wilson, program specialist in ecology education, weekdays at 914-677-5358.

Fall Calendar

CONTINUING EDUCATION PROGRAM

Fall Semester

Among the many courses, workshops and excursions scheduled for fall are:

- Oct. 3 (Workshop): **Deer Management and Control Methods**
Oct. 3 (Excursion): **Ecology and Earth History: The Taconic Highlands**
Oct. 4 - Nov. 4: **Plant Community Ecology for Landscape Designers**
Oct. 13 - Nov. 17: **Drawing I**
Oct. 16 (Excursion): **A Day-Trip to the Rainforests**
Oct. 21 - Nov. 4: **Pen and Ink I**
Oct. 18 - Nov. 1: **Colored Pencil Techniques**
Oct. 24: **Basic Autumn Nature Photography**
Oct. 26 - Nov. 16: **Botanical Watercolor Painting**
Oct. 26 - Nov. 16: **Ecology for Teachers**
Nov. 7 (Workshop): **Restoring Nature to the Residential Landscape**
Nov. 14 (Workshop): **Wetlands: Ecology and Restoration**
Nov. 21 (Workshop): **Careers in Landscape and Garden Design and Construction**
• *In addition, classes that fulfill the requirements for certificates in Landscape Design and in Gardening are offered. Catalogues describing these programs are available at the Gifford House. Call the number below for information.*

SUNDAY ECOLOGY PROGRAMS

Free public programs are held on the first and third Sunday of each month, except over holiday weekends. Programs begin at 2 p.m. at the Gifford House on Route 44A unless otherwise noted. Call (914) 677-5359 to confirm the day's topic.
Oct. 4: **Mammals of New York Fields and Forests**, a walk led by Dr. Richard Ostfeld
Oct. 18: **Tree's Loss Is Stream's Gain: Autumn's Benefits to the Aquatic Ecosystem**, a walk led by Dr. David Strayer
Nov. 1: **Farmers, Fields and Forest History**, a walk led by Dr. Charles Canham

Sunday Programs, continued:

Nov. 15: **Mystery in Ecosystem Science Activity: "The Owl and the Water Glass"**, an indoor activity for young people, ages 8 and up, and their parents, led by Lisa Morganstern
Dec. 6: **An Origami "Forest Ecosystem"**, an activity led by Jill Cadwallader
• *For outdoor programs, lounge pants, socks and sturdy waterproof shoes are strongly suggested. In case of inclement weather, call (914) 677-5358 after 1 p.m. to learn the status of the day's program.*

IES SEMINARS

The Institute's program of scientific seminars features presentations by visiting scientists. Free seminars are held at the Plant Science Building on Fridays at 3:30 p.m.
Sept. 25: **Relatedness and Population Regulation in Meadow Voles**, by Dr. Stephen R. Pugh, Boston Univ. (*see story on page 1*)
Oct. 2: Topic: **Agro-ecology**, by Dr. Paul F. Hendrix, Univ. of Georgia
Oct. 9: **Bacteria and Stable Isotopes**, by Dr. Richard B. Coffin, Gulf Breeze Environmental Research Lab
Oct. 16: **The Orinoco River: An Ecological System, but Not an Ecosystem**, by Dr. Bill Lewis, Univ. of Colorado
Oct. 23: **Climate Change and Chaos in the Boreal Forest**, by Dr. John Pastor, Univ. of Minnesota-Duluth
Oct. 30: **Ecology at the Mesoscale: The Influence of Regional Processes on Local Communities**, by Dr. Robert Holt, Univ. of Kansas
Nov. 6: **Patterns in the Body Size and Abundance of Animals**, by Dr. John H. Lawton, Imperial College, U.K.
Nov. 13: **The Meeting of Frontiers: Joining Scientists, Teachers and Students Through the Sci-Link and Globe-Net Projects**, by Dr. Harriet Stubbs, North Carolina State Univ.
Nov. 20: **Phylogeny and Behavioral Ecology: From Pattern to Process**, by Dr. Deborah McClennan, Univ. of Toronto

GREENHOUSE

The IES greenhouse is a year-round tropical plant paradise as well as a site for controlled environmental research. The greenhouse is open during Arboretum hours. Admission is by free permit from the Gifford House.

GIFT SHOP

Senior Citizens Days: On Wednesdays, senior citizens receive a 10 % discount on all purchases (except sale items).
Two-for-Tuesdays: Special sales every Tuesday in the Gift and Plant Shop.
Annual Pre-Holiday Sale: Friday, Saturday and Sunday, December 4-6 — members receive a 20% discount on gifts and plants, and a 10% discount on books.

ARBORETUM HOURS

(Winter hours: October 1 - April 30; closed on public holidays)

Arboretum grounds are open Mon. - Sat., 9 a.m. to 5 p.m.; Sun. 1 - 4 p.m.
The Gift and Plant Shop is open Tues. - Sat., 11 a.m. to 5 p.m. and Sun. 1 - 4 p.m.
(Closed weekdays from 1 - 1:30 p.m.)
• *All visitors must obtain a free permit at the Gifford House for access to the Arboretum. Permits are available until 3:00 p.m. daily.*

MEMBERSHIP

Become a member of the Mary Flagler Cary Arboretum. Benefits include a member's rate for IES courses and excursions, a 10% discount on purchases from the Gift Shop, a free subscription to the IES NEWSLETTER, and parking privileges and free admission to the Enid A. Haupt Conservatory at The New York Botanical Garden in the Bronx. Individual membership is \$30; family membership is \$40. For information on memberships, contact Janice Claiborne at (914) 677-5343.

For more information, call (914) 677-5359 weekdays from 8:30 - 4:30.

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