ILLINOIS NATURAL HISTORY SURVEY
150 years
Reports

Winter 2009
No. 398

INSIDE

Cowbirds Use Mafia Tactics and Farming Behavior as Part of Their Parasitic Racket

Avian brood parasites lay their eggs in the nests of other birds (called hosts) that subsequently incubate the parasitic egg and raise the parasitic chick. Hosts of avian brood parasites pay severe costs for rearing these unrelated young, often producing few or none of their own. Hosts of parasitic cuckoos (*Cuculidae*) typically eject eggs that do not mimic their own. Why then do most hosts of parasitic cowbirds (*Molothrus spp.*) accept eggs that differ dramatically in appearance from their own? At least two nonexclusive hypotheses have been suggested to resolve this paradox of nonrejection in the face of costly brood parasitism: (1) evolutionary lag (short time of coexistence between host and parasite); and (2) evolutionary equilibrium through cognitive and physiological constraints on detection and rejection (rejection costs and errors in the host).

Proponents of evolutionary equilibrium tend to focus on the limited abilities of hosts to recognize or reject parasitism. Few have explored the possibility that avian brood parasites could enforce acceptance by destroying eggs or nestlings of hosts that eject parasitic eggs. This "mafialike" retaliatory behavior has been reported in one species of parasitic cuckoo, but there has never been an experimental test of whether parasites themselves are destroying nests of hosts that eject parasitic eggs. Mafia behavior has not been documented in parasitic cowbirds, but results from a few studies suggest that Brown-headed Cowbirds (*Molothrus ater*) may occasionally depredate nonparasitized host nests thereby creating opportunities to parasitize those hosts' renesting attempts ("farming").

Female Brown-headed Cowbird. Photo courtesy of C. Young

Male Prothonotary Warbler at nesting box. Photo by Jeff Hoover, INHS

For over a decade we have studied the effects of cowbird parasitism on a cavity-nesting host, the Prothonotary Warbler (*Protonotaria citrea*), in the Cache River watershed in southern Illinois. During 1996–2002, we attempted to make some nests (n=472) predator-proof by attaching nest-boxes to pieces of greased conduit (instead of trees) and we never removed Brown-headed Cowbird eggs from the parasitized warbler nests (n=230). As a result, nearly all (>95%) nests in predator-proof nest-boxes were successful regardless of parasitism status. In 2002, as part of a separate study, we removed cowbird eggs from some parasitized predator-proof nests (n = 50) and only 60% were successful, indicating that cowbirds may depredate nests in response to our rejection of their eggs (mafialike retaliation). This finding led us to test experimentally for both mafia and farming behaviors in cowbirds.

We devised an experiment where we removed (rejected) or accepted cowbird eggs and controlled cowbird access to otherwise predator-proof nests of Prothonotary Warblers to determine if cowbirds were retaliating

Continued on back page

A Change in the Population Dynamics of the Zebra Mussel in the Hudson River, NY

Invasive species are organisms that become established and reproduce successfully outside their native, historical ranges. The zebra mussel, *Dreissena polymorpha*, is an invasive species that is thought to be one of the most aggressive aquatic invaders worldwide. Since the introduction of the zebra mussel from its native Black Sea to the waterways of the United States via ballast water, this mussel has spread throughout Illinois and the Great Lakes region, resulting in profound economic (clogging and damage to water intake pipes) and ecological impacts (reductions in oxygen concentrations, native species abundance, and disruption of food webs). The zebra mussel has now been sighted as far south and west as Louisiana and California. Zebra mussels have accomplished this dispersal feat in the U.S. in only 20 years, causing scientists to wonder what makes these small, less than 5-cm-long, creatures so successful.

The success of the zebra mussel has been mainly attributed to a life history strategy that includes a planktonic larval stage. The larval stage is microscopic and easily carried by water currents, thus larvae may drift for miles before eventually settling out of the water column onto suitable hard surfaces to metamorphose into the adult form. However, despite speculation of a critical role for the larval stage in the success of this invader, most studies of zebra mussel population dynamics have paid little or no attention to early life history stages.

Helen Bustamante and Dr. Nils Carlsson preparing to deploy exclusion cages at Norrie Point, NY. Photograph courtesy of Sarah Fernald, Research Coordinator, Hudson River National Estuarine Research Reserve, Norrie Point, NY

Helen Bustamante, a graduate student based at Illinois Natural History Survey and her advisor, Dr. Daniel Schneider, are paying attention to the early life history stages. They intend to decipher the role of early life stages to the abundance and distribution of this highly successful invasive species in the Hudson River. For the past three years, Helen has been collecting information on abundance, growth, and survivorship of all life stages of zebra mussel populations in the Hudson River. One trend she discovered surprised her: virtually all adult zebra mussels disappeared during late summer each year of her study. A dynamic on this scale, repeated in consecutive years, had never been seen in the Hudson River previously. Large numbers of small animals that do not survive longer than one year now comprise the population. Previously adults lived around two to four years and animals of different sizes and ages had comprised the population. Helen asked what could have led to such a drastic change in the population structure? The cause appeared to be a major predation event rather than water quality as some animals survived in sheltered nooks and crannies that presumably offered a refuge from predation.

Photograph showing a blue crab caught in a typical crab pot at Norrie Point, NY. Photo by Helen Bustamante, INHS

In April of 2008, Helen presented her findings at the Northeast Natural History Conference in Albany, NY. Her talk generated much interest and led to her collaboration with Dr. Nils Carlsson at the Cary Institute of Ecosystem Studies, Millbrook, NY. Helen and Nils designed an exclusion experiment to investigate predation on Hudson River zebra mussels. At two sites in the Hudson River, they deployed cages containing rocks with attached zebra mussels (collected previously from the river using SCUBA). Half the cages were open to predators and half closed to predators. Every three weeks they removed a set of cages and calculated how many zebra mussels had

Continued on page 5

ILLINOIS NATURAL HISTORY SURVEY

INTRODUCING OUR PUBLICATION SALE CALENDAR

We are happy to introduce our annual publications sales calendar. This issue will highlight the first four months of 2009 special pricing. If you would like additional information or a copy of the entire calendar, either e-mail or telephone us at the contact information listed below.

JANUARY—POSTER FEVER:

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- Aquatic Invertebrates
- Cycle of the Gypsy Moth
- INHS Poster Pack
- Illinois' Living Alphabet
- Wild & Wet
- World Beneath our Feet posters

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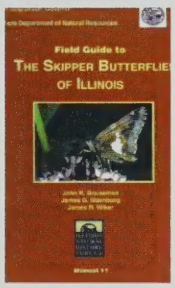
- Waterfowl of Illinois: Abbreviated Field Guide



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- Field Guide to Silkmoths of Illinois
- Field Guide to The Skipper Butterflies of Illinois
- Field Manual of Illinois Mammals

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The Transition to Organic Production: Summing Up

Six short years ago we plowed down conventional soybean stubble and seeded the rye cover crop that began an organic transition research and outreach project involving scientists and extension educators at the University of Illinois, Illinois Natural History Survey, and University of Wisconsin. We posed two research questions: 1) For lands transitioning from conventional to organic production, are there ways to structure the transition process to aid the goal of balanced soil biological processes when the required three-year transition ends and the land can be certified for organic production? 2) How do biological systems in transitioning systems change as soil organisms become more diverse and as growers rely on ecological processes rather than synthetic inputs to build soil organic matter and reduce pests?

With help from an advisory board of organic growers and a Unites States Department of Agriculture (USDA) Organic Transitions Program grant, we established research plots on a six-acre site in Champaign in 2003. The experiment compared three farming-system treatments—vegetable crops, cash grain crops, and perennial pasture—with different levels of soil disturbance (i.e., cropping intensity) that represent useful strategies for Midwest growers transitioning land for organic certification. There were also three sub-treatments differing in organic matter and fertility management. These treatments were in place during the 2003–2005 transition growing seasons. Post-transition (2006–2007), the treatments were disbanded and the same crops (organic tomato and pepper varieties in 2006, organic soybean in 2007) were grown in all the research plots, which then differed only in farming system treatment history. This allowed us to evaluate how the three transition schemes initiated in 2003 have affected soil fertility, crop productivity, weed communities, beneficial insects, and pathogen/insect pest problems.

Part of the organic research team and helpers take a welcome photo break (and a chance to stand up) while transplanting butternut squash in 2005. Pictured on the back row (L to R): Michelle Kiang, Eric (last name unknown), Ed Zaborski, Dan Anderson, Chris Gittings, (name unknown), Ayna Salas, and Grifith Lizarraga. Pictured on the front row (L to R): Carmen Ugarte, Emily Marriott, Michelle Wander, Cathy Eastman, and Darin Eastburn. Photo taken by Ed Zaborski.

We are now in the assessment phase, pondering reams of data and identifying linkages among them. While there is much yet to be analyzed, here are some highlights.

First, all three transition strategies improved soil fertility following conversion from conventional to organic management and were similar in their ability to build soils. The only difference was in soil pH, which was increased in the low-disturbance (perennial pasture) treatment compared to the vegetable (high-disturbance) and cash grain (intermediate) treatments. Fertility sub-treatments (cover crop residues alone, residues plus compost, residues plus manure) did not alter soil fertility significantly.

Second, there were effects of type of sub-treatments on some diseases during the transition (e.g., increased rust in grasses in the perennial pasture system and corn in the cash-grain system plots amended with manure). There were also differences in disease levels in tomatoes in 2006 (the first year after transition) associated with farming-system treatment and amendment sub-treatment, with lowest disease levels in tomatoes grown in the former pasture system plots that were amended with manure. In related greenhouse experiments with soil taken from the research plots, the farming-system treatments were similar in terms of enhancing the disease suppressiveness levels of soybean with the pathogens causing damping-off and sudden death syndrome.

Third, the perennial pasture treatment had the fewest weeds. While the number of weeds per plot decreased between the first and fourth growing seasons, weed

continued on next page

Organic Production

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species diversity and weed seed bank diversity increased.

Fourth, in the first year after transition (2006), tomato yields were significantly higher in the former perennial pasture treatment compared to other treatments for the Classica and Bellstar varieties, but only marginally higher for the Roma variety. For soybean in the second year following transition (2007), yields were 42% higher in the former perennial pasture treatment.

While the number crunching and data interpretation phases of the research are in high gear, the hubbub of field activities is silenced. Covered in a pasture mix planting of timothy, orchardgrass, alfalfa, and red clover, the research plots are now in a holding pattern as we await the field inspection process to certify the site for organic research. Land certified for organic research is sorely needed; the Organic Farming Research Foundation (2003) reported that organic research is being conducted on only 0.13% of the total research acreage at land-grant institutions. What the next organic research projects might be at the research site are open questions. To quote Alice M. Coats, "It is apparent that no lifetime is long enough in which to explore the resources of a few square yards of ground."

Acknowledgments: Funding for this project was provided primarily by grant number 2003-51106-02086 from the Organic Transitions Program of the USDA's Cooperative State Research, Education, and Extension Service.

Cathy Eastman, Division of Biodiversity and Ecological Entomology with Edmond Zaborski, Michelle Wander, Darin Eastburn, John Masiunas, Leslie Cooperband, Deborah Cavanaugh-Grant, Dan Anderson, Carmen Ugarte, Shin-Yi Lee, and Isabel Rosa (Department of Crop Sciences and Department of Natural Resources and Environmental Sciences, University of Illinois), and Jonathan Lundgren (USDA Northern Grain Research Laboratory, Brookings, South Dakota)

Cathy Eastman takes a look at the Austrian winter pea cover crop in 2004. Photo taken by Debra Levey Larson.

Zebra Mussels

continued from page 2

been eaten by predators. Traps and an underwater video camera enabled them to monitor the numbers and types of predators around the cages. Helen and Nils found that zebra mussel mortality increased dramatically as soon as blue crabs, *Callinectes sapidus*, appeared in their traps. Blue crabs migrate northwards, arriving into the freshwater part of the estuary (where study sites are located) around mid- to late summer and the timing of the mortality appeared to coincide very well with blue crab migration. In addition, there was a lag between zebra mussel mortality at the southernmost site, where blue crabs were caught first, and zebra mussel mortality at the second site which was 15 miles further north, where blue crabs did not arrive until later. These results strongly suggest that blue crab predation is responsible for much of the disappearance of adult zebra mussels in the Hudson River. The outcome suggests that, in the long term, the Hudson River ecosystem may be more resilient than initially thought to zebra mussel invasions and that native organisms "learn" to make use of invaders. This finding contradicts the conventional view of invaders having solely negative impacts on native organisms and their ecosystems and indicates that there is still much to be learned about invasions.

Helen Bustamante and Dr. Nils Carlsson using epoxy putty to secure rocks with attached zebra mussels inside their exclusion cages at Norrie Point, NY. Photo by Sarah Fernald

Helen Bustamante, Division of Ecology and Conservation Sciences

Photograph showing zebra mussels inside cages, one type excludes predators and the other type allows predators access to the zebra mussels. The cages are being prepared to be deployed at Tivoli field site, Hudson River, NY. Photographer: Dan Stich

Species Spotlight

Gray Tree Frogs

Susan Post

It's a perfect April day and I have just gotten out of the van at La Rue/ Pine Hills snake road. Tiger and zebra swallowtails are nectaring on the abundant larkspur and all around cricket frogs are clacking. Yet I also hear a trill. Who could be making that noise and where is it coming from? The call resonates. I'm searching, searching. Finally one of the instructors calls, "Look at the oak. Go over to the knot, where the branches cross." Bingo! A well-camouflaged gray tree frog that for the untrained looks like just another knot on the tree. —Illinois Wilds Institute for Nature, Field Notes, April 12, 2006

Illinois has two species of gray tree frogs—*Hyla versicolor* (common gray tree frog) and *Hyla chrysoscelis* (Cope's tree frog)—which can be distinguished only by studying their voices and chromosomes. *H. chrysoscelis's* mating call (trill rate) is faster and it is diploid (has 24 chromosomes). *H. versicolor* is tetraploid (has 48 chromosomes). These frogs are found throughout Illinois and range east of the Great Plains. The two species are found in mixed woods and temporary wetlands where they prefer to remain out of sight in woodland trees, sleeping by day. They may be glimpsed near suburban or rural homes, perched in tree cavities, hollow stumps, or on decks and swimming pools

A gray tree frog of the complex Hyla chrysoscelis/versicolor. Photo courtesy of Michael Redmer

Hyla versicolor in Latin means "color-turning." Common names include dusky tree toad, chameleon tree frog, common tree toad, tree toad, and changeable tree toad. *Hyla chyrsoscelis* comes from a Latinized word meaning "gold-colored," and common names include northern tree toad. The common name of tree toad for both species refers to the frog's skin, which has a rough, granular, dry, warty appearance that people usually associate with toads.

The skin color of both species varies from brown to greenish gray with darker blotches and bright orange on the undersurfaces of the hind legs. They have a white spot just below each eye. The frogs' overall coloration disguises it among the lichens and rough bark. Another common name —chameleon tree frog—refers to the frogs' ability to change colors. These color changes are brought about by the change in shape of the pigment cells. Low temperatures or subdued light will cause the cells to expand and the skin to assume a dark color. High temperatures or bright light has the opposite effect.

Large, rounded, adhesive toe disks enable these frogs to climb and also distinguish this species as a tree frog. These toe pads allow the frog to cling to rough and smooth surfaces, even glass!

The mating season is usually from April to August. The males will seek out shallow ponds or creeks and begin to sing. Their calls are short, resonant trills that are lower pitched and of shorter duration than those of American toads. These calls have been described as "the charm of contentment; in fact, it is much like the purring of a cat only louder. At a distance, it sounds something like the bleating of a lamb." They give their calls from perches, which are thought to enhance the males' chances of attracting females. Horizontal branches with few leaves arched over a pond are strategic perches. Females attracted to the males' calls will walk, not hop, toward them. A female will choose a male by touching him with her nose or even leaping upon him.

While the courtship and breeding season may last for several weeks, a female will mate only once. Females lay up to 2,000 eggs attached, singly or in small groups, to vegetation at the surface or beneath the water. The eggs hatch after two to five days. The tadpoles are an olive-green color with a bright, orange-red tail. The tadpole stage lasts from one to two months. When gray tree frog tadpoles emerge from the water as froglets, they are about 1.5 inches long and a bright shade of green, which helps camouflage them on their journey from pond, through grass, to a tree. The frogs are sexually mature after two years and will be 2.0 to 2.5 inches in length.

Gray tree frogs usually hibernate on the ground beneath fallen leaves, rocks, or in underground crevices. They have the ability to withstand subfreezing temperatures—to as low as -20° F—by manufacturing glycerol in their blood.

The Naturalist's Apprentice

Mimic Frog Calls

Carolyn Nixon

Mimic Frog Calls

There are 21 species of frogs and toads in Illinois, and each has its own unique song or call. You can listen to recordings of these calls on a CD or the Internet. Many people learn to identify frogs in the field by their calls. Some frog and toad calls can be mimicked by humans, either by voice or by some mechanical device. Here are some you can try. First listen to a recording of the frog or toad and see how closely you can copy it.

Western chorus frog and upland chorus frog—run a finger over the teeth of a comb. The harder plastic combs make a more chorus froglike sounds than a softer nylon, although either type will work.

Cricket frog—click two marbles together quickly. Holding them in one hand and quickly clicking them by moving your fingers in and out works very well. Make the marbles both click and scrape against each other.

cricket frog

Northern leopard frog—rub a wet hand over an inflated balloon to make it squeak.

Wood frog—quickly move wet finger tips over the surface of a wet balloon, much like a person picking a banjo or guitar.

Spring peeper—scrape a finger nail or a piece of chalk on a blackboard until it squeaks to mimic a single frog, or shake a string a sleigh bells to sound like a group of spring peepers.

Green frog—stretch a rubber band across a hole cut in the top of a cardboard box. First attach the rubber band to one end of the box by hooking it over a pushpin. Pluck the rubber band like a banjo string. You can vary the sound by stretching or relaxing the rubber band or by using different thicknesses of rubber bands. See the diagram below.

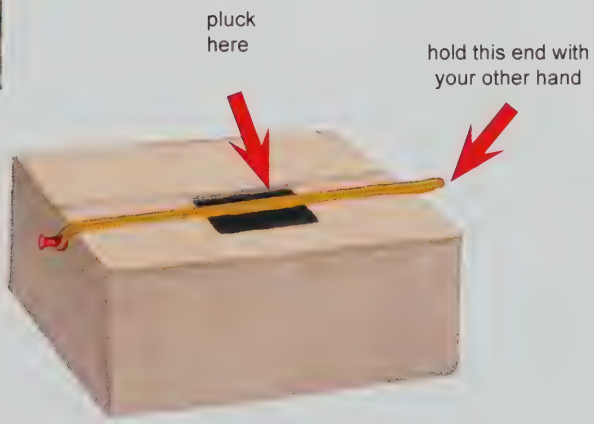
American toad

American toad—make a trilling sound with your voice and your tongue.

Listen to the recordings as you are trying to mimic them, and make adjustments to try to match them more closely. Also, listen to other frog and toad calls and try to find ways to copy their songs as well.

green frog

Photos by Michael Jeffords
Drawing by Carolyn Nixon



Box for mimicking green frog calls.

spring peeper

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Cowbirds

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(mafia), farming, or having no predatory effect on the warbler nests in our study system. When cowbird access to parasitized nests was allowed, 56% of "rejecter" nests were subsequently ransacked compared to only 6% of "accepter" nests. No nests were ransacked when we removed cowbird eggs ***and*** denied cowbirds further access to nests (by reducing the size of the nest-box opening) or when cowbird access was never allowed. Mafia behavior in brood parasites can hold hosts in an evolutionary state of acceptance only if hosts that accept parasitic eggs have higher reproductive output relative to hosts that reject parasitism and suffer the penalty. This requirement was met in our experiment and the predatory tactics of cowbirds significantly reduced the average number of warbler offspring produced per nest in rejecters (1.2) compared to accepters (2.7). Nonparasitized nests (cowbird accessible) were ransacked 20% of the time, suggesting that cowbirds are also farming these warblers. Renesting attempts of female warblers whose nests were ransacked were parasitized at a very high rate (85% versus ambient rate of 36%), suggesting that cowbirds do benefit from their own predatory behaviors.

Collectively, these results provide the first experimental evidence that cowbirds employ both mafia and farming behaviors and show that the predatory tactics of female cowbirds are much more sophisticated than previously thought. Arguably, loss of habitat along with increases in nest predation (by generalist nest predators) and cowbird parasitism linked to breeding habitat fragmentation pose the greatest threats to populations of birds that serve as cowbird hosts. However, farming and mafia behaviors in cowbirds could exacerbate these threats and further jeopardize populations of some cowbird hosts. In addition, if mafia behavior is widespread or becoming more prevalent in cowbirds, it could factor prominently in delaying the evolution of ejection behaviors in some of the more than 100 species that currently accept cowbird parasitism.

Jeff Hoover, Division of Ecology and Conservation Sciences

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Reports

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UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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INSIDE

A Long-standing Tradition in Springtail Systematics at INHS

Soil is a buzzing, living metropolis inhabited by millions of tiny arthropods and other invertebrates. Individuals in soil communities interact in complex ways, ensuring a rather efficient recycling of organic materials, thus maintaining soil fertility. These soil communities typically comprise nematodes, centipede-like symphylans, millipedelike pauropods, mites, proturans, diplurans, other insects, and springtails. Springtails are tiny insectlike arthropods (Fig. 1) ranging in size from 0.3mm–11mm, which traditionally have been placed close to the insects as either the order or class Collembola. Springtails are easily recognized by the presence of a ventral tube or collophore on the sternum of the first abdominal segment, and in many species, the jumping organ complex comprising the catapultlike furcula (the "tail" in the common name spring tail, Fig. 2) and the furcula catch or retinaculum. Although most described species of springtails are found in soil or leaf litter, the group has successfully invaded many habitats and can be found anywhere from the equator to the poles, from deep in the soil to the canopy of the tallest trees, and from deserts below sea level to glaciers at high elevations in temperate regions.

Figure 1. Orchesella hexafasciata, *this is one of the most common species in leaf litter in forests east of the Mississippi in North America. This individual was collected in Brownfield Woods, Champaign County.* Photo by Felipe Soto-Adames, INHS

Figure 2. Salina banski decorata, *this species is typically found in grasses and is rare in collections from Illinois. This individual was collected at Midewin National Tallgrass Prairie.* Photo by Felipe Soto-Adames, INHS

The springtail collection at the INHS is one of the most important collections in the world. The main collection contains specimens in approximately 22,000 alcohol vials and nearly 6,000 microscope slide pieces. In addition, the type material is maintained in 295 alcohol vials and 224 slides. The oldest springtail types kept at the INHS are three species described by Packard in 1873. Packard was a physician from Massachusetts, and the types were probably deposited at the INHS only years after their description, during J.W. Folsom's tenure in the U of I Department of Entomology around 1900. This important collection has been established as a result of a long institutional tradition of support for springtail taxonomists, including a staff of curators, research associates, graduate students, and affiliates, dating back to the nineteenth century.

Although Folsom was not the earliest entomologist to publish on North American springtails, he completed most

Continued on back page

Flocks of Birds out of Visual Contact?

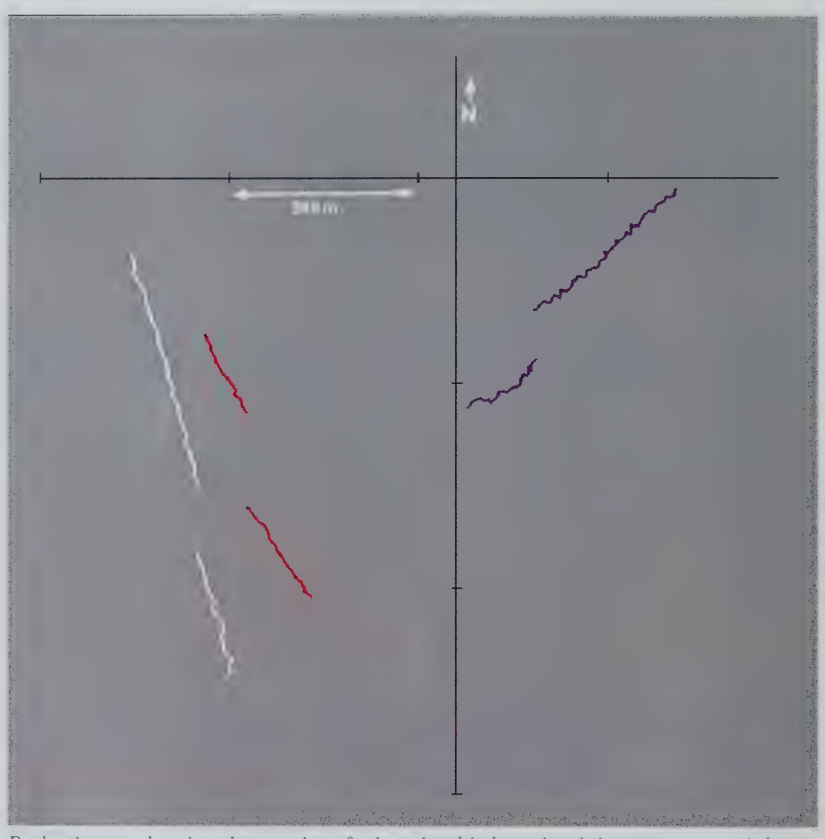
We often see flocks of birds in daytime, but most kinds of birds migrate at night, presumably in light levels that are too low for them to see other birds at any distance. Do they nevertheless fly in flocks at night also?

When researchers use light beams or watch shadows of migrating birds crossing the face of the full moon, they report a few tightly spaced flocks such as are common in daytime, but they also report seeing some birds apparently grouped in time, with longer intervals between groups. There is some agreement that sometimes birds migrating through the night sky are loosely clumped or grouped, but the nature of these aggregations has eluded us.

Scientists at the Illinois Natural History Survey have used radar to study migrating animals as long as half a century ago. Radar has the advantages that it does not disturb the birds (they are unaware their flight is being recorded) and it can operate at night as well as in daytime. During the 1980s and again recently, a specialized INHS tracking radar followed the flight of individual birds as they passed by as far as thousands of meters away.

In *Integrative and Comparative Biology*, Ronald Larkin and Robert Szafoni describe using this equipment to prove that the grouping in space is real and that the birds stay together socially albeit at some considerable distance from each other. The tracking radar reports the position of individual birds that pass close enough to be registered and has the advantage that it operates automatically once it "locks on" a flying bird. The resulting data are objective records of the flight of single birds; however, other birds can be seen on the radar display in addition to the one being auto-tracked. To investigate birds flying together, the researchers (with assistance from many colleagues and field workers) sometimes switched off auto-tracking during a track, pointed the radar at a different bird, and tracked it. In this way paths of two or even three birds could be recorded to see how similar their paths were through space. The size of the flocks could not be determined but was probably greater than just two or three.

Although the proof for loose nocturnal flocks is largely statistical in nature, these example radar tracks (see figure) illustrate the essentials. Tracks of three pairs of birds are mapped in different colors. The two birds shown in white were flying about 141 meters apart and their speeds differed by only 0.3 meters/second (about 0.1 mph, well within the error of the radar data). We know they were small birds passing through east-central Illinois because the radar signal fluctuated with their wing beats in the pronounced "flap-coast" pattern we often see in small birds—goldfinches or woodpeckers are good daytime examples. Tracks of two other pairs of birds, at different times and locations, are shown in red and purple, respectively.



Radar image showing three pairs of migrating birds maintaining contact at night.
Image generated by Ron Larkin, INHS

Paths this closely parallel are almost never observed when tracking migrating insects or birds a great distance apart and thus completely out of contact. They are almost exactly parallel, far too similar in direction and speed for the similarity to be a chance event even among the thousands of birds that pass near the radar unit over the course of a night.

Considering that birds take off about dusk on their nighttime migratory flights, they had been airborne for several hours when they came close enough to be tracked by radar. They could not have stayed together without remaining in contact with each other over distances of a football field length or more. How the birds accomplish this remains open to speculation, although their flight calls do provide a possible means of contact.

Ron Larkin, Illinois Natural History Survey

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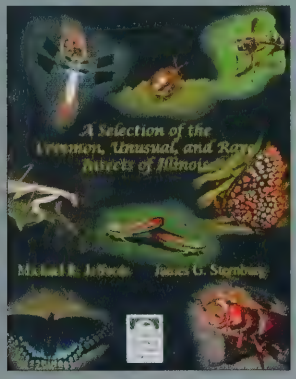
JUNE—THOSE PESKY PESTS

AT LEAST 1/3 OFF SELECTED "BUG STUFF"



A Selection of the Common, Unusual, and Rare Insects of Illinois (publication # EM01). These colorful booklets are letter sized and beautifully printed on high-quality paper. Regular price $3—Sale price $2

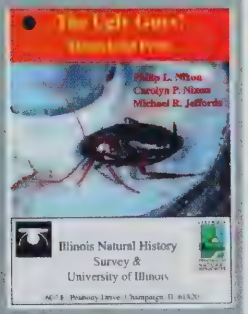
How to Collect and Preserve Insects (publication # SP17). This spiral bound book provides basics on collecting, preserving, and identifying insects. Correct methods of pinning and labeling insects are explained. Regular price $8—Sale price $3

Bug Cards: Four individual sets of laminated cards (below) with colored photographs and concise descriptions to aid in the identification of beneficial and pest insects. The photos and information on each card provide sight identification of the organism or group of organisms considered. Regular price $10—Sale price $7

(publication # IC, 30 species identified)

(publication # ICB, 30 species identified)

(publication # ICB2, 30 species identified)



(publication # ICU, 31 species identified)

For comments or questions, please call the publications office at (217)-244-2161, write 1816 S. Oak Street, MC-652, Champaign, IL 61820, or e-mail to: pubs_sales@inhs.uiuc.edu. Prices noted above are subject to change and additional shipping and handling charges may apply.

Impacts of Temperature and Dissolved Oxygen Stressors on Largemouth Bass

Temperature and dissolved oxygen are two important components of the aquatic environment that strongly influence the abundance and distribution of aquatic organisms. Fish will often select a preferred temperature and oxygen concentration to optimize physiological processes, but the characteristics of the environment around them can change quickly and drastically. Fish can be subjected to anthropogenic temperature and oxygen challenges that can result in mortality or that require them to utilize a variety of behavioral and physiological responses to withstand such stressors. Some levels of thermal or oxygen shock may not result in mortality but they are still of interest because they can have negative, sublethal impacts on fish. Understanding the physiological disturbances incurred by fish species subjected to an array of temperature and oxygen stressors will provide critical information for setting guidelines for minimum dissolved oxygen concentrations and determining acceptable thermal loads, and will also aid in predicting the abilities of fish species to respond to anticipated environmental changes associated with global climate change.

We subjected largemouth bass to two levels of heat- and cold-shock and to two levels of hypoxia (low oxygen) and hyperoxia (high oxygen) for 1 and 6 hours in a controlled laboratory setting (Photo 1). Temperature treatments were created by pumping heated or chilled water into individual containers and consisted of decreases from 20°C to 15°C and from 20°C to 8°C, and increases from 20°C to 25°C and 20°C to 32°C. Dissolved oxygen treatments were created by pumping oxygen or nitrogen gas into containers and consisted of a decrease in dissolved oxygen concentration from 8mgO_2/L to 4mgO_2/L and from 8mgO_2/L to 2mgO_2/L, and an increase from 8mgO_2/L to 12mgO_2/L and from 8mgO_2/L to 18mgO_2/L. Following 1 or 6 hours exposure to these treatments, white muscle and blood was collected from the fish and processed for a variety of physiological parameters (Photo 2).

Photo 1. Experimental set up. Individual containers hold one largemouth bass each and heated/chilled water or oxygen/nitrogen is pumped into the containers to create the temperature and dissolved oxygen changes. Photo by Cory Suski, UIUC

Largemouth bass subjected to a cold shock from 20°C to 8°C showed increases in plasma cortisol (primary stress hormone) and glucose (indicator of secondary stress response) concentrations 1 hour following the shock and these parameters returned to resting values 6 hours after the shock. Lactate dehydrogenase activity (tissue damage indicator), however, was low 1 hour following this shock but increased by about 4-fold 6 hours after the temperature change. This suggests that cold shock of this magnitude instigated immediate and long-term physiological disturbances in largemouth bass. Largemouth bass subjected to a heat shock from 20°C to 32°C showed an increase in plasma glucose concentration after 1 hour that was corrected after 6 hours, suggesting largemouth bass were initially disturbed by the temperature change but were able to recover after 6 hours. Bass subjected to temperature changes of ±5°C did not exhibit any physiological disturbances.

Hypoxia of 4mgO_2/L proved to be a challenge for largemouth bass as plasma potassium concentrations decreased after 6 hours of exposure, signaling a disruption to the ionic balance of the fish. Hypoxia of 2mgO_2/L was even more challenging as largemouth bass showed decreases in potassium after only 1 hour and increases in muscle lactate (a product of anaerobic respiration) after 6 hours, suggesting this oxygen concentration was particularly harmful. Bass subjected to hyperoxia as high as 18mgO_2/L did not exhibit any physiological disturbances.

Our results suggest that largemouth bass are relatively tolerant of temperature and oxygen shocks, but shocks that are large in magnitude should be avoided. Temperature shocks may interact and magnify the effect of other stressors so temperature shocks greater than 5°C should be avoided if possible. Long-term exposure to dissolved oxygen concentrations 4mgO_2/L and lower may represent a problem for largemouth bass. Responding to stressors requires energy expenditure by fish and can increase susceptibility to disease and decrease growth. So, minimizing stressors when possible can help ensure the future quality of several fisheries.

Photo 2. Collecting blood from a largemouth bass. Photo by Cory Suski, UIUC

Matthew M. VanLandeghem and David H. Wahl, Illinois Natural History Survey; Cory D. Suski, Department of Natural Resources and Environmental Science, University of Illinois at Urbana-Champaign

Science in a Web 2.0[1] World

I could spend my days listening to science podcasts[2], reading science blogs[3], poking around Wikipedia[4] or BugGuide[5], learning to build my own avatar and explore Second Life's SciLands[6], or signing up for Twitter[7]and Facebook[8] to expand my social networking possibilities amongst the scientists (OK, OK, probably not just scientists) hanging out there. Gone are the days when just having a home page was cool (oh so last century!). Now scientists are trying to overcome their apprehensions about technology to collaborate globally using EDIT Scratchpads[9], contributing to standards of data sharing through wikis[10], building species pages on the Encyclopedia of Life[11] (EOL), crafting on-line keys to taxa in DiscoverLife[12], sharing their photos on Flickr[13] or Picasa[14], or commenting or contributing to someone else's blog[15] as they work up to starting their own. I think I need a Third Life.

"But," you say, "you're a techno-science geek, that's just not me." Fair enough, but I wasn't always this way, in fact, I have a B.A. in French. Back in the 1960s, I was told that my high school spent 37 cents per student per year on science curricula. Even back then this was appalling. Becoming an entomologist was not even a blip on my career radar, and in fact although I liked nature and biology growing up (thanks to good teachers and mentors who played a crucial role), I was interested in so many things, that choosing a career path became less a matter of planning than of following good opportunities. Scratch below the surface of many scientists and you will find that serendipity has played a large role in where they ultimately find themselves today. The value of these insights for today's students and the parents and teachers mentoring them lies primarily in nourishing their curiosity about life so as to recognize potential opportunities and then being prepared to embrace a world that will certainly change significantly in their lifetimes.

Even five years ago the amount and increasing quality of information available to most of us did not approach the exponential growth we see today. The Internet provides opportunities for students and teachers to find out more about science in this special Year of Science 2009[16], as well as to explore possible careers in biological science[17]. The Illinois Natural History Survey's[18] and State Geological Survey's[19] outreach and education groups have resources for all ages, from habitat-related posters[20] to classes[21] and excursions[22]. Had my high school science teachers had access to resources on the Web such as Kitchen Science[23] or Science News for Kids[24], the physics class I avoided then because it was "just another math class," might have enticed the imagination of more students while still keeping within the budget by using ordinary household items.

Just keeping up with what Google[25] could bring to the classroom can be a full-time job. Aside from its prodigious searching capabilities and bourgeoning tool chest, Google Earth 5[26] was just released at the end of January. No longer "Google Dirt" as one oceanographer put it, this release can take you on a journey under the world's oceans as well. From mostly land-locked Illinois, this type of exploration will be a treat indeed. And if you are not satisfied with exploring our planet, Google will take you to Mars[27].

One of the finest examples of integrating several types of Web 2.0 technologies and real life experiences in the classroom is Miss Baker's Biology Class[28]. Watching the engagement of Miss Baker's students makes me hopeful that others will seize similar opportunities and look beyond what is and try to create a mashup[29] of something new.

The value of these Web 2.0 creations is not just in passively exploring what others have done, but an invitation to contribute to global conversations and data gathering, to address different styles of learning, and to use the data being contributed from many sources to learn about our world in novel ways. But we should recognize that the challenge is not just the creation and use of new tools for manipulating existing data, but the mobilization of data not currently shared and an agreement on and adherence to standards that will allow data sharing from many diverse sources (e.g., biodiversity data[30, 31]).

Gail E. Kampmeier, Illinois Natural History Survey

[1] http://en.wikipedia.org/wiki/Web_2.0
[2] http://www.inhs.illinois.edu/outreach/podcasts.html
[3] http://scienceblogs.com/channel/life-science/
[4] http://en.wikipedia.org/wiki/Portal:Science
[5] http://bugguide.net/node/view/15740
[6] http://scilands.wordpress.com/
[7] http://twitter.com/
[8] http://www.facebook.com/
[9] http://scratchpads.eu/node
[10] http://wiki.tdwg.org/twiki/bin/view/DarwinCore/WebHome
[11] http://eol.org/
[12] http://www.discoverlife.org/mp/20q
[13] http://flickr.com/
[14] http://picasaweb.google.com/ncsuinsects/CostaRica2008
[15] http://blogs.lib.ncsu.edu/roller/insects/search?q=Gail
[16] http://www.copusproject.org/
[17] http://www.aibs.org/careers/
[18] http://www.inhs.illinois.edu/outreach/
[19] http://www.isgs.illinois.edu/education/education.shtml
[20] http://www.inhs.uiuc.edu/outreach/edmats.html
[21] http://www.inhs.uiuc.edu/outreach/IWIN.html
[22] http://www.isgs.illinois.edu/education/field-trips.shtml
[23] http://www.thenakedscientists.com/HTML/content/kitchenscience/
[24] http://www.sciencenewsforkids.org/
[25] http://www.google.com/intl/en/options/
[26] http://earth.google.com/
[27] http://www.google.com/mars/
[28] http://www.missbakersbiologyclass.com/
[29] http://en.wikipedia.org/wiki/Mashup_(web_application_hybrid)
[30] http://wiki.ghif.org/ghif/wikka.php?wakka=DIGIT
[31] http://www.tdwg.org/standards

Species Spotlight

Yellow Bellwort

Susan Post

When March 21 appears on the calendar, I am ready for spring, with all its wildflowers, migrating warblers, and fresh new smells. I quickly head for the woods to look for my favorite wildflowers, but I am usually greeted by mud, brown leaves that cover the ground, and a gray sky. By mid-April, though, spring wildflower blooming is in full swing and one of the choicest is yellow bellwort— a touch of gold against the brown forest.

Yellow bellwort, Uvularia grandiflora. Photo by Mike Jeffords, INHS

Yellow bellwort, *Uvularia grandiflora*, is a member of the lily family. It's genus, *Uvularia,* is native (endemic) to North America and comprises five species. All are members of North America's early spring flora. According to R. Mohlenbrock's *Vascular Flora of Illinois*, our state has two species *U. sessilifolia* and *grandiflora*. The latter is found in almost every Illinois county in moist, shady, woods.

Bellwort's common name comes from the bell-like shape of the blossoms. In Latin its scientific name *Uvualaria* refers to the flower, which hangs from its stalk like the human uvula from the palate. The uvula is the pendantlike, fleshy lobe in the center of the soft palate in the back of our mouths. Early herbalists thought bellwort was a cure for throat problems due to this resemblance. *Grandiflora* means big flower and again refers to the blossoms.

When you come upon the plant in the woods, it looks as if it needs to be watered. It has a twisted, droopy, and wilted appearance. The stem is usually branched at the top. The alternate, oblong-to-oval leaves have parallel veins. The bases of the leaves completely surround the stems, giving the appearance of the stems piercing the leaves. These are called perfoliate leaves and they are one of the best ways to identify the plant, whether it is blooming or not. It is also the only member of the lily family in Illinois to have perfoliate leaves. The six-parted bright, yellow flowers are up to 1.5 inches long with six long petals. Each plant will have four to six drooping flowers that grow at the end of an arching branch. Bellwort blooms from April to May and even when in full bloom the blossoms look almost closed. After the flowers have died, the plant continues to grow in a zigzag pattern. These clumps of leaves will remain green well into the summer.

Inside the narrow bell of the flowers is a deep, nectar-bearing groove, bordered on each side by a thick ridge. Insects that have come for the nectar sip and then back out, scraping off pollen onto their wings and backs as they leave. When they visit the next bellwort, the pollen is scraped off their wings and backs, pollinating the flowers.

Early settlers cooked the upper stem and leaves as greens. The upper stem was also used as a substitute for asparagus.

Yellow bellwort is a soon-to-be-favorite that signals spring is here. In the words of Illinois State Museum author Virginia Eifert, *"...a light and airy spring flower with its gold bells twinkling through the woods when April once again is on the land."*

The Naturalist's Apprentice

The Acrostic Poem

Susan Post

Creating an acrostic poem can be helpful in learning spring wildflowers. Many times when I visit an area or want to write about an organism, but have difficulty beginning, I create an acrostic poem. An acrostic poem is a free verse poem in which the first letter (or the last letter of the line) taken in order, form a word or phrase, that is the subject of the poem. The acrostic can be merely a list with a different item on each line, or it can be a sentence or two that continues through the poem. It can even be a combination of these two possibilities.

To begin, write the name of what you want to write about in capital letters going vertically down the left side of your paper. Then start building a poem about the subject with words that begin with each letter. Since the first word of each line has to start with a particular letter, the acrostic form can inspire you to discover new possibilities in your subject as you proceed from line to line. The letter at the beginning of each line may direct your imagination in surprising ways. Your notes and observations about an organism or an area will come in handy, as the acrostic should be factual. Feel free to look up further information in a field guide or nature book, and don't forget the thesaurus or dictionary, as the first letter of each line must come from the title or subject. In addition to writing about the subject, you will be learning facts about it. Warning: It is hard to stop at writing just one, and playing with the acrostic form can be quite addictive!

Uvularia
By Susan Post

Underneath the canopy
Venturing out in spring
Underground roots send up a sturdy shoot
Leaves and lemon-colored flowers
Appear to dangle to and fro
Redbud and violets, may apple, and trilliums
Intermix on the forest floor
Aaah, in spring the *Uvularia* blooms!

Shooting Star
By Patty Dickerson

Shooting stars
Hot pinks and white
Observed in spring
Open woods and prairies
Three species are native to
Illinois
Nodding their heads as if saying
Grace

Streaks across
The ground, not the sky
Always
Regal

Snow Trillium
By Le Ann Benner

Smiles up from the ground
Never frowns
Orderly
White blossoms

Treasure of spring
Rises through the dried leaves
Ingores the cold
Linear yellow stamens
Lovely to look at
Instrument of happiness
Uniform plant
Makes me smile

Non-Profit Org.
U. S. Postage
PAID
Champaign, IL 61820
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Springtails

continued from front page

of the early groundwork on the springtails of the continent. During his tenure at the University of Illinois and shortly thereafter, Folsom produced a series of articles and monographs not equaled in taxonomic scope or geographic breadth until the publication of *The Collembola of North America* by Christiansen and Bellinger in 1980. A substantial portion of the material studied by Folsom was collected in Illinois. Of the 36 or so currently accepted species with type locality in Illinois, 15 were described by Folsom, and 11 of them were collected in Champaign County. Many of Folsom's holotypes, paratypes, and other material that he collected are currently deposited in the INHS Insect Collection. Additional early historically important contributions to springtail taxonomy were made by Alexander MacGillivray, a contemporary of Folsom and also member of the U of I Department of Entomology. Practically all of MacGillivray's work on springtail taxonomy was published before he joined the university in 1911, but types of the taxa he described were eventually deposited in the INHS Insect Collection. MacGillivray's types include common North American species and some genera such as *Neanura* and *Salina* (Fig. 2), subsequently found to have worldwide distributions.

After Folsom's departure, Harlow B. Mills joined the INHS, ensuring the continued addition of material to the collection. Most of the material currently housed in the INHS collection was gathered in Mills' tenure during the late 1940s to early 1970s, not only by Mills himself, but also by Herbert Ross and Lewis Stannard. Collections made by Mills, Stannard, and Ross were of vital importance in the completion of the monograph of the *Collembola of North America* by Christiansen and Bellinger. During Mills' tenure as Chief of the INHS and after his retirement, part of the responsibility curating the collection fell upon graduate students working on taxonomic reviews of individual groups as part of their thesis projects (e.g., Richards on Sminthuridae, Snider on *Lepidocyrtus*, Mari Mutt on Orchesellinae). The historical importance of the INHS collection is recognized by Collembola systematists from around the world who continue to send types and other material to the INHS. The most recently described taxa (2007) based on material deposited at the INHS are the Onychiuridae genera *Wandaphorura* and *Similonychiurus*.

The current taxonomic organization of the collection follows the first edition of the *Collembola of North America*. However, the new edition of the *Collembola of North America* will incorporate recent advances in the taxonomy of the group and the INHS collection is being reorganized accordingly.

Felipe Soto-Adames, INHS

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ILLINOIS NATURAL HISTORY SURVEY Reports

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INSIDE

Inventory of the Discomycetes of Great Smoky Mountains National Park

The All Taxa Biodiversity Inventory (ATBI) is well on its way to cataloging the diversity of life that occurs in the Great Smoky Mountains National Park (GSMNP). As of July 2008, the ATBI program has discovered over 16,800 organisms in the park. These findings have resulted in the identification of over 6,100 species not previously known to occur in the park including 890 species new to science. The sampling of fungi, especially microfungi, is vital to ensure a complete and thorough survey of the park's organisms. Fungi constitute the most diverse group of eukaryotic (organisms with distinct cellular nuclei) organisms on earth, second only to insects in the number of species thought to exist. Although over 85,000 species of fungi have been described, some suggest as little as 5% of the total number of fungi have been discovered.

Figure 1. Sarcoscypha dudleyi, *commonly known as the scarlet elf cup.* Photo by Vince Hustad, University of Illinois

Dr. Andrew Miller of the Illinois Natural History Survey and his doctoral student, Vince Hustad, have recently been funded through a Discover Life in America grant to carry out an inventory of discomycetes that occur in the park. Discomycetes are a large, diverse assemblage of fungi that occur in the phylum Ascomycota. The most widely known discomycete may be the common morel, which is a frequently sought edible that occurs in the spring throughout the U.S. However, most discomycetes exist as small, brightly colored, cup-shaped fruiting bodies (Fig. 1). Their taxonomic status has long puzzled researchers due to insufficient morphological characters and lack of thorough sampling. Recent advances in the field of molecular systematics have provided an unprecedented opportunity to refine the taxonomy of discomycetes to a level that has been, until now, unreachable. Discomycetes are important both economically and ecologically in that they: 1) are responsible for much of the decomposition of woody and herbaceous plant materials, 2) develop endophytic (growing within another plant) associations with vascular plants and bryophytes, 3) develop symbiotic mycorrhizal associations with the roots of vascular plants, and 4) frequently comprise the fungal component of the lichen

Continued on back page

The Illinois Natural Areas Inventory (INAI)

Component I

The original Illinois Natural Areas Inventory (INAI), carried out from 1975 to 1978, has provided a set of information about high-quality natural areas, habitats of endangered species, and other significant natural features. This information is used to guide and support land acquisition and protection programs by all levels of government as well as by private landowners and conservation organizations.

Although the INAI has been maintained and updated to a certain extent by the Illinois Department of Natural Resource (IDNR), it no longer fully meets the needs of conservation-minded landowners, land managers, and regulatory agencies. Thus, on June 1, 2007, a statewide update of the INAI was begun. The first component, funded by IDNR, consists of thoroughly and systematically screening the state to find, describe, evaluate, classify, and map new natural areas. Dr. Brian Anderson, Director of the Illinois Natural History Survey (INHS), is the lead for this project. Other members of the INAI Team at INHS include Dr. Geoff Levin, Randy Nyboer, Connie Cunningham, Tari Tweddale, George Krumins, and Diane Szafoni. Additional partners include staff of Applied Ecological Services, Ecological Services, and Environmental Planning Solutions, Inc.

Regional Ecologist Chris Benda examines aerial photos to identify Potential Natural Areas (PNAs). Photo by Randy Nyboer

New technologies and criteria were developed that could identify perhaps twice as many natural areas of statewide significance as are currently known. Five regional ecologists have begun the INAI survey. The process to find new natural areas has six stages, usually conducted in this order:

Aerial survey of Williamson County for forest PNAs. Photo by Randy Nyboer

1. Compile and review available information—Natural resource professionals and local experts are contacted to identify and compile information related to the location of potential survey sites.

2. Examine map and aerial photos—A statewide ocular examination of maps, historic and modern aerial photography, digital soil surveys, and satellite imagery is conducted to identify Potential Natural Areas (PNAs).

3. Conduct remote surveys—Aerial and/or ground-based (drive-by) surveys of PNAs are conducted to further assess their quality. PNAs may be eliminated from further consideration at this stage.

4. Conduct preliminary site survey—Determine whether PNAs should become Candidate Sites or Nonqualifying Sites. Sites which are dropped from consideration as Candidate Sites at this stage may still be considered as Sites of Local Significance or Best of Kind Sites. If the site is determined to be a Candidate Site, boundary maps and community subclass maps shall be created using the spatial mapping tool of the Natural Areas Tracking System (NATS). Potential significant natural communities will also be mapped. If listed species are encountered, the locations will be mapped with the customized spatial mapping tool, and appropriate GIS data and EOR forms will be sent to the IDNR endangered species project manager.

5. Conduct final site survey—The Natural Areas Evaluation Protocol will be used to assess the quality (grade) associated with natural communities of potential statewide significance. Vegetation sampling will be conducted in communities that are determined to be high quality. Sampling will be conducted using IDNR INAI Standards and Guidelines. If sites are dropped as Candidate Sites at this stage, they may still be considered as Sites of Local Significance or Best of Kind Sites. If listed species are encountered at this stage, the locations will also be mapped and appropriate GIS data and EOR forms will be sent to the IDNR endangered species project manager.

6. Recommendation for listing—Sites still considered Candidate Sites will be recommended to the IDNR Natural Areas Evaluation Committee for listing as Category I INAI natural areas. To date, a total of 2,071 potential INAI sites were identified in 68 counties. Aerial surveys were conducted on 1,514 sites, and 192 drive-bys completed as of May 1, 2009. Eight sites were taken completely through the process, resulting in seven nominated

Continued on next page

INAI

continued from previous page

sites to date. The 2009 field season will be very busy, with 660 sites scheduled for initial ground surveys and 29 sties scheduled for final field surveys.

Component II

IDNR has recently amended their existing INAI contract to provide $127,000 to pilot the remapping, regrading, and vegetation analysis of existing Category I natural areas in the 2008 field season. The results from this pilot project allowed the Work Plan for Component II to be fleshed out and refined before the December 1, 2008 implementation. The same INHS team and partners are responsible for this project, with funding provided by the Grand Victoria Foundation ($2,000,000), Illinois Clean Energy Community Foundation ($400,000), and the Illinois Association of Conservation and Forest Preserve Districts ($166,000). The Boeing Corporation provided a gift of $50,000 to the INHS that will be used to complete the work in Cook County and develop educational materials to promote their broader visitation by the public.

When the existing Category I INAI sites were originally designated natural communities and were mapped, each community was graded, and quantitative plant data were collect for high-quality communities. For this project, ecologists will visit (subject to landowner permission), remap, and regrade the 664 existing Category I natural areas, and conduct quantitative vegetation surveys for each high-quality natural community type. In all cases the procedures will be identical to those being employed by the INAI Update to identify new Category I INAI natural areas. A redundant subsample of approximately 25 of these sites will be sampled independently for Quality Assurance/Quality Control (QA/QC) purposes. Arms-length QA/QC of digital data will also occur before archiving.

As part of this project, Dr. Deanna Glosser of Environmental Planning Solutions, Inc. is developing The Strategic Natural Areas Protection Plan (SNAPP). SNAPP is being developed to document the human and financial resources needed to maintain the new Illinois Natural Areas Inventory (INAI) once updated, continue to aggressively pursue protection of existing and new INAI natural areas, and provide ongoing management of protected natural areas. This plan will consist of seven major goals.

Regional Ecologist Meg Timpe ([L] Region 3) and Chris Benda ([R] Region 5) conducting preliminary site survey. Photo by Randy Nyboer

Goal 1—Conduct a programmatic infrastructure needs assessment for agencies and not-for-profit organizations, evaluating the roles that are or could be played by governmental entities and not-for-profits across the state in protecting INAI sites.

Goal 2—Assemble existing land acquisition information regarding natural resources land acquisition programs and referenda by the IDNR, Forest Preserve Districts, Conservation Districts, and key not-for-profit organizations in order to provide an historic perspective on land acquisition expenditures in Illinois over the past five years,.

Goal 3—Calculate the costs to acquire INAI sites based on land values by county, the costs per acre for restoration (bringing all sites to maintenance level) and management by community class and subclass where appropriate, and geographic region of the state through the year 2030 in order to project the total financial resources needed to protect INAI sites.

Goal 4—Calculate future funding needs to maintain the INAI. Project the costs annually through 2020 for IDNR to provide a database and GIS staff to maintain the database, field staff to monitor and defend sites, and the equipment needed to perform this work in order to ensure the INAI database is fully maintained.

Goal 5—Examine the need and costs to provide buffers to INAI sites to protect them from herbicide drift, sedimentation, hydrological disturbances, and other incompatible urban and rural land uses to ensure INAI sites are maintained in perpetuity.

Goal 6—Assess the use of the INAI as a tool to meet broader conservation goals, such as creating larger landscape-scale grasslands or forests.

Goal 7—Organize a statewide INAI symposium to share the results of the INAI Update and to finalize the SNAPP.

The Web site for the INAI project can be found at http://www.inhs.illinois.edu/research/inai/

Diane Szafoni, Connie Cunningham, Randy Nyboer, and Brian Anderson INHS; Deanna Glosser of Evnironmental Planning Solutions, Inc., and Jack White of Ecological Services.

Moist-soil Management for Waterfowl on Illinois State Lands

Millions of waterfowl migrate through Illinois annually, seeking food and shelter in the state's wetlands. In the late 1930s, Illinois Natural History Survey (INHS) researcher Frank C. Bellrose recognized the importance of wetland plant seeds to migrating ducks and geese in the Illinois River valley and coined the term "moist-soil" to refer to this type of vegetation. Since Bellrose's initial work, waterfowl scientists have determined that moist-soil plant seeds are especially important waterfowl foods because they are high in energy and contain essential nutrients and amino acids not found in crops, such as corn. Managers can encourage growth of moist-soil plants by manipulating water levels and seed banks in wetlands, and moist-soil management has become a popular technique to provide food for migratory waterfowl in Illinois and beyond. It is important to understand the production of these foods in Illinois, because provision of adequate forage may influence survival and breeding success in waterfowl.

INHS researcher takes a wetland core sample. Photo by INHS Forbes Biological Field Station staff

An abundant crop of millet in a managed wetland provides vital food resources for waterfowl in Illinois. Photo by INHS Forbes Biological Field Station staff

More than 70 sites are managed by the Illinois Department of Natural Resources (IDNR) to provide waterfowl foraging habitat, and many of these employ moist-soil management to meet habitat objectives. However, management techniques vary among sites, and IDNR staff may lack the resources needed to evaluate success. Additionally, the U.S. Fish and Wildlife Service's (USFWS) conservation strategy relies on Illinois to provide food for migratory waterfowl, but the contribution of IDNR lands to foraging carrying capacity is unknown. Given these needs, staff of the INHS Forbes Biological Station investigated moist-soil plant seed production on IDNR lands during falls 2005–2007.

We employed a multi-stage sampling design to estimate moist-soil plant seed biomass precisely at IDNR waterfowl management areas. Thus, we randomly selected 8–10 IDNR sites for sampling each year. Within sites, we randomly selected two wetland units (if available) and extracted 15 soil-core samples (10-cm diameter, 5-cm depth) from random locations in each wetland during September and October 2005–2007. We painstakingly separated seeds from soil—most samples took hours to sort—and dried and weighed the contents to estimate biomass (kg/ha). Further, we compiled data for use in modeling seed abundance in relation to environmental and management-specific covariates, such as temperature, precipitation, the number of desirable plant species, management intensity (active or passive), and an index of employee effort (staff per-unit-area). Finally, we used published information to translate seed biomass estimates into energetic use-days (EUD; number of days an area could support a Mallard-sized duck) to understand foraging carrying capacity.

These ducks at Lake Chautauqua along the Illinois River are beneficiaries of moist-soil management. Photo by INHS Forbes Biological Field Station staff

Average seed biomass among IDNR sites ranged from 502 kg/ha in 2007 to 1,030 in 2005, and individual sites produced 191–1,803 kg/ha of plant seeds. Our overall estimate of moist-soil plant seed abundance (691 kg/ha) suggested that, on average, one hectare of moist-soil wetland could meet the energetic needs of about 197 Mallard-sized ducks for a 30-day migration period. Models of seed biomass indicated that wetlands with more desirable plant species produced more seed. Further, actively managed wetlands (i.e., those that were dewatered plus another activity, such as soil disturbance or herbicide treatment) produced about 35% (240 kg/ha) more seed than passively managed wetlands (dewatered only).

Our estimates of moist-soil plant seed production on IDNR lands were similar to or exceeded those from other states, and suggested IDNR sites alone could meet nearly 45% of the foraging habitat objective for Illinois posed by the USFWS. Further, active management that promoted plant diversity (as opposed to monotypes) resulted in considerable increases in seed production. Our results have been incorporated into regional conservation plans and provide new information to assist waterfowl conservation planning in Illinois and throughout North America.

Joshua Stafford, Aaron Yetter, Chris Hine, Randy Smith and Michelle Horath, INHS

BIG BOOK SALE

IN ORDER TO MAKE ROOM FOR SOME EXCITING NEW PUBLICATIONS, WE HAVE DECIDED TO DEEPLY DISCOUNT OUR "BIG BOOKS"

Crayfishes, also know as crawfish, crawdads, or mudbugs are a diverse and important component of freshwater aquatic and semi-aquatic ecosystems around the world. Their familiar form is recognizable by almost anyone who has spent time in and around lakes or creeks. Crayfishes are found natively on every continent except Africa and Antarctica and occur in almost every type of aquatic and semi-aquatic habitat.

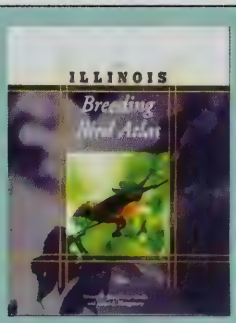
REGULAR PRICE $20, SALE PRICE $10 (50%OFF)*

The Crayfishes of Kentucky (219 pages) by Christopher A. Taylor and Guenter A. Schuster

The Illinois Breeding Bird Atlas (459 pages) by Vernon M. Kleen, Liane Cordle, and Robert A. Montgomery

The Illinois Breeding Bird Atlas presents a comprehensive summary of information about birds that currently breed in the state, based primarily on data from the Illinois Breeding Bird Atlas project and the North American Breeding Bird Survey, as well as the knowledge gained over many years of experience with the state's avifauna. As the word "atlas" implies, the book includes maps that illustrate the distribution of breeding bird species in Illinois, but it also includes information on their ranges, abundance, habitats, life histories, historical status, and recent population trends.

REGULAR PRICE $26, SALE PRICE $13 (50%OFF)*



The Chewing Lice World Checklist and Biological Overview (501 pages) by Roger D. Price, Ronald A. Hellenthal, Ricardo L. Palma, Kevin P. Johnson, and Dale H. Clayton

REGULAR PRICE $35, SALE PRICE $10 (71%OFF)*

This work was intended as an update of "A Check List of the Genera & Species of Mallophaga" published by G. H. E. Hopkins and Theresa Clay in 1952 and its two supplements published in 1953 and 1955. This was to be augmented by a full list of the known chewing louse-host associations. Subsequently, family and genus keys, along with genus illustrations, were added and, through the collaboration of Kevin P. Johnson and Dale H. Clayton, a section on chewing louse biology, ecology, and evolution was included.

REGULAR PRICE $60, SALE PRICE $45 (41%OFF)*

A comprehensive source on the status, management, and biology of Illinois waterfowl. A variety of topics relating to waterfowl were investigated and are discussed in book. This book captures the strong traditions of waterfowling in the heart of the Mississippi Flyway and will be a welcome addition to the literature for those with a special interest in waterfowl. Illustrations, tables, and color photos in this remarkable collection document a century of waterfowl investigations.

Waterfowl of Illinois: Status and Management (628 pages) by Stephen P. Havera

For additional information, please contact the Publication Office at (217) 244-2161 or email: <pubs_sales@inhs.illinois.edu>. *Additional shipping and handling costs apply, sales prices good through August 31, 2009.

Species Spotlight

Camel Crickets

Susan Post

During a recent field trip to Wildcat Bluff in southern Illinois, I found a camel cricket molting—wedged in a crack between towering, sandstone walls. A month later, during a full-moon hike in central Illinois, I watched as a different species of camel cricket consumed an offering of oats I had proffered at the edge of the trail. Curious about both, I decided to learn more.

An adult camel cricket. Photo by Michael Jeffords, INHS

Camel crickets belong to the insect order Orthoptera and are related to katydids and grasshoppers. They are members of the family Rhaphidophoridae and are found throughout the world, but are most numerous in the United States. About 150 species of camel crickets reside in the United States, with at least 90 species belonging to the genus *Ceuthophilus*. Several members of this genus occur in Illinois.

While these insects may be common, they are rarely seen, as camel crickets are nocturnal. During the day they hide in caves, animal burrows, tree holes, or under logs and stones. At night they come out to socialize and scavenge on dead insects, moving silently about, guided by their antennae. These crickets are harmless, yet their common names have included stone cricket and devil's coach horse. In 1918 a writer referred to these crickets as "an ungainly insect with a cringing attitude."

A camel cricket nymph. Photo by Michael Jeffords, INHS

A camel cricket's appearance is distinctive; one author described them as "shrimp with big legs." Yet identification to species is difficult. Upon encountering camel crickets you will notice several characteristics. They have arched or humped backs with overlapping plates that armor their backs (thus the shrimp reference). Their heads are oval and bent downward and backward between their front legs. They have large hind legs and long, sweeping antennae that are as long or longer than their bodies. These are studded with sensory receptors. As they walk along they sweep their antennae ahead of them. Camel crickets spend a lot of time grooming—keeping their legs and antennae clean. To clean their antennae they bend them, pulling each through the mouth, working along their lengths until the tip ends snap free and the antennae pop back into place.

Camel crickets are at least an inch long and are various shades of brown, with darker brown and black markings, depending on the species. While called a cricket, they are not like the familiar field cricket that serenades during the summer. Camel crickets have no wings, nor do they sing. They are deaf to airborne sound, but they can pick up vibrations.

Females lay oblong eggs in groups in the soil during late summer. Depending on the species, the insects will over winter as eggs or as small nymphs. These insects undergo incomplete metamorphosis—egg, nymph, and adult. They will molt seven or eight times before reaching adulthood. The whole cycle takes less than a year. After each molt the newly emerged cricket will eat its cast-off skin.

To see these interesting insects, grab a flashlight or head lamp and head to your favorite woodland trail. Who knows, maybe you will be rewarded with a glimpse of these interesting detritivores.

The Naturalist's Apprentice

Oating for Orthopterans

Carolyn Nixon

An adult camel cricket. Photo by Phil Nixon, University of Illinois

Many crickets (members of the order Orthoptera) are strongly attracted to grain products, especially grains that are cracked or broken. Biologists have learned that they can attract these insects, many of which are difficult to spot in their natural habitat, by using grains as bait.

There are many species of crickets, most of which are overlooked because they are active at night and because they are cryptic, that is, they blend in with their habitat. To get a chance to view some of the variety of crickets in your yard, you can put out grain products to attract them. One of the best grain products to use is rolled oats (uncooked oatmeal). You can purchase the old-fashioned rolled oats at your local grocery store.

In your yard or schoolyard, find a place where the ground is devoid of vegetation, such as in shady areas in a woods, or on a path or sidewalk. Spread a trail of rolled oats at the edge of the path. *(To see a video of oating for crickets, go to:* http://www.inhs.illinois.edu/publications/VID00048.mp4*)* Go back after dark with a flashlight to see what has been attracted to the bait. You can also cover the oats with newspapers and leave them overnight. Some species of crickets will be attracted to the bait and stay under cover in the morning. When you lift the newspaper, they may start to run or fly, so be ready for action.

A bush cricket nymph. Photo by Phil Nixon, University of Illinois

Some of the other grain products that you can use to attract crickets are wheat bran, oat bran, and rolled barley. You can even use crumbled bread. These will also attract grasshoppers, and some species of grasshoppers will come to wheat bran moistened with a little corn oil.

Try different baits and habitat types, such as grassy areas or woods. See what different species you can find using different baits, checking in the evening, or which species will be there in the morning under a cover. Take photos of the crickets and try to identify them.

The field cricket is an Orthopteran with which most of us are familiar. This is a male on a garage. Photo by Phil Nixon, University of Illinois

Some resources to help you identify crickets:

Field Guide to Grasshoppers, Katydids, and Crickets of the United States, by John L. Capinera, Ralph D. Scott, and Thomas J. Walker. 2004. Cornell University Press.

How to Know the Grasshoppers, Cockroaches, and Their Allies, by Jacques R. Helfer. 1953. Wm. C. Brown Company Publishers.

Kaufman Field Guide to Insects of North America, by Eric R. Eaton and Kenn Kaufman. 2007. Houghton Mifflin.

To download a page of Illinois crickets, go to: http://www.inhs.illinois.edu/outreach/downloads/Illinois_Crickets.pdf

Institute of Natural Resource Sustainability
ILLINOIS NATURAL HISTORY SURVEY
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Discomycetes

continued from front page

symbiosis. Most discomycetes are overlooked by the untrained eye due to their small size and ephemeral nature, typically occurring as superficial inhabitants of living and dead plant parts.

While Miller has recently completed a four-year survey of microfungi (pyrenomycetes) in the park and Dr. Ron Petersen (University of Tennessee at Knoxville) has inventoried the macrofungi, neither study focused on the discomycetes. This inventory will be the first comprehensive inventory on the diversity of discomycetes within the GSMNP. In his 1979 compilation of fungal species occurring in the park, Petersen lists 94 species of discomycetes, however, only the most common and conspicuous species were included in this species checklist. Preliminary collecting in the park indicates a high diversity of discomycetes, with over 70% of collected species representing new park records. There is also a high probability of discovering several species new to science. Although it is difficult to speculate how many discomycetes occur in the GSMNP, Miller and Hustad conservatively estimate at least 500 species.

Collecting will occur throughout the park at various elevations to sample a wide variety of habitats ranging from pine-oak forests to hardwood coves to northern red oak forests. Collecting in the GSMNP will greatly enhance the INHS Mycology Herbarium by providing hundreds of voucher specimens from an underrepresented area of the U.S. These specimens will allow comparisons to be made with material collected throughout Illinois and help establish fruiting patterns, abundance, species ranges, and host specificity. An on-line interactive identification key will also be created along with species pages for the most common taxa found in the park. This project is designed not only to provide a preliminary inventory of this economically and ecologically important group but also to address a number of questions critical to our understanding of fungal biodiversity and biogeography.

Andrew Miller and Vince Hustad, INHS

NATURAL HISTORY SURVEY Reports

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Institute for Natural Resource Sustainability

Autumn 2009
No. 401

INSIDE

Revisionary Synthesis of Deltocephaline Leafhoppers

Leafhoppers (Cicadellidae) are one of the largest families of insects with more than 22,000 described species and countless additional species remaining to be discovered. These plant sap-sucking insects are ubiquitous, occuring wherever their vascular plant hosts are found, from tropical rainforest to arctic tundra. The largest leafhopper subfamily is Deltocephalinae, with approximately 6,500 species worldwide and 300 recorded from Illinois. This group includes important vectors of plant pathogens, such as the aster leafhopper (*Macrosteles quadrilineatus*), beet leafhopper (*Neoaliturus tenellus*), and maize leafhopper (*Dalbulus maidis*) that have potential economic impacts wherever they occur. It also includes most of the European leafhopper species that have become established in the United States, as well as a North American pest of grapevine (*Scaphoideus titanus*) that has recently become established in Europe. Several Eurasian deltocephaline species have been recorded for the first time in Illinois within the past 15 years. Because many species of deltocephaline leafhoppers specialize on grasses, they are abundant in native prairies. Consequently, the group also includes many species of conservation concern, including 62 species considered "species in greatest need of conservation" by the Illinois Department of Natural Resources, and the only three leafhopper species officially listed as threatened or endangered in Illinois.

Deltocephaline leafhoppers from Illinois (A–F) and Argentina (G–I). A, Pendarus tullahomi*; B,* Flexamia areolata*; C,* Scaphoideus *sp.; D,* Athysanella incongrua*; E,* Hecalus magnificus*; F,* Menosoma cincta*; G,* Agudus sexmaculatus*; H, undescribed genus and species; I,* Neocrassana undata.

Despite their economic importance and conservation significance, the taxonomic classification of Deltocephalinae remains rudimentary. Leafhopper taxonomists studying the faunas of different continents have proposed different classifications for their regional faunas, and the only previous attempt to treat the world fauna comprehensively was published in 1947. Species and higher taxa are notoriously difficult to identify because most available keys are many decades out of date, and identification of species often requires dissection and examination of the male genitalia.

With funding from a new National Science Foundation Grant, Illinois Natural History Survey (INHS) entomologists James Zahniser and Chris Dietrich plan to reconstruct the phylogenetic relationships among major groups of Deltocephalinae, revise the genus-level classification of the subfamily, and provide improved tools for the identification of these leafhoppers. Zahniser's recently completed dissertation research yielded the first comprehensive estimate of phylogenetic relationships among major lineages of Deltocephalinae, based on a combination of morphological and DNA-sequence data. Building on these results, and

Continued on back page

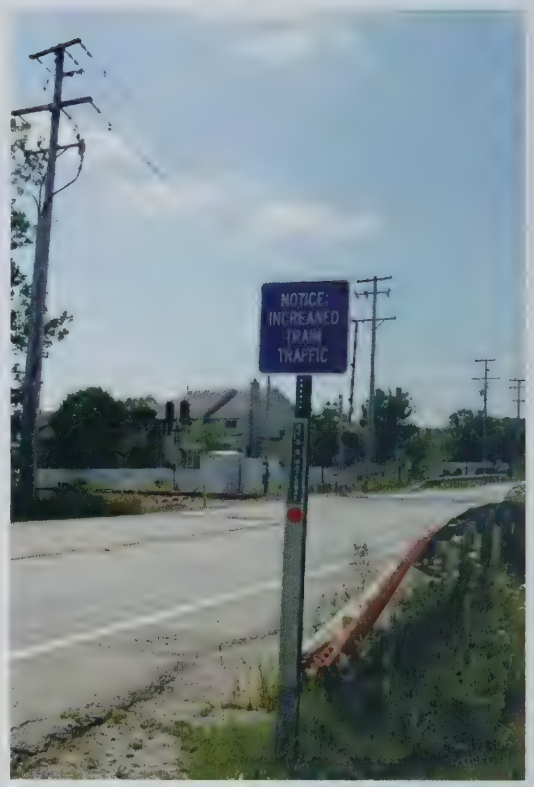
Big Railroad Blues

Transportation is key to our society — allowing movement of raw materials, agricultural products, manufactured goods, and people. Transportation, in all its forms, has ecological impacts. The most studied impacts are those associated with the over 4 million miles of highways in the United States. Less known are potential impacts of the 233,000 miles of railroad tracks in the U.S. So when the Canadian National Railway (CN) proposed purchasing the Elgin, Joliet and Eastern Railway (EJE), with 198 miles of class II tracks that operate in the suburbs of Chicago, both governmental and nongovernmental entities cited concerns over the lack of knowledge about how this transaction could potentially affect natural areas that the EJE tracks cross. The tracks were already in place, but the number of trains per day was expected to increase substantially, in some places more than tripling. Owing to the wide ecological expertise resident within the Illinois Natural History Survey (INHS), we were identified by key stakeholders (including Forest Preserve Districts of Cook, Du Page, Lake, and Will counties) to monitor potential impacts as CN moved their trains from their existing tracks onto the EJE.

Our main monitoring sites are forest preserves within the affected counties. These include Spring Creek Valley and Poplar Creek in northwest Cook County; Pratt's Wayne Woods and West Chicago Prairie in Du Page County; Cuba Marsh and MacArthur Woods in Lake County; and Lake Renwick and Lockport Prairie in Will County. An additional study site includes the tracks adjacent to Fermilab in DuPage County.

Topics of concern to the stakeholders include: 1) Effects of train noise (acoustic disturbance) on wildlife, especially nesting birds but also other species that use acoustic signals during breeding such as many amphibians and invertebrates. 2) Direct kills of wildlife, particularly turtles, by increased train traffic. 3) Effects of contaminants, vibrations, and noise on aquatic habitats near railroad tracks. 4) Effects of herbiciding, as well as other contaminants and general disturbance resulting from increased train traffic, on high-quality plant communities near railroad tracks. 5) Effects of increased train traffic on the spread or increased abundance of invasive species, both plants and insects.

Species of concern to stakeholders include: 1) Illinois threatened and endangered species and nesting and migratory species considered Federal Trust Resources occurring at forest preserves and other protected sites. 2) Songbirds in all habitats, but especially some grassland and shrubland species that are rare or declining. 3) Herons, egrets, and cormorants at the Lake Renwick rookery. 4) Aquatic communities in general, including mussels, aquatic invertebrates, and fish at several streams, ponds, and wetlands. 5) Wetland-associated species, especially amphibians. 6) Butterflies that may be attracted to food sources near tracks. 7) Turtles, snakes, and other species that may be attracted to railroad tracks as basking areas, or that may become trapped between rails as they try to cross tracks where they could suffer direct mortality from trains.



Sign at intersection of Shoe Factory Road and EJE rail track in northwest Cook County, near the Poplar Creek Forest Preserve, warning residents to look for increased rail traffic. **Photo by Chris Whelan, INHS**

CN rail cars on EJE along Spring Creek Valley Forest Preserve in northwest Cook County. **Photo by Chris Whelan, INHS**

Continued on next page

Railroad Blues

continued from previous page

To address those concerns, we assembled a team of survey scientists including Yong Cao (aquatic ecology), Dave Enstrom (acoustic ecology), Ed Heske (track monitoring for direct take), Jeff Levengood (ecotoxicology), Brenda Molano-Flores (insect ecology), Alan Plocher (plant ecology), John Tucker (amphibian and reptile ecology), and Chris Whelan (breeding bird ecology). Following approval of a project proposal by CN and the stakeholders, work commenced in June 2009. The project is being fully funded by the Canadian National Railroad.

Our main approach will be to survey species and taxonomic groups, or measure contaminants, at locations near railroad tracks and away from tracks (e.g., >100 m) within sites. We will also conduct surveys and monitoring both at sites where rail traffic should increase and sites where it should not increase over five years. This combined approach will assist us in attributing any effects observed to changes in railroad traffic over time (i.e., between years), as well as to railroad tracks in general (sites near and away from tracks). We also will quantify responses to train traffic by specific targets (e.g., the heron rookery) or species (e.g., nesting songbirds). A novel and unique method being used in this study is the establishment of acoustic microphone arrays near and away from tracks to record the behavioral responses of birds, insects, and anuran amphibians to passing trains and other loud, environmental noise.

Mass transit and high-speed rail are part of the wave of the future. Transporting freight by train also leaves a smaller carbon footprint than transporting the same amount of freight by truck. Monitoring the effects of increased train traffic on wildlife and plant communities should be an essential component of developing this transportation infrastructure. We're pleased to help the Illinois Natural History Survey lead the way in these efforts.

Christopher J. Whelan and Edward J. Heske,
Illinois Natural History Survey

Chicks of Indigo Bunting, in nest 9 m west of EJE tracks on eastern edge of Spring Creek Valley Forest Preserve on August 25, 2009. The chicks fledged by 28 August. **Photo by Chris Whelan, INHS**

Ed Heske and Manette Sandor of INHS observing wildlife and examining tracks for direct kills on EJE track on west edge of Poplar Creek Forest Preserve in northwest Cook County.
Photo by Chris Whelan, INHS

How We COPE with Outreach and Education

For 151 years the Illinois Natural History Survey (INHS) has been the recorder and guardian of the state's biological resources. In this capacity INHS has become a kind of archives for Illinois' biological memory with which it carries on its four-fold mission of monitoring, research, publishing, and outreach and education. Outreach to citizens has been an integral component of our mission from the beginning. In the late nineteenth century, our first "Chief" Stephen A. Forbes started our first outreach efforts by compiling a series of collections of representative Illinois plants and animals and distributed these to high schools and colleges throughout the state.

Naturally, as the mass media evolved, the diversity of ways in which INHS could reach the public also increased. Not only printed materials became a staple of our outreach, but radio and TV presentations, films and videos, drama, and musical performances became part of our repertoire. Eventually, a speakers' bureau, classes, workshops, and field trips were added to our arsenal of outreach tools. Recently, the Internet and two traveling science centers have joined the cause.

Illinois school children enjoy the INHS Mobile Science Center. **Photo by Michael Jeffords, INHS**

Outreach Web Site

The INHS Web site is at: <http://www.inhs.uiuc.edu/>. Click on the "Outreach and Education" link to access the INHS educational activities, services, and products. For instance, if you are a teacher, and would like a mobile science center to visit your class, there is a link that provides contact information to help schedule an appointment.

IWIN

If you are an adult who would like an adventure into the wilds of Illinois with your own personal natural history expert, we have just the ticket for you. Our Illinois Wilds Institute for Nature (IWIN) offers hands-on field experiences. IWIN adventures generally last for two to three days and are led by scientists with expertise in the plants and animals of the state. Course participants are also provided with classroom lectures and natural history workshops in addition to many fun hours identifying organisms in the field. Past IWIN courses studied butterflies, amphibians and reptiles, and mammals. For future offerings, check the IWIN link at the "Outreach and Education" Web site or contact the IWIN registrar at 217-333-4322.

Corps of Discovery

For citizens who are interested in a more long-term relationship with the natural history of Illinois, we have the Corps of Discovery. Inspired by the Lewis and Clark Corps of Discovery that started in Illinois during the administration of Thomas Jefferson, our "new" Corps of Discovery emulates the methods of observation and documentation employed by the original corps. Today, Corps of Discovery participants learn the technical skills of photography, drawing, and descriptive writing and how to integrate these disciplines to depict and describe the changes in natural areas over several years.

Participants who complete the four to six core-course workshops are eligible to join a Corps of Discovery Group that monitors a natural site. Currently, there are six groups throughout the state.

Information about the INHS Corps of Discovery program can be found at the INHS "Outreach and Education" Web site.

COPE

INHS has just established an umbrella organization to coordinate its outreach and education efforts. This new entity is named Corps for Outreach and Public Engagement (COPE). COPE's foundation consists of:

- IWIN
- Corps of Discovery
- Traveling and Mobile Science Centers
- Speakers Bureau
- *Illinois Steward* Magazine
- Educational Materials
- Exhibition Design and Construction
- a Collection of World-class Photos of Natural History Subjects.

More initiatives shall find their way under COPE's canopy as needs arise. One way or another, INHS shall COPE with every outreach and educational challenge that comes its way. Watch for more about COPE in the coming months.

Charlie Warwick, Illinois Natural History Survey

CALENDAR SALES ITEMS FOR OCTOBER THROUGH DECEMBER

THEY MAKE GREAT HOLIDAY GIFTS!

OCTOBER – WETLAND PLANNING SAVINGS EVENT

Wetland Wonders curriculum guide, slide set, poster, and a game board:
Regular Price $11 (w/set of 30 posters, $31)
Sale price $7 (w/set of 30 posters, $20)

Wetland Resources of Illinois, An Analysis and atlas:
Regular price $4—Sale price $3

Selected Wetlands-related Legislation and Programs Applicable to Illinois:
Regular price $3—Sale price $2

Illinois Wetland Restoration & Creation Guide:
Regular price $15—Sale price $8

Status and Functions of Isolated Wetlands in Illinois:
Regular price $2—Sale price $1

Assessment of Created Wetland Performance in Illinois:
Regular price $6—Sale price $3

Illinois had an estimated 8 million acres of wetlands. Since Illinois became a state in 1818, more than 95% of these have been drained.

Michael Jeffords, 1990–Our Living Heritage: The Biological Resources of Illinois

NOVEMBER – BUG STUFFERS

The Good Guys!, The Bad Guys! Sets 1 & 2, and The Ugly Guys! are sets of 31 or 32 laminated cards with color photos and concise descriptions of insects and other organisms that are either beneficial (The Good Guys), that can cause damage in the home vegetable, fruit and flower gardens or the home landscape (The Bad Guys), or that can become pests in the home (The Ugly Guys).

Regular price $10—Sale price $5

Waterfowl of Illinois: Status and Management (628 pages) by Stephen P. Havera

Regular price $60—Sale price $45

DECEMBER – WATERFOWL IN A WINTER WONDERLAND

Just because the birds have flown south for the winter doesn't mean that you can't enjoy them! Get a set of both of our *Waterfowl of Illinois* books for $50

Waterfowl of Illinois: Abbreviated Field Guide (72 pages) by Stephen P. Havera

Regular price $15—Sale price $10

For additional information, please contact the publication office at (217) 244-2161 or email: pubs_sales@inhs.illinois.edu. *Additional shipping and handling costs apply, prices subject to change.

Species Spotlight

Cooper's Hawk

Susan Post

"[The cooper's hawk] had become a brown-cloaked, streak-breasted torpedo, weaving through a world of shadows." Pete Dunne *The Wind Masters*

The Cooper's Hawk, *Accipiter cooperii*, was named after the naturalist William Cooper, one of the founders of the New York Academy of Sciences. Common names include Big Blue Darter, Bullet Hawk, Swift Hawk, Black-capped Hawk, Striker, Chicken Hawk, Hen Hawk, Quail Hawk, Partridge Hawk, and Pigeon Hawk. Some of these names are based on physical characteristics of the bird, while other names refer to hunting tactics or prey. It is for the latter [prey items] that early settlers persecuted these hawks.

A Cooper's Hawk, Accipiter cooperii, *perches in a tree on the University of Illinois campus.* **Photo by Michael Jeffords, INHS**

Cooper's Hawks belong to the genus *Accipiter*, a group of birds adapted for short bursts of weaving flight through heavy brush to capture their prey in deep woods and thick undergrowth. Surprise is the ally of an accipiter, not endurance. Think of these birds as sprinters or like cheetahs. If the prey is not taken in the first attempt or after a short chase, pursuit is broken off. There birds hunt by stealth, listening and watching, approaching their prey through dense cover, and then pouncing with rapid powerful flight

In the United States there are three members of the genus *Accipiter*—Sharp-shinned Hawk, Cooper's Hawk, and Goshawk. Distinguishing one from the other is not easy. Cooper's Hawks are lanky, with long, straight tails with dark bands ending with white terminal bands. Their tails have round tips. The adults are slate blue above with orangish breasts. They have dark caps and red eyes. Juveniles are clean breasted and have a dark, hooded appearance. They have yellow eyes and are warm brown in color. In flight Cooper's Hawks appear long-necked and they look like flying crucifixes or Roman crosses.

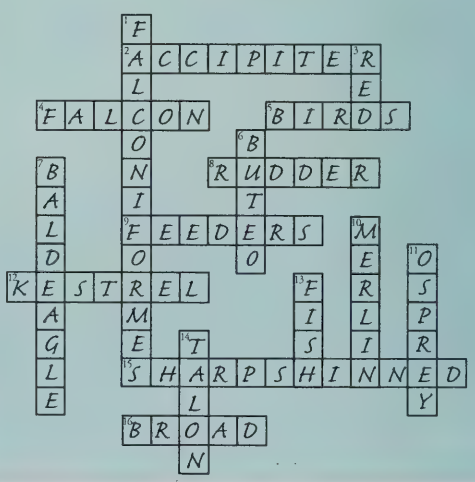
The hawk's victims are almost always birds that vary in size from wood warblers to Pheasants. While they will pursue warblers or chickadees, they favor larger prey, birds up to the size of Pheasants and mammals as large as squirrels. Cooper's Hawks need robin-sized meals daily, and in energy requirements it takes less time and energy to capture one robin-sized bird than six warbler-sized birds.

They capture their prey with their feet and kill them by repeated squeezing their talons. Cooper's Hawks hold their catch away from the body until it dies.

The Cooper's Hawk nest, a bulky structure of sticks lined with bark, is in a tree and is usually 25 to 50 feet above ground. Many times the nest will be on top of an abandoned squirrel nest. Three to five pale bluish white eggs are laid. Incubation lasts 34 to 36 days. During this time the male will bring food to the female. Once the eggs hatch, both parents feed the hungry chicks, which will be able to fly in about four to five weeks.

Cooper's Hawks may be found in a variety of forest and woodland habitats—open woodlands, mature forest, wood edges, and river groves. They have even adapted to our backyard bird feeders. Perching in trees overlooking the feeder, they swoop down and scatter the other birds in order to capture one in flight.

Answers to Hawk Crossword Puzzle on following page.



The Naturalist's Apprentice

Hawk Crossword Puzzle

Carolyn Nixon

See if you can complete the crossword puzzle using the clues below. If you need some help, read the "Species Spotlight" on the Cooper's Hawk (preceding page), and search in a field guide to birds of either North America or Illinois.

Across

2. The scientific name for Cooper's Hawk is _____ cooperii
4. The Peregrine _____ is the fastest animal in the world.
5. These are the favorite food of Cooper's Hawks.
8. The tail of a Cooper's Hawk acts as a _____, allowing it to zig-zag through the forest at fast speeds.
9. Cooper's Hawks often wait at bird _____ to catch their prey around town.
12. The American _____ is Illinois' smallest hawk.
15. The _____-_____ Hawk looks very similar to the Cooper's Hawk, but is smaller.
16. The _____-winged Hawk, a relative of 6-Down, lives in forests.

Down

1. Hawks belong to this bird family.
3. The _____-shouldered Hawk is a relative of 6-Down and 16-Across, and prefers to live in wet areas, such as swamps and bottomland forests. It is listed as State Threatened.
6. The scientific name of the Red-tailed Hawk is _____ *jamaicensis*.
7. This large hawk is the symbol of the United States of America.
10. A close relative of 12 Across, but slightly larger, it does not nest in Illinois, but does migrate through it.
11. This hawk has long, slender wings, and is found near water. It is State Endangered.
13. The only food of 11-Down.
14. The name for the long, sharp claws of hawks.

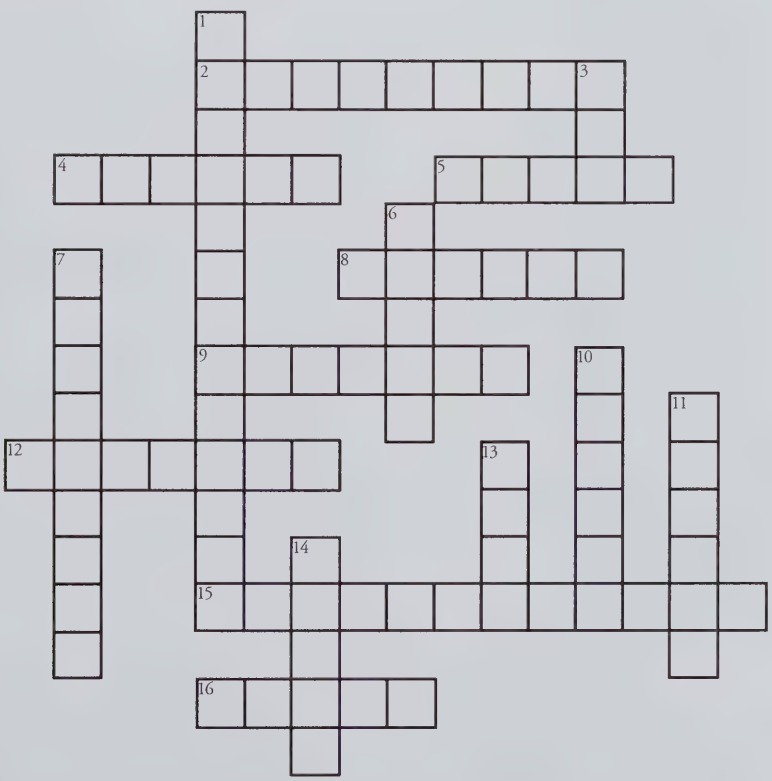
Glossary

- State Threatened—Any breeding species which is likely to become a state endangered species in the foreseeable future in Illinois.

- State Endangered—Any species which is in danger of extinction as a breeding species in Illinois.

American Kestrel by Carolyn Nixon, INHS

Red-tailed Hawk by Carolyn Nixon, INHS



Institute of Natural Resource Sustainability
ILLINOIS NATURAL HISTORY SURVEY
1816 South Oak Street,
Champaign, Illinois
61820 USA

Illinois Natural History Survey Reports is published quarterly by the Illinois Natural History Survey, 1816 South Oak Street, Champaign, IL 61820. Headquartered on the campus of the University of Illinois at Urbana-Champaign, the Survey is a division of the University of Illinois Institute of Natural Resource Sustainability.

INHS Reports is edited by Charlie Warwick and printed on recycled and recyclable paper. Design by Otto-Walker Communications.

Leafhoppers

continued from front page

using specimens from the INHS insect collection or borrowed from other institutions, Zahniser and Dietrich will attempt to examine and record morphological data for representatives of all 277 known genera of the large and poorly defined deltocephaline tribe Athysanini, as well as representatives of the 35 other previously recognized tribes. They will use these data to conduct a more detailed phylogenetic analysis. Results of this analysis will be used as the basis for a revised taxonomic classification of the group.

Data gathered as part of the comparative morphological and phylogenetic study will also be used to produce on-line interactive identification keys. These keys will be developed using 3I (Internet-accessible Interactive Identification), a software package developed by INHS entomologist Dmitry Dmitriev. An illustrated key to deltocephaline tribes is available on-line at: http://ctap.inhs.uiuc.edu/zahniser/keyasp?key=Delt&lng=En&i=1&keyN=1

Chris Dietrich and James Zahniser, Illinois Natural History Survey

NATURAL HISTORY SURVEY Reports

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Institute for Natural Resource Sustainability

Winter 2010
No. 402

INSIDE

Interspecific Interactions between Invasive and Native Mosquitoes

Aedes triseriatus—*eastern treehole mosquito (larvae)*. Photo courtesy of Alex Wild, 2009

The Asian rock pool mosquito, *Aedes japonicus,* whose native range includes Japan, China, Korea, and Taiwan has recently spread to several new areas in the world. In the continental United States, this invasive species was discovered in 1998 in Connecticut, New York, and New Jersey. The arrival of this species in the U.S. was most likely attributable to the used tire trade. *Aedes japonicus* has now spread throughout the East Coast, midwestern states, and a few states in the western U.S. The Illinois Natural History Survey Medical Entomology staff discovered the Asian rock pool mosquito in Urbana, Illinois, during the summer of 2006, representing the first state record. Surveillance by our local Champaign-Urbana Encephalitis Prevention Program has documented continued range expansion of *Ae. japonicus*. The immature stages of this species inhabit natural and artificial containers, some of which are also occupied by the native treehole mosquito *Aedes triseriatus*, the primary vector of LaCrosse Encephalitis Virus.

The distribution of *Ae. japonicus* and *Ae. triseriatus* overlap, which suggests that interspecific interactions, especially among the larval stages, should be common. Competition within and between larval mosquito species is common and plays an important role in determining individual mosquito life history traits and community structure. Several studies have demonstrated that the success of invasive species is, in part, due to their superior competitive abilities over native species. Also, larval competition may have important consequences for disease transmission. Previous studies have shown that competitively stressed and smaller adult mosquitoes have higher rates of infection and dissemination of arthropod-borne viruses. Competition-induced alterations in a mosquito's phenotype may also contribute to parasite transmission in other ways. The extrinsic incubation period is the time from initial acquisition of a parasite until the vector is capable of transmitting the parasite. The probability of transmission of a parasite is reduced as the adult life span (longevity) approaches the extrinsic incubation period.

A laboratory experiment was used to examine intraspecific (between individuals of the same species) and interspecific (among individuals of different species) effects of larval density and resources on interactions between these mosquito species. The goal of this study was

Continued on back page

Aedes triseriatus—*eastern treehole mosquito (adult)*. Photo courtesy of Alex Wild, 2009

Islands as Models for Biodiversity Studies

Although the Hawaiian Islands are just 1/10 the size of Illinois and only 5 million years old, they are home to more than 6,000 endemic plants and animals. The extraordinary endemicity on the islands has arisen so rapidly and in such a small area that Hawaii is an ideal place to investigate some fundamental biological questions. Why are there so many species on Hawaii? How and why did they diversify so rapidly?

The Hawaiian Islands are the most isolated major island chain in the world. Each island has emerged as lava from a volcanic hotspot that accumulated on the ocean floor. The islands are arranged in linear order by age: Kauai, at about 5 million years is at the western extreme and the Big Island of Hawaii at only 0.5 million years is at the eastern extreme. At emergence, the islands were barren rocks void of any life. They presented a rich variety of unoccupied habitats for organisms that were able to make the journey from elsewhere. The endemic fauna of Hawaii is dominated by animals that are good dispersers, such as birds, insects, and spiders. Aside from a single bat species, there are no mammals, reptiles, or amphibians native to Hawaii. The classic model of colonization of the islands (the stepping-stone model) predicts that organisms colonized the oldest island first, then moved down the chain as new islands arose (Fig. 1).

Research by Emilie Bess and Kevin Johnson at the Illinois Natural History Survey (INHS) addresses fundamental questions on the origin and diversification of a group of understudied endemic Hawaiian insects—bark lice (Psocoptera). These studies are using taxonomy and phylogenies to understand how these insects speciated in the Hawaiian Islands and how fast new species can evolve. The endemic Hawaiian bark lice in the genus *Ptycta* are very diverse and are an excellent model for these questions. *Ptycta* is a large genus of about 170 species distributed worldwide, with 51 species described from Hawaii,

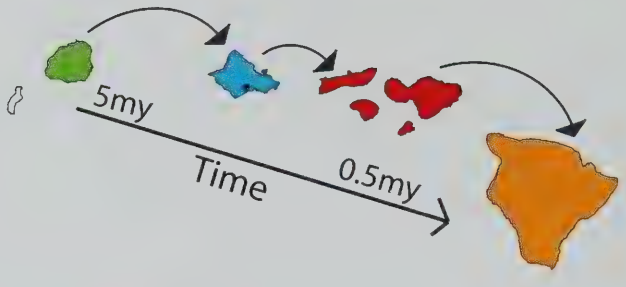


Figure 1. "Stepping stone" hypothesis. Oldest-to-youngest colonization mode for the Hawaiian Islands. A colonizing organism establishes on the oldest island; its progeny move down the chain as new islands become available.

although recent collections suggest that there are 100–150 species of *Ptycta* in Hawaii. These small insects (3–9 mm in length) live on tree bark and eat the fungi, algae, and lichens that grow on the bark (Fig. 2). Bark lice do not harm the tree, but they can be found in large numbers on damaged trees that have abundant fungal growth. They are among the most abundant insects in the Hawaiian forest ecosystem.

With funding from the National Science Foundation (NSF) and the University of Illinois Research Board, *Ptycta* bark lice were collected from the islands of Kauai, Ohau, Molokai, Lanai, Maui, and the Big Island of Hawaii during four collecting trips during 2006–2008. Sampling focused on as many unique sites as possible. Two dominant endemic trees, *Metrosideros polymorpha* and *Acacia koa*, are reliable hosts for the bark lice, although bark lice were found on more than a dozen endemic tree species. After four months of collecting, more than 7,000 new specimens of *Ptycta* were used in the molecular and morphological study. This number more than doubled the existing specimens of this genus from Hawaii across insect collections worldwide.

Using DNA sequences from two nuclear and three mitochondrial genes, phylogenetic trees were reconstructed, and these show some unexpected pat-

Figure 2. Bark lice from the genus Ptycta *that live off of fungi, lichens, and algae on trees in Hawaii.*

Continued on page 5

Can Riparian Forests Help Improve Stream Communities in Illinois Agricultural Watersheds?

Many stream ecosystems in the midwestern United States have been greatly degraded by agricultural land use, particularly in Illinois where agriculture covers more than 76% of the state's total area. An estimated one-third of Illinois streams have been altered by channelization for drainage or irrigation of farmlands. Riparian areas comprise a significant portion of the remaining forested vegetation in Illinois, but are generally confined to the lower reaches of the watersheds. Removal of riparian vegetation in agricultural areas increases the severity and magnitude of flooding and creates higher loads of sediment and nutrients entering streams. These physical and chemical alterations have significant consequences for stream ecosystems and may be linked to declines in species diversity, alterations of trophic structure, and loss of ecosystem integrity.

Forested riparian buffers, typically 30–50 m wide alongside streams, are an accepted management practice to mitigate the impact of agriculture or other nonpoint sources of pollution. Studies have shown that forested buffers can improve stream water quality by reducing soil erosion and filtering fertilizers and pesticides out of runoff before it enters a stream. In addition, forested riparian zones provide important inputs of organic matter and can moderate stream water temperature through shading. While previous studies have addressed the size and width of riparian buffers needed to reduce pollutants, scientists at the Illinois Natural History Survey (INHS) are investigating how much riparian vegetation is sufficient to ameliorate the effects of agricultural activities on stream biota.

We are examining the influence of riparian forest and watershed agriculture on headwater stream community structure and ecosystem metabolism. Most studies of stream condition focus only on descriptive variables, such as water chemistry or biological community structure. However, functional measures such as metabolism are beginning to be used in stream assessments to gain a more complete picture of ecosystem condition. Stream ecosystem metabolism reflects the balance between autotrophic (primary production) and heterotrophic (respiration) processes. Since primary production and respiration respond to variables influenced by watershed disturbance (e.g., light, nutrients), they are ideal measures of stream condition. Therefore, in addition to evaluating community structure, we are measuring stream metabolism in order to provide a more comprehensive assessment of ecosystem condition.

(L–R) Edward Bates, Eden Effert, and Lorraine Chow use backpack electrofishing to collect stream fish. Photo by Hannah Grant

Methods. We examined nine agricultural streams with a gradient of riparian forest (16%–92%) to determine the effect of riparian and watershed land use on macroinvertebrate and fish communities in Illinois streams. All sites are second and third order streams located in the Embarras River watershed in east-central Illinois. Land use within the watershed is dominated by row-crop and small grain agriculture (73.5%). The study reaches were selected to have similar channel width, depth, and watershed area (range 27–39 km^2) to minimize differences unrelated to land use. Sampling was conducted seasonally (spring, summer, fall) over three years to explore temporal patterns in macroinvertebrate and fish assemblages related to land use, in-stream habitat, and water quality parameters. We compared species compositions and ecosystem metabolism among streams to identify patterns and influential factors related to riparian forest and agricultural land use.

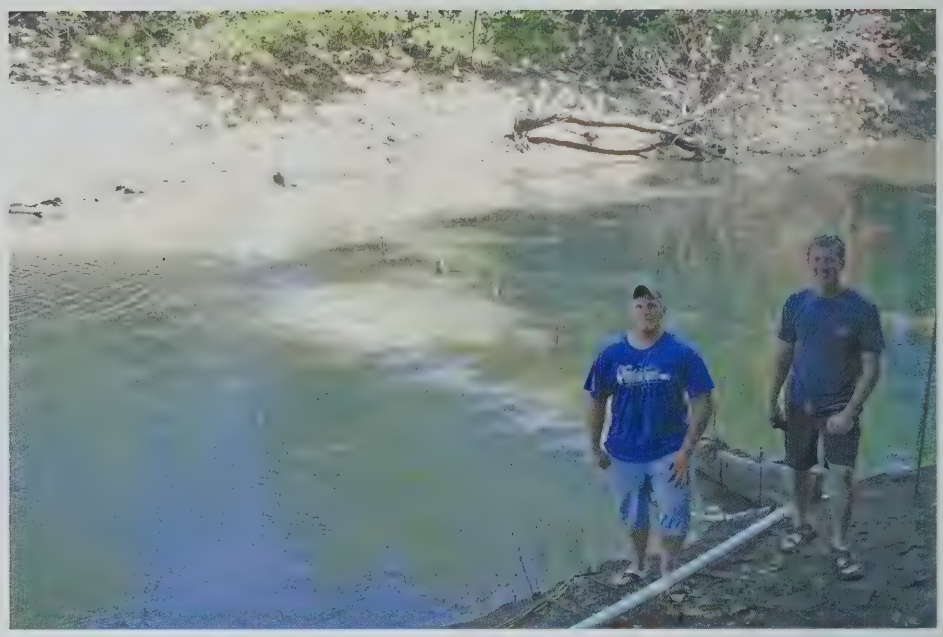
Preliminary Results. While there were significant seasonal and annual differences, relationships among streams with different land use type were relatively consistent. Streams with low percent forest buffer had higher nitrate nitrogen levels, higher primary productivity, and higher densities of macroinvertebrates and fish. Though there were higher abundances in streams with low forest buffer, macroinvertebrate and fish assemblages were dominated by pollution-tolerant taxa such as chironomids (midge larvae) and green sunfish. Streams with the highest percent forest buffer and lowest percent watershed agriculture had the highest biotic integrity, greatest abundance of pollution-sensitive species, and the most complex trophic structure. Streams with high forest buffer had more top predators, such as grass pickerel and largemouth bass, indicating a more balanced, trophically diverse ecosystem.

Next Step. We are currently performing stable isotope analyses to examine trophic interactions and energy flow within each stream. These analyses will allow us to determine how land use changes affect in-stream food web interactions. Results of our study will provide information on the influence of riparian forest on Illinois stream communities and have implications for managing and restoring riparian areas in agricultural watersheds.

Eden L. Effert and David H. Wahl, Illinois Natural History Survey

Ecosystem-scale Evaluation of Sound Bubble Barrier Technologies to Prevent Range Expansions of Asian Carps

Invasive Asian carps, collectively bighead (*Hypophthalmichthys nobilis*) and silver carp (*H. molitrix*), have expanded their range upstream in the Illinois River and efforts have been increased to prevent them from entering Lake Michigan through the Chicago Shipping and Sanitary Canal (CSSC), which links the Illinois to Lake Michigan. Invading bighead and silver carps in the Illinois River have negatively influenced native fish populations by competing with them for habitat and food resources. Because Asian carps have been detected less than one river mile downstream of the CSSC Electric Barrier at Romeoville, these invasive species pose an imminent threat to the Lake Michigan ecosystem. Asian carps are very efficient planktivores. Therefore, resource managers are concerned that Asian carps will further contribute to the increased negative ecological effects observed in recent years due to numerous aquatic invasives entering Lake Michigan. In an attempt to slow the range expansion of Asian carps, Sound Projector Array Bio-acoustic Fish Fence (i.e. sound-bubble strobe light barriers) technologies have been tested to determine their effectiveness as potential deterrents. This type of system was chosen because Asian carps are sensitive to high sound frequencies, in the range of 750–1500 Hz. In a 2005 study, sound-bubble barrier technologies were shown to be 95% effective at deterring adult bighead carp passage through hatchery raceways. Because this technology is effective at deterring Asian carps in a mesocosm setting, researchers at the Illinois River Biological Station (IRBS) at Havana are conducting an ecosystem-scale evaluation of sound-bubble barrier technologies to determine their effectiveness at an appropriate scale for management and implementation.



Anthony Erickson (left) and Blake Ruebush after installing a bubble barrier in Quiver Creek near Havana, Illinois. Photo by Michelle Horath, INHS

Blake Ruebush (left) measures and tags a captured fish. Photo by Blake Bushman, INHS

In July 2009, field staff from the IRBS installed a sound-bubble strobe light barrier system in Quiver Creek (a tributary to the Illinois River) in order to test its effectiveness in deterring Asian carps and to investigate associated effects on native fishes. The upstream portion of Quiver Creek above the barrier is blocked by a lowhead dam, which prevents fishes from moving further upstream, making this an ideal location for this type of study. With assistance from Fish Guidance Systems, Ltd. and EIMCO Water Technologies, the sound-bubble strobe light barrier was fully functional by August 26 and operated continually until October 7. During this testing period, 1,240 fish were captured upstream of the barrier, measured, floy-tagged, and released downstream of the sound-bubble strobe light barrier. Fish were collected upstream of the barrier using

Continued on next page

Islands

continued from page 2

terns. Rather than supporting the classic oldest-to-youngest island colonization pattern, *Ptycta* seems to have colonized the islands in the reverse order, from youngest-to-oldest. The Hawaiian *Ptycta* also cluster into two distinct groups in the phylogenies, suggesting either that the genus colonized the islands twice or that a very early divergence occurred among the Hawaiian species (Fig. 3). These initial results have exciting implications for the evolutionary history of Hawaiian bark lice. The youngest-to-oldest pattern of colonization suggests that the diversification of Hawaiian *Ptycta* was extraordinarily rapid, possibly the most rapid rate yet seen in any insects. Ongoing work is aimed at documenting the number of species on the Hawaiian Islands and describing the many new species that were collected. The phylogenies will be refined and used to understand in more detail how the remarkable diversity of these insects on the Hawaiian Islands came to be. Information on the biodiversity of these insects will be used to document areas of endemism for these insects, which will be important for conservation of existing habitat.

Emilie Bess and Kevin Johnson, Illinois Natural History Survey

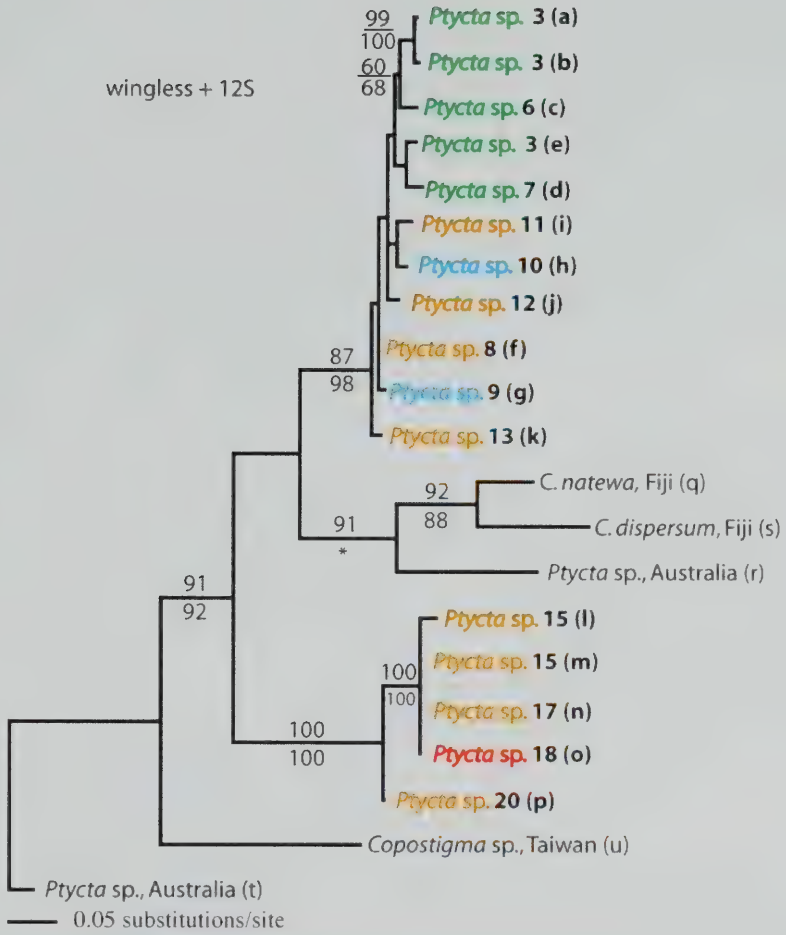


Figure 3. Phylogenies of Hawaiian bark lice of the genus Ptycta.

Bubble Barrier

continued from previous page

a backpack electrofisher, hoop nets, and by angling. In addition, silver carp were captured from the mainstem Illinois River using a boat electrofisher and were transplanted below the sound-bubble strobe light barrier. In total, 34 fish species were captured and tagged in the first field season of this study.

Preliminary results from the first field season suggest that the barrier technologies are 97% effective at repelling upstream passage of the fish species tested. Barrier effectiveness was determined by upstream recaptures. Of the 141 silver carp that were captured and tagged in this study, none were recaptured upstream of the sound-bubble-strobe light barrier system. Species that did challenge and pass the barrier included bluegill (*Lepomis macrochirus*), common carp (*Cyprinus carpio*), green sunfish (*Lepomis cyanellus*), and largemouth bass (*Micropterus salmoides*). Bluegill were the most commonly recaptured species. This study will continue next spring and into the fall of 2010. Due to high water levels and the possibility of increased damage to the barrier during winter months, it will be removed from Quiver Creek to eliminate this risk. If this system proves to be an effective method of deterring Asian carps after a second field season, it could be used in concert with the CSSC Electric Barriers and in other areas where Asian carps pose a threat. This study was funded by the NOAA National Sea Grant College Program.

Blake C. Ruebush and Greg G. Sass, Illinois Natural History Survey

Species Spotlight

Brown Recluse Spider

Susan Post

"Just received word the University of Illinois is planning some pest management monitoring here at the Forbes Natural History Building for brown recluse spiders. They will be placing a few monitoring stations here in the building this next couple of business days (and may knock on your door for access)."

E-mail message from Cathy Bialeschki (INHS), Friday November 13, 2009

Cathy's e-mail message piqued my curiosity, especially when a few days later a black rectangular spider trap was placed under my desk. What do these spiders look like? Would they really be in my office? Should I be concerned?

Photos by Michael Jeffords, INHS

The brown recluse spider, *Loxosceles reclusa*, is found throughout the south-central and midwestern United States. These spiders are rare outside of their range and are widely over reported. They may be transported to a non-native area in boxes or furnishings, but infestations seldom become established.

Only one-half inch or less in length, this spider is easily overlooked, especially in dark corners. They may be brown, gray, or deep yellow in color and have long, thin legs that lack conspicuous spines. Their cephalothoraxes (unlike insects, spiders only have two body parts—the cephalothorax and the abdomen) have the eyes, fangs, and legs attached. The dorsal markings resemble violins with the neck of the violin pointing to the rear of the spider. This mark, while less obvious in young spiders, has led to the common names of fiddleback spider, brown fiddler, or violin spider.

The eye pattern of recluse spiders is the definitive diagnostic feature, but most people will need a hand lens to see it! They have six eyes arranged in pairs; most other spiders have eight eyes. Even with this many eyes they have limited vision and rely mainly on touch.

During the day brown recluse spiders usually seek refuge in dim, secluded areas. These refuges are lined with dark, irregular webbing. Outdoors (their natural habitat) the webs may be built under rocks, logs, woodpiles, and debris. Rotting tree bark is a favorite habitat. Yet these spiders have adapted to living indoors with us, hiding in cracks and corners of our homes. Indoors they seem to favor cardboard and are able to persist many months without food and water. Females seldom venture far from their retreat, while males and juveniles tend to wander, ending up in shoes, clothing, or bedding where they may become trapped against someone's skin.

Unlike most web weavers, they leave their webs at night to hunt, seeking insect prey, either dead or alive.

From May through July the female will deposit 40–50 eggs in an off-white, silken sac. These sacs are 2/3 of an inch in diameter. Spiderlings (which resemble tiny versions of a fully grown adult) emerge from the sac in about a month and will molt up to eight times before becoming adults. It takes about a year for the spiders to mature. These spiders have an annual life cycle, but may live up to three years in captivity. A female will produce up to five egg sacs during her lifetime.

Most spiders have poison glands, which they use to paralyze their prey (any creature that happens to wander into their web or near the spider). The brown recluse is one of only four spiders in the United States whose venom poses a danger to humans. The black widow, hobo, and yellow sac spiders are the others.

As the name suggests, the brown recluse is not terribly aggressive. Bites, while rare, usually occur when a person inadvertently trespasses on a spider's turf. Most bites happen in response to body pressure, when a spider is inadvertently trapped against bare skin. These spiders have small fangs and cannot bite through clothing. The spider's venom is cytotoxic, meaning it kills cell tissue. The initial bite is usually painless. Several hours later the bite site may become red and swollen. Most bites remain localized and will heal within three weeks.

So far the spider trap under my desk remains empty. But there is no need for me to worry. These tiny arachnids are more inclined to avoid me, as much as I am them. Whether we encounter each other or not, we seem to have achieved a very natural and peaceful coexistence.

Handy references

A Guide to the Common Spiders of Illinois. Bennet Moulder. 1992. Illinois State Museum Popular Science Series, Vol. X.

A Golden Guide to Spiders and Their Kin. Herbert W. Levi and Lorna R. Levi. 1968. Golden Press.

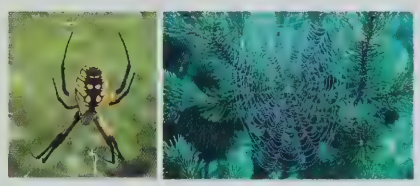
The Naturalist's Apprentice

Illinois Spiders

Carolyn Nixon

More than 500 species of spiders live in Illinois. While all spiders have venom, most spiders are harmless to humans because their fangs are too small to puncture the skin. Most alleged cases of spider bites are likely insect bites or other small injuries that have become infected by bacteria. Spiders are generally not aggressive towards humans and are actually beneficial predators. They are fascinating creatures to observe, especially once you learn to recognize the different types. Learn to recognize the two dangerous types and then enjoy the rest.

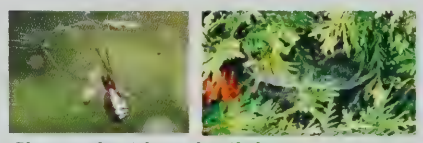
Here are some of the more commonly encountered groups of spiders. When you find a spider, try to determine which group it belongs to.



Orb web made by black and yellow argiope spider (left). Photos by Phil Nixon, UIUC

Web building spiders (spider webs are often easiest to view in early morning, when they are covered with dew).

• Orb weavers—these spiders spin very intricately designed webs attached to plants and structures. The webs are usually vertical, with strands of silk radiating out from the center and sticky cross-strands circling the center.



Sheet web with spider (left). Photos by Phil Nixon, UIUC

• Sheet web—these spiders spin small, sheetlike platform webs in plants, such as grass and branches of trees and shrubs. They often go unnoticed until they are covered with dew.

• Funnel web—these spiders spin sheetlike webs with a funnel-like tunnel at one end.

Funnel web with spider (above). Photos by Phil Nixon, UIUC

• Cobweb spider—these spiders spin a loose tangle of silk, often most noticeable inside structures such as houses.

Cobweb spider (above). Photo by Phil Nixon, UIUC

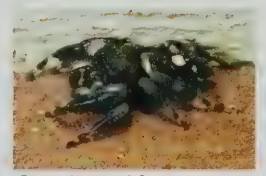
Spiders without webs

• Wolf spider—these often large, somewhat hairy spiders roam the ground and low foliage as they hunt for prey. Some species are quite large. They can be easily seen at night with a head-lamp. (See "The Naturalist's Apprentice, Shining for Spiders," *INHS Reports,* Autumn, 2007 at http://www.inhs.uiuc.edu/resources/inhsreports/

Wolf spider (left). Photo by Phil Nixon, UIUC

Crab spider. Photo by Michael Jeffords, INHS

• Crab spider—these crab-shaped spiders sit and wait to ambush prey. They are often camouflaged, matching the color of a flower or leaf. They are often only noticed once the observer sees the prey insect dangling from its fangs.



Jumping spider. Photo by Phil Nixon, UIUC

• Jumping spider—these stocky, short legged, quick moving, hairy spiders are recognizable by their jerky movements. They hunt down their prey and jump onto it. They often have interesting markings and have large, forward-looking eyes.

Fishing spider. Photo by Michael Jeffords, INHS

• Fishing spider—these spiders closely resemble wolf spiders, but are found near, and often on water surfaces. They can dive underwater where they catch small fish or tadpoles.

Brown recluse spider. Photo by Michael Jeffords, INHS

Venomous spiders

• Brown recluses—(*Loxosceles reclusa*) make loose, messy webs, but are often seen away from the web. These are brown spiders with long, thin legs. There are no spots or stripes on the abdomen or legs. Their legs have no spines and are never dark brown. They have a light-colored cephalothorax (the head area) with a distinct, dark brown violin-shaped marking. They are neither hairy nor shiny.

Black widow spider. Photo by Phil Nixon, UIUC

• Black widow—is an orb weaver that is glossy black with a red, hourglass-shaped marking on the underside of the abdomen. Many similar looking spiders have red markings on the top of their abdomens. These are NOT black widows. Two species of black widow occur in Illinois (*Latrodectus mactans*—southern black widow, and *L. various*—northern black widow). The northern black widow is seldom found around human habitation, but the southern black widow was once common in outhouses, where people were often bitten.

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Mosquitoes

continued from front page

to determine whether: 1) the invasive mosquito *Ae. japonicus* is the superior larval competitor over native *Ae. triseriatus*; 2) competitive stress at the larval stage and body size alter adult longevity. Competitive treatments showed similar effects of intraspecific and interspecific competition on survivorship to adulthood and a composite index of population performance which estimates the realized per capita rate of population change. Similar results were observed for development times to adulthood for *Ae. triseriatus*. However, *Ae. japonicus* development times for both males and females were significantly reduced when in the presence of *Ae. triseriatus* relative to *Ae. japonicus*, an indication of improved performance. Although development times suggest competitive asymmetry between these two species, other important life history and population level responses suggest that these species may be acting as ecological equivalents as larval competitors and neither species has a competitive superiority over the other species. Additional studies will be necessary to determine whether results from the current laboratory research translate similarly under field conditions.

The second objective was to determine whether competitive stress at the larval stage and adult body size alter mosquito longevity. For both mosquito species, low larval resources were associated with reduced adult female longevity. Similarly, competitively stressed and smaller mosquitoes had reduced longevity relative to larger and less stressed individuals. Similar observations for both species suggest a generalizable effect of resource and competitive stress, which may be applicable to other mosquito species. These observations strongly suggest that larval conditions may continue to adulthood and alter parameters (life span) that determine transmission of vector-borne diseases. This research was supported by the Illinois Waste Tire and Emergency Public Health Funds.

Barry Alto, Illinois Natural History Survey

NATURAL HISTORY SURVEY

Reports

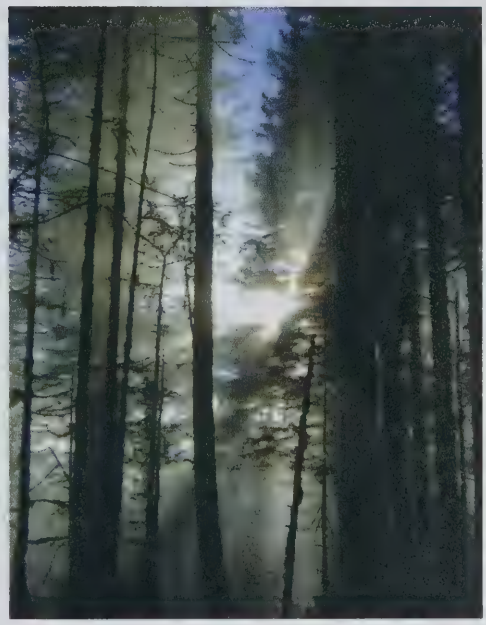
ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Institute of Natural Resource Sustainability

Spring 2010
No. 403

INSIDE

Learning from Naturally Occurring Epizootics in Insects

Stands of eastern hemlock, *Tsuga canadensis* (L.) Carrière, are facing an alarming decline. Two invasive insects, the elongate hemlock scale, *Fiorinia externa,* (Fig. 1). and the hemlock woolly adelgid, *Adelges tsugae*, have been identified as primary causes in the decline. Control efforts have focused mainly on *A. tsugae*. However, the rapid geographic expansion of the scale in the last 20 years (present and/or established in all eastern coast states from southern New England to western Ohio and Tennessee) has raised public awareness and concern for the potential impact of this species. If dispersal of both pests continues unimpeded, drastic changes in forest tree composition will follow. Hemlocks play a particularly important ecological role along streams, where their shade provides shelter, sustains aquatic ecosystems, and creates a unique microclimate for forest wildlife. As hemlock trees decline in vigor, openings in the canopy allow an increase in understory light levels. As a result, hardwood species especially black birch (*Betula lenta* L.) establish, leading to major landscape changes by transforming large areas dominated by conifers to young, rapidly growing hardwoods



Sun breaking through Hemlock forest on Mount Rose. Mt Skokomish Wilderness Area in Washington state. Photo courtesy of Byron Schurch and the Washington Trails Association

In 2001, an epizootic (outbreak of disease in animals) was detected in *F. externa* populations in the hemlock forest at the Mianus River Gorge Preserve in Bedford, New York. Large sclerotia masses (compact mass of fungal mycelium) were found in mummified specimens concealing in many cases the body of the adult (Fig. 2, back page).

Figure 1. Shielded Fiorinia externa *adult female with eggs and crawler enclosed in filamentous waxy cover exudates in hemlock needle.*

We found that up to 36.8% of the sampled populations were partially or completely covered with sclerotia. A fungus was the most commonly retrieved pathogen in 36 sites from New York, Pennsylvania, Connecticut, and New Jersey, suggesting it might play a key role in the epizootic.

The fungus retrieved from wild infected *F. externa* was successfully inoculated into uninfected laboratory populations of this host and subsequently recovered from dead scales, after surface sterilization. DNA was extracted from our unknown fungus, and an array of nuclear genes were sequenced.

Continued on back page

Climate Change and Biodiversity

(The following article is excerpted from the Winter 2009/Spring 2010 issue of *Illinois Steward* magazine with the kind permission of Robert Reber, editor). Photos by Michael R. Jeffords.

When I came to Illinois in 1985, there was consensus that the greatest threat to fish, wildlife, and flora was habitat loss. Illinois was last or near last in the nation in public open space per capita; and 79.9% of Illinois was plowed, paved, drained, or landscaped.

Over the next decade, with the rise of globalization, the onslaught of invasive species would quicken, until in 2005 it was estimated that invasive alien species in the United States caused environmental damages and losses of almost $120 billion per year. There were approximately 50,000 foreign invasive species on U.S.-controlled soil, and about 42% of the species on various state and federal threatened or endangered species lists were at risk primarily because of invasive alien species.

Climate change is perhaps the most insidious of the threats to biodiversity because its impacts will be felt species by species, and it will be difficult to identify conclusively the decline of a particular species as climate-related without eliminating many other potential causes. In short, our native biota could fall victim to a proverbial "triple whammy."

Our Climate Is Changing

I have found it frustrating to endure over a decade of debate about whether climate change was "real." Even if you do not believe that climate change is human induced, our climate *is* changing; and as a result of habitat loss and the fragmentation of our remaining habitats, our native plants and animals are less able to "adapt" to this change than they might have been in the historic landscape.

It Will Become Warmer and Rain Harder in Illinois

The Illinois State Water Survey (ISWS) is a recognized international leader in climate modeling. It has developed a Regional Climate Model that does a much better job of predicting historic climate than some of the global models relied upon by other parts of the country. One recent national study in which the ISWS participated suggests that while the average precipitation may not have increased significantly, the intensity of precipitation across the eastern United States has been increasing over the last century.

Monitoring Is the First Line of Defense

Illinois is one of the few states in the nation that has a statewide monitoring program across a broad spectrum of habitat types (forests, woodlands, savannas, prairies, and wetlands)—the Critical Trends Assessment Project (CTAP) established in 1997. The Illinois Department of Natural Resources has had the foresight to continue funding this program; and now with the recognition of climate change as a major threat to biodiversity, CTAP data have become invaluable.

Another long-term study being conducted by the Illinois Natural History Survey, The Nature Conservancy, and the Department of Natural Resources and Environmental Sciences at the U of I is the 100-Year Bird Survey, which is re-surveying the birds present at sites originally investigated in 1906 and again in 1956. These data suggest that killdeers have increased in numbers and that cardinals and red-bellied woodpeckers have expanded their ranges during the past century. One might hypothesize the range expansions were related to climatic warming; but they are also forest birds, and the acreage of forests in northern Illinois also increased during this period. Both are also species that are becoming adapted to living in suburban settings, which could also have contributed to their range expansions in concert with increasing suburban areas.

The Most Vulnerable

Threatened and Endangered Species: The species that will be most vulnerable to the impacts of climate change will be species that are already listed as threatened or endangered. With the threat of climate impacts, it is imperative to monitor those species that have the fewest occurrences, the least capacity to migrate to new habitats, and occur in communities subject to drying out. These would include species that require specialized habitats. If climate impacts are detected amongst these at-risk species, it would help us predict which other species might become endangered or threatened without management intervention.

Did the Red-bellied Woodpeckers move north as the climate warmed, or did they move into the suburbs?

Extreme Habitats: As our climate changes, we would expect shifts in temperature and moisture first to affect species living in habitats at the extremes

Continued on next page

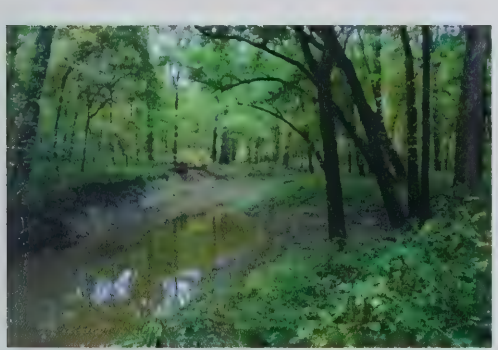
Climate Change

continued from previous page

of these gradients. Very dry sites, like sand prairies and glades, could become too hot and dry in the middle of summer to support some species that occur there now, and wetlands that now stay wet all year long could dry up. The CTAP should be expanded to cover some of these extreme habitats.

Extreme habitats such as sand prairies and glades can become too hot to support the species living there now.

Headwater Streams and Shallow Streams: Headwater streams and streams small enough to wade, along with the fish and invertebrates that live in them, could be extremely vulnerable to climate change. It is critically important to characterize the species living in headwater and shallow streams now, to establish a baseline for assessing the impacts of climate change on them in the future. A statewide survey of wadable streams should be begun as soon as possible.



Small streams are sensitive to warming temperatures.

Habitats That Are Small by Their Nature: Natural communities such as seeps, fens, algific slopes, and even sedge meadows are dependent upon unique hydrologic and geologic characteristics; and they are seldom large. The climate vulnerability of the species living there is directly related to the small areas covered by these communities. The total number of individuals of any species that lives in these habitats is limited by the size of the community. Fewer individuals results in less variability, rendering the populations of these species more vulnerable to shifts in climate.

Small High-quality Habitats: In the same way that small habitats are vulnerable to climate change, so are small patches of any natural community. Many of Illinois' native plants and animals are *only* found in very high-quality natural communities. Because small sites are vulnerable to losing species when undergoing rapid environmental changes, for many species found nowhere else, the potential for loss of less common species is quite high. It is imperative that resources be found to monitor routinely the species composition of such lands because they are the "rarest of the rare."

From Monitoring to Management: Adapting to Climate Change

The best defense against climate impacts on natural resources is to build complexes of habitat connected by corridors that would allow migration of many species in response to a changing climate.

With rigorous monitoring programs in place, we should be able to identify species that are less mobile and whose numbers are either decreasing or increasing. It will then be important to bring together scientists and managers to discuss which changes are likely to be related to changes in climate or to other causes, and to formulate appropriate management responses. Initially, we may have to adopt the "triage" protocols used in hospital emergency rooms; identifying the species most in need of help, and where we actually have a management strategy or technology that can help them. When species with critical management needs are identified but we do not currently have a management response, such cases will have to be turned over to teams of specialists for further diagnosis, the conservation community's version of television's *House*.

Small high-quality natural communities such as Loda Cemetery Prairie Nature Preserve could lose less common species as a result of a changing climate.

While the "triple whammy" is a formidable opponent, I remain optimistic that our natural resource scientists and natural resource managers will meet the challenges ahead if we provide them the needed resources. They have an admirable track record!

Brian Anderson, Director of the Illinois Natural History Survey

Exploring Offshore Reefs in Illinois Waters of Lake Michigan: Are They Suitable for Lake Trout Spawning?

Lake trout (*Salvelinus namaycush*) is a cold water predatory species, native to North America including the Great Lakes. It thrives in oligotrophic, oxygen-rich waters, where it grows fairly slowly and matures relatively late (at age 5–6). Due to these characteristics, lake trout populations are susceptible to overexploitation. Historically, lake trout was the dominant predator throughout the Great Lakes. However, by the mid-1950s, this native fish was nearly extirpated from Lake Michigan due to a combination of commercial overfishing and sea lamprey (*Petromyzon marinus*) predation. Lake trout were returned to Lake Michigan with the advent of a sea lamprey control program administered by the Great Lakes Fishery Commission and intensive federal stocking efforts, which began in 1965. Since that time, spawning aggregations of stocked lake trout, fertilized eggs, and lake trout fry have been observed in Lake Michigan, but evidence of naturally produced (wild) adult lake trout remains rare. Thus far, restoration efforts have been largely unsuccessful at developing a sustainable, naturally reproducing lake trout population in Lake Michigan.

Contemporary lake trout restoration efforts are focused on promoting natural reproduction and the protection and restoration of critical habitat. The quantity and quality of spawning habitats are a vital determinate of spawner selection and egg/embryo survival. Recent work on the mid-lake reefs, an area known to attract lake trout in northern Lake Michigan during the spawning season, reported the presence of lake trout eggs on areas characterized by strong vertical relief and complex cobble substrate. Interstitial spaces at least 20 cm deep within cobble/rubble substrate are thought to afford lake trout eggs and fry some degree of protection from predators. Although a significant amount of research on lake trout spawning aggregations and habitat suitability has been conducted in northern Lake Michigan, offshore reefs in the southern basin are poorly described. Two bedrock reefs off the Illinois Lake Michigan shoreline, Julian's and Waukegan Reefs, are part of an extensive complex of bedrock highs exposed on the Lake Michigan lakebed and are believed to provide spawning habitat for

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Waukegan and Julian's Reef Location Map

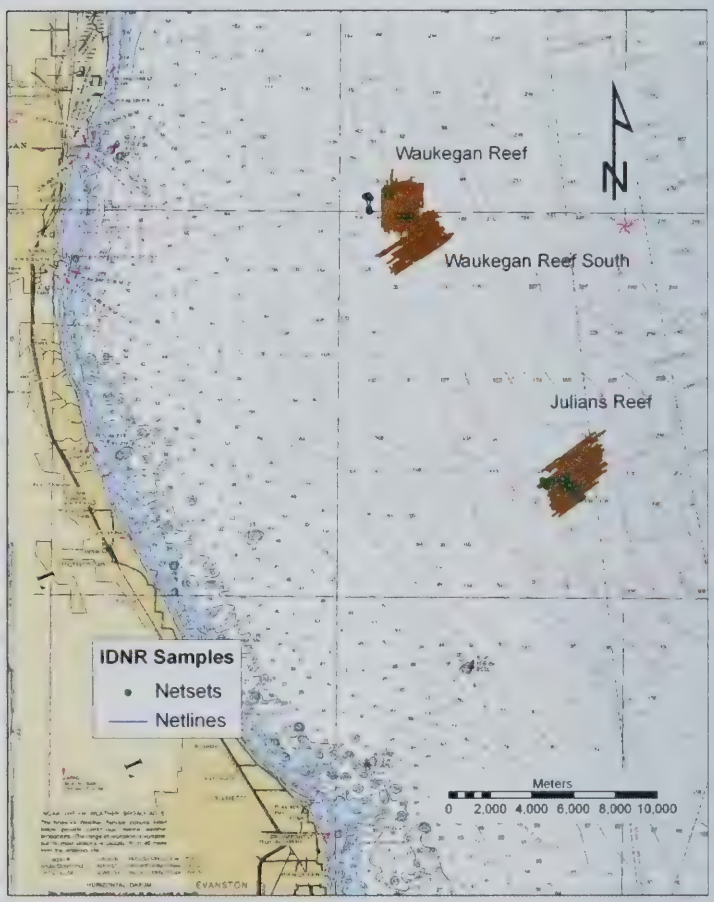

Figure 1. Map showing the location Julian's and Waukegan Reefs off the Illinois Lake Michigan shoreline along with sidescan sonar survey lines (brown areas) and IDNR lake trout sampling sites (dark green circles).

Lake trout larva. Photo by INHS Great Lakes Biological Station staff

Offshore Reefs

continued from previous page

lake trout (Fig. 1). Illinois Department of Natural Resources (IDNR) sampling shows that large numbers of lake trout aggregate at these reefs during spawning season, but there are no detailed maps of these reefs and no recent information on egg deposition.

During 2009, researchers from the Illinois Natural History Survey (INHS) Lake Michigan Biological Station along with collaborators from Habitat Solutions, Inc. used sidescan sonar and underwater video to develop substrate maps for Julian's and Waukegan Reefs and identify potential lake trout spawning habitat. The project team covered 10 km^2 of lakebed from the Waukegan Reef complex and 7.2 km^2 of lakebed from Julian's Reef. Multiple previously unknown bedrock areas were detected south of the area originally associated with Waukegan Reef (Fig. 2). The discovery of these bedrock areas indicates the area of potential spawning habitat may be greater than anticipated and shows a lack of adequate information regarding habitat and substrate characteristics within southwestern Lake Michigan.

Several areas over Julian's and Waukegan Reefs were identified as potential lake trout spawning habitat due to the presence of coarse cobble-boulder substrates (Fig. 3). These areas were targeted with deep-water egg traps during the 2009 spawning season, but no intact eggs or egg chorions were found at either reef. The project team plans to evaluate the bathymetry (lakebed relief) of both reef complexes during 2010. Integration of fine-scale bathymetric data with existing substrate maps will allow identification of areas with both significant vertical relief and cobble substrate and lead to a more accurate evaluation of egg deposition during the 2010 spawning season.

Rebecca Redman and Sergiusz Czesny, Illinois Natural History Survey

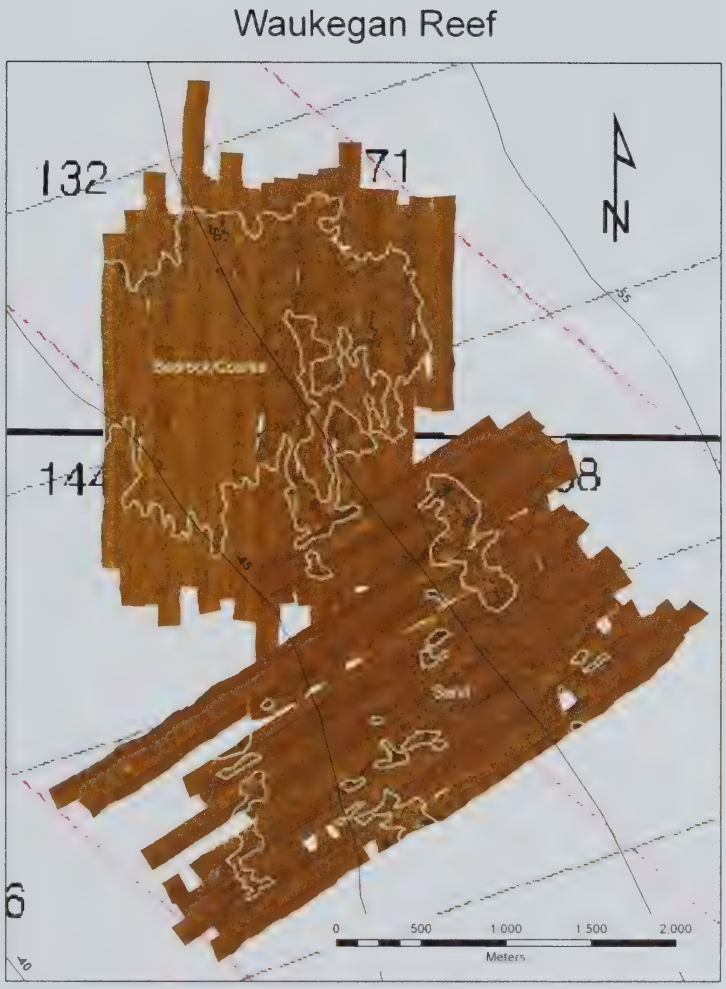

Figure 2. Detailed sidescan sonar coverage of the Waukegan Reef complex. The white line delineates areas of bedrock and coarse cobble substrates. The fragmented bedrock areas south of the main bedrock high were previously unknown.

Figure 3. Sidescan sonar waterfall display showing areas of massive fractured bedrock dropping down to a smooth rippled sand substrate (upper right portion of the image) along the southern flank of Julian's Reef.

Species Spotlight

Minks

Susan Post

During a late February evening I was driving to a frog monitoring class. As I wound my way through the local forest preserve, my mind was wondering when it would be warm enough to hear frog calls? Suddenly a dark shape bound in front of the car, hurrying from snow bank to snow bank—a mink! Wow, a wildlife encounter beats a frog call any day! Why wasn't it hibernating and what was it doing? Time to pester one of my favorite Illinois Natural History Survey mammologists, Joe Merritt, author of *The Biology of Small Mammals*, to find out more about mink.

Photo courtesy of James F. Parnell

Minks (*Mustela vison*) are never found far from fresh water and occur throughout the United States, with the exception of the Southwest, which is too dry for their needs. In Illinois they may be along the banks of drainage ditches and streams or the marshy shores of ponds and lakes where there is suitable cover and food resources. An abundance of minks is directly correlated with large populations of muskrats, upon which the mink prey.

As members of the weasel family—the Mustelidae—they are related to badgers, otters, and weasels. This family is the largest in the mammal order Carnivora. They share several characteristics with other weasels, including a flexible backbone, which permits them to arch their backs while bounding. They have small, flattened heads and short sturdy legs. They differ from other members of the genus *Mustela* (long-tail and least weasels), in Illinois, as minks are larger, have bushier tails, and longer hind feet. Their under and upper parts are nearly the same color, rather than white or white with an orange wash. Minks are found in aquatic habitats, and unlike weasels, minks do not turn white in the winter.

Minks, who are excellent swimmers, are specialized for an aquatic life and seldom wander far from water. Their toes are connected with webs at their bases. They have bushy tails and small ears that barely project above their fur. Their water repellent fur is a dark chocolate brown and is lighter on the bottom than the top.

With poor eyesight and hearing, they must rely on their keen sense of smell to locate prey. Their prey includes muskrat, fish, cottontails, crayfish, waterfowl, amphibians and reptiles, and insects. Usually they feed and hunt at night. To subdue the prey they inflict a series of fatal bites to the neck and base of skull. Their diet varies, depending on the availability of food items at different times of the year. As minks are active year-round, they will cache prey for the winter. Minks are solitary except during the mating season and while the young are with the mother. Minks will mate from January to March, and due to delayed implantation of the embryo, young are not born until April or May. A litter consists of three to six hairless, pink kits (young). They quickly grow fur and their eyes will open in about three weeks. They will be weaned between 1.5 and 2 months, and by 10 months the kits are sexually mature.

Mink dens are usually near the water, and may be in hollow logs, under stumps or tree roots, in rock piles, or a burrow in the bank. The dens are located one to three feet below ground and have several entrances.

While great horned owls, foxes, coyotes, and bobcats will occasionally prey on minks, humans are their principal predators. Trapping takes its toll, but habitat destruction and drainage of wetlands are also factors.

Answers to "Where Do Minks Fit in the Family Tree of Carnivores" on next page.

1(a-bobcat, i-mountain lion); 2(d-coyote, n-wolf); 3(b-black bear, k-polar bear); 4(g-harbor seal); 5(o-striped skunk); 6(l-raccoon); 7(h-badger); 8(e-river otter, j-sea otter); 9(c-fisher); 10(m-mink); 11(f-wolverine).

Those that live in Illinois are: a(bobcat); d(coyote); e(river otter); h(badger); l(raccoon); m(mink); o(striped skunk).

Those that once lived in Illinois, but no longer do are: b(black bear); i(mountain lion); and n(wolf).

The Naturalist's Apprentice

Minks in the Family Tree of Carnivores

Carolyn Nixon

Where Do Minks Fit in the Family Tree of Carnivores?

There are 52 species of carnivores (members of the order Carnivora) in North American, and 11 species in Illinois. Minks are in the weasel family (Mustilidae), which includes the weasels, ferrets, badgers, otters, martins, fishers, and wolverines. Look at the family tree of North American Carnvores below. See if you can match the photos with the correct group. Do you know their names? If you don't, try finding them in a North American mammal field guide. Which of these occur in Illinois? Circle the pictures of those that do. Are there any that used to live in Illinois but no longer do? Underline the photos of these species.

Recommended Reference: *Field Manual of Illinois Mammals*, by Joyce E. Hofmann

Photos:
Philip Nixon (bobcat, black bear, wolverine, badger, harbor seal, sea otter)
Carolyn Nixon (raccoon, mink)
Michael Jeffords (coyote, river otter)
Riverdeep Interactive Learning Limited (mountain lion, polar bear, wolf) (© <2010> Riverdeep Interactive Learning Limited, and its licensors. All rights reserved.)
John James Audubon (painting of fisher)

Institute of Natural Resource Sustainability
ILLINOIS NATURAL HISTORY SURVEY
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Epizootics

continued from front page

DNA sequences from our unknown pathogen showed a high degree of similarity to those originating from a fungus in the genus *Colletotrichum*. How could this plant fungus infect an insect? A hard look at the literature uncovered a previous report of pathogenicity in insects from a fungus in the genus *Colletotrichum*.

We named the unknown epizootic-causing organism, *Colletotrichum acutatum* var. *fioriniae* var. nov., to indicate that it is similar to *Colletotrichum acutatum* but differing in its pathogenicity on *Fiorinia externa* (Fig. 3).

We molecularly documented the ubiquitous occurrence within epizootic areas of *C. a. fioriniae*, growing as a nonpathogenic endophyte in 28 plant species (i.e., no signs or symptoms of disease in the host). This was confirmed in laboratory plant trials with various species of plants showing no external symptoms or signs of infection (reported in some entophytic strains in this genus), in opposition to the necrotrophic (intracellular colonization of the fungus in the host causing necrosis) growth in *F. externa*.

Figure 2. Sclerotic masses in mummified scale insect from an epizootic area.

C. acutatum has been shown to inhabit different niches. It has been hypothesized that these may be specialized monomorphic groups that constitute distinct lineages.

Our research showed that genetic variation in the fungus *Colletotrichum* may give rise to new biotypes with a propensity to infect insects. The conidial anastomoses (fusion of conidia or conidial germ tubes) between isolates of two different *Colletotrichum* species, *C. lindemunthinum* and *C. gossypii*, have been previously reported. Anastomosis can facilitate the exchange of genetic material between members of the same as well as different species, giving rise to hybrids with new characteristics. *C. a. fioriniae* displays the unusual characteristic of being able to infect animal tissue, a drastic change from the common phytopathogenicity of the genus, representing an inter-kingdom host shift, previously reported once for the genus *Cordyceps*.

Jose Marcelino, University of the Azores, Portugal and Rosanna Giordano, Illinois Natural History Survey

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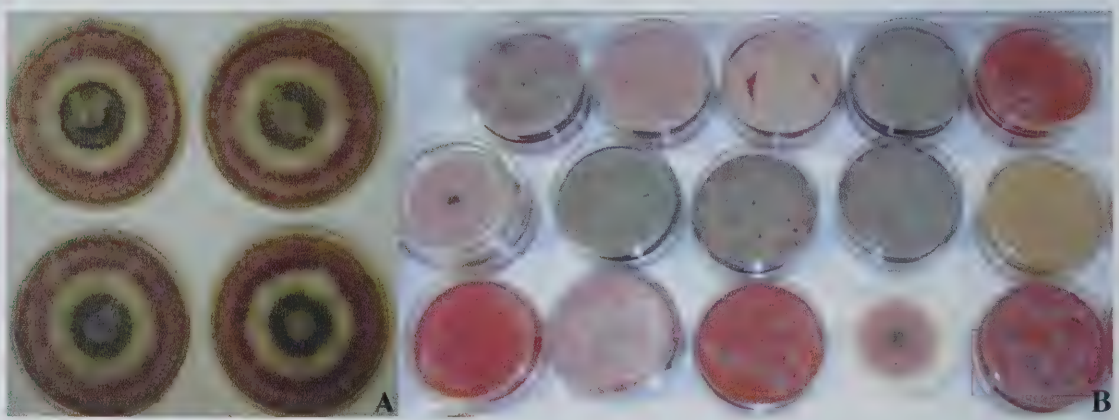

Figure 3. Phenotypic plasticity of C. acutatum fioriniae *multispored cultures (A) and single spored cultures (B). No contaminant was detected after microscopic analysis.*

NATURAL HISTORY SURVEY
Reports
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INSIDE

Engineering Students Learn while Helping Bat and Bird Conservation at INHS

Migratory bats and birds sometimes fly at the same height as large commercial wind turbines. Because these flights take place at night high in the air, the danger to the flying wildlife posed by the spinning turbine blades is impossible to investigate by conventional wildlife techniques such as binoculars and leg bands. The animals come from far away, meaning that radio transmitters are not an option either. The one technique we have to observe flying animals at a great distance at night is radar, which can detect bats and birds while they are flying, without disturbing them.

Fortunately, the Illinois Natural History Survey operates two radar units devoted to conservation of migratory wildlife. The units are currently working on research contracts funded by the U.S. Department of the Interior and U.S. Department of Energy, both aimed at determining how bats and birds are killed at turbines.

Three ECE students and an engineer aim a mechanized platform they created to point a night-vision imager in three dimensions. Photo by Ron Larkin, INHS

Two UIUC Electrical and Computer Engineering students fine-tune the INHS Doppler radar unit. Photo by Ron Larkin, INHS

To help in keeping these specialized research instruments up to this task, teams of University of Illinois students in an Electrical and Computer Engineering (ECE) senior design class routinely work with INHS scientists to modify and augment the radar units. The students receive what is sometimes their first experience actually designing and building a complex piece of equipment and the Survey's ability to carry out sponsored research is strengthened.

One team of ECE students in spring semester 2010 built a circuit to accurately point the antenna of an old military radar so it can count flying animals more nimbly. Another team made a mechanized platform that will point a telescopic night-vision imager in three dimensions to permit biologists to look at what is flying by at night and begin to determine their identity beyond merely "radar targets."

Ron Larkin, Illinois Natural History Survey

Sweeter than Honey: Honey Bee Health

The European (or Western) honey bee was imported to North America by European settlers soon after colonization began and the importance of these bees for pollination services and production of honey in North America is undisputed. Honey bee husbandry represents an estimated $8–20 billion industry in the U.S. alone, and the successful production of many high-value crops would be compromised without the presence of this pollinator. Importing insect species to environments where they did not previously exist, however, whether intentional or accidental, and whether the imported species is beneficial (like the honey bee) or is a pest, generally raises many issues concerning the natural enemies—predators, parasites and pathogens—of the imported species.

The global trade of the European honey bee and the migratory nature of the honey bee pollination industry in the U.S. has resulted in increased exposure and transmission of parasites and pathogens, possibly including new disease organisms and increased prevalence of disease. In addition, the extent and intensity of human management of the honey bee adds to the potential for a variety of stresses that increase susceptibility to parasites and pathogens and may cause increasingly ill effects.

Honey bee drinking sugar water from pipette tip in laboratory experiments.

European honey bees (*A. mellifera*) are known to harbor a large number of species of disease-causing organisms that includes viruses, bacteria, and fungi. Perhaps more pathogen species have been described from honey bees than from other insects because of the intense agricultural/economic interest in this species. However, transmission and persistence of disease organisms are aided by highly dense host populations with, in the case of honey bees, similar genetic makeup and nests (hives, trees) that protect the bees but also protect the pathogens.

Postdoctoral research scientist Wei-Fone Huang feeding honey bees in laboratory experiments on the relationship between disease and temperature.

Two microorganisms that commonly infect honey bee colonies are *Nosema apis* and *Nosema ceranae*, members of the Microsporidia, a group of fungal pathogens that infect animals in all known classes. Although microsporidian infections tend to be chronic in nature, infection often results in harmful effects such as decreased egg-laying, shorter adult lifespans, lethargy and early death, effects that collectively can, and often do, severely reduce populations of their hosts. *Nosema apis* is a well-known and well-studied species and was thought to be the only microsporidian pathogen of honey bees, but it now appears that *Nosema ceranae* is more commonly found in North American honey bee populations.

It is possible that *Nosema ceranae* is an invader originating from the Asian honey bee, *Apis cerana*, as has been suggested, but it has been the dominant honey bee microsporidium in the U.S. since 1995, if not earlier. *Nosema ceranae* has been linked to Colony Collapse Disorder (CCD) in Spain, and we are currently studying the disease in North American honey bee populations to determine its effects on the honey bees and how it interacts with other honey bee disease organisms, particularly viruses. While our recent results showing lower than expected infectivity and mortality for *Nosema ceranae*, and information from other North American researchers with whom we collaborate do not suggest a direct connection with CCD, the presence of several disease organisms in most apiaries, in addition to other factors such as pesticides, habitat destruction, and changing climate, may result in synergistic effects, with honey bee colonies rendered unable to cope with the excessive stresses. By studying these interactions, we provide information on pathogen biology and efforts needed to develop better treatments for disease and beekeeping methods that reduce the loss of colonies.

Leellen Solter and Wei-Fone Huang, Illinois Natural History Survey

The Global Plant Initiative: A Unique Opportunity for the Herbaria of the University of Illinois

The three herbaria of the University of Illinois at Urbana-Champaign (UIUC) have joined with over 150 herbaria from 50 countries around the world to become part of the Global Plant Initiative (GPI). The GPI is a worldwide effort funded and organized by the Andrew W. Mellon Foundation to digitize and database herbarium type specimens from around the world and make them available via the World Wide Web (WWW).

An herbarium is a collection of preserved plant specimens. These specimens are made by collecting and drying plants (either whole plants or plant parts) and mounting them on herbarium sheets, each with a label containing information such as collector, date of collections, location collected from, etc., (see photo). A type specimen is the herbarium specimen "to which the name of a taxon is permanently attached." Each time a new plant species is described, a type specimen is designated and that specimen forever represents the name of that species. Plant systematists and taxonomists often find it necessary to consult type specimens as they conduct their research, but type specimens are located all over the world making their viewing difficult, as people must either travel to the herbaria where they are housed or request the specimens be shipped to them as loans. Many type specimens are very old and each time they are shipped there is the risk of damage or loss. Therefore making high-resolution scanned images of herbarium type specimens available on-line will greatly facilitate the research of many scientists and prevent the possible loss or damage of type specimens.

In 2009 scientists from the Illinois Natural History Survey (Mary Ann Feist, Rick Phillippe, and Brenda Molano-Flores) obtained a GPI grant to digitize and database 4,349 vascular plant type specimens from the three University of Illinois herbaria. According to Janelle Weatherford, Associate Director of University of Illinois Foundation Relations, this was the first grant awarded by the Authur W. Melon Foundation to anyone at the University of Illinois. Jenny Stratton, a recent graduate of the Plant Biology Department's Master's program, was hired to database and digitize the type specimens. She and Mary Ann Feist attended a weeklong training session in October 2009 at the New York Botanical Garden to learn about digitizing, databasing, and quality control. Since that time, Jenny has entered the label information from all of the type specimens into the type database and is now scanning the specimens using the Herb Scan, a special scanning device constructed at the Kew Royal Botanic Garden with an inverted high-resolution scanner and a cushioned platform for the type specimens.

The three UIUC herbaria involved in this project are: the University of Illinois Herbarium (ILL), the Illinois Natural History Survey Herbarium (ILLS), and the Crop Evolution Laboratory herbarium (CEL). Each of these herbaria is unique in its contribution to this project. Below we provide a brief history of each herbarium.

The collections at ILL date from 1869 and consist of about 520,000 specimens (430,000 plants and 90,000 fungi). They are worldwide in scope with particular strengths in Loranthaceae, Viscaceae, mimosoid Fabaceae, and Piperaceae. These collections include a large number of plant types, the majority of which are from Latin America (2894/4349). Over the years, ILL curators have acquired numerous collections from many renowned collectors and have actively added collections through gifts, purchases, and exchanges. Some of the unique vascular plant holdings include J.T. Buchholz's many types and other collections of southern hemisphere conifers, G.N. Jones's extensive collections of North American Salicaceae, A.G. Jones's Aster specimens, and D.S. Seigler's New World Acacia collections.

ILLS, founded in 1858, contains about 301,000 specimens (242,000 plants and 59,000 fungi) and is fully databased. ILLS specimens are primarily from the midwestern United States, especially Illinois. In recent years, however, the ILLS collections manager has made an effort to broaden the scope of the herbarium; significant collections have been added from Kyrgyzstan and Uzbekistan and a specimen exchange program was started with China in 2007. Eleven vascular plant type specimens are held at this herbarium.

Type specimen of Tripsacum bravum *scanned by Jenny Stratton for the Global Plants Initiative project.*

CEL houses about 30,000 specimens of cultivated grasses and legumes and their wild relatives. The collection is international in scope and includes specimens of many cultivated forms, including numerous land races and many documented hybrids. It is also rich in wild species, including rare endemics and many topotypes. CEL also holds a large collection of tropical cultivated species and their wild relatives. This is a truly unique collection that has value to systematists and agronomists, as well as to anthropologists and archeologists studying the origins of agriculture. Twenty plant type specimens are a part of the CEL collection.

Although these herbaria have been housed and managed separately, a new facility that is currently under construction will soon house all of them. This new facility will have a combined holding of over 850,000 specimens, making it about the 15th largest plant and fungus collection in the United States. Illinois Natural History Survey staff will manage the three herbaria. The GPI grant is the

Continued on last page

Extending the History of the Passenger Pigeon

"The Passenger Pigeon was no mere bird, he was a biological storm. He was lightning that played between two biotic poles of intolerable intensity: the fat of the land and his own zest for living. Yearly the feathered tempest roared up, down, and across the continent, sucking up the laden fruits of forest and prairie, burning them in a traveling blast of life. Like any other chain reaction, the pigeon could survive no diminution of his own furious intensity. Once the pigeoners had subtracted from his number, and once the settlers had chopped gaps in the continuity of his fuel, his flame guttered out with hardly a sputter or even a wisp of smoke." – Aldo Leopold, 1947, On a Monument to the Pigeon.

Perhaps no extinction in North America is more famous or more poignant than that of the Passenger Pigeon. The dramatic and tragic extinction of the Passenger Pigeon in 1914, when the famous last pigeon "Martha" died in the Cincinnati Zoo, was a hard lesson that humans could cause the loss of a species so abundant its extinction would seem unthinkable.

The Passenger Pigeon (*Ectopistes migratorius*) was no doubt the most abundant bird in North America, with an estimated 3 to 5 billion birds. Its success was a result of its remarkable ability to take advantage of super-abundant tree seeds from oaks and beeches, widespread in eastern North American forests. These trees use a "mast" strategy of producing seeds in very large numbers synchronously with other trees in a local forest during only certain years. In this way these trees can overwhelm any local seed predators by concentrating their reproductive efforts.

Painting of the Passenger Pigeon by J.J. Audubon.

However, they could not overwhelm the Passenger Pigeon. The large nomadic flocks of these birds would seek out patches of forest where mast seed crop was being produced and set up a breeding colony to take advantage of this super-abundant food. The Passenger Pigeons themselves were a "mast" species, able to satiate predators by their huge locally distributed flocks.

But, alas, one insatiable predator finally caught up with them—humans. Once a pigeon colony was discovered, people would come from miles around to slaughter them for market. These giant hunts disturbed the breeding colonies to such an extent, causing abandonment, that this species effectively did not reproduce for years on end. This constant slaughter and lack of reproduction eventually lead to steep declines in population size. Deforestation of vast tracts of eastern deciduous forest also took their toll on the pigeons' food supply. By the time humans noticed the coming demise of this species, it was too late. Because of its colonial breeding habits, the Passenger Pigeon lost any form of predator defense. Once its population size got too low, even if human hunting and deforestation had ceased, natural predators would have done the rest.

While many aspects of the biology of the Passenger Pigeon are well known, considerable speculation still exists regarding where it came from in the first place. Why is this species unique among pigeons and doves, being a monotypic genus, and what are its closest relatives? Based on morphological features, such as a long tail, many had suggested the Passenger Pigeon is closely related to the Mourning Dove (*Zenaida macroura*), another common avian species in North America. However, studies using DNA sequences from museum specimens by Dr. Kevin Johnson at the Illinois Natural History Survey with colleagues at the National

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Passenger Pigeon

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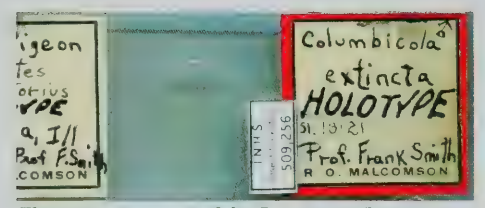


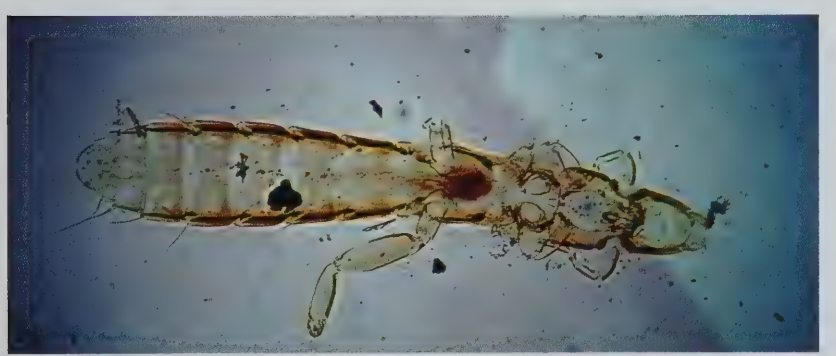
The type specimen of the Passenger Pigeon louse, (Columbicola extinctus) *housed in the INHS Insect Collection.* Photo by Paul Tinerella, INHS

Museum of Natural History, California Academy of Sciences, and University of Utah have shed new light on this question. Gene sequences obtained from DNA extracted from the toe pad of a museum specimen of the Passenger Pigeon were compared to the same gene sequences from other pigeons and doves (Columbiformes). Methods for reconstructing evolutionary trees from these sequences reveal that in fact the Passenger Pigeon is not closely related to the smaller Mourning Dove, but rather is a true pigeon being a close relative of other large pigeons in the New World, including the Band-tailed Pigeon (*Patagioenas fasciata*) from western North America. Furthermore, more detailed reconstruction of the relatives of the Passenger Pigeon reveals this species might trace its lineage back to cuckoo-doves (*Macropygia*) of eastern Asia. Cuckoo-doves also have a long tail like the Passenger Pigeon, and juvenile Passenger Pigeons have a similar ruddy coloration of the wing feathers to that of cuckoo-doves. If the ancestors of the Passenger Pigeon did indeed cross the Pacific to reach North America, it would be one of few lineages of birds to have done so.

Further evidence of this history comes from studying the feather lice of these pigeons. Feather lice are wingless ectoparasitic insects found on most groups of birds. The Passenger Pigeon was host to a species of louse, *Columbicola extinctus*, described after its extinction in 1937 by R.O. Malcomson, a member of the Department of Entomology at the University of Illinois. The lice were removed from a museum skin of a Passenger Pigeon collected in Urbana, Illinois, in 1895. The type specimen of the louse, *Columbicola extinctus*, is housed in the Insect Collection of the Illinois Natural History Survey. Because feather lice are generally specific to a single species of host, this parasite was thought to have gone extinct at the same time as its host. However, recent taxonomic work on this genus revealed that the Band-tailed Pigeon also harbors *Columbicola extinctus*, resurrecting this parasite from extinction. Phylogenetic studies of pigeon lice also reveal that the lice of New World pigeons, including *Columbicola extinctus*, are closely related to those of cuckoo-doves, lending further support to the Pacific-crossing hypothesis.

While it is hard to know the full extent of how the extinction of the Passenger Pigeon affected the forest ecosystems of eastern North America, its demise might have been a factor in the rise of another parasite, *Borrelia burgdorferi*, the bacteria causing Lyme Disease. In forests that already have Lyme Disease present, the prevalence of the disease increases in years where forest trees produce mast seeds. This is because the primary reservoir for Lyme Dsease, mice and other small mammals, feed on this super-abundant crop of seeds and their populations increase. It seems possible that the Passenger Pigeon, because of its amazing population sizes, might have competed with these rodents for these mast crops, preventing them from increasing their reproduction during mast years. This might have kept the prevalence of Lyme Disease at a much lower rate than is seen today in eastern forests. While this idea might be difficult to test, it might be possible to evaluate the prevalence of Lyme Disease in museum specimens before and after the extinction of the Passenger Pigeon. Such connections in ecosystems show how preserving biodiversity may be important in preventing the rise of infectious diseases, a recurrent theme in the study of emerging infectious diseases at the Illinois Natural History Survey.

Kevin P. Johnson, Illinois Natural History Survey



A photomicrograph of the type specimen of the Passenger Pigeon louse. Image by Paul Tinerella, INHS

Species Spotlight

Luna Moth

Susan Post

Moonlight Tango
By Susan Post

On a Full Moon stage
Her heady perfume
Lures a partner

Shimmering lime, twisted tails
Circling up and around
An "Abrazo" perfected

Dawn—dancers spent
Actias luna's twisted tango
Consummates a new generation.

As an entomologist, if I had to choose, my favorite insect would be the Luna Moth. Growing up I remember early morning encounters in our lawn mower shed. The shed was near an outdoor light and the moths would be resting on the door or the sides of the small building. Their lime-green wings stood out in contrast to the faded white shed. Now grown, my encounters with Luna Moths have been less often. Usually I find a wing here and there, the luna victimized by a night-feeding bat. Last June during a black lighting adventure under a full moon, a female came to the light around 10:00 pm. When we turned the light off and packed the sheet to go home, she circled up to the sky, nothing but a shadow—gone. It was magical and inspired the above poem

An adult luna moth perching on vegetation.
Photo by Michael Jeffords, INHS

The Luna Moth, *Actias luna*, is a large, lime-green silk moth (Family Saturniidae) with a wingspan of 3 to 4.5 inches. Like its Saturniid relatives, the Cecropia and Polyphemus moths, Luna Moths have eyespots on their wings. These eyespots are used to confuse potential predators. The moths rest with the hindwing eyespots covered, but when disturbed the wings open, revealing the eyespots and hopefully startling the predator, giving the moth time to escape. Unlike it's near relatives, Luna Moths possess elongated hindwing tails, which lend an air of aerodynamic elegance.

Luna Moths occur from east of the Great Plains to the Atlantic Coast and from Nova Scotia to Florida and Ontario to Texas. They may be found throughout Illinois. The moths prefer a forest or woodland habitat, and in Illinois their principal larval hosts are walnuts, hickories, and persimmon.

In Illinois, the moth overwinters as a pupa, emerging during May and June. Adults emerge from their cocoons in the morning and begin to inflate their wings. Since their wings are soft, the moths climb to a safe spot where they are inactive until evening. Females will release a pheromone and the males will locate her by flying upwind toward the odor source. Mating usually takes place after midnight and may last until dusk of the following day. Females will mate only once, but males can mate each night of their short life. During their adult lifespan (7–10 days) the moths will never eat or drink as they have no mouthparts.

Once mated, the female begins to lay brownish eggs in small groups (4–7) on the underside of leaves—hickory, walnut, or persimmon. She will lay up to 300 eggs that will hatch in about a week. The larvae are lime-green caterpillars with magenta spots. They will undergo 5 molts before pupating. Each instar (period between molts) will take about a week to complete. To pupate, the fifth instar will spin a silk cocoon, incorporating a leaf from its food source. This unattached leaf will soon die and the leaf with the cocoon will fall to the ground where it will be hidden among the leaf litter under the tree. Within the cocoon, the pupa is active, as it will wiggle about. In Illinois, there are usually 2 generations of moths with adults flying in May throughearly June and again in late July through August.

I am not the only one given to descriptive prose when encountering a Luna Moth.

In 1876, Missouri's State Entomologist C.V. Riley wrote, *. . . Luna, our queen of the night, entire supremacy in grace, elegance and chasteness. No other North American insect can wing this distinction from her, the delicate green, relived by the eyespots and by the broad purple-brown or lilaceous anterior border, the soft downy hair of the body, and above all the graceful prolongation of the hind wing . . .*

The Naturalist's Apprentice

Rearing Silk Moths

Michael Jeffords
and
Carolyn Nixon

Giant silk moths, such as Polyphemus or Cecropia, members of the family Saturniidae, can easily be reared in the home or classroom. Before you start, you will need to build a cage to rear your larvae. It should be at least 1ft x 1ft x 2ft tall, and should be covered with a fine mesh screen or cloth.

1. Find a female moth, usually at lights during summer nights. Place her in a brown paper bag and close it up by folding over the top and creasing it. Check her in the morning. If she was ready to lay eggs, there were be several clusters of eggs attached to the paper. Release the female outside. (note: male moths have large, feathery antennae; female moths have narrower antennae with large, fat abdomens.)

2. Eggs will hatch about two weeks after being laid by female moths. Watch them carefully so they do not starve! They need to feed shortly after hatching and are very tiny at this stage.

3. Collect twigs with several leaves from a nearby tree of the correct species, make a bouquet with water in a vase and place the leaf bouquet inside the cage. Cover the top of the vase with cloth or paper to keep the caterpillars from falling into the water and drowning. You will not need a lot of leaves while the larvae are still small. This WILL change as they grow. Appropriate leaves for Polyphemus are Apple, Black Cherry, Dogwood, Elm, Maple, or Oak. Cecropia larvae will feed on Apple, Birch, Box Elder, Dogwood, Silver Maple, and Wild Cherry. Once you start with a particular tree species, keep that same species throughout the rearing process.

4. Use a soft paintbrush to transfer the young larvae to the foliage in the cage. Be careful to not drop them or damage them in the move.

5. The larvae will settle down and eat, and eat, and eat . . .

6. When the leaves begin to wilt or dry or are all eaten, they must be changed. It's best to create a new bouquet and just cut off the old leaves or stems that contain the larvae and clip them to the new foliage until they transfer over. This process will be repeated until they are full-grown and spin a cocoon.

7. Polyphemus moths will emerge in a few weeks. Cecropia moths have one generation a year. Once your larvae pupate, put them in a mouse-proof wire cage, and keep them in an unheated porch or garage until spring. They should emerge as adult moths the next May, so bring them indoors where you can watch them in late April. Place a male and a female in a paper bag, let them mate, and begin the entire process again.

Alternately, if you find silk moth caterpillars (larvae), you can collect them and leaves from the tree they are feeding on, and proceed from #3.

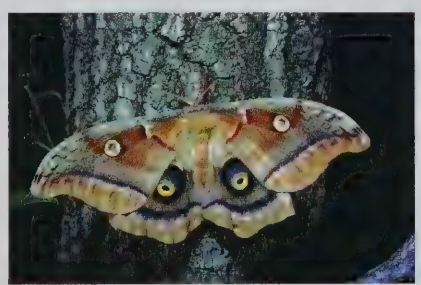
To identify adult and larval silkmoths, and to see a list of plants which the caterpillars will feed on, see *Field Guide to Silkmoths of Illinois*, by John K. Bouseman and James G. Sternburg, Illinois Natural History Survey Manual 9.

Hatching Polyphemus larva. Photo by Michel Jeffords, INHS

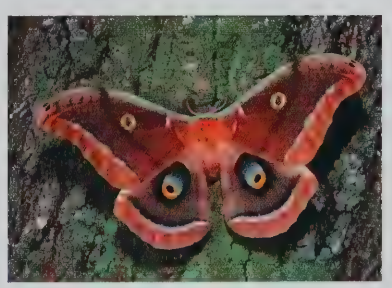
Polyphemus larva, first instar. Photo by Michael Jeffords, INHS

Polyphemus larva, fifth instar. Photo by Michael Jeffords, INHS

Mature Polyphemus larva. Photo by Michael Jeffords, INHS



Adult female Polyphemus moth. Photo by Michael Jeffords, INHS



Adult male Polyphemus moth. Photo by Michael Jeffords, INHS

Polyphemus pupa. Photo by Michael Jeffords, INHS

Institute of Natural Resource Sustainability
ILLINOIS NATURAL HISTORY SURVEY
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Global Plant Initiative

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first joint project involving all three herbaria. A second proposal is currently being developed to obtain additional funding to digitize the approximately 4,800 fungal type specimens. Digital images and label data for all of the type specimens will be accessible through JSTOR's Plant Science Web page (http://plants.jstor.org/). In addition to the type specimens, other primary data sources relating to plant systematics, including books, manuscripts, letters, artifacts, and prints, will be available on this Web page.

Brenda Molano-Flores, Mary Ann Feist, and Rick Phillippe, Illinois Natural History Survey

ILLINOIS NATURAL HISTORY SURVEY
Reports
ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Prairie Research Institute

Winter 2011
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INSIDE

INHS Library Open House Celebration

On October 28, 2010, the Illinois Natural History Survey Library Committee held an open house celebrating the John K. Bouseman Natural History Survey Library Endowment Fund. The celebration honored everyone who had contributed to the fund over the years and provided an opportunity for people to visit the library and view the collection. Numerous items were on display including rare books, endowment materials, prints, and photographs. A silent auction was held for three original prints from the *Banks Florilegium Tierra del Fuego* plates (see http://www.facebook.com/pages/Banks-Florilegium/108376322520596#!/pages/Banks-Florilegium/108376322520596?sk=wiki), with all proceeds going to the endowment. The event was very well attended and we were able to raise an additional $4100, bringing the fund's total to $51,500.

Recent INHS publications were given away as door prizes to five lucky attendees. The *Field Manual of Illinois Mammals*, by Joyce Hofmann, proved to be the favorite title selected by door prize winners.

Retired INHS Director David Thomas (left), current Director Brian Anderson (center), and retired Director Lorin Nevling (right). Photo by M. Wetzel, INHS

The INHS Library Collection

The current collection of about 65,000 volumes includes a wealth of materials covering Illinois natural history, plants, animals, ecology, conservation, habitat restoration, wildlife, and natural resources. Of the collections 500+ active subscriptions (print and on-line), many of the journal runs begin with volume one. The collection also includes numerous rare books and folios, an archive of INHS publications, and many resources unique to Illinois.

The INHS Library collection began taking shape even before the Natural History Society received its charter in 1861 in Bloomington, Illinois. Society founder Cyrus Thomas formed a library committee, which immediately began to assemble a library of scientific literature. The library was provided for in the society's charter and one of the committee members was a librarian. By 1860 they had already procured 300 volumes.

The INHS Library collection has moved a few more times since then—the most recent move was November 2005 to the I-Building (now called the Forbes Natural History Building) in the UI South Research Park. The attractive new library has spacious reading areas, three public computer terminals available for users to search the Internet or access the library's catalog and electronic resources, and rooms dedicated to rare books, archives, and special collections. Electric compact shelving provides space for future growth.

Today the Illinois Natural History Survey Library is in

continued on back page

Botanical prints on display during the INHS Library open house. Photo by Beth Wohlgemuth, INHS

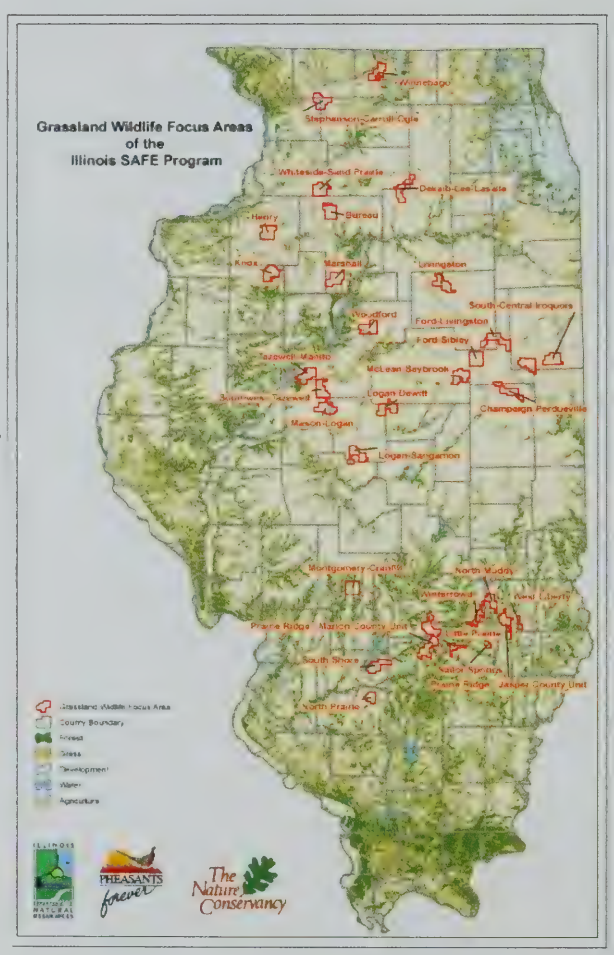
A Strategic Approach to Establishing Grasslands in Illinois (SAFE)

SAFE or State Acres For Wildlife Enhancement is an extension of USDA's Conservation Reserve Program (CRP). Unlike other practices within the CRP, which often have a soil erosion or water quality emphasis and are available statewide, SAFE is intended to address priority wildlife conservation issues, and only lands in certain focus areas are eligible for enrollment in SAFE and its special incentives. While SAFE is a USDA program, in Illinois the guidelines for SAFE were developed by the Illinois Department of Natural Resources (IDNR), Pheasants Forever, The Nature Conservancy, and Illinois Audubon Society to achieve the goals of the Farmland & Prairie Campaign from the Illinois Comprehensive Wildlife Conservation Plan.

There are 22 SAFE areas in Illinois where farmers receive rental payments and other incentives to convert agricultural fields to grasslands. The rationale for this is based on the ecology of grassland animals. Grassland animals tend to be area sensitive, residing in areas with large fields and generally preferring landscapes with large amounts of grassland. Therefore, while CRP may be scattered throughout Illinois, the 22 SAFE sites were selected to concentrate grasslands in core areas, many of which are "anchored" by publicly owned grassland. The ultimate goal is to develop grassland landscapes.

From the beginning, researchers from the Illinois Natural History Survey, along with many other agencies, have been meeting to coordinate the rare opportunity to both establish grasslands in agricultural landscapes and to monitor how animal communities respond to this establishment. The IDNR via the Pittman-Robinson Fund provided a grant to the Illinois Natural History Survey and the Department of Natural Resources and Environmental Sciences (NRES) at the U of I to monitor how birds and small mammals respond to the creation of grasslands via SAFE.

Since 2008, 7,000 acres of grasslands have been established by SAFE. While this is a great start, the Illinois SAFE program is authorized to enroll 20,300 acres. One of the factors restricting the program is simply education, letting the farmers know about this program. Because of this, the IDNR along with Pheasant's Forever have hired biologists to facilitate the enrollment of lands into this program. And, as to be expected, the program has been more successful in some areas than others. For example, the SAFE area in Tazewell County has enrolled approximately 1,500 acres, while less than 100 acres have been enrolled in Winnebago County. While we hope to enroll 1,000 acres in all sites, these differences do provide a good opportunity to investigate how effective SAFE is in restoring grassland animal communities.



We have been monitoring these SAFE fields for two years. Because these fields are coming out of crop production, the grasslands tend to be sparse, However, in many locations, we have documented rapid colonization by grassland birds. Grassland species preferring more open, sparse grasslands (Grasshopper Sparrow) have shown a strong response to the program and we expect that as these grasslands mature they will benefit the entire suite of grassland birds including Ring-necked Pheasants, Henslow's Sparrows, and Eastern Meadowlarks. Dr. Robert Schooley (UI-NRES) and his students have been monitoring the response of small mammals to SAFE and they have found a similar strong response.

The current landscape of Illinois is dominated by agriculture and it is likely that agriculture will dominate Illinois into the future; therefore, it is imperative that we understand the ecology of animals living in this landscape. Previous research has suggested that a "shotgun" approach to establishing grasslands may only have limited success (i.e., the continued decline of grassland birds). SAFE is a focused program with specific goals, which will provide the kind of program needed for effective conservation in Illinois. In addition, this program brings together many agencies involved in very different aspects of managing our lands and natural resources. While it is still too early to know, we hope that by involving multiple agencies, taking a focused approach, and monitoring the effects of the program, we will provide a roadmap for other conservation efforts in Illinois, including redirecting USDA programs to more effectively deliver measurable wildlife benefits.

Michael P. Ward, UIUC and Jeff Walk, The Nature Conservancy

Homer Buck — *In Memoriam*

Former INHS aquatic biologist Homer Buck passed away on April 30, 2010. He is survived by his wife Ruth, three daughters, a son, and eight grandchildren.

Homer began his career at INHS on February 1, 1956 and conducted most of his research at the INHS Sam Parr Field Station in Kinmundy. He became director of the field station in 1964. There, he supervised a wide range of studies in experimental ponds and small reservoirs. In 1976, Homer participated in the FAO Technical Conference on Aquaculture in Kyoto, Japan, followed by an eight-week tour of various centers of aquaculture in Asia and Europe. He conducted a special study for the National Science Foundation in Taiwan.

On the grounds of the Fin and Feather Club near Dundee, IL, Homer supervised construction of 15 one-acre ponds as a cooperative project among the INHS, Illinois Department of Conservation, and the North American Wildlife Foundation.

Prior to his tenure at INHS, Homer conducted research for the Oklahoma Game Commission and the U.S. Army Corps of Engineers at Fort Worth, TX.

Homer served in the U.S. Marine Corps in World War II as a bomber pilot in the Philippines, and during the Korean War as a helicopter pilot. He graduated from San Jacinto High School, Houston, TX, in 1938, earned a B.S. from Texas A & M University in 1943, and his Ph.D. from Oklahoma State University in 1951. He held memberships in the American Fisheries Society, the World Mariculture Society, and the American Society of Limnology and Oceanography.

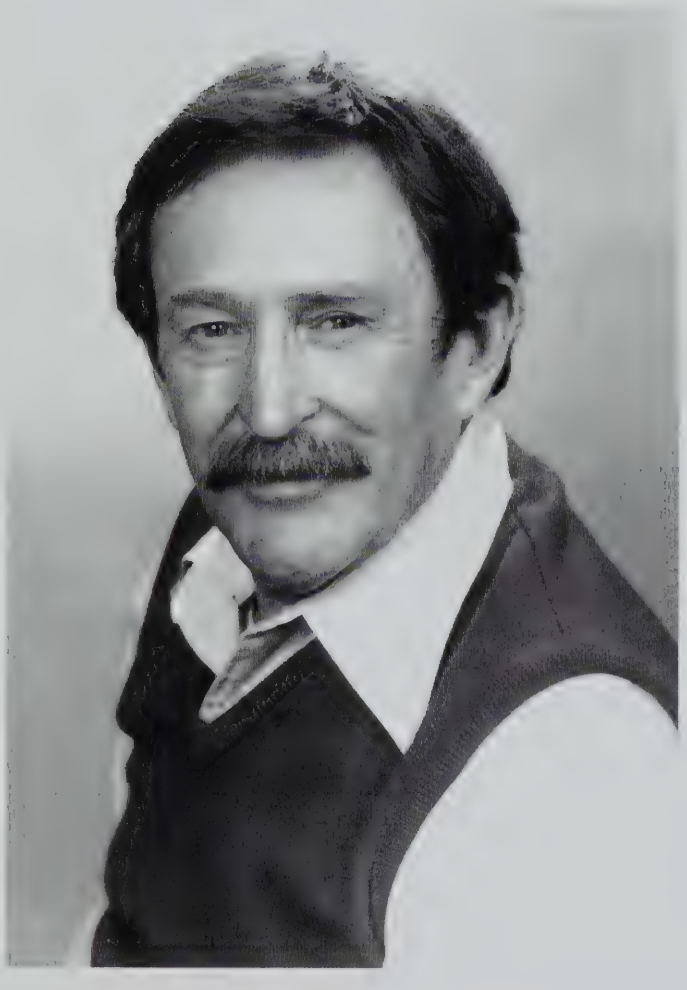


Photo from INHS Image Archives.

During his career, Homer gave a number of presentations and invited papers to international conferences and symposia. He served as chairman of the Small Catfish Farmers and Catfish Farmers Economic Workshop in 1978 and led a symposium on Aquaculture and Agriculture at the University of Hawaii in 1979. In 1970, he was awarded the "Most Significant Paper in Volume 99" of the *Transactions of the American Fisheries Society*. He was author and co-author of many articles in scientific journals throughout his career. He continued to write and publish nearly until his death. His final article appeared in the December 2009 issue of *World Aquaculture*.

Homer traveled extensively throughout his life, visiting 39 countries on 4 continents and all 50 states.

What Doesn't Kill Mosquitoes Makes Them More Dangerous

Arthropod-borne virus (arbovirus) diseases, particularly those transmitted by mosquitoes (e.g., dengue, yellow fever, West Nile Virus [WNV]), remain major threats to human and animal health and are important contributors of negative socio-economic development in many countries around the globe. Dengue alone accounts for more than 50 million clinical cases annually, and the combined burden of all mosquito-borne arboviral infections is likely many times higher. Despite intense efforts to eradicate or contain these arboviruses, international travel and business have been the gateway for rapid expansion of emerging and resurgent mosquito-borne infectious diseases. West Nile Virus is an example of how fast an arbovirus can spread across North America. After its introduction into New York City in 1999, few thought the virus would survive the winter in the northern latitudes, yet within five years WNV became an endemic seasonal threat from the Atlantic to Pacific coasts. Human vaccines are typically not available for most arboviruses, so the main disease management strategy is to reduce vector populations, primarily by larvicides and adulticides.

Current data indicate that each year, more than 5 billion kilograms of pesticides are devoted to pest and vector control around the world. The United States alone accounts for one-third of this total; 70% of which is used for agricultural purposes. In addition to direct application of pesticides in wetlands to control mosquitoes, aquatic habitats are also contaminated with pesticides through surface runoff from treated agricultural lands. In fact, pesticide pollution from agricultural areas is regarded as one of the greatest causes of contamination of ground water. Many species of mosquitoes breed in transient and permanent water bodies within and around agricultural areas and may be exposed to both target and non-target pesticide contamination. Furthermore, urban residential use of pesticides is relatively high for turf, ornamental, and vegetable treatments. Contamination of common mosquito container habitats around the home is probably common. Because today's pesticides have shorter half lives and do not bioaccumulate, pervasive use of pesticides was previously considered of little or no ecological consequence. However, recent studies suggest that low concentrations of pesticide can cause serious ecological disturbances. One of the research focuses at the Illinois Natural History Survey Medical Entomology Laboratory (MEL) is discovering significant changes in adult mosquito fitness and ability to transmit viruses due to exposure of larvae to low concentrations of pesticides

Glove box used to separate blood-fed from unfed female mosquitoes and to dissect blood-fed mosquitoes that survive the 14-day virus incubation period. Photo by Ephantus Muturi

The presence of a pesticide in an aquatic environment, even at low concentrations, can be an additional stress that interacts with other ecological stressors (e.g., larval competition, food quality and quantity, temperature) to produce unexpected results. One of my research objectives is to study how exposure of mosquito larvae to pesticides in the presence of other environmental stressors alters the resulting adult mosquito abundance, longevity, and ability to transmit arboviruses. I work with four model vector species; *Aedes aegypti*, *Aedes albopictus*, *Culex pipiens*, and *Culex restuans*. These mosquitoes are typically found in containers and although they have different life histories and habitat preferences, they sometimes occur together in these habitats. I found that stressful environments increase the sensitivity of mosquito larvae to toxicants and that larval exposure to sublethal concentrations of a toxicant induce changes that modify adult mosquito fitness (e.g., adult longevity, size) and vector competence for arboviruses. However, these results are species specific.

In a study to determine how intraspecific competition among larvae and low concentrations of malathion alters *Ae. aegypti* and *Ae. albopictus* adult life history traits and competence for Sindbis virus, we manipulated two larval densities (low, high) and two malathion concentrations (0 and 0.04 parts per million) and exposed the resulting females to an infectious blood meal. For both species, competition and the presence of malathion reduced survival to adulthood. The presence of malathion eliminated the negative effects of competition, which resulted in lengthened development time and smaller sized adults. For *Ae. aegypti*, but not *Ae. albopictus*, high competition conditions and the presence of malathion independently led to twofold increases in virus dissemination from the midgut to other tissues. It remains to be seen how reductions in adult mosquito populations through the direct lethal effects of pesticides combine with altered vector competence among surviving mosquitoes to alter transmission of diseases. However, these results indicate that biotic interactions may reverse the impact of pesticides on mosquito-borne disease. Other studies are required to document this phenomenon under field conditions, but these results are a starting point to evaluate how pesticide use interacts with biotic factors in nature to influence parameters important to mosquito-borne diseases.

Ephantus Muturi, INHS

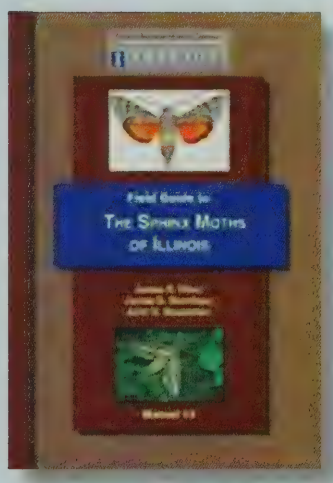
Two New Publications available from INHS

Illinois Birds
A Century of Change
Special Publication 31

by
Jeffery W. Walk
Michael P. Ward
Thomas J. Benson
Jill L. Deppe
Stacy A. Lischka
Steven D. Bailey
Jeffrey D. Brawn

This 8½" x 11", full color, 230 page, softbound book compares bird population trends from three extensive state-wide bird surveys of Illinois spanning 100 years (1906, 1956, and 2006). It compares changes in habitats, often with photos of the same site taken during each survey. 44 representative species are discussed in detail, with basic natural history and habitat preferences, changes in distribution and abundance, an overview of how the species has faired over the last 100 years, and the outlook of the species in the future.

$25 plus shipping & handling



Field Guide to
The Sphinx Moths of Illinois
Manual 13

by
James R. Wiker
James G. Sternburg
John K. Bouseman

This long-awaited field manual contains 242 color photos, 21 illustrations, along with descriptions, range, natural history, and larval food plant information for all of the sphinx moths that have been found in Illinois, or are likely to found in Illinois or surrounding states. At 155 pages, it is small enough to carry along in the field, and has a laminated soft cover.

$20 plus shipping & handling

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Compilation by Claudia Corlett-Stahl, INHS; design and layout by Carie Nixon, INHS

Species Spotlight

Eastern Meadowlark

Susan Post

Perhaps no bird is more representative of the farmland and open country of eastern North America than the Eastern Meadowlark. Growing up in rural central Illinois, I remember hearing meadowlarks singing on the fence posts at the edge of our property. It meant spring was here and school would soon be out!

The Eastern Meadowlark, *Sturnella magna*, is not a lark at all but a member of the blackbird family—Bobolinks, Red-winged Blackbirds, and Common Grackles—are their relatives, and they are one of North Americas most widely distributed species. Meadowlarks can be found in native grasslands, pastures, weedy cropland borders, or other open areas with good grass and litter cover. Since 1960 they have expanded their range west into the plains of southern Kansas and the Texas panhandle, and as forest is being cleared for agriculture in Central America, they are increasing in numbers in Costa Rica and Panama.

An Eastern Meadowlark perching on a fence post. Watercolor by Carie Nixon, INHS

Eastern Meadowlarks are medium-sized songbirds with pointed bills, slender heads, plump bodies, long legs, and short tails. Their breasts are bright yellow with black crescents. When approached a meadowlark will squat down and hide its yellow upper parts—the dry grass pattern on its back should hide the bird as it tries to slink away. Otherwise, the bird will explode into flight where its conspicuous white tail margins can be observed.

Meadowlarks feed on top of the ground, probing beneath the soil and searching under sod clods for insects—grasshoppers, crickets, cutworms, and caterpillars—that make up 75 % of their diet. Their winter diet consists of weed seeds and waste grain.

Male meadowlarks will usually have two concurrent mates and a successful first nesting is followed by the construction of a second nest. Nests are camouflaged in their grassland habitat. They are shallow depressions on the ground in fairly dense vegetation and are constructed by the female of dried grasses, plant stems, or bark. These are then interwoven and attached to the surrounding vegetation and lined with finer grasses.

A female will lay one egg per day during the early morning. A clutch is two to six eggs. When the last egg is laid, she will begin to incubate them, which lasts 13 to 14 days. When the eggs hatch, the young are nearly naked and their eyes are closed. By day 8 the young are alert, active, and capable of leaving the nest if they are frightened. Within 10–12 days, they are fully fledged, and while their bodies are covered with feathers, they are incapable of sustained flight. By 21 days, they can fly and will be ready to mate the following year.

A meadowlark's life span is three to five years and causes of death include poison grain used for rodent and insect control, exposure to deep snow and ice, mowing in the hay fields, predation by hawks, foxes, cats, dogs, skunks, and coyotes, and the disruption of eggs and nestlings due to human activity. Meadowlarks are extremely sensitive to humans in their breeding territory. A female flushed from her nest during incubation will usually abort. As for mowing, it is recommended to delay it until August to avoid destruction of the nest and young.

A note to those interested in a deeper view of this and other Illinois birds—"Have changes in land cover, agricultural practices and climate affected Illinois's meadowlark populations?" To find the answers check out the newest Illinois Natural History Survey publication *Illinois Birds: A Century of Change*. An Eastern Meadowlark graces the cover (see watercolor on this page).

The Naturalist's Apprentice

Color a Meadowlark

Carolyn Nixon

Drawing by Carie Nixon, INHS

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Open house

continued from front page

transition. The state scientific surveys merged in 2008 to form the Prairie Research Institute and are collaborating to develop an institute library. Library materials from other surveys' library collections are being added to the University Library catalog, and some materials will move into the current INHS Library space. Librarians from the Illinois State Geological Survey, Illinois Sustainable Technology Center, and the Illinois State Water Survey are helping to provide service at the current INHS Library location.

Combined, the institute libraries will integrate the strengths of their individual collections and the focused expertise of their four professional librarians, providing the campus and Illinois citizens with access to a full complement of information on the Illinois and regional environments and the stewardship of their natural resources.

Roxanne Frey (left)—Director of the UI Library Advancement Office, Tammie Bouseman (center)—wife of John Bouseman, namesake of the John K. Bouseman Natural History Survey Library Endowment, and Patricia Askew (right)—a long-time endowment supporter.

Photo by Mark Wetzel

INHS Library Endowment Fund

The INHS library staff is dedicated to continuing the work of their predecessors by building a natural history collection that serves the INHS scientists, the university community, and the citizens of Illinois. An endowment fund was established in 2003 by John Bouseman and a small group of generous library supporters. The fund was designed to help the INHS librarians to continue to build an excellent natural history collection. For further information or to make a donation to the endowment, visit http://www.library.illinois.edu/nhx/give/endowment.html

Beth Wohlgemuth, INHS Librarian

INHS Library Information

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ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

Reports

Summer 2011
No. 406

INSIDE

Understanding the Asian Carp Invasion

Bighead carp (*Hypophthalmichthys nobilis*) and silver carp (*Hypophthalmichthys molitrix*), collectively referred to as Asian carp, have gained particular notoriety due to the high densities they have attained in parts of the Mississippi River basin in recent years. These two species are high-volume filter feeders that are capable of substantially reducing phytoplankton and zooplankton densities, potentially competing with native fishes and altering entire aquatic food webs. First imported to North America for aquaculture purposes in the 1970s, these species became established in the Illinois River in the 1990s. An electric aquatic nuisance species barrier currently operates on the Chicago Sanitary and Ship Canal (CSSC) in an attempt to halt the spread of Asian carp into the Great Lakes, where they could cause substantial economic and environmental impacts. However, recently developed environmental DNA technology (eDNA) suggests that some bighead and silver carp may already be present upstream of the electric barrier, and a single bighead carp was captured less than 10 miles from Lake Michigan in 2010. These findings have raised concerns about the ability of standard sampling gears to detect Asian carp in low densities, and have reinforced the need to understand the interactions of these invasive fish with native aquatic communities.

Jason Stuck, graduate student at Eastern Illinois University, left, and John English of INHS, right, check a fyke net for Asian carp on a backwater lake of the Illinois River.

Photo by Steven Butler, INHS Kaskaskia Biological Station

Asian Carp Map. Location of the electric barrier and areas being sampled as part of a study examining the effectiveness of various sampling gears at capturing Asian carp.

The Illinois Natural History Survey (INHS) is engaged in a variety of research activities examining the distribution, detectability, and ecological effects of Asian carp. Multi-agency sampling and removal efforts are ongoing in the Illinois River and the Chicago Area Waterway System (CAWS) to monitor the distribution of Asian carp and attempt to reduce their abundance. Several sampling methods are being employed by various agencies in these efforts. However, the relative efficiency of each of these techniques and the amount of effort required to detect Asian carp at different densities, have not been rigorously evaluated. Fisheries scientists from INHS are investigating the ability of a variety of sampling gears (electrofishing, hydroacoustics, trammel nets, gill nets, hoop nets, mid-water trawls, purse seines, trap nets, mini-fyke nets, cast

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The Forests and Woodlands Campaign of the Illinois Wildlife Action Plan

The tree canopy of the Shawnee National Forest. Photo by Michael Jeffords, INHS

The Forests and Woodlands Campaign is one of the seven campaigns outlined in the Illinois Comprehensive Wildlife Conservation Plan and Strategy (wildlife action plan). These campaigns are designed to address the most widespread and urgent issues facing wildlife and habitats in an efficient, effective, and comprehensive manner. The wildlife action plan highlights the many current conservation issues involving Illinois' wooded habitats, including the alteration or loss of natural disturbance processes, changing composition of forested habitats away from oak-hickory dominance to maple dominance, general decline in forest quality caused by increasing numbers of invasive exotic species, and extensive forest fragmentation. While the wildlife action plan provides direction in the form of a general list of priority actions, the Forests and Woodlands Campaign will, over the next several years, specifically move the wildlife action plan forward to implementation by addressing the following needs:

1) Forging new and reinvigrating existing conservation partnerships consisting of those groups committed to improving Illinois' forests and forest wildlife;

2) Identifying and collaborating with organizations and conservation partners that are implementing specific forest wildlife conservation activities, particularly those emphasizing the already-identified Conservation Opportunity Areas (COAs) around the state;

3) Developing strategies to facilitate additional priority forest management actions outlined in the wildlife action plan;

4) Establishing goals and specific targets for the response of both wildlife and habitat to these actions;

5) Using the best science available to establish monitoring protocols to measure the effectiveness of management activities and to determine whether or not wildlife and habitat goals are being achieved;

6) Establishing new and identifying existing demonstration sites where land managers and the public can observe and learn more about forest management in action and how it benefits wildlife.

In addressing these needs, the Forests and Woodlands Campaign will establish protocols for monitoring the effects of forest management activities on Illinois' wildlife, and document whether or not forest management activities are successfully promoting populations of focal wildlife species and meeting the goals of the wildlife action plan.

The monitoring phase of the Forests and Woodlands Campaign will be initiated by establishing monitoring programs at three or more locations where timber stand improvement (TSI), fire, control

continued on next page

Action Plan

continued from previous page

of invasive exotic plant species, or other techniques are being used to manage forests. Sites that are likely to be used initially include, but are not limited to, the Shawnee National Forest and Trail of Tears State Forest, Kaskaskia Bottoms, Pere Marquette State Park/Copperhead Hollow, Lake Shelbyville/COE, Siloam Springs State Park, Iroquois County Conservation Area, and Mississippi Palisades State Park. Logistically, feasible monitoring protocols will be implemented in conjunction with forest management activities to document the responses of various wildlife species to management actions and therefore measure the success of forest management techniques. An initial goal is to monitor the responses of Wild Turkeys and breeding forest songbirds to the various forest management practices. Other wildlife will be added as appropriate and feasible.

Many of these forest management practices are designed to improve forest "health" while at the same time promoting habitat for wildlife. We will work with land managers to know where and when forest management activities are taking place so that we can effectively and efficiently monitor responses of wildlife populations to these activities, and establish the most scientifically rigorous experimental designs that monitor wildlife before and after forest management takes place both in treatment (where management occurs) and control (where no management occurs) sites. It will be important to also monitor whether management is having the desired effects on forest structure and composition. As the forests change in response to management, populations of wildlife being monitored may show positive, neutral, negative, or lagged (initial negative or neutral followed by positive) responses. We will have a monitoring program in place to detect any of these possible outcomes. Paul Brewer with the Illinois Department of Natural Resources and Kent Adams with the National Wild Turkey Federation are both heavily involved in this campaign.

Jeff Hoover, Illinois Natural History Survey

Owen Glissendorf—*In Memoriam*

Editor's Note: Owen Glissendorf served as head of the INHS Publications and Public Relations Office until his retirement in 1975. The following obituary is reprinted with the kind permission of the *Park Falls* (Wisconsin) *Herald.*

Owen Glissendorf, 92, of Urbana, IL, passed away on Thursday, June 16, at his home.

He was born on June 18, 1918, in Phillips [Wisconsin]; the son of Richard and Emma Glissendorf, and was a graduate of Phillips High School and Price County Normal School.

He taught at Viola Villa (1937–1938) and Miller Road School (1938–1939) before entering the University of Wisconsin.

At the onset of World War II, he interrupted his studies by moving to Long Beach, CA, where he worked as a ship fitter.

In 1942, he joined the United States Army, and served four years, training as a pilot and then being transferred to the infantry and being sent to the Philippines. He was in the occupation forces in Japan for one year.

In July of 1946, he married Marie Muehrcke in Madison, and then resumed his studies at the University of Wisconsin. He earned a master's degree in agricultural journalism in 1949.

He subsequently spent the next 27 years in several communications fields—radio and television, as well as teaching, writing, and editing, mainly at Michigan State College and the University of Illinois.

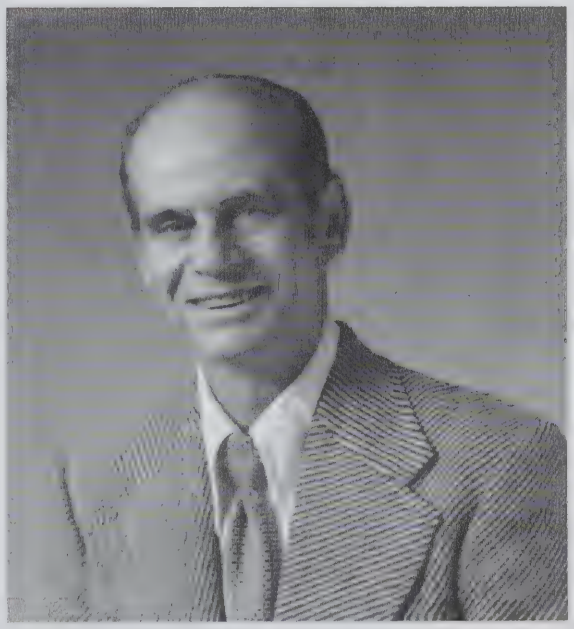
His career included two foreign service appointments with the U.S. Department of State as a communications consultant, 1961–1963 in Brazil and in 1971 in India. In his last 10 years as a writer/editor, he served as technical editor and head of publications and public relations for the Illinois Natural History Survey .

Glissendorf and his wife, Marie, were half-time residents, May through October, in the Phillips area from 1978–1999, first at Soo Lake and then at Deer Lake.

He was a member of the VFW Post in Phillips.

Surviving are his wife, of Urbana, IL; three sons, Dan of Newport, OR, David of Memphis, TN, and Dale of Urbana, IL.

He was preceded in death by his parents; his sister, Eve; and his brother, Wilmar.



A Celebration of Life/Open House will be held at their Urbana home in July.

Cremation rites have been accorded by East Lawn Funeral Home in Bloomington, IL. Online condolences may be submitted to http://www.eastlawn-bloomington.com/dm20/en_US/locations/44/4485/index.page.

Park Falls Herald, The (WI) ... June 23, 2011 Glissendorf, Owen, 92

Brown Marmorated Stink Bug Identified in Illinois

The brown marmorated stink bug (BMSB), *Halyomorpha halys*, is the most recent invasive insect found in Illinois. The brown marmorated stink bug was first confirmed in Illinois in 2010 (Cook and Kane counties). Adults were confirmed in two additional counties, Champaign and McLean, in spring of 2011.

In its native range of China, Japan, Korea, and Taiwan, this insect is a known pest of fruit trees and legumes. It is believed to have found its way to the United States as a stowaway in packing crates from Asia. Though first identified in 2001 near Allentown, Pennsylvania, it is suspected this insect was present in the United States several years earlier. This stink bug has slowly dispersed across the United States since then. It is currently found in 33 states, including every state east of the Mississippi River and as far west as California, Washington, and Oregon.

Adult brown marmorated stink bugs are roughly 0.67 of an inch long and shield-shaped, similar to other more familiar stink bugs in Illinois such as the green (*Acrosternum hilare*) and brown (*Euschistus servus*) stink bug species. White stripes on the brown marmorated antennae, red eyes, and black and white bands along the margins of the front pair of wings help to separate this species from other stink bugs frequently encountered in Illinois. Nymphs emerge from elliptical eggs that are light yellow to yellowish-red and are most often found on the lower surfaces of leaves. Egg masses of 20 to 30 eggs can be found. Immature stink bugs go through five nymphal instars prior to reaching the adult stage. During the spring, adults break their dormancy, mate, and the females begin laying eggs. Egg laying will occur throughout the summer months. A single generation per year is expected for most of Illinois. Some areas of southern Illinois could experience another generation. Typically, the adults will begin to move to overwintering locations in September, with peak movement in late September and early October. Homeowners may start to see BMSBs begin gathering on homes, barns, and garages during this time.

Like many invasive insects, the brown marmorated stink bug has a very long list of host plants on which it feeds. In addition to several woody, ornamental trees, it feeds on many crops that are grown in Illinois—peaches, apples, grapes, soybeans, corn, tomatoes, peppers, and more. In addition, the brown marmorated stink bug is also considered a nuisance pest to homeowners. Much like boxelder bugs or multicolored Asian lady beetles, brown marmorated stink bugs congregate on houses in late fall and move indoors to overwinter. Homeowners are likely to first spot new infestations as these insects will initially feed on common landscape ornamentals.

Adult brown marmorated stink bug. Photo by Michael Jeffords, INHS

How homeowners can deal with these insects is somewhat tricky. The best way to keep them out of homes, apartments, etc., is to prevent them from entering through cracks, screens, and such. Insecticide applications (outside) are generally most effective in keeping numbers down when made in the fall (just before they start looking for a nice, warm place to ride out the winter). Some of the easiest ways to deal with them once you have them in your home is to vacuum them up or sweep them into a container of soapy water. Inside insecticide applications are generally not recommended for this pest. Foggers may not kill all of the stink bugs that are hiding in cracks and crevices, and spraying chemicals inside your home may or may not work (in addition to the concern of exposure of people and pets to them).

While the brown marmorated stink bug is currently not a problem in Illinois, it is not to be taken lightly. Unlike many insect pests that only attack plants during certain times of the growing season, the brown marmorated stink bug will feed on host plants all season long. Populations in the mid-Atlantic states have grown tremendously over the past several years. It has become a serious pest of fruit, vegetable, and agronomic crops in that region and will likely threaten these commodities in other areas of the United States in the future.

Kelly Estes, Illinois Natural History Survey

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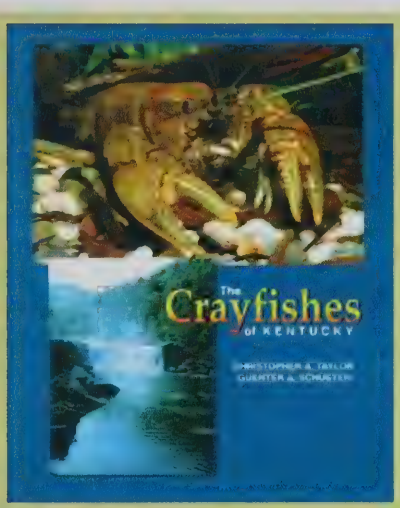

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Species Spotlight

The Tree Squirrel Bot Fly

Susan Post

During May, as I looked out at our multitude of grey squirrels that we feed daily, I noticed a very "special" squirrel. It had a golf-ball-sized lump on its jaw, giving it a chipmunk cheek! I thought it odd, but then promptly forgot about it. A month later, as my spouse and I were checking our geraniums for water, we noticed a small, fury, beelike insect nestled in a bloom. We both said, "Wow look at that bee mimic," and I said, "It's so good we better get a photo." So my spouse got the camera and as he got close he discovered the fly had no mouthparts. He became quite excited, calling me over to take a look. "This is an insect family you just don't see!" he exclaimed. What we had was a Cuterebridae, a robust bot fly.

A tree squirrel bot fly.
Photo by Michael Jeffords, INHS

Our *Peterson Field Guide to Insects* revealed that these are "large robust flies resembling bumble bees, and adults are rare." Like any good entomologists, after photos we collected it and brought the specimen to share with our colleagues at work.

The tree squirrel bot fly, *Cuterebra emasculator*, is an obligate parasite of tree squirrels and chipmunks throughout eastern North America. A parasite is an organism that lives in another without killing it, and an obligate parasite is one that cannot live independently of its host. If the bot flies kill their hosts before they are fully developed, they will also die.

While this bot fly may resemble a bumble bee, it is actually a fly and a member of the insect Order Diptera. It undergoes complete metamorphosis—egg, larva, pupa, and adult. There is only one generation per year.

As described above, these flies resemble bumblebees. They are about an inch long with black and straw-colored thoraxes and dark wings. While ours was on a flower, it was not visiting for food—tree squirrel bot flies do not have mouthparts, so they cannot eat. They also do not bite or sting.

These bot flies overwinter as pupae buried in the soil for anywhere from 8 to 10 months. They emerge in early summer seeking mates. The female lays her eggs on twigs, branches, or vegetation that is in the habitat of the hosts. They do not lay their eggs directly on their hosts. These off-white, oblong eggs resemble tiny grains of rice.

While the legless larvae of flies are called maggots, the larvae of bot flies are referred to as bots. The developing first instar larvae remain within their eggs until the body heat from a potential host stimulates them to emerge from the eggs. These first instar larvae are the infective stage. They are whitish and encircled with bands of black spines. If the instar contacts a potential host (squirrel or chipmunk), it will enter through one of the animal's body openings (mouth, nostrils or anus) or a wound. Once it enters the host, the first instar travels through the body. This journey takes about a week. The first instar then settles underneath the host's hide, molts to the second instar, and creates a hole to the exterior. This hole provides air and a route for the elimination of excrement. The presence of the larvae stimulates a response in its host's tissues; a pocket (warble) is formed that encloses the larva.

There are three larval instars and usually only one larva per pocket or warble. The larvae (instars) do not feed on blood, but instead ingest lymph fluid, cellular debris, and leukocytes of the host. Development in their hosts usually lasts three to four weeks. The mature larvae emerge from the hosts by backing out of the exterior holes, dropping to the ground, and burrowing into the soil where they pupate.

These are native parasites of chipmunks and squirrels, and unless the infestation is high, there is usually no detrimental effects on the hosts. The empty warbles usually heal after a week.

What happened to our bot fly? After show and tell and more photos, it was given to one of the entomology graduate students who is assembling an insect collection. After all, it is a rare family, and our squirrels are certainly grateful.

Answers for following page:

1) b 2) d 3) a 4) b 5) a 6) c 7) a 8) b 9) b 10) d

The Naturalist's Apprentice

Insect Specializations

Carolyn Nixon

Insects are a large and diverse group of animals and they have many different strategies for survival. Test your knowledge about different types of insects? See how many of the questions below you can answer correctly. Choose the best answer of the four listed for each question.

1. Most insects have two pairs of wings and three pairs of _____.
   a) antennae b) legs c) tarsi d) cerci

2. What do both flies and mayflies have in common? _____
   a) They have incomplete metamorphosis.
   b) The young are aquatic and the adults are terrestrial.
   c) Their larvae have no eyes.
   d) The adults do not feed.

3. Only _____ bees can sting.
   a) female b) male c) bumble d) honey

4. The immature stages of dragonflies and damselflies live in _____.
   a) leaf litter b) water c) soil d) rotting wood

5. Most caterpillars feed on leaves of plants, but when they become adult butterflies and moths, they feed on _____.
   a) flower nectar b) rotting wood c) animal hair d) tomatoes

6. So that they can easily move through animal hair, fleas _____.
   a) hold their wings vertically.
   b) keep their wings held tightly to their body.
   c) are flattened from side to side.
   d) are flattened from top to bottom.

7. What do ants and termites have in common? _____
   a) They are wingless, except when they are starting new colonies.
   b) They eat only wood and other plant materials.
   c) They are Hymenoptera, the same order as bees and wasps.
   d) All of the above.

8. Green lacewing larvae are very predatory. So that they do not eat the unhatched eggs of their brothers and sisters, _____.
   a) No two eggs are laid on the same plant.
   b) Each egg is laid on the end of long stalks.
   c) The eggs are hidden in under bark.
   d) The eggs are camouflaged.

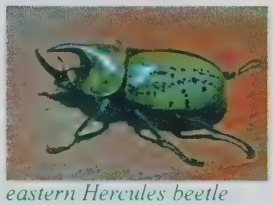
9. Bees are economically important because they _____.
   a) destroy thousands of trees every year.
   b) pollinate many kinds of plants.
   c) are popular in movies.
   d) make good pets.

10. There are more types of these insects than any others. _____
    a) butterflies b) spiders c) flies d) beetles

Answers on bottom of previous page


gold-bodied snipe fly

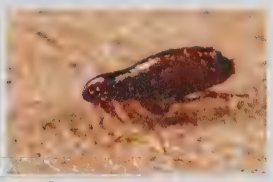

robust bot fly


eastern Hercules beetle


white-lined sphinx moth


tiger swallowtail butterfly

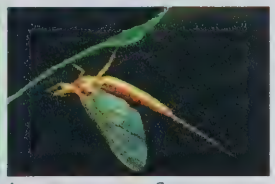

green lacewing


cat flea


twelve-spotted dragonfly


bumble bee


ebony jewelwing damselfly


burrowing mayfly

All photos courtesy of A Selection of the Common, Unusual, and Rare Insects of Illinois *by Michael R. Jeffords and James G. Sternburg, Illinois Natural History Survey*

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Asian Carp

continued from front page

nets, and seines) to capture both juvenile and adult Asian carp. These gears are being evaluated at multiple sites in three segments of the Illinois River and the CAWS: the middle Illinois River (where Asian carp are present in high densities), the upper Illinois/Des Plaines River (where Asian carp are present in low to moderate densities), and the CAWS (where Asian carp are either absent or present in very low densities). The data generated from this sampling regime will be used to evaluate gear efficiency and to develop detection probability models for each gear type.

In addition to sampling for juvenile and adult Asian carp, INHS is conducting larval fish sampling throughout the Illinois River and CAWS. Many fish species have very high reproductive output, but also high, but variable, mortality during early life stages. Identifying relationships among environmental variables and survival of early life stages can therefore provide insight into factors that influence recruitment to adult populations. INHS scientists are sampling larval fish to identify areas where Asian carp are reproducing, determining the timing of spawning, and examining relationships among environmental variables and larval Asian carp abundance. Larval fish sampling may also prove to be an early method of detecting Asian carp in the CAWS, and may provide information useful for developing control strategies that target Asian carp during spawning and their early life history.

Asian carp are generally found in high-productivity systems. Because these filter-feeding fish rely largely on zooplankton and phytoplankton as food resources, it has been hypothesized that they might actively associate with areas of higher productivity where food resources are more abundant. Biologists with INHS are identifying such areas by sampling throughout the Illinois River and CAWS for nutrient concentrations, chlorophyll concentrations, and zooplankton abundance, as well as examining relationships among these variables and abundances of Asian carp and other planktivorous fishes. This may ultimately indicate areas where Asian carp are more likely to occur and where sampling and removal efforts should be concentrated. Moreover, as the factors affecting phytoplankton and zooplankton dynamics in rivers are poorly understood, this information will also help improve our general knowledge of large river ecology.

Jason Stuck, graduate student at Eastern Illinois University, left, and John English of INHS, right, remove bighead carp from a trammel net on the Illinois River. Photo by Steven Butler, INHS Kaskaskia Biological Station

Because Asian carp have the ability to reduce densities and alter the composition of plankton communities, INHS scientists are attempting to evaluate the direct and indirect effects of Asian carp on native fishes and food webs. Stable isotopes provide a long-term, integrated record of an organism's diet, and thus are useful for studying trophic relationships among organisms. Stable isotope analysis using carbon ($\delta\ ^{13}C$) and nitrogen ($\delta\ ^{15}N$) will be used to examine both contemporary and historic food webs in the Illinois River. Contemporary food webs will be sampled as part of gear evaluation sampling from sites where Asian carp have become abundant and from sites beyond the Asian carp "invasion front." Historic samples will be obtained from specimens in the INHS fish collections. These fish will be from recent pre-invasion (10–20 years ago) collections taken from sites where current sampling is also occurring. The use of both historic and geographic references will allow us to compare invaded and non-invaded food webs while controlling for natural temporal variability. These analyses will provide an examination of niche overlap between Asian carp and native planktivores, and for an examination of the potential cascading effects of Asian carp on other trophic levels. The results of these studies will help guide management decisions regarding Asian carp throughout the Mississippi River basin and will offer some empirical evidence that can be used to predict the effects of Asian carp should they become established in the Great Lakes.

Steven E. Butler, Jonathan A. Freedman, Matthew J. Diana, and David H. Wahl, Illinois Natural History Survey

Illinois Natural History Survey Reports is published semi-annually by the Illinois Natural History Survey, 1816 South Oak Street, Champaign, IL 61820. Headquartered on the campus of the University of Illinois at Urbana-Champaign, the Survey is a division of the University of Illinois Prairie Research Institute.

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ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

Reports

Winter 2012
No. 407

INSIDE

The Origins of Ornamental *Acalypha*

Many ornamental plants are brought directly into cultivation from the wild, with good documentation of the domestication process. In other cases, however, it is difficult to determine the origins of garden plants. The three ornamental species of *Acalypha*, a widespread genus of about 450 species (6 in Illinois) in the spurge family (Euphorbiaceae), provide examples of the latter situation. Recent research by INHS botanist and *Acalypha* expert Geoff Levin, conducted with his colleague Victor Steinmann of the Instituto de Ecología, Pátzcuaro, Mexico, and former graduate student Vernie Sagun, has clarified the origins of these commonly cultivated plants.

Copperleaf has many forms, some with contorted leaves like this one, others with colorfully patterned leaves. Photo by Geoff Levin, INHS

Two shrubby *Acalypha* species, chenille plant (*A. hispida*) with its bright red, showy catkins and copperleaf (*A. wilkesiana*), grown because of its colorful, often variegated and curiously shaped leaves, have been in cultivation for many years. Chenille plant was first reported in the scientific literature in 1767 and copperleaf in 1866, both from plants collected in Melanesia where European and American explorers found them already in cultivation. Interestingly, neither is known from the wild, apparently having been domesticated by the Melanesians long before European exploration of the region. Indeed, chenille plant cannot grow in the wild because it has only female flowers and thus produces no seeds; it is propagated entirely by cuttings. Levin and his coworkers used DNA sequencing to examine the relationships of these species and found that they are extremely closely related, perhaps even derived from the same wild species. This is consistent with reports of fertile hybrids between chenille plant and copperleaf (with copperleaf always the male parent, of course!). As expected, the wild relatives of both plants are found in Melanesia and nearby southeast Asia.

*Chenille plant (*Acalypha hispida*) has showy spikes of fertile female flowers.* Photo by Hickory Rose, Creative Commons

The third ornamental *Acalypha*, which won the British Royal Horticultural Society's Award of Garden Merit in 2002, is commonly called strawberry firetails for its bright red, erect spikes of female flowers. The first report of this perennial herb in the literature stated that it had "sprung from nowhere" in the middle 1980s and the earliest specimens were collected from gardens around that time. Reflecting the mystery of its origin, strawberry firetails has been called various scientific names, all of which clearly apply to different species.

Continued on back page

Environmental Stress Makes Mosquitoes More Competent Vectors

When the term "stress" is mentioned, the first thing that comes to mind is the frustrations associated with our daily lives. These may include missing an important appointment due to stalled traffic or the agony of paying a late fee for a missed credit card loan. However, stress is more than just life inconveniences. All living organisms are frequently exposed to some form of environmental stress that may impair fitness and increase disease risk. These may include thermal stress, intra- and interspecific competition, risk of predation, and exposure to toxicants. Our own health provides a perfect example of how stressful environments may influence disease risk. Stressed individuals have compromised immune functions that predispose them to various sorts of maladies. For example, the greatest burden of some major life-threatening human diseases such as HIV/AIDs, malaria, and tuberculosis is concentrated in sub-Saharan Africa where people experience a variety of environmental stressors including starvation, malnutrition, shortage of clean water, crowding, and frequent displacements due to political instability. It is costly to maintain an immune system and stressed individuals may lack sufficient energy to mount effective immune responses, making them more vulnerable to diseases. Using this line of argument, it is reasonable to assume that environmental stress should increase the risk of disease transmission. However, stress may at the same time decrease host survival, resulting in rapid removal of the pathogen from the population or impact negatively on the pathogen leading to increased recovery rates of infected individuals. These opposing effects make it difficult to predict how a particular environmental stressor may impact disease transmission.

Just like humans, mosquitoes experience stressful environmental conditions in the course of their development. These stressors may range from exposure to toxicants, intra-and interspecific competition, threats from predators, and temperature fluctuations. The aquatic stages of mosquitoes are more vulnerable to these stressors because unlike the adult stage, they do not have the capability to fly and escape the harsh conditions in their breeding habitats. Although mosquitoes are among the most important vectors of human and wildlife diseases, we have a poor understanding of how environmental conditions they experience during immature development affect the capability of subsequent adults to transmit pathogens. The focus of previous research has mainly been on the impact of environmental stressors on the adult stage but a growing body of knowledge has shown that conditions of the larval environment are equal or more important determinants of adult mosquito capability to transmit pathogens.

Our long-term goal is to evaluate how different types of environmental stressors encountered by mosquito larvae influence the capability of adult mosquitoes to transmit arthropod-borne viruses (arboviruses) such as West Nile Virus (WNV). In one of our recent studies, we reared larvae of the yellow fever mosquito *Aedes aegypti* either under optimal conditions or under one of four environmental stressors; suboptimal nutrients, starvation, thermal stress, and sublethal dose of malathion. We then exposed the resulting adults to Sindbis Virus (SINV) by allowing them to feed on SINV-infected blood meal and measured how these stressors influenced adult mosquito susceptibility and potential to transmit SINV. We found that in general, stressed mosquitoes had enhanced capability to transmit SINV compared to unstressed mosquitoes (Fig. 1). These findings suggest that conditions of the larval environment contribute more to arbovirus transmission than currently appreciated. Similar effects of different stressors on vector competence suggest a general mechanism for enhanced competence. From the point of view of mosquito control, any human activity that stresses but does not kill mosquito larvae may make them more competent vectors as adults.

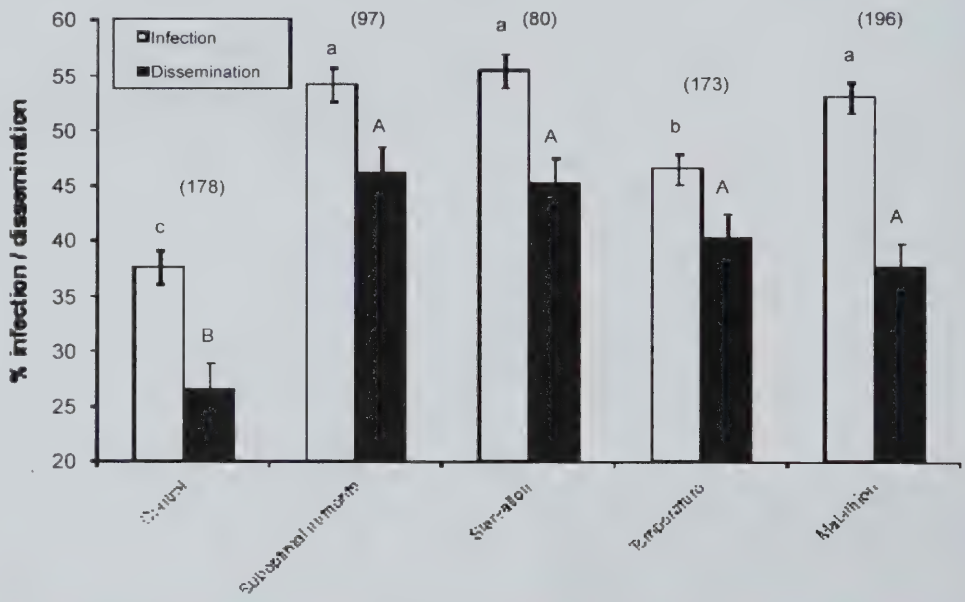


Figure 1. LS means (±SE) percent infection and dissemination grouped by treatment. Numbers associated with means represent the total mosquitoes tested. Means followed by different lower and upper case letters show significant differences for pair-wise comparisons. This figure has been published in Muturi et al. 2011, Trop Med Inter Health 16:955–964.

Ephantus J. Muturi, INHS

Status Assessment Survey for Springtails (Collembola) in Caves of Illinois' Salem Plateau

Caves contain unique habitats populated by specialized, endemic invertebrates. Despite the harsh conditions of subterranean life, caves are vulnerable to invasion by exotic species, with potentially devastating effects on native communities. To detect changes in the health of cave invertebrate communities, we must first develop baseline information on species diversity.

Springtails are small insectlike arthropods commonly found in soil, leaf litter, and caves. Many cave springtails exhibit adaptations to subterranean habitats and may be indicators of the health of cave communities. However, knowledge of the springtails of Illinois caves is incomplete. Four of Illinois five karst regions have been partially surveyed for springtails; 60% of those reported are known from single caves, and fully 88% are restricted to a single karst region.

To develop baseline information on the diversity and abundance of springtails in Illinois caves, we surveyed eight caves in the Salem Plateau of southwestern Illinois. We evaluated several sampling protocols including: pitfall traps, Berlese funnel processing of plant litter, quadrat and drip pool sampling, bait stations, and random searches.

Pitfall trapping, hand collections, and Berlese funnel extractions accounted for 85% of the specimens and 45% of the species collected. Examination of drip pools produced only 2% of the specimens, but 30% of the species identified. Future studies of Illinois caves should utilize pitfall traps, Berlese funnels, examination of drip pools, and hand collections, as these are the most effective sampling methods for cave springtails.

Steve Taylor and Felipe Soto conducting quadrat sampling at Illinois Caverns. **Photo by JoAnn Jacoby, UIUC**

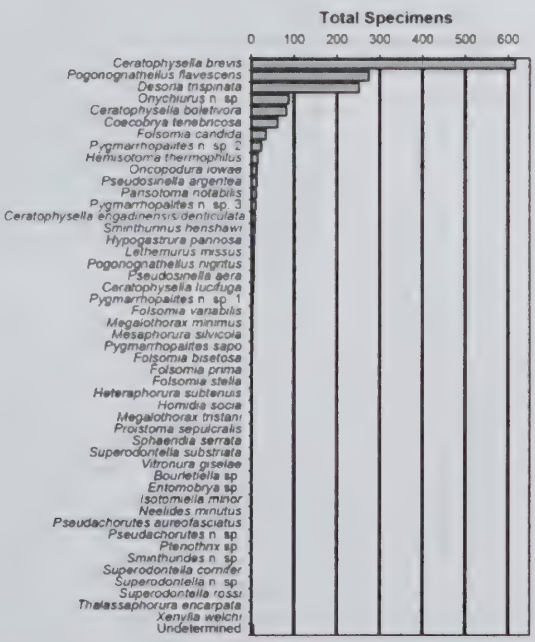
In total, 49 species of springtails were found, 7 of which are new to science, with 8 others representing new state records. This more than doubles the number of springtails species known from caves in the Salem Plateau. More than half the species were ranked as rare at the state level (i.e., S1–S2). For some species, this ranking may reflect incomplete sampling, but others (*Pygmarrhopalites* spp.) are rare regional endemics. Interestingly, the most common species of Entomobryidae, *Coecobrya tenebricosa*, appears to be an introduced, invasive species of a genus otherwise known from Asia. *Coecobrya tenebricosa* is the only member of the *Sinella-Coecobrya* complex found in our study, but further south, in Illinois' Shawnee Hills, there are several native, cave-adapted *Sinella* species that could be threatened by *C. tenebricosa*.

Three springtail species accounted for 71% of all individuals collected, whereas 49% of the species were represented by only one or two specimens. Based on the observed diversity and endemicity, we determined that protecting six of the eight caves would preserve 95% of the species. Protecting three caves — Wanda's Waterfall Cave, Stemler Cave, and Wizard Cave — would provide some protection for 75% of the species. The two caves with the least conservation value, Illinois Caverns and Hidden Hand Cave, are those most impacted by human visitation.

Coecobrya tenebricosa, *the most common member of the family Entomobryidae in the caves surveyed, appears to be an introduced, invasive species.* **Photo by Felipe N. Soto, INHS**

Our sampling is incomplete, and we estimate that the true number of species lies in the range of 60 to 105, implying that 11 to 56 springtail species remain undetected in caves of this region. Clearly, additional species and state records will be found as more caves are examined.

Felipe N. Soto-Adames and Steven J. Taylor, INHS



Individual frequency distribution of species collected in eight caves in the Salem Plateau region of Illinois.

River Otter Reintroduction Programs Successful, But How Are They Impacting Prey Species?

Although the North American river otter (*Lontra canadensis*) was once abundant in Illinois, unregulated harvest and habitat degradation caused its numbers to decline dramatically throughout the Midwest. By the 1980s, fewer than 100 river otters remained in Illinois, with one remnant population in the extreme northwestern corner of the state and possibly another in the extreme south.

During the 1980s and 1990s, state conservation agencies translocated more than 2,000 river otters to the lower Midwest (IA, IL, IN, KY, MO), including 346 individuals in Illinois. Track and sign surveys suggest that their numbers are increasing and that they are expanding their range. Using demographic models, Illinois' population of river otters was estimated to have increased to 4,600 by 2004 and 11,000 by 2009.

The resurgence of the river otter in an ecosystem that functioned without it for more than 150 years could have implications for other species, especially those less tolerant of anthropogenic changes and predation. For example, European otters (*Lutra lutra*) have been considered an obstacle to the recovery of endangered salmonids in Denmark and endangered mussels in Poland. In Illinois, river otters were reported to have killed 9 of 30 two-year-old alligator snapping turtles (*Macrochelys temminckii*) released in 2009 as part of a recovery program. Furthermore, because of complicated species interactions, river otter predation on nonthreatened species may have unexpected effects on nonprey species. For example, increased predation on a given fish species might lead to an expected increase in that fish's prey.

During 2011, the legislature granted authority for a trapping season in Illinois. The Illinois Department of Natural Resources (IDNR) is in the process of satisfying legal and logistical prerequisites for opening a season in 2012–2013. The trapping season may allow for a reduction in otter numbers, particularly in areas where their numbers may be negatively impacting other species.

Dr. Damian Satterthwaite-Phillips, a postdoctoral research associate in the lab of Dr. Nohra Mateus-Pinilla at the Illinois Natural HIstory Survey (INHS), a division of the Prairie Research Institute of the University of Illinois, is developing quantitative tools based on fatty acid analysis to determine the river otter's diet in Illinois. Also collaborating are Drs. Jan Novakofski (UIUC Departent of Animal Sciences), Kevin Cummings (INHS), and Robert Bluett (IDNR). The literature on the river otter diet from other locations is based on observational data, gut and scat contents and suggest that the majority of the otter's diet is made up of fish and crayfish. In some locations, frogs make up a sizeable proportion of the diet. Otters are also known to eat other small reptiles and amphibians, insects and their larvae, mollusks, and waterfowl, though these are generally thought to make up a smaller portion of the diet.

However, the existing methods for inferring the otter's diet have limitations. Unfortunately, gut and scat analysis only reflect recent foraging and are biased because prey without scales, bones, or exoskeletons are more completely digested and less likely to be detected in scats and gut contents. Observational studies report mollusks as part of the river otter's' diet, but their overall contribution cannot be inferred from scat or gut content samples alone.

*A North American river otter (*Lontra canadensis*) peeking out of the water.* Photo courtesy of Ivan Petrov, UIUC

As numerous mussel species are already threatened or endangered in Illinois, one of our goals is to assess the contribution of mussels to the otter's diet and the threat that otters may pose to their conservation and survival.

To compensate for the shortcomings in scat and gut-content analyses, and to evaluate the contribution of shellfish to the otter diet, they will use quantitative fatty acid analysis (QFASA). QFASA is a technique capable of providing high resolution in differentiating diet species.

Continued on next page

River Otter

continued from previous page

Unlike scat and gut-content analyses, fatty acids (FAs) reflect diet over a longer time span. Because many fatty acids move up the food chain intact, a predator's FA profile is a proportional representation of its prey.

The accuracy of the QFASA has been tested experimentally. The QFASA was applied to the diet of grey seals (*Halochoerus gyrpus*) and mink (*Neovison vison*) with known controlled diets, and the QFASA inferred the diet correctly. The QFASA has already been used to determine the diet of several whale and seal species. Experiments with harbor seals in Prince William Sound (PWS), Alaska, demonstrated that QFASA was able to determine not only the specific fish species in the diet of seals, but could also determine the size class of the fish, and the location within PWS from which they came. This reflects the ability for the QFASA to provide fine-detailed resolution of the diet.

One of the underlying assumptions in the QFASA is that individual species can be identified according to their fatty acid profiles. To test this hypothesis, we ran a principal-components analysis on published fatty acid profiles from 46 individuals from 5 different species, including two geographically distinct populations of ringed seals. All data for a given species formed distinct clusters, as did the two populations of seals. This provides additional support that fatty acid profiles can indeed make fine distinctions, identifying not only species, but even sub-species accurately. While fatty acids are not evenly distributed throughout the body, the fatty acid profile is somewhat dependent on the location on the body from which the fat sample is collected. (This is partially because certain body regions, like extremities are more strongly affected by cold.) Using the same published data, our principal-components analysis demonstrated that different fat deposits provide different signals, but species- and subspecies-level clustering still occurred (see Figs. 1a and b below). The use of a principal-components analysis will allow them to determine if there is any overlap in fatty acid profiles by species. Such species will not be separable by the QFASA and will have to be grouped together. However, both published data and our preliminary results indicate that this is unlikely to be a serious problem.

From left to right: Postdoc Damian Satterthwaite-Phillips and undergraduates, Matthew Aardsma, Samantha Carpenter, Katie Monick, and Nicole Deeke preparing for a routine necropsy of a river otter.

Photo by Elizabeth Buckingham, INHS

Over the last year, Dr. Nohra Mateus-Pinilla's lab has received 65 otter carcasses from IDNR, representing incidental otter deaths from throughout the state. With the collaboration of Dr. Kuldeep Singh from the Veterinary Diagnostic Laboratory at the UIUC College of Veterinary Medicine, students from Drs. Novakofski's and Mateus-Pinilla's labs have been performing routine necropsies and collecting tissue samples that include adipose samples used for this research. Additional fat samples will continue to be collected as opportunistic otter necropsy samples allow.

One of our future goals is to infer the otter's diet both in terms of larger taxonomic levels (e.g., the proportion of fish, mollusks, amphibians, etc.), as well as at finer resolutions for select species, and perhaps subspecies, especially for those such as freshwater mussels that may be threatened by predation. We also expect to identify regional and seasonal variations in the otter diets, and to provide data to wildlife managers that will allow otters to be managed to minimize the adverse effects on their prey species.

Damian Satterthwaite-Phillips, Nohra Mateus-Pinilla, and Kevin Cummings (INHS); Bob Bluett (IDNR); Jan Novakofski and Singh Kuldeep (UIUC)

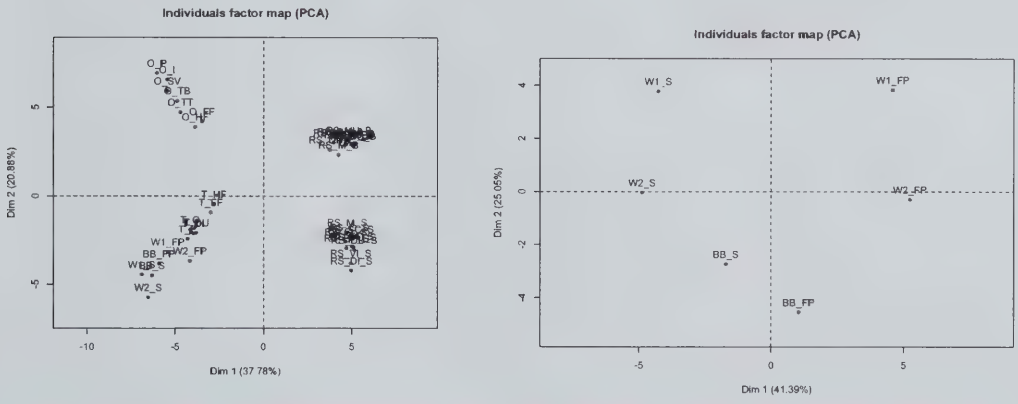


Figure 1 (a & b) The figure on the left shows a PCA using multiple fat depots from multiple species and subspecies. Here we see clear separation of each species: the upper left data points (beginning with O) are from different otter depots, and the two clusters on the right (RS) represent different subpopulations of ringed seals. The lower left quadrant has a clear raccoon dog (also known as a "tanuki") cluster (T), and wolf (W) and brown bear (BB) clusters. (b) Although wolf and brown bear overlap when comparing all data at once (left), they separated clearly when examining only these data (right). In the right-hand graph, it can be seen clearly that the first principal component (the left-right split), divides the data by fat depot—all data points on the right are from forepaw (FP) depots, and the left are all subcutaneous (S) torso depots. The second principal component (top-bottom gradient) separates the two species, as well as the two individual wolves (W1, W2) investigated here.

Species Spotlight

Horned Larks

Charles Helm and Susan Post

What creature builds its home on prairies, golf courses, sandy shores, or near airports, can survive in the Arctic tundra as well as the deserts of the southwest, and is as much at home at high altitudes as at sea level? If you answered, "humans and Horned Larks," you are correct.

Like humans, the hardy Horned Lark (*Eremophila alpestris*) is a year-round resident of Illinois. In the autumn and winter, flocks of Horned Larks often gather in harvested fields and along country roadsides to glean spilled grain and weed-seeds. Blending well with their background, a flock communally feeding on such a roadside treat may temporarily scurry further to the side or simply crouch quietly if annoyed by a passing car. But when truly alarmed by a predator or the occasional human interloper, the entire group takes off in a low undulating pattern, voicing a few faint tinkling calls as they flit from harm's way.

A Horned Lark. Photo courtesy of the U.S. Fish and Wildlife Service

Without doubt, the birds' most distinctive features are the two erect feathers on their heads, which from a distance resemble horns—hence their common name. Their faces and throats are yellowish-white with black chest bands, black masks, and black forehead bands highlighting the horns. Otherwise, Horned Larks are rather inconspicuous—a little smaller than a robin with plumage that varies considerably throughout their range.

Horned Larks are one of the earliest nesters of Illinois resident birds. They often build their nests in February and it is not unusual for their first clutches of eggs to be destroyed by a late winter or early spring storm. Fortunately, these birds are persistent breeders that can hatch two, three, and even four broods in a single season. The Horned Lark nest is built in a hollow in the ground and is lined with fine grass. These birds often pave the area next to one side of the nest with small flat stones upon which they can stand—a kind of avian patio. Horned Larks lay three to five grayish white eggs almost uniformly covered with brown spots—an ideal camouflage. Eggs are incubated for 11 to 14 days by both parents. The Horned Lark is unusual in that it prefers barren areas with short grass for its nesting sites. This may be one reason it breeds so early in the year—so it can hatch and raise its young before the grass around the nest becomes too high.

So, if you are like the Horned Lark and prefer wide open spaces any season of year, then winter is a perfect time to get to know these feathered neighbors. Flocks of up to a 100 are easy to spot in harvested fields and barren stretches of land. Listen for their unusual, high-pitched tinkling song, and if you're observant you'll see their telltale horns too. Horned Larks may not have the flash of a cardinal or the raucous call of the blue jay, but they definitely add a welcome bit of life and fun to our, otherwise austere, winter landscapes.

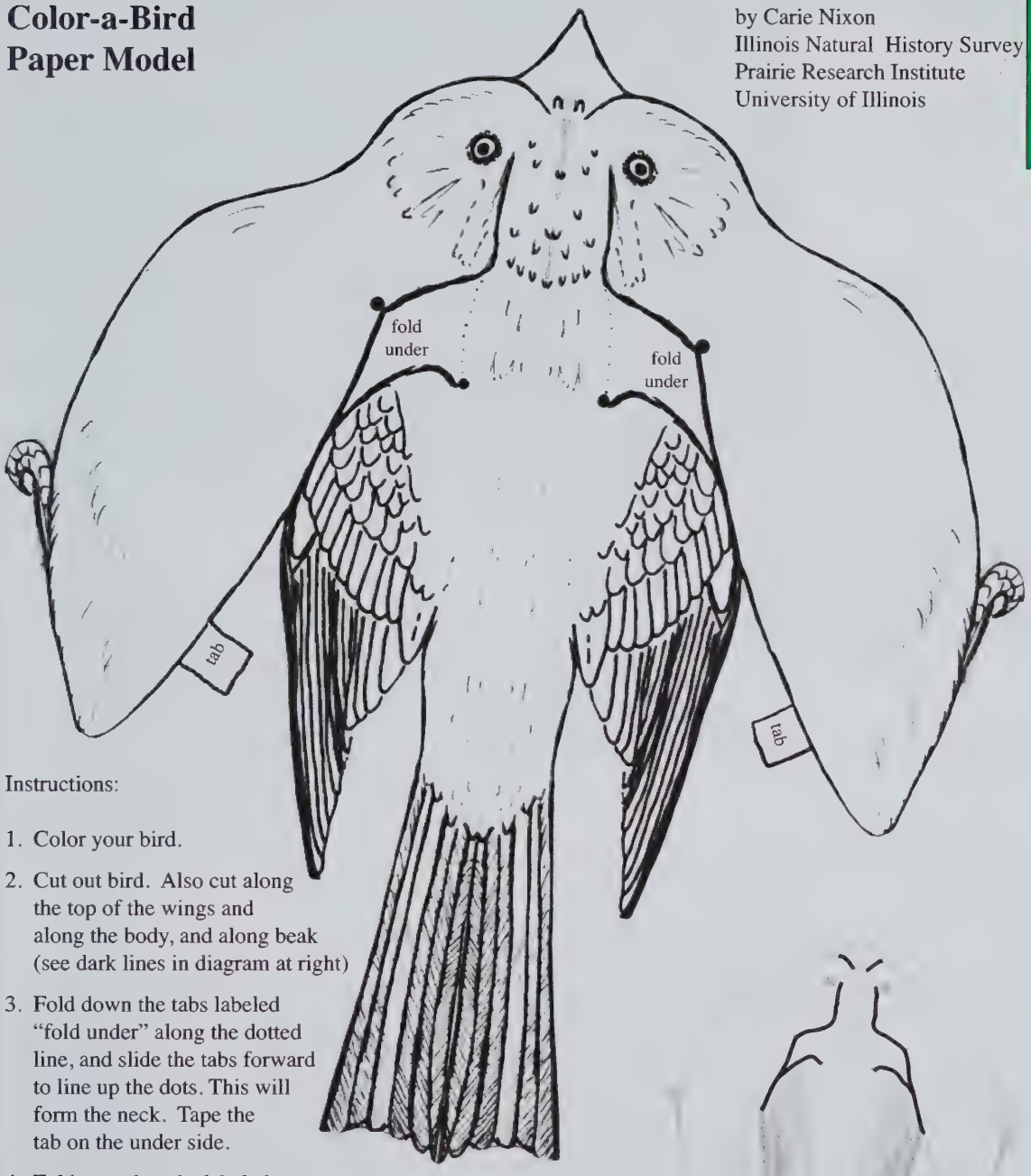
The Naturalist's Apprentice

Color-a-Bird Paper Model

Carolyn Nixon

Color-a-Bird Paper Model

by Carie Nixon
Illinois Natural History Survey
Prairie Research Institute
University of Illinois



Instructions:

1. Color your bird.
2. Cut out bird. Also cut along the top of the wings and along the body, and along beak (see dark lines in diagram at right)
3. Fold down the tabs labeled "fold under" along the dotted line, and slide the tabs forward to line up the dots. This will form the neck. Tape the tab on the under side.
4. Fold over the tabs labeled "tab" and tape them underneath the body. Then roll a small piece of tape into a tube and place near the tail-end of the body so the right and left sides meet.
5. Crease the beak along the center.

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Acalypha

continued from front page

Armed with their knowledge of *Acalypha* and the tools of modern systematics, Levin and his coworkers set out to determine the origins of strawberry firetails and its correct scientific name. Their first step was to sequence the plant's DNA and compare it with other *Acalypha* species. They found that the DNA was similar to that found in a group of species from southern South America, but it did not exactly match any *Acalypha* species among the many they had studied. As Levin and his colleagues were discussing their results, he realized that strawberry firetails strongly resembles *A. herzogiana*, a species from Argentina and Bolivia they had not yet sequenced. Close examination showed that they share some features not found in any other *Acalypha* and are in fact virtually indistinguishable. They differ only in that at the branch tips where wild *A. herzogiana* has spikes of male flowers, strawberry firetails produces its showy spikes of female flowers. (Like chenille plant, strawberry firetails is entirely female, but differs in having both showy spikes of flowers and inconspicuous flowers like most other acalyphas, including *A. herzogiana*.) After some searching, Levin and his coworkers located a fairly recently collected herbarium specimen of *A. herzogiana* and were able to sequence its DNA. To their delight, it proved to be identical to that of strawberry firetails, conclusively showing that they are the same species.

*Strawberry firetails (*Acalypha herzogiana*) has showy but sterile female flowers where its wild ancestor has male flowers.* **Photo by Victor Steinmann, Instituto de Ecología, Pátzcuaro, Mexico**

So how did strawberry firetails originate? It appears that a plant of *Acalypha herzogiana* underwent a mutation that changed its male flowers into female flowers. These transformed flowers retain many male characteristics. Not only are they arranged on the plant in the same way as the male flowers of *A. herzogiana*, but like male *Acalypha* flowers they also have four sepals, whereas normal female *Acalypha* flowers, including the inconspicuous ones of strawberry firetails, have three sepals. Furthermore, unlike normal female *Acalypha* flowers, which have a single pistil consisting of an ovary topped by three stigmas, they have eight pistils, each consisting only of a stigma, borne in the positions occupied by the eight stamens in male *Acalypha* flowers. Thus the mutation appears to act by converting stamens into stigmas. Chenille plant's superficially similar female spikes are also organized like male *Acalypha* spikes but consist of normal female flowers and probably arose via a quite different mutation.

Levin and his coworkers studied the ornamental species of *Acalypha* as part of a larger project examining the evolution of the genus worldwide, with support from the National Science Foundation.

Geoffrey A. Levin, INHS

Illinois Natural History Survey Reports is published semi-annually by the Illinois Natural History Survey, 1816 South Oak Street, Champaign, IL 61820. Headquartered on the campus of the University of Illinois at Urbana-Champaign, the Survey is a division of the University of Illinois Prairie Research Institute.

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ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

Reports

Summer 2012
No. 408

INSIDE

Spillway Escapement of Muskellunge

INHS Fisheries Technician Dan Schermerhorn with a muskellunge. **Photo by Max Wolter, INHS**

Many of the quality recreational fishing opportunities in Illinois occur in reservoirs. Fish emigration from reservoirs during periods of overflow is termed "dam" or "spillway escapement." Escapement can detract from recreational fishing opportunities in the reservoir and can disturb downstream ecosystems by creating an influx of unwanted and/or non-native fish. Previous research on spillway escapement has been limited, but existing studies highlight the magnitude of the issue. In a two-year period, 10,000 largemouth bass, sunfish, and bullheads were estimated to have escaped from a 65-hectare lake in Illinois. Another study showed losses of up to 30% annually for a largemouth bass population.

A simulated spillway.
Photo by Max Wolter, INHS

Muskellunge are stocked by the Illinois Department of Natural Resources (IDNR) into over 30 lakes across Illinois. Escapement of muskellunge is observed and reported from many of these reservoirs. In some instances, high-density muskellunge populations persist in tailwaters below spillways, presumably supported by annual influxes of escaping fish, and are popular angling destinations. In smaller tailwaters, however, prey and oxygen resources are often not adequate to support these large predators and high rates of mortality can occur.

The Illinois Natural History Survey (INHS) recently began a research project aimed at gathering data that would further our understanding of muskellunge spillway escapement and lead to management solutions. A laboratory study incorporating a simulated reservoir and spillway was conducted to observe escapement under varying levels of ambient light, turbidity, habitat, and flow. Conventional thought going into this project was that escapement predominantly occurred at night when muskellunge are largely inactive and situate high in the water column. However the laboratory study revealed that escapement was more likely to occur during the day when muskellunge activity rates are high.

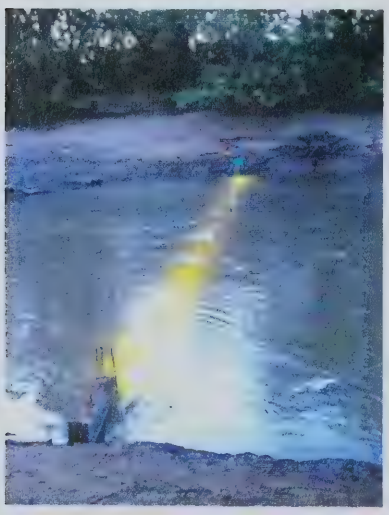
The INHS was also interested in collecting real-time data on escapement of muskellunge in the field. Passive integrated transponder (or PIT) tags are often used in fisheries research and management to differentiate among individuals. These tags can be as small as a grain of rice and are inserted into the body of the fish. Typically, PIT tags are read when a fish is recaptured using a handheld wand to "excite" the tag, which then transmits a unique numeric code. An antenna

Continued on back page

Environmental Contaminants in Asian Carp from the Illinois River

Silver (*Hypophthalmichthys molitrix*) and bighead (*Hypophthalmichthys nobilis)* carp, two invasive species of cyprinid native to Asia, escaped from aquaculture facilities in the lower Mississippi River basin in the 1970s and rapidly spread throughout the river system. Populations of these Asian carp in the Illinois River increased dramatically in the 1990s, to the point where they caused safety concerns for boaters and became a potential detriment to native fish populations. Concerns that the carps would reach Lake Michigan through greater Chicago waterways led to implementation of measures designed to decrease the likelihood of that occurring. One such measure is to commercially harvest the fish in order to reduce their populations. This has led to the creation of markets for Asian carp to make commercial fishing for them an economically viable activity.

In addition to use as a protein source for animal feed and fertilizer, Asian carp from the Illinois River are now served in high-end restaurants ("silverfin"), provided as a protein source for needy people, and, ironically, shipped to China for human consumption. There are also continued efforts to introduce the fish into the diets of the typical U.S. consumer.



Experimental electrical barrier designed to prevent Asian carp from migrating from the Illinois River into Lake Michigan. **Photo from INHS Image Archives**

Based on the result of a pilot study we conducted in 2005 (Environ Monit Assess. 2009 157:211-22), we determined that mercury (Hg) was present in some individuals of both species at levels that would trigger consumption advisories. Selenium (Se) levels in some fish exceeded the FDA tolerance levels for feed additives (0.3 ppm), and given consumption of a large meal of these individuals, could exceed the recommended daily allowance of selenium for pregnant woman (60 µg/day). Concentrations of arsenic (As) and Se also differed by species and location. Polychlorinated biphenyls (PCBs) were detected in a few fish in our pilot study, and detectable concentrations were well below the FDA action level of 2.0 ppm in the edible portion of the fish.

A larger study was needed to better quantify the effects of species, size, and location on contaminant burdens in Asian carps. Therefore, we measured concentrations of As, cadmium (Cd), Hg, Se, PCBs, chlordane, hexachlorobenzene (HCB), hexachlorocyclohexane (HCH), polybrominated diphenyl ethers (PBDE), and fluorinated compounds (FLC) in fillets (skinless) and samples of ground bighead and silver carp from a number of locations on the Illinois River. This allows state agencies to better assess the risks associated with the use of these species as a commercial protein source.

We collected 120 fillets from silver and bighead carp during 2010 and 2011 from the Alton, LaGrange, and Peoria pools of the Illinois River. We also took samples of whole, ground carp from the Alton, LaGrange, Peoria, Starved Rock and Marseilles pools.

Concentrations of elements differed by pool and species, but were not of concern as animal feed. Mercury in fillets was below the FDA Action Level and EPA Screening Value for recreational fishers, and was comparable to levels in low-mercury commercial food fish such as pollock and catfish. Mercury concentrations in some larger fish fell within more conservative guidelines for consumption restrictions. Arsenic was below detection in most fillets, although some were within thresholds for consumption limits. Concentrations of selenium, an essential element, were not of concern.

Researchers at the INHS Great Rivers Field Station sample bighead and silver carp in the Mississippi River with trammel nets. **Photo courtesy of INHS Great Rivers Field Station**

Organochlorine pesticides were detected in over half of the whole fish samples; concentrations increased in bighead, and decreased in silver, carp, respectively, moving upstream. Chlordane predominated the organochlorine pesticides we measured, perhaps not surprisingly as the state of Illinois issues fish consumption advisories for this chemical. Chlordane concentrations in some fish exceeded the FDA limit for animal feed. Lindane (and isomers) and HCB concentrations were not of concern. Pesticides were below detection limits in most fillets, and concentrations were similar across pools.

Polychlorinated biphenyls are synthetic chemicals that were widely used as insulating and hydraulic fluids and were banned in the U.S. in 1979 due to their persistent and toxic characteristics.

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Asian Carp

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Mean PCB concentrations were higher in bighead carp than in silver carp; however, the maximum value in whole fish was in a silver carp. This value approached the USDA tolerance level for PCBs in animal feed. Total PCBs generally increased upstream in both species, and dramatically so in silver carp fillets from above the Alton pool. The greater Chicago area provides a large source-area for contaminants, thus increased concentrations of industrial pollutants like PCBs in fish collected further upstream is not surprising. PCB concentrations were well below the FDA Action Level and were lower than in many commercially available fish such as salmon. Some fillets, primarily silver carp, fell within sportfish consumption advisory levels for sensitive cohorts. Some fillets, including all but one from silver carp, were above the Do Not Eat threshold for cancer health endpoints (U.S. EPA).

Polybrominated diphenyl ethers (PBDE) are flame-retardants that are virtually ubiquitous in the environment. Consumers of wild fish are exposed to PBDEs, and, although health risks to humans from consumption of PBDEs are not clear at this time, exposure to low doses of these compounds has produced endocrine and neurodevelopmental abnormalities in animal models. PBDE concentrations in our whole fish samples generally increased upstream. Concentrations of PBDEs in fillets were very low and highly variable. Concentrations of deca- and penta- forms, considered two of the most problematic, did not exceed the maximum acceptable oral dose

Fluorinated compounds (FLC) are stick- and stain-resisting chemicals used in a variety of consumer products. FLCs are recently emerged contaminants that are present in fish in the upper Mississippi River and Great Lakes, and fish consumption is a source of human exposure. Health effects of exposure in humans and animal models include modulation of the endocrine system and developmental abnormalities. Fluorinated compounds in our samples were present in very low concentrations and were well below the Minnesota Department of Health's sportfish meal advisory.

Overall, concentrations of environmental contaminants that we measured were low and of little concern. However, it is noteworthy that individual fish may contain levels that exceed consumption thresholds and that concentrations of some chemicals differ between the species and among pools, and between the two types of tissues we examined. These findings should be considered when developing recommendations for use and consumption of Asian carp from the Illinois River.

Jeff Levengood, Dave Soucek, Amy Dickinson, Greg Sass, and John Epifanio, INHS

INHS Human Dimensions Research Program

The Human Dimensions Research Program at the Illinois Natural History Survey conducts social research throughout Illinois and North America on various issues affecting wildlife management, ecosystems restoration, and environmental health. Our clients include the Illinois Department of Natural Resources, other state and federal agencies, as well as private foundations. We are dedicated to enhancing stakeholder values and the perceptions they hold in respect to specific problems involving wildlife and natural resources management. Our projects focus on the social-psychological aspects of conservation issues by identifying potential sources for conflict and determining management solutions preferred by various concerned segments of the public. The Human Dimensions Research Program strives to better our understanding of the complex nature of decisions concerning resource management. Using a variety of research approaches, including mail and Internet surveys, we gather data from stakeholders on specific issues of interest. A portion of our projects involves investigating harvest, participation, and attitudes toward wildlife management of hunters and trappers for the Illinois Department of Natural Resources under longstanding contractual agreements. The balance of our studies focuses on public perceptions and support for policies regarding natural resources management, such as wildlife diseases, water quality, and land management. We provide quantitative and qualitative social science data based on scientific survey methods to assist decision makers in understanding the complex perspectives of stakeholders.

Hunters in the field representing our hunter harvest survey. **Photo by Mark Alessi**

INHS grad students Elizabeth St. James (L) and Molly Spacapan (R) processing mail survey responses. **Photo by Mark Alessi**

Craig Miller, INHS

Sharpshooting for Chronic Wasting Disease Control Has Minimal Effects on White-tailed Deer Reproduction

In 2002, chronic wasting disease (CWD) was first found in white-tailed deer (*Odocoileus virginianus*) populations in northern Illinois (Fig. 1). CWD is a spongiform encephalopathy, similar to "mad cow" disease and Creutzfeldt-Jakob disease in humans. Like these diseases, CWD is caused by an infective misfolded protein, or prion that causes degenerative damage in the central nervous system, and is always fatal. At present, there is no cure for CWD, and although the specific routes of transmission are unclear, infective prion proteins have been found in saliva, urine, and feces of deer, any of which might have infective agents.

Figure 1. Comparison of deer showing symptoms of chronic wasting disease (left), and a healthy deer (right). **Photo on left by Dr. Terry Kreeger, reprinted with permission of the Chronic Wasting Disease Alliance. Photo on right by Macomb Paynes, courtesy of the U.S. Fish and Wildlife Service.**

Controlling CWD is important for at least two reasons. First, although the probability of natural transmission from deer to other animals is exceedingly low, it is known from experiments that CWD can cross the species barrier and infect other animals. Second, without control, CWD would spread, reducing the overall health of deer herds. This would impact deer hunting, which is an important source of revenue for the state of Illinois, provides recreation for many hunters, and helps with the management of natural resources that support other native species.

To manage CWD, the Illinois Department of Natural Resources (IDNR) implemented a control strategy based on identification of infected sites followed by a sharpshooting program aimed at reducing deer densities at locations where CWD has been found.

The sharpshooting season occurs from mid-January until mid-March. IDNR biologists collect fetuses from the sharpshot animals during this time of the year. Examining fetuses allows researchers to study the effects of localized CWD management on reproduction. While sharpshooting is a necessary means for CWD control, it is important to assess whether it has had reproductive consequences in white-tailed deer.

University of Illinois researchers, Drs. Nohra Matteus-Pinilla, Damian Satterthwaite-Phillips, Mary Beth Manjerovic, Michelle L. Green, and Jan Novakofski (from the Illinois Natural HIstory Survey (INHS) and the UI Department of Animal Sciences) have been investigating these questions. Using a data set from eight years of sharpshooting (2003–2010), including data from over 2,800 does and 3,600 fetuses, they analyzed whether sharpshooting affected: (1) overall and age-specific pregnancy rates; (2) number of offspring per pregnant doe—litter size; (3) fetal sex ratios; (4) fetal mass as an indicator of overall health of the mother, as well as an indicator of the likelihood of the newborn fawn surviving; and (5) population structure measured as the proportion of different age classes (fawns, yearlings, and adults). They analyzed these parameters in response to the average number of deer sharpshot annually over 8 years at 53 different locations. Across locations and time, sharpshooting varied in intensity from 0 – 72 does culled annually.

They found that the proportion of fawns in the sample increased as sharpshooting intensity increased (Fig. 2). However, even at the highest sharpshooting intensity, the number of fawns in the population only increased by10% compared to no sharpshooting. The wide

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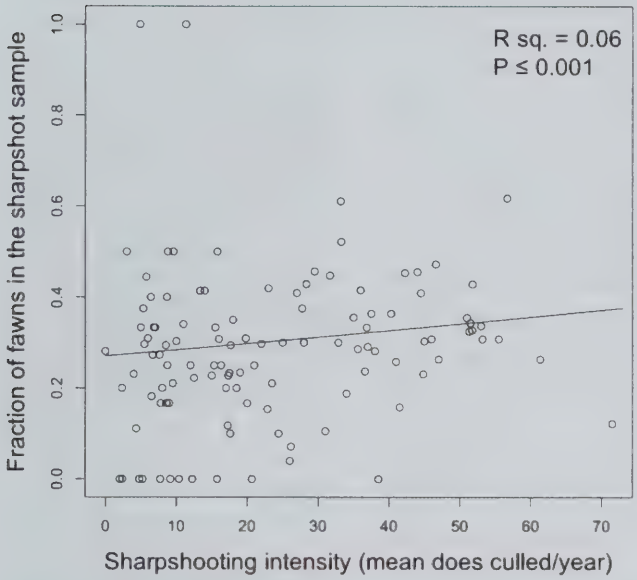


Figure 2. Proportion of fawns in the sample in response to sharpshooting intensity. The line represents a generalized linear model fit by least squares. Fawns make up 27% of the population when no sharpshooting has occurred, and increases to only 37% at the highest sharpshooting intensity. The poor fit of this model (r2 = 0.06), indicates that sharpshooting does a poor job at explaining the variation seen in the proportion of fawns.

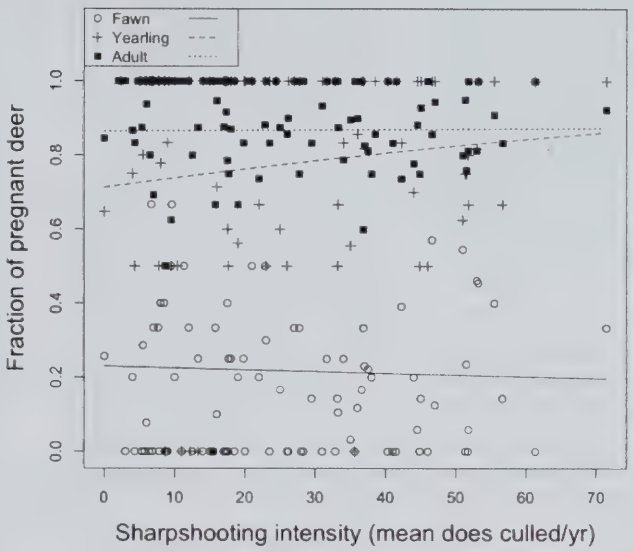


Figure 3. Age-specific pregnancy rates in response to sharpshooting intensity. The increase in yearling pregnancy rates was significant (p = 0.04). The changes in adult and fawn pregnancy rates were not significant.

distribution of points around the model line indicate that factors other than sharpshooting can cause much of the variation seen in the proportion of fawns here.

Pregnancy rates (number of pregnant does / total number of does) and mean litter sizes (average number of fetuses per doe) decreased slightly as sharpshooting intensity increased. These changes could be attributed to the increase in fawns. There are two reasons for this. First, many fawns are not yet mature enough to reproduce, so a smaller proportion becomes pregnant than older deer. Second, when fawns do become pregnant, they tend to have smaller litter sizes than older deer. Thus, more fawns results in both lower overall pregnancy rates and mean litter size. However, sharpshooting did not affect age-specific pregnancy rates for either adults or fawns, although pregnancy rates increased for yearlings as sharpshooting increased (Fig. 3).

Fetal sex ratios did not change significantly in response to sharpshooting. Fetus size has been shown to correlate with both adult size and probability of survival while total fetal mass has been considered an indicator of health of the doe and the resources that she is able to allocate to reproduction.

The findings of this study indicate that individual fetus size was not significantly affected by sharpshooting. As expected, older mothers tended to have more and larger fetuses and total fetal mass also increased with the mother's age. These findings also indicate that total fetal mass increased slightly with increased sharpshooting, independent of mother's age or litter size. Comparing the highest sharpshooting intensity to no sharpshooting, the increase in total fetal mass was 4% for single-fetus litters, and 2% for litters of two or more.

Because of the type (actual fetuses) and size of the data set, the researchers were able to detect small differences in reproductive parameters associated with sharpshooting with high statistical confidence. Still, observed changes were small indicating that the impact of sharpshooting on reproduction has been minimal. Considering the small impact of sharpshooting and the fact that it is a very localized event, occurring only within about a two-mile radius of known CWD-positive deer, sharpshooting is expected to have an even smaller impact on the deer populations at a larger geographical scale. The researchers recommend continued monitoring of reproductive characteristics as sharpshooting continues, adding an evaluation of the temporal changes in hunter-harvested deer to monitor long-term effects on reproductive parameters.

Damian Satterthwaite-Phillips and Nohra Matteus-Pinilla, INHS; Michelle L. Green and Mary Beth Manjerovic, INHS and UIUC Animal Sciences; Jan Novakofski, UIUC Animal Sciences

Species Spotlight

Ticks

Jen Mui

This time of year we all love to be outside, hiking through the woods and grasslands, exploring the diversity of life around us. After spending a day watching birds and butterflies soar, seeing bumble bees fly from flower to flower, and listening to frogs sing, we return home only to find that unexpected visitors have hitched a ride on us or on our beloved dog. Ticks!

The mention of ticks brings a shudder to many, but this diverse and often misunderstood group deserves our attention. For years, when I discovered a tick, I would simply remove it and put it in a vial of alcohol to save for the Illinois Natural History Survey (INHS) Entomology Collection or an educational display. I never gave them much consideration, until this year, when for the first time, there was a red circle surrounding an attached tick on my shoulder. As I began reading about ticks and tick-borne diseases, I realized I had discovered a fascinating group of organisms and the potential consequences of encountering them.

Although many people think of ticks as insects, they are actually arachnids, more closely related to spiders and scorpions. Adult ticks have four pairs of legs and no antennae. Ticks cannot jump or fly, only crawl to the edges of plants where they wait for an animal to pass by. Holding onto the vegetation with their hind legs, they stretch their front legs to detect and grab onto the next host. The Haller's organ, found on the forelimbs of a tick, enables it to sense changes in temperature and humidity as well as increases in carbon dioxide from an animal exhaling.

Approximately 20 species of ticks occur in Illinois, divided in to two groups, the "soft bodied" and the "hard bodied." "Soft" ticks typically feed on birds and bats so we rarely encounter them. The "hard" ticks commonly found in Illinois are the American dog (wood) tick, blacklegged (deer) tick, lone star tick, and the brown dog tick.

Typical bull's-eye rash that resulted from infection by a black-legged tick. **Photo by Jen Mui, INHS**

The "hard" tick requires three blood meals to complete its life-cycle, which can take up to three years. Ticks feed by plunging their hypostome (a rodlike structure with barbs) into the host animal. The barbs on the hypostome keep the tick from being easily removed. Most ticks also secrete a gluelike substance that cements the tick in place until it is done feeding. Once engorged, the tick removes its hypostome, falls off the host, goes underground, and transforms to the next life stage.

The "hard" tick hatches as a tiny, six-legged larva and after feeding on the blood of an animal, transforms to an eight-legged nymph. The nymph must find another animal to feed on before molting to its adult form. After the adult finds a meal, the female lays eggs and the process begins again.

Because an individual tick must feed on several animals throughout its life cycle, they are capable of transmitting certain diseases from one animal to another. Tick-borne diseases include Rocky Mountain spotted fever, tularemia, Lyme disease, babesiosis, anaplasmosis, and ehrlichiosis.

It is important to note that most ticks are not infected with these pathogens, but some regions may have a higher level of infection potential.

Ticks are found in shaded, humid areas in a variety of habitats including woodlands, grasslands, and urban areas. Black-legged (deer) ticks are the main vector of Lyme disease to humans, dogs, and other animals. This species was believed to be most common in wooded areas, acquiring *Borrelia burgdorferi* (the bacteria that causes Lyme disease) from white-footed mice. Recent research by INHS wildlife epidemiologist Nohra Mateus-Pinilla and Jennifer Rydzewski found that in the fragmented landscape of central Illinois, where forests are limited, prairie voles are serving as hosts to the *Borrelia burgdorferi* bacteria. This additional host allows the bacteria to survive in open habitats as well as the forest. This research has shown that there is still much more to learn about these beguiling creatures.

Four Species of Hard Tick

*American dog ticks, (*Dermacentor variabilis*) are the most commonly encountered ones in Illinois. Adults are active from April to September and can carry the pathogens for Rocky Mountain spotted fever and tularemia.* **Photo by Jen Mui, INHS**

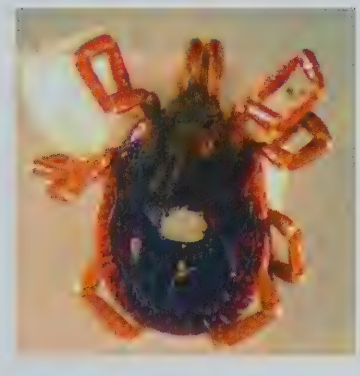
*The black-legged tick (*Ixodes scapularis*) is present year round and can carry the pathogens for Lyme disease, babesiosis, and anaplasmosis. All life stages of the black-legged tick will bite humans, dogs, and other animals.* **Photo by Jen Mui, INHS**

The Naturalist's Apprentice

Keeping Yourself Tick Free While Exploring the Outdoors

Jen Mui

*The lone star tick (*Amblyomma americanum*) is found from April through fall and all stages will bite humans. The lone star tick can carry the pathogens for Rocky Mountain spotted fever, tularemia, and erlichiosis.* **Photo by Jen Mui, INHS**



*An engorged brown dog tick (*Rhipicephalus sanguineus*) rarely bites humans and is not an important carrier of diseases for humans. This tick is a tropical species and unable to survive outdoors during Illinois winters.* **Photo by Jen Mui, INHS**

Keeping Yourself Tick Free While Exploring the Outdoors

There are so many things to see out in nature, and fear of ticks should never be a reason to avoid exploring. Taking proper precautions while enjoying the outdoors can greatly decrease your risk of being bitten by a tick.

Step 1: Preventing Tick Bites

- Wear light colored clothing to make it easier to spot ticks.
- Wear long pants tucked into your socks and secured with duct tape.
- Use a bug spray containing DEET.
- Stay on trails and avoid overhanging brush where ticks might be.

Step 2: Inspecting Yourself for Ticks

Even with the above precautions, there is still the possibility of bringing home a tick.

- Carefully inspect yourself and your pets for any ticks, paying extra attention to warm moist areas such as armpits, waistlines, etc.
- Wash your clothing immediately to prevent ticks on clothing from biting later.

Step 3: Removing a Tick

If a tick has attached to your skin, do not panic. While not all ticks carry diseases, it is important to remove a tick as soon as you notice it to decrease the chance of infection.

- Using fine-point tweezers, grab the tick as close to the skin as possible. Avoid squeezing the body of the tick as that may force its contents into your body.
- Gently and repeatedly tug until the tick releases from your skin.
- The tick can be saved in a jar of alcohol for identification or killed and flushed down the toilet.
- Clean the bite area as you would any insect bite and watch the area over the next several weeks for signs of a spreading rash.
- If a rash appears or flulike symptoms occur, consult your doctor and tell them that you were bitten by a tick (it is helpful to still have the tick in a vial of alcohol for identification).

For more information about ticks in Illinois see:
http://www.inhs.illinois.edu/outreach/animals/ticks.html

ILLINOIS NATURAL HISTORY SURVEY
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Spillway Escapement

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capable of reading PIT tags was installed on the spillway at Lake Sam Dale, Illinois. A tag interrogator and datalogger along with a battery to power the system were housed nearby. Fish were sampled and tagged in early spring and a population estimate for the lake was acquired. The antenna was activated as soon as water began to top the drop-box style spillway of the lake.

During the spring of 2011, the Lake Sam Dale spillway had almost continuous overflow for two months between March and late April. When examining tag detections by the antenna, we determined that during this period of time 21% (24 of 117) of the muskellunge that were tagged in the lake escaped over the spillway. Our sampling estimates indicated that there were 190 muskies inhabiting the lake at the beginning of the season. By extrapolating the 20% escapement rate, we estimated that about 40 muskellunge had escaped in 2011. Tag numbers recorded by the antenna were matched to fish survey data and showed that escapement was mostly restricted to adults as 22 of the 24 escaping fish were age 3 or older. There was no difference between sexes as male and female fish escaped in proportions very similar to those observed in the general population. Time stamps for each tag detection revealed that, like in the lab experiments, a majority of escapement happened in the daytime or evening hours. Heavy rain in the fall produced several days where the amount of overflow was comparable to that observed in the spring, but no muskellunge were shown to escape during this time.

A PIT tag antenna at Lake Sam Dale, Illinois. **Photo by Max Wolter, INHS**

Understanding the magnitude and mechanisms of escapement is important as this phenomenon could be one of the primary factors structuring and limiting sportfish communities in reservoirs. Initial conclusions are that adult muskellunge are more likely to escape than juveniles, and escapement happens more often during daytime when the fish are more active. Additionally, seasonal timing and the disproportionate escapement of adults indicate that escapement may be related to post-spawn behavior, making fish less susceptible to it in the fall. The data generated by these studies could be used to develop a variety of management practices to mitigate or limit spillway escapement, including the improved application of nets and physical barriers, adjustment of stocking rates, and alternative spillway designs and dam operation procedures.

Max Wolter and David Wahl, INHS

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ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

Reports

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No. 409

INSIDE

Conservation and Management of a Rare Carnivorous Plant, *Pinguicula ionantha*, in the Florida Panhandle

Pinguicula ionantha *is found in sandy open areas and in shallow standing water.*
Photo by Jean Mengelkoch, INHS

It has been estimated that 600 species of carnivorous plants, belonging to 9 families and 19 genera, exist worldwide. Carnivorous plants are unique among flowering plants for their ability to capture and consume prey using highly derived traps. Such adaptations have allowed them to thrive in habitats with nutrient-poor soil such as bogs and fens in the temperate zone. Based on data generated by the International Union for the Conservation of Nature, of the 102 carnivorous plant species that have been evaluated, half, including members from the genus *Pinguicula*, are threatened due to natural and anthropogenic habitat changes.

A closer look of Pinguicula ionantha *leaves with prey.*
Photo by Jean Mengelkoch, INHS

Approximately 80 species of *Pinguicula* occur throughout the world. All have a rosette of carnivorous leaves and multiple stalks consisting of a single flower. Six of these species (*P. caerulea, P. ionantha, P. lutea, P. planifolia, P. primuliflora,* and *P. pumila*) are located in the Florida panhandle. Five of them are listed as endangered at the state level and one, *Pinguicula ionantha* R.K. Godfrey (Godfrey's butterwort, Lentibulariaceae), also is listed as a federally threatened species. Populations of *P. ionantha* are restricted to herb bog communities in the wet flatwoods of six Florida counties along the Gulf Coast.

Prior research indicates that wet flatwoods are very sensitive to burn regimes and require a burn cycle of every two to three years to maintain ecosystem health. In the absence of fire, more aggressive species outcompete *P. ionantha*. While the effect of fire on *P. ionantha* has been addressed, research to understand specific biological and ecological interactions, such as plant-pollinator and plant-prey interactions, are absent and require immediate action to prevent further species decline.

In collaboration with Eastern Illinois University, Augustana College, the U.S. Bureau of Land

Continued on back page

The Illinois River Valley Provides a Haven for Shorebirds During Fall

The Illinois River valley (IRV) hosts hundreds of thousands of migrating shorebirds during late summer and early fall. Shorebirds passing through Illinois come from as far away as the Arctic, and may be headed to the U.S. Gulf Coast or portions of Central and South America. Populations of many shorebird species appear to be declining in North America, and the quality of stopover habitats may be a contributing factor. Many shorebird species forage on mudflats or in shallow water with little or no vegetation. These wetland conditions can be abundant in the IRV during late summer and fall as backwater lakes, moist-soil wetlands managed for ducks, and floodplain areas of the Illinois River de-water and expose mudflats rich in benthic invertebrates.

During late summer and fall 2007–2008, we measured food resources available to migrating shorebirds in the IRV. Additionally, we experimentally collected four species of shorebirds (Killdeer [*Charadrius vociferus*], Least Sandpiper [*Calidris minutilla*], Pectoral Sandpiper [*Calidris melanotos*], and Lesser Yellowlegs [*Tringa flavipes*]) to determine body condition and food use and selection. We located foraging flocks of shorebirds, watched them feed for ≥10 minutes, and collected focal individuals using shotguns. Immediately after collection, we preserved ingested food and collected core samples at the foraging location and a random location within the same wetland. We obtained morphological measurements for each bird and identified, enumerated, and weighed invertebrate foods found in the digestive tract and in core samples.

Using morphological measurements to calculate condition indices, we determined that all species except Killdeer were in good to excellent condition. Shorebird diets were dominated by invertebrate taxa from the Orders Diptera (fly larvae) and Coleoptera (beetles). Invertebrate biomass at foraging and random sites was generally similar, indicating that birds did not select foraging sites within wetlands based on overall invertebrate biomass. Conversely, we found considerable evidence for selection of some invertebrate taxa within particular foraging sites, and consistent avoidance of aquatic worms (Order Oligochaeta). Overall, the dry mass of potential invertebrate foods in the IRV was 51.2 kg/ha, more than 25 times than what is assumed to be available by U.S. Fish and Wildlife Service regional conservation plans.

In this study, shorebirds did not appear to select habitats based on overall biomass of individual foods (third-order selection); however, they did appear to select several invertebrate taxa and consistently avoided aquatic worms (fourth-order selection). We suspect that potential food was so abundant in the IRV that shorebirds did not need to select foraging sites, but were able to select certain food items within foraging sites that were preferable. We suggest shorebirds may forage opportunistically when food densities are low, but may become more selective when food densities are high. Additionally, shorebirds were abundant on privately owned wetlands, especially those managed for dabbling ducks. Many privately owned wetlands are currently not assumed to contribute to estimates of foraging habitat availability for shorebirds and are seldom surveyed. Thus, the IRV may support far greater numbers of shorebirds during fall migration than previously assumed.

Lesser Yellowlegs and Pectoral Sandpiper using mudflats at Chautauqua National Wildlife Refuge. **Photo by INHS Forbes Biological Station staff**

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Shorebirds

continued from previous page

Although the Illinois River and associated wetlands have been highly modified and habitat has been eliminated or severely degraded for many species, mudflats appear to provide abundant and high-quality habitats for shorebirds during the fall. Future research should examine spring migration ecology, or further investigate how current wetland management and flood pulses affect shorebird abundance, distribution, and stopover duration in the IRV.

Randy Smith, Joshua Stafford, Aaron Yetter, Michelle Horath, Chris Hine, Heath Hagy, INHS

Lesser Yellowlegs collected and processed by Aaron Yetter. **Photo by INHS Forbes Biological Station staff**

In Memoriam — Don Webb

In September, the Illinois Natural History Survey said goodbye to longtime Entomologist/Insect Systematist Don Webb, who passed away on September 5th at the age of 73. Dr. Webb joined the survey in 1966 and was actively involved at INHS even after his retirement in 2007. Don pursued his interests in systematics and ecology of aquatic, semi-aquatic, and terrestrial insects all over the world. He was an author of nearly 100 journal articles, book chapters, monographs, and proceedings. In addition to his career in science, he was a musician and an avid sports fan. He played racquetball, softball, golf, and pool.

Don was born on July 12, 1939, in Brandon, Manitoba, to Orville and Ivy Webb. He married his high school sweetheart, Lois (Kelly) Webb on May 12, 1961; she survives.

Also surviving are daughters, Janice (Mark) Wettstone and Diane (David) McClain; grandchildren, Maggie McClain, Bradley McClain, Evan Wettstone, Ryan (Laura) McClain and Christopher McClain; great-grandchildren, Tyler and Aiden McClain.

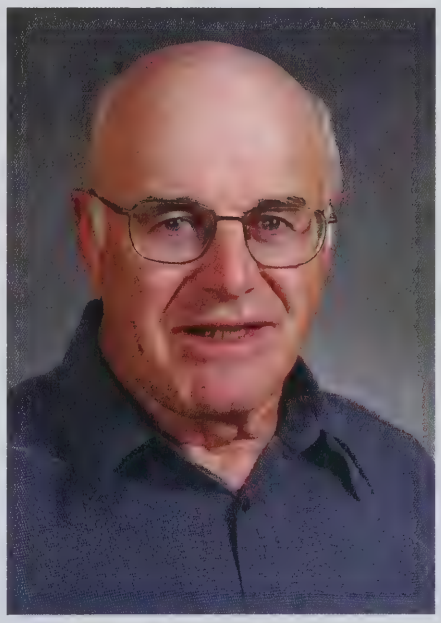


Photo from INHS Image Archives

He was preceded in death by his parents and brother, Barry.

Don earned his Bachelor and Master of Science degrees from the University of Manitoba. In 1981, he earned his Ph.D. from the University of Illinois. He garnered the North American Benthological Society (NABS) Distinguished Service Award in 1999.

Don served the Society of Freshwater Science as Chair of the Literature Review Committee for nearly 30 years and, in collaboration with Ron Hellenthal, was responsible for converting the annual bibliography to a searchable database.

Rosemary Mackay wrote in her history of NABS ". . . Don liked to come across as a crusty curmudgeon but he always had a twinkle in his eye to let everyone know that it was all in good fun."

And, Don had a rejoinder to Will Rogers' saying that "I never met a man I didn't like." A bumper sticker on Don's office door stated, "Will Rogers never met Bobby Knight."

Don was the life of any gathering whether professional meeting, INHS luncheon, or watercooler encounter. Almost always, you left his presence with a smile. He was a character in every sense of the word.

Biofuels Production and Mosquito Populations

There is a growing interest in biofuels as the alternative solution to the world's energy needs. In the U.S., the major biofuel is ethanol derived from corn. Because corn production requires more fertilizers and pesticides than any other major U.S. food or biofuel crop and energy inputs that may limit the desired energetic benefits over fossil fuels, there is increasing interest in biofuel crops that can produce high-energy yields per hectare under low-input methods. These "second generation" biomass feedstocks, which include several perennial grasses, may offer economic and environmental advantages by requiring less energy, water, fertilizers and pesticides, as well as increasing carbon sequestration and improving habitat for wildlife. *Miscanthus* (*Miscanthus* x *giganteus*) and switchgrass (*Panicum virgatum*, Fig. 1), are among the leading candidates for second generation biomass feedstocks, which require fewer inputs and offer increased yields over "first generation" biomass feedstocks such as corn. Restored native prairie polycultures have also been targeted because they are well adapted to the climate and soils of the central U.S., require fewer inputs, and offer substantially higher conversion efficiency than corn.

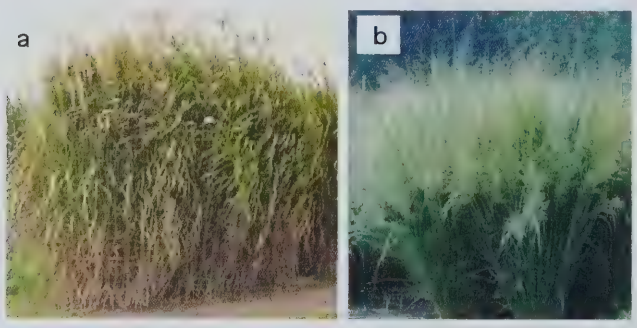


Figure 1. Second generation biofuel crops: a) Miscanthus *and b)* swtichgrass. **Photo courtesy of Ephantus J. Muturi, INHS**

Land-use changes associated with biofuel production may have detrimental environmental impacts. Conversion of forests and grasslands into biofuel crop lands could increase carbon emissions. Marginal lands that were long economically unattractive for cultivation (but very important as refuges for biocontrol agents and other wildlife) are under consideration for biofuel production as the value of existing croplands increases. There is further concern that biofuel production will decrease global food supplies by diverting land, water, and energy away from food production.

Ecological changes associated with biofuel production can also affect human health by altering the transmission dynamics of vector-borne diseases. Transitions from one crop to another can alter the local microclimate and create new breeding sites that may favor production, survival, and development of vector populations, such as mosquitoes. The chemical and nutritional composition of surrounding aquatic habitats may also be altered by inputs of senescent tissues of biofuel plants, affecting their suitability as breeding sites for vector mosquitoes. Further, ecological changes associated with crop transitions may influence vector diversity and abundance by changing the availability and density of preferred vertebrate hosts (the blood meal sources). For example, the establishment of row crop agriculture has decreased the diversity of associated avian populations, while providing forage for large flocks of bird species that are highly competent reservoirs for West Nile Virus (e.g., Common Grackles and American Crows).

This study used a model system consisting of the yellow fever mosquito *Aedes aegypti* (Fig. 2) and the Asian tiger mosquito *Aedes albopictus* to examine the effect of first generation (corn) and second generation (switchgrass and *Miscanthus*) biofuel crops on mosquito survival and oviposition site selection. We conducted oviposition choice experiments where blood-fed females were housed in paperboard cages and provided access to three oviposition cups containing leaf infusions of one of three biofuel crops. First instars of the two species were also reared in infusions of the three crops at varying intra- and interspecific densities (*Ae. aegypti*: *Ae. albopictus*; 10:0, 20:0, 40:0, 10:10, 20:20, 0:40, 0:20, and 0:10). Both mosquito species laid significantly fewer eggs in *Miscanthus* compared to the corn infusion (Fig. 3). In addition, *A. aegypti* females laid more eggs in the switchgrass infusions than in the *Miscanthus* infusions. These findings provide evidence that biofuel crops can potentially influence the population dynamics of vector mosquitoes by altering the attractiveness of aquatic habitats to gravid females. Further, although corn infusion was the best oviposition attractant, significantly fewer larvae survived to adulthood in the corn infusion compared to the switchgrass and *Miscanthus* infusions. Thus, it appears that attraction of gravid females to corn infusions might present an "ecological trap," a phenomenon that occurs when there is a mismatch between habitat attractiveness and its value for survival and reproduction. This was unexpected because corn is composed of rapidly degrading starches that should promote microbial growth—the major food base for mosquito larvae. Corn production in the U.S. relies heavily on pesticides, and residual systemic neonicotinoid insecticide in senescent corn leaves may have contributed to the observed mortality. Further research is needed to examine this possibility, but our findings are a good starting point to address the potential impact of second generation biofuel crops on mosquito population dynamics and the risk of mosquito-borne disease.

Figure 2. Fourth instar larvae of Ae. aegypti. **Photo courtesy of Ephantus J. Muturi, INHS**

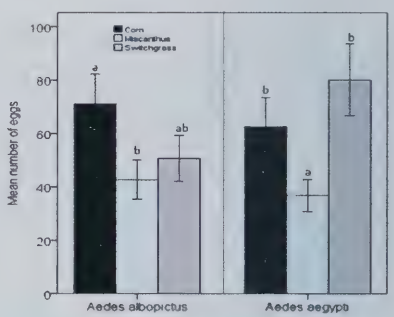


Figure 3. Mean number (SE) of Ae. albopictus *and* Ae. aegypti *eggs laid in infusion of senescent leaves of three biofuel crops.* **Graph courtesy of Ephantus J. Muturi, INHS**

Ephantus J. Muturi and Joseph Spencer, INHS; Brian F. Allan, UIUC

Monthly Visitation Rates of River Otters at Two Latrines in East Central Illinois

When Illinois achieved statehood in 1818, the North American river otter (*Lontra canadensis*) was widely distributed throughout the prairie state. However, several decades of unregulated trapping and habitat destruction left fewer than 100 river otters in Illinois by the 1980s. The population of river otters in Illinois is now estimated to exceed 15,000 individuals, following successful recovery and relocation efforts implemented by the state between 1994 and 1997.

Small mammal population estimates are often based on observation of animal signs (e.g., tracks, scat, scent marks). Otter latrines are terrestrial sites where river otters scent mark by depositing scat, urine, and glandular secretions. Data collected from latrine sites have been used as an otter population monitoring tool to improve our understanding of river otter distribution and other population characteristics. In Illinois, otter latrine surveys are conducted from August to October. Seasonal variations in visitation rates at latrine sites may influence the likelihood of detecting otter signs in a latrine during these months. The goal of this study was to compare otter visitation rates at two adjacent latrine sites in the Vermilion River Conservation Opportunity Area (VRCOA) of central Illinois.

Two adjacent latrine sites (<50 meters apart) in the VRCOA were selected based on detection of river otter scat. Latrine 1 was located on a dam close to a one-acre fish pond and Latrine 2 was located on the south bank of the Salt Fork of the Vermillion River. We expected similar patterns of visitation rates at the two latrine sites because they are in close proximity and connected by an animal-made trail used by river otters.

We placed one SPYPOINT™ PRO-X digital game camera at each latrine site to record visitation rates of the river otters (Fig. 1). We visited each site on a weekly to bi-weekly basis from August 2011 until August 2012 to collect video data and check the equipment. Visitation rates were estimated based on the number of otter sightings in the videos/month in relation to the number of working camera days (days that the camera was capable of recording data) per month. We defined a night visit as activity between sunset and sunrise, and a day visit between sunrise and sunset. Multiple otters observed in a single video were considered multiple visits (i.e., three otters in one video were classified as three visits).

We recorded a total of 183 otter visits to the two latrine sites between August 2011 and August 2012. Cameras operated for a total of 192 camera days at Latrine 1 (dam) and 188 camera days at Latrine 2 (river). Although we expected similar visitation rate patterns at the two latrine sites, this was not the case. Otter visitation rates were highest at Latrine 1 during the winter months, peaking at 2.5 visits per camera day in December (Fig. 2). On the other hand, visitation rates in Latrine 2 were highest during fall and late winter, peaking at 0.6 visits per camera day in March (Fig. 2). Months of observed peaks in visitation rates at Latrine 2 (river) were consistent with other studies of river otter latrine sites in river corridors. Visitation rates of river otters in both Latrine 1 and Latrine 2 occurred more frequently at night (Fig. 3a and 3b), consistent with previous findings of river otters in Pennsylvania, Tennessee, and Ohio.

Our results suggest a large variation in visitation rates even at latrines within close proximity of each other, highlighting the need for large-scale otter latrine studies within the VRCOA. Understanding the relationship between space use and latrine use can inform management decisions based on latrine surveys. Furthermore, evaluating river otter behavior at latrine sites could shed light on the biology that underlies seasonal variation in visitation rates at latrine sites in this region.

Katie Monick, a James Scholar student at INHS and UIUC Animal Sciences; Nohra Mateus-Pinilla, Samantha K Carpenter INHS; Michelle L. Green, INHS and UIUC Animal Sciences.

Figure 1. River otters photographed at latrine sites in the VRCOA.

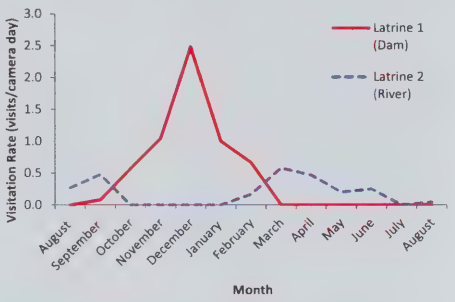


Figure 2. Monthly visitation rates of Illinois North American river otters from August 2011 to August 2012 at the VRCOA.

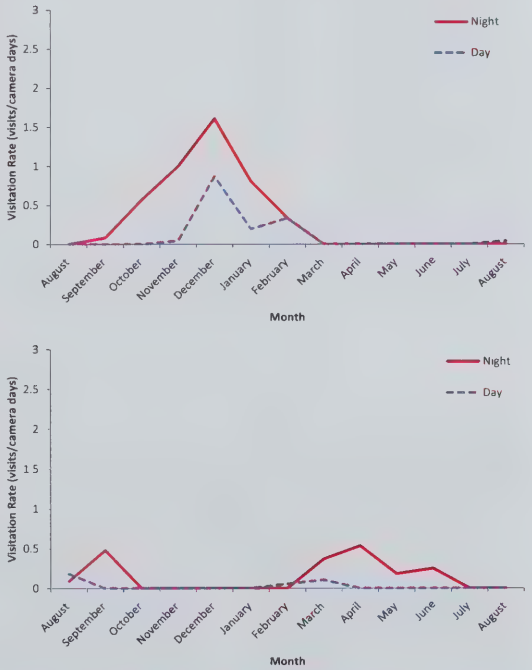


Figure 3a (top—Latrine 1) and 3b (bottom—Latrine 2). Nocturnal and diurnal visitation rates of North American river otters from August 2011 to August 2012.

Species Spotlight

Bats

Jen Mui

The silhouettes of a group of bats flying through the evening sky, swooping to capture flying insects raised many questions for me — How much do they eat? Where do they go during the day or in winter? What about vampire bats and diseases? How can I see more bats? Determined to find out, I turned to Jean Mengelkoch, a mammalogist at INHS.

Accordinig to Jean, there are approximately 1,200 bat species worldwide, all belonging to the order Chiroptera, meaning hand-wing. The wing is made up of elongated forearm and finger bones covered by a strong, thin membrane. The thumb is not covered by the membrane and has a claw to allow grasping.

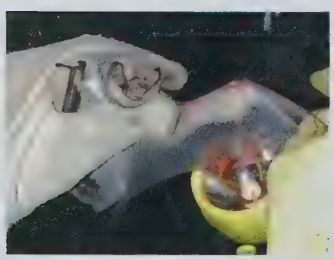
Silver-haired bat. **Photo by Jean Mengelkoch, INHS**

Approximately one-third of bat species eat fruit or nectar, serving as pollinators and seed dispersers in the process. The largest species of bat, the Malaysian flying fox, is a fruit eater, using its strong senses of sight and smell to locate food. These bats have a wingspan of over five feet.

The smallest bat species in the world is the bumblebee bat, with a body length of one inch and a wingspan of only six inches. The bumblebee bat and two-thirds of all bat species are insectivores, finding prey by echolocation —emitting sound waves and sensing their reflection. Bats have voracious appetites, with individuals capable of eating 1,000 small insects per hour. All 13 species of bat found in Illinois are insectivores and consume large numbers of insects whose larvae destroy farm crops, including cutworms, rootworms, and leafhoppers.

Big brown bat. **Photo by Jen Mui, INHS**

There are only three species of "vampire" bats, all living in Latin and South America. Unlike most bats, vampire bats are capable of walking or running, allowing them to sneak up on their prey. They do not suck the blood of their prey, rather they bite and lap up the blood, needing only about a teaspoon per meal. The saliva of these bats has a potent enzyme that is capable of dissolving blood clots, allowing blood to flow freely. This enzyme is used in medicines to dissolve blood clots in human stroke victims.



Hoary bat. **Photo by Jean Mengelkoch, INHS**

Roosting

During the spring, summer, and fall, bats roost in a variety of places — in trees, under tree bark, or in buildings and caves. Some bats, including the eastern red bat and the hoary bat, roost in solitary, while others gather in colonies. Bat feet, like those of many birds, are locked in a curved position, allowing them to hang with little effort. But unlike most birds, bats hang upside down. Scientists aren't certain why they hang upside down, but one reason might be that the leg bones are too weak to support standing. Hanging upside down also allows the bats to attain flight quickly by releasing from their roost and flapping while free falling.

Migration

Most people are familiar with birds, and even some insects, flying south for the winter. Many Illinois bat species migrate between summer habitats and caves or mines for the winter.

Some bats, including the big brown bat, are considered sedentary, traveling only short distances, if at all, between summer and winter habitats.

Regional migrants, for example the eastern pipistrelle, Indiana bat, little brown bat, and northern bat, travel between 60 and 300 miles to the nearest hibernaculum. These subterranean habitats do not have to be to the south, so some bats will even migrate north to their winter caves. Long distance migrants are capable of traveling over 600 miles and include the evening bat, hoary bat, red bats, and silver-haired bats. Some of these migrate to areas where food is still plentiful in the winter months. In Missouri, red bats will actively feed during the winter and can take shelter in the leaf litter.

Big brown bat. **Photo by Jean Mengelkoch, INHS**

Torpor

Bats have a resting heartbeat of approximately 300 to 400 beats per minute (bpm), but are capable of dropping that rate to as low as 10 bpm to conserve energy during periods of limited food resources. Some species of bat can enter this state, known as torpor, for a few hours each day during the spring, summer, and fall. During the winter, torpor can last a few days to a few weeks, with periods of arousal.

Silver-haired bat. **Photo by Jen Mui, INHS**

Diseases

Rabies is carried by less than 0.5% of wild bats, and even though this is relatively rare, NEVER touch a bat. If you find a bat flying around in your house, open the windows to allow it to fly out or if it has landed, put a pail over it and slide cardboard between the pail and the wall and take it outside to release.

If you have large numbers of bats living in your home, there is the danger of a buildup of guano that can contain histoplasmosis. Consult the Bat Conservation International Web site for suggestions. http://www.batcon.org/

The Naturalist's Apprentice

How to Help Bats

Jean Muir

Over 25% of bat species are threatened or endangered, and in Illinois, all bats are protected by the Illinois Wildlife Code. Like many other species, habitat destruction or disturbance is a problem for bats. Pesticides used in the environment may be present in the insects eaten by the bats, and lead to poisoning. Disturbances during torpor may awaken the bats, which wastes energy and fat stores, and can lead to starvation.

The increase in wind turbines across the landscape has led to an increase in bat mortality. Some bats collide with the blades, while others, caught in the vacuum formed by the blades, experience a rapid change in pressure causing the lungs to expand and capillaries to burst.

A recently discovered threat, White-nose Syndrome (WNS), appears as a fungus on the muzzle and wings of infected bats. It is transmitted from bat to bat by direct contact, but it can survive on cave walls and floors and be carried from cave to cave by humans and other animals. Over winter, affected bats awaken more frequently, wasting energy reserves leading to starvation. More than 6 million bats have been killed by WNS in North America over the past six years.

With so many threats, bats need all the help we can give them, but remember NEVER touch a bat.

Things you can do:

- Avoid entering caves where bats are roosting, especially between October and April.
- Be sure to clean any shoes, clothing, or equipment that you use in a cave before going into another cave.
- Limit your use of pesticides.
- Build a bat house.

Bat Conservation International (http://www.batcon.org) has free plans for different styles of bat houses, but here is the basic Single-chamber Bat House:

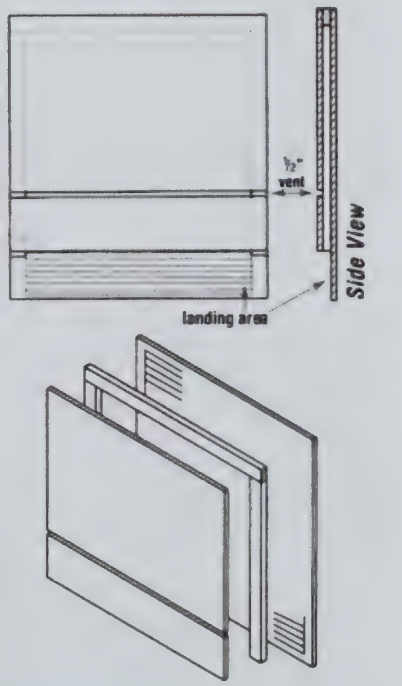
Materials (makes one house)

- 2' x 4' piece of 1⁄2"-thick outdoor grade plywood
- One piece 1" x 2" (3⁄4" x 1 1⁄2" finished) x 8' pine (furring strip)
- 20 to 30 exterior-grade screws, 1"
- One tube paintable latex caulk
- 1" x 4" x 28" board for roof
- Water-based stain

Completed bat house. **Photo courtesy of Bat Conservation International**

Instructions

- Measure and cut plywood into three pieces: 26 1⁄2" x 24" 16 1⁄2" x 24," and 5" x 24"
- Roughen inside of backboard and landing area by cutting horizontal grooves with sharp object or saw. Space grooves 1⁄4" to 1⁄2" apart, cutting 1⁄32" to 1⁄16" deep.
- Apply two coats of dark, water-based stain to interior surfaces. Do not use paint, as it will fill grooves.
- Cut furring strip into one 24" and two 20 1⁄2" pieces.
- Attach furring strips to back, caulking first. Start with 24" piece at top. Roost chamber spacing is 3⁄4".
- Attach front to furring strips, top piece first (caulk first).
- Leave 1⁄2" vent space between top and bottom front pieces.
- Caulk all outside joints to further seal roost chamber.
- Attach a 1" x 4" x 28" board to the top as a roof .
- Apply three coats of stain to the exterior.
- Cover roof with shingles or galvanized metal (optional).
- Mount on building (south or east sides usually best).



Bat house plans. **Courtesy of Bat Conservation International.**

Learn more about bats at http://www.inhs.illinois.edu/outreach/animals/bats.html

ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

1816 South Oak Street,
Champaign, Illinois
61820 USA

Pinguicula ionantha

continued from front page

Management, the U.S. Fish and Wildlife Service, the U.S. Forest Service, the U.S. Air Force, St. Joe Company, and the Florida Forest Service, we are conducting a multi-year project to better understand habitat requirements as well as biological and ecological interactions associated with *Pinguicula ionantha* and other *Pinguicula* species. During this period, we will be evaluating habitat suitability based on GIS technology, investigating plant -pollinator/prey interactions, determining population genetics, pursuing seed biology such as dormancy and seed banks, and assessing the impact of woody encroachment on reproduction.

The results of this study aim to fill gaps in the ecological understanding of *P. ionantha* and other *Pinguicula* species in order to create conservation goals and management strategies. A successful management plan will not only guarantee viable future populations, but will help to improve management decisions for all *Pinguicula* species in the area. Furthermore, these findings will broaden the ecological understanding of both rare and carnivorous plants.

Samantha Primer (MS-Plant Biology UIUC), Brenda Molano-Flores (INHS), Janice Coons (Eastern IL Univ), Jenna Annis (BS-Eastern IL Univ), Jennifer O'Brien (BS-Eastern IL Univ), and Jason Koontz (Augustana College)

A closer look of Pinguicula ionantha *flowers.* **Photo by Jean Mengelkoch, INHS**

*Woody encroachment by swamp titi (*Cyrilla racemiflora*) is affecting* Pinguicula ionantha *habitat.* **Photo by Jean Mengelkoch, INHS**

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ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

Reports

Summer 2013
No. 410

INSIDE

Occurrence of Blood Parasites in Illinois Game Birds

Avian blood parasites are found where there is suitable habitat for their vectors (i.e., mosquitos, black flies, and biting midges). They can cause mortality in both wild and captive bird populations and are known to cause lesions on the visceral tissue they invade and rupture from. While inside the host's blood cells (intracellular stage), they can induce anemia, anorexia, lethargy, depression, and death.

Infection starts with the sporozoite, a stage of the parasite found in the insect's saliva. Once the insect feeds on a bird, the sporozoites are transmitted to the host where they travel to various tissues such as liver, lung, muscle, and spleen were they replicate for several generations.

After a period of adaptation to the avian host, the parasites rupture from the tissue and enter the blood stream, invading red or white blood cells, where they grow until sexual maturity. When a biting insect takes a blood meal from an infected bird, the parasite enters the insect and mates in its gastrointestinal tract. Sporozoites are produced and later travel to the insect's salivary glands where the cycle starts again.

Our objective was to obtain preliminary data on the current prevalence and intensity of hematozoa in wild birds from Illinois. The last research in this area was conducted in 1957 in Illinois. We sampled birds that cover a wide range of habitat types, are ubiquitous throughout the state, and have economic importance to Illinois: Mourning Doves, Wild Turkeys, Wood Ducks, and Canada Geese.

Kendall Annetti about to take a blood sample from a Mourning Dove. **Photo by Samantha Carpenter, INHS**

Avian blood samples were collected through collaborations with the Illinois Department of Natural Resources, researchers at the University of Illinois Champaign-Urbana, and hunters throughout the state. Blood smears were created and analyzed under a light microscope until 10,000 red blood cells had been observed. Parasites were classified to genus; *Plasmodium, Leucocytozoon,* or *Haemoproteus* (Table 1, Fig. 1). Prevalence was

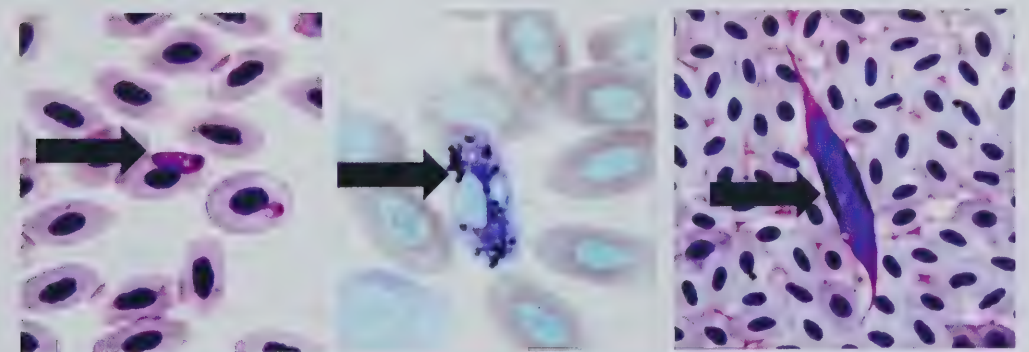


Figure 1. Three different parasite genera, from left to right: Plasmodium *spp.,* Haemoproteus *spp., and* Leukocytozoon *spp.* **Photomicrographs by Kendall Annetti, UIUC**

Continued on back page

Understanding the Effects of Asian Carp on Native Fishes

Bighead and silver carp, together known as Asian carp, are large-bodied, invasive fish species native to Asia that have become established throughout much of the Mississippi River basin. Because Asian carp are planktivores, there is great concern about their effects on native fishes. For instance, large-bodied native planktivores such as bigmouth buffalo, paddlefish, and gizzard shad have lower body condition since Asian carp became established. Understanding the influences of Asian carp on native fishes and food webs is therefore an important step towards devising effective management and control strategies, and forecasting their potential impacts in novel habitats such as the Great Lakes.

An electric barrier currently operates on the Chicago Sanitary and Ship Canal to prevent upstream migration of Asian carp from the Illinois River into Lake Michigan, and although a single bighead carp was captured in Lake Calumet (approximately three miles from Lake Michigan) in 2010 and several bighead carp were captured in Lake Erie between 1995 and 2000, there is no evidence that they have yet become established in the Great Lakes. However, if they were to successfully invade, there is concern that they could devastate the Great Lakes ecosystem and impact the associated multi-billion dollar commercial and sport-fishing industries.

To determine the effects of Asian carp on native fishes, we used controlled competition trials and field-based examination of changes in food web structure over time. In one controlled competition trial, we varied the densities of both bighead carp and native bluegill sunfish in experimental tanks to investigate the effects of both inter- and intra-specific competition. We also recorded changes in zooplankton density, macroinvertebrate density, chlorophyll-a concentration (a measure of phytoplankton abundance), and phosphorus concentration to better understand how these fish influence the entire aquatic community.

Our results were surprising. Whereas bluegill appear to exhibit density-dependent competition, the bighead carp grew larger and were in better condition when they occurred with bluegill. Bluegill rely on larger zooplankton than bighead carp; they selectively remove large zooplankters from the water column, which allowed populations of small zooplankton to increase. The increases in small zooplankton populations seemed to benefit the bighead carp, as they can filter these smaller zooplankters out of the water column. Once the large-bodied zooplankters were removed, they were unable to recover due to the filtering capabilities of the bighead carp, which resulted in a shift to smaller-bodied zooplankton populations. Unlike some species, bluegill are omnivorous and can switch to prey sources other than zooplankton; however, it is unclear if decreased zooplankton prey resources will be detrimental.

Because the biochemical compositions of different food sources vary, and these differences are passed on to consumers such as invertebrates and fish, we can use a technique called stable isotope analysis to look at changes in the ratios of different isotopes of carbon (^{12}C and ^{13}C) and nitrogen (^{14}N and ^{15}N). Together, these reveal whether a fish has been deriving nutrients from benthic or planktonic sources and where in the food chain (at what trophic level) it has been feeding. Furthermore, these stable isotope "signatures" are conserved in fishes, which have been preserved in museums for decades. Using a grant from Illinois-Indiana SeaGrant, we examined changes in stable isotope signatures of fishes from before Asian carp invaded the Illinois River (~1960 – 1980), and compared them with modern post-invasion samples (2011) to look at changes in food web structure.

The stable isotope analysis revealed that there is high overlap between Asian carp and many native species such as gizzard shad and bluegill. We also found lower observed trophic levels of most native species since Asian carp invaded. This suggests that Asian carp are altering the zooplankton community and outcompeting native fishes.

Silver carp jumping out of the water near Havana, IL. Photo by Jonathan Freedman, INHS

Continued on next page

Asian carp

continued from previous page

Smaller zooplankton are less energy efficient prey for fishes, and consuming them may thus impact not only large native planktivores, but also small minnows that provide food for sportfish such as largemouth bass. Juveniles of most fish species also feed on plankton, so recruitment and condition of all native fish species may be affected by Asian carp.

By using controlled experiments and observational field data, we found that Asian carp compete directly with native and established species and decrease their growth rates and condition. By shifting the Illinois River plankton community to a smaller size structure, Asian carp are reducing food resources for native fishes. Plankton densities are significantly lower in the Great Lakes than in the Illinois River; if Asian carp become established in the Great Lakes, competition for plankton resources may be greater and therefore have an even larger impact on native fishes than what we observed in the Illinois River. Asian carp, with their high abundance in the Illinois River and potential threat to the Great Lakes, highlight the unique problems that invasive species can pose, both to ecosystems as well as the people that depend on those systems.

Jonathan Freedman, Kirsten Nelson, Steven Butler, Matthew Diana, and David Wahl, INHS

Bighead carp at the Shedd Aquarium, Chicago, IL. **Photo by Jonathan Freedman, INHS**

Experimental tanks at Sam Parr Biological Station used for determining competition between Asian carp and native fishes. **Photo by Kirsten Nelson, INHS**

Does Larval Environment Influence the Microbial Communities in Mosquito Midguts?

Microorganisms are an indispensable component of our ecosystem. They play a primary role in regulating the biological, geological, and chemical systems in all environments. However, a small fraction of these microorganisms impact negatively on human, veterinary, and wildlife health by causing debilitating and sometimes life threatening diseases or by promoting the growth and survival of arthropod vectors. Mosquitoes are among the most important vectors that have an obligate relationship with microorganisms. Microbial communities associated with decaying organic matter serve as food for mosquito larvae, stimulate egg hatching, and provide chemical cues that enable gravid females to select oviposition sites that would promote larval growth and survival. Some of the microbes ingested by mosquito larvae colonize the mosquito midguts and provide important physiological functions including blood digestion, stimulation of the immune system, and protection against pathogens including arboviruses. Clearly, microbial communities are critical determinants of mosquito population dynamics and reproductive success and can directly influence the risk of mosquito-borne pathogen transmission. A better understanding of mosquito-microbe interactions could open new avenues for vector-borne disease management through manipulation of microbial communities. Currently, our knowledge of the composition, diversity, and abundance of microbial communities in mosquito larval habitats and midguts is limited.

Figure 1. Waste tire piles at the U of I South Farm study site, Urbana, IL. **Photo by Ephantus Muturi, INHS**

One of our current research goals is to generate knowledge that will enhance our understanding of mosquito-microbe interactions. Some of the research objectives we are addressing include: 1) identifying the microbial communities in different types of detritus and how they influence mosquito performance and the outcome of interspecific competition, 2) identifying the specific bacterial species that are utilized as food by mosquito larvae, and 3) elucidating how conditions of the larval environment influences microbial community assembly in mosquito larval habitats and midguts and associated impact on vector ability to transmit pathogens such as dengue and La Crosse viruses.

In efforts towards this endeavor, we conducted studies to elucidate how the larval environment influences the relative abundance of seven bacterial phyla/subphyla in the larval habitats and in mosquito midguts. Water samples and mosquito larvae and pupae were collected from waste tire habitats (Fig. 1) located at two study sites: Trelease Woods and South Farm in Urbana, IL. The pupae were allowed to eclose and larval and adult mosquito midguts were dissected under sterile conditions. Genomic DNA was extracted from the water samples and mosquito midguts and the relative abundance of the seven bacterial taxa was determined by rDNA quantitative polymerase chain reaction (qPCR). At both study sites, the relative abundances of different bacterial taxa were identical between the water samples and mosquito larval midguts, and completely different from adult female mosquito midguts (Fig. 2). In particular, *actinobacteria* were more abundant in water and larval midguts while Bacteriodetes were more abundant in adult female midguts. These findings appear to support previous findings that bacterial communities in mosquito midguts are acquired from the larval environment and that a significant proportion of these bacteria are lost during metamorphosis from pupae to adult. We are currently in the process of identifying these bacterial communities to species level, which will provide a more refined picture of the relationship between the larval environment and mosquito midgut microbial communities.

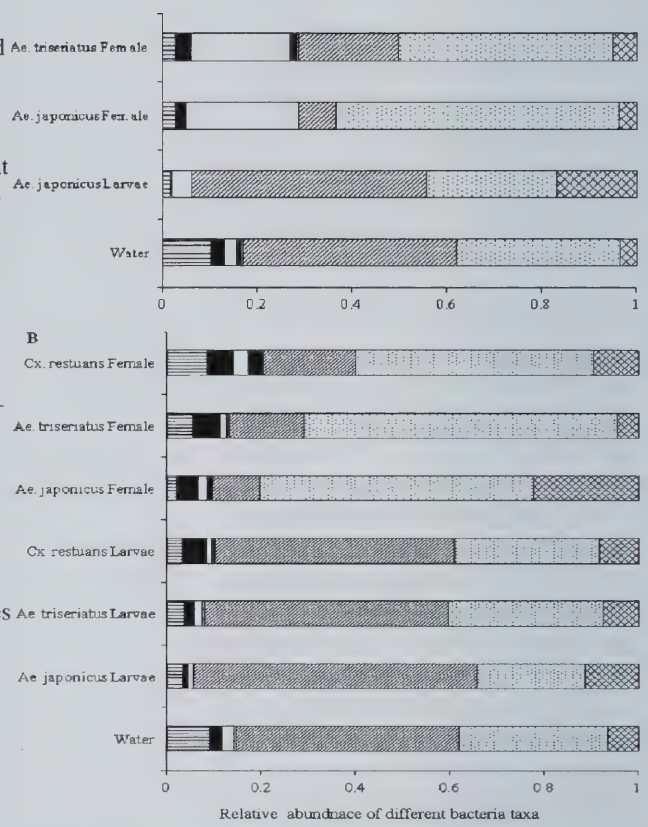


Figure 2. Relative abundance of bacterial taxa in water and mosquito samples from waste tires at A) Trelease Woods and B) U of I South Farms.

Ephantus J. Muturi and Chang-Hyun Kim, INHS

Time Flies on Ancient Wings: Insect Fossils and Their Importance

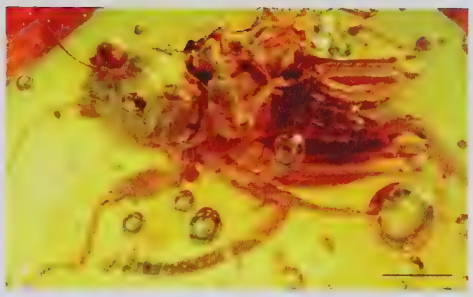
After more than 3.5 billion years of biotic evolution on our planet, one group of organisms—the insects—has surpassed all others in terms of its biodiversity. Indeed, insects are unrivalled in terms of their numbers (both of species and individuals), their morphological and ecological diversity, and their great antiquity. The earliest insects appeared over 400 million years ago during the Early Devonian and were among the first animals to conquer life on land. Since then, they have undergone numerous explosive evolutionary radiations, culminating in their truly remarkable contemporary diversity. Understanding the origins of this diversity and reconstructing evolutionary history through the study of the insect fossil record is the primary focus of paleoentomology. In fact, the study of fossil insects is essential if we are ever to understand the big picture of insect evolution, and it can shed important light on questions concerning the relationships of modern insect groups as well as provide insight into the nature of the evolutionary process itself and the effects of global environmental change.

On the whole, insects have rather low preservation potential with their chitinous exoskeletons easily broken down by microbes *post mortem*. Disintegration of insect cuticle can take place alarmingly fast and transportation of remains in water can further reduce insect bodies to a jumble of disarticulated fragments long before they reach the site of deposition. Once in a suitable body of water where incorporation into the sedimentary record can take place, the remains must first penetrate the surface tension boundary in order to sink—no mean feat for something so small—and once buried in the sediment below, survive the microbial and chemical onslaught that can rapidly decompose and obliterate their fragile bodies. Despite these seemingly insurmountable obstacles, the insects have a rich and temporally extensive fossil record reaching back over 400 million years. This record, though incomplete, serves as an archives of insect biological history—a testament to their astonishing evolutionary success and one that we have only recently started to explore.

A dragonfly (Odonata: Anisoptera) from the Early Cretaceous (~110 million years ago) Crato Formation limestone of northeast Brazil. Scale bar = 10 mm. **Photo by author**

The oldest fossil insects are tiny fragments preserved in 410 million-year-old chert from Rhynie, Scotland. We know little about the biology of these oldest insects, but we do know that they were well adapted to life on land and probably already possessed the wings that would lead to their future ascendancy. The insects were the first animals to evolve powered flight and did so at least 100 million years before pterosaurs (extinct flying reptiles that first evolved during the Triassic), 220 million years before birds (the earliest undisputed flying birds appeared during the Cretaceous), and 300 million years before bats (which first took to the wing during the Eocene). Moreover, insects are the only invertebrates known to have evolved flight, an adaptation that has undoubtedly contributed to their remarkable success.

Fossil insects are preserved in a variety of ways, the most famous of which is undoubtedly as inclusions within amber; the fossilized resin of ancient trees. Insect fossils are also often found as organic compressions or mineral replications in sedimentary rocks, or encapsulated within crystalline mineral deposits, and even entombed within the asphalt of ancient tar seeps. Fossil insects represent an invaluable source of data concerning not only their own evolutionary history, but also the evolution and ecological dynamics of the ancient biotas they represent. They provide information about ancient continental configurations and the climate of the remote past. Their fossil record helps us understand significant events in the history of life. Events such as the evolution of flowering plants and the origin and spread of grasslands had significant impacts on the insects—a group well known for their sensitivity to environmental change—all of which is documented in their fossil record by changes in the composition of ancient insect faunas and the rates of their origination and extinction through time. A resource as valuable as the insect fossil record will provide unprecedented insight into the evolution of these fascinating animals and—because of the important ecological roles they play—the very nature of terrestrial ecosystems in general. The insects have witnessed the rise and fall of dinosaurs, mammoths, and mastodons, all the while evolving in a complex and inextricable chorus with the other life around them. Their ancient lineage has experienced extreme environmental and climatic changes and survived global mass extinctions time and time again. Yet, we have only just begun to scratch at the surface of this great archives of knowledge and still have much to learn about the evolution of the insects.



The pygmy grasshopper Baeotettix lottiae *(Orthoptera: Tetrigidae) in Early Miocene (~18 million years old) amber from the Dominican Republic. Scale bar = 2 mm.* **Photo by author**

Sam W. Heads, INHS

Species Spotlight

Northern Riffleshell

Jen Mui

Historically, Illinois rivers supported approximately 80 species of freshwater mussels. Scientists estimate that 17 of those species have been extirpated (5 of which are globally extinct), including the northern riffleshell (*Epioblasma rangiana*). Last seen in Illinois over 100 years ago, the riffleshell was listed as federally endangered under the Endangered Species Protection Act in 1994.

Found in the shallow, oxygen-rich riffles of medium and large rivers, northern riffleshells bury themselves fully or partially in the gravel or sand bottom, leaving their "siphons" exposed. A muscular "foot" holds the mussel in place but can also be used to move through the substrate. Water is pumped in through the incurrent or branchial aperture and out through the excurrent or anal aperture. Food particles, including detritus (organic debris formed from the decay of organisms) and plankton (small floating plants and animals) are filtered from the water.

Reproduction

Males release sperm into the water, which is taken in by females downstream. Eggs are fertilized internally and stored in a brood pouch (marsupium) located in the female's gills. After the eggs develop into the larval glochidia stage, the female northern riffleshell uses a lure to attract a fish to serve as a host, (e.g., darter or sculpin) to complete its life cycle. The female grabs the fish by the head and transfers the larvae into the fish's mouth. The larvae attach to the gills of the fish where they remain until they grow shells of their own and drop into the sediment.

The first part of the shell formed is the umbo or beak, which is the dorsal margin of the adult shell. The mantle (the soft tissue that surrounds the body) secretes calcium carbonate to form the hard shell throughout its life. Northern riffleshells are small, up to 2 inches in length, yellowish brown or green with two ridges separated by a sulcus (shallow depression). On the posterior end, males have a sulcus from the umbo to the ventral margin, whereas females are broadly rounded. Northern riffleshells have a shorter lifespan than many other mussel species, living approximately 15 to 20 years.

Ecosystem Function

Mussels are often referred to as "the livers of the rivers" because of their ability to filter particles and contaminants from the water. (To see mussel filtering in action, watch our video http://www.illinois.edu/outreach/mussels. Mussels are also an important part of the food web, consuming detritus, bacteria, and plankton and in turn being eaten by minks, otters, muskrats, raccoons, birds, and fish. Species like the northern riffleshell are sensitive to environmental conditions and serve as a sort of "canary in the coalmine." As their population declines, this indicates problems with water quality.

Northern riffleshell mussels with PIT (passsive integrated transponder) tags. **Photo by Jeremy Tiemann, INHS**

Problems for Mussels

According to INHS malacologist Kevin Cummings, more than 70% of the 300 freshwater mussel species historically known from North America are threatened, endangered, or in need of conservation. A variety of causes have been identified for declines in freshwater mussel populations. Erosion leads to an increase of silt in rivers, which can suffocate and bury mussels. Chemical pollutants can be taken in and accumulate in tissues, poisoning the mussel. Large numbers of the exotic invasive Zebra mussel (*Dreissena polymorpha*) attach to living native mussels and deprive them of food, thus starving or suffocating them. Dams and other modifications alter the riverine habitat and disrupt the movement of host fish.

Re-introduction in Illinois

INHS researchers are studying the viability of re-establishing populations of northern riffleshells using mussels displaced by construction.

The Hunter Station Bridge on the Allegheny River in Pennsylvania is scheduled for removal in 2018. Perhaps the last location with a large population of northern riffleshells, it was estimated that this project would directly impact over 25,000 mussels.

INHS researcher Jeremy Tiemann identified two rivers within the historic range of the northern riffleshell in Illinois that had protected areas, diverse high-quality mussel assemblages, and populations of host fish. In 2010, researchers attached PIT (Passive Integrated Transponder) tags to 150 individuals gathered from the bridge site in Pennsylvania and released them in the Salt Fork and Middle Fork of the Vermilion River in east-central Illinois. After a year and a half, 80% of the individuals in this pilot study were able to be located again.

In 2012, INHS researchers were part of a multi-state team that gathered 3,900 mussels from under the Hunter Station Bridge. After quarantine and tagging, 1,200 northern riffleshells were hand planted by a team of volunteers in the Salt Fork and Middle Fork rivers. Monitoring of these populations will help shape future conservation efforts for freshwater mussels in our state.

The Naturalist's Apprentice

Mussel Crossword

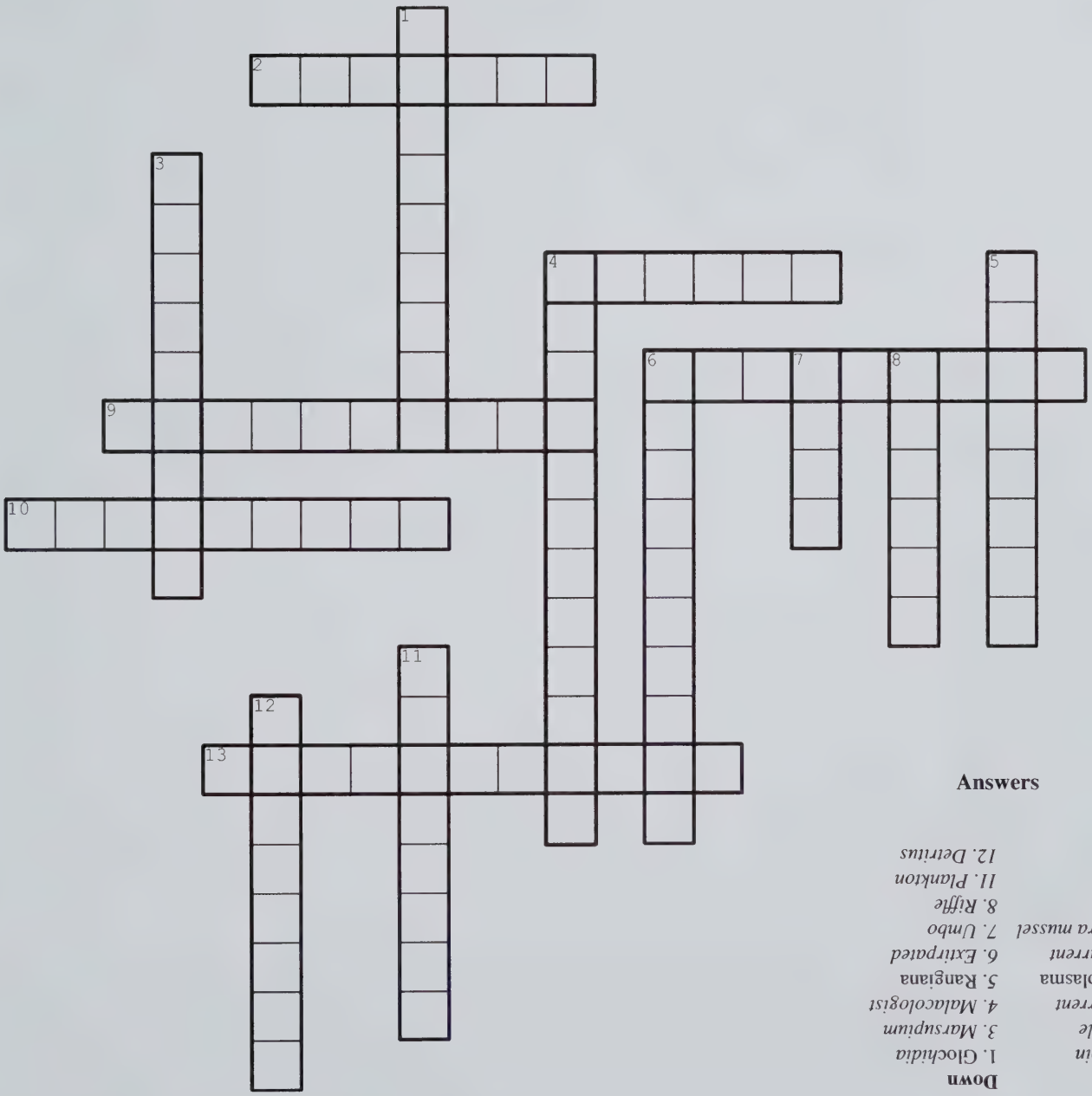
Jen Mui

Across

2. *a host fish for northern riffleshell larvae*
4. *the soft tissue covering the body of the mussel*
6. *aperture used to excrete waste*
9. *with 5 down, scientific name of the northern riff leshell*
10. *aperture used to bring water and nutrients into the mussel*
13. *an exotic species that covers native mussel species*

Down

1. *larval stage of freshwater mussel lifecycle*
3. *brood pouch in female mussel*
4. *scientist that studies mussels*
5. *with 9 across, scientific name of the northern riffleshell*
6. *term for a species that is locally extinct*
7. *the oldest portion of the mussel shell, also called a beak*
8. *shallow, oxygen rich habitat in streams*
11. *small floating organisms eaten by mussels*
12. *organic debris from decaying organisms*



Answers

Across
2. Sculpin
4. Mantle
6. Excurrent
9. Epioblasma
10. Incurrent
13. Zebra mussel

Down
1. Glochidia
3. Marsupium
4. Malacologist
5. Rangiana
6. Extirpated
7. Umbo
8. Riffle
11. Plankton
12. Detritus

ILLINOIS NATURAL HISTORY SURVEY
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Blood Parasites

continued from front page

defined as the number of infected birds out of the total number sampled. Intensity was defined as the number of parasitized blood cells out of the total number of blood cells examined.

Of the 77 Mourning Doves sampled, 44.2% (34/77) were infected with at least one parasite genus and had the most intense infection, ranging from 0.002–5.14% infected red blood cells. Blood parasite infections were seen in 73% (11/15) of the Wild Turkeys and exhibited high intensity infections ranging from 0.001–3.48% of cells infected.

These results are comparable with a study conducted in 1995 on Wild Turkeys from South Carolina where 100% of the turkeys examined were infected (n=76) but exhibited a lower infection intensity (0.001–.046%) than in our study.

Wood Ducks and Canada Geese had an infection prevalence of 5.4% (6/111) and 11.8% (2/17), respectively. Our study differs with previous studies done in Michigan where 100% of the Canada Goose goslings were infected and up to 87% avian mortality was documented. Overall parasite prevalence and prevalence by parasite genera are shown in Table 1.

There were no significant differences in parasitemia due to age or sex in our sampled birds. However, we did observe trends towards hatch-year birds having more intense infections than after-hatch year birds, and males having more intense infections than females. Future studies to better assess the role of landscape and environmental factors (temperature, soil moisture, and land usage) on parasite transmission and infection rates in both avian and vector communities as well as monitoring hematozoa related mortalities would be beneficial to the overall understanding of hematozoa ecology.

This study was conducted by Kendall Annetti who completed her undergraduate honors project with the UIUC Departments of Animal Sciences and Integrative Biology in the lab of Dr. Nohra Mateus-Pinilla at the Illinois Natural History Survey. Funding was provided by the Wildlife Restoration Project W-146-R, James Scholar Honors Program at the University of Illinois (LAS and ACES), ISAS, the Robert H. Davis Undergraduate Research Prize, and the National Wild Turkey Federation. Assistance was provided by Illinois hunters, Samantha Carpenter and Aaron Yetter at INHS, and IDNR biologists Wade Louis, Darryl Coates, and Dan Newhouse.

Kendall Annetti, UIUC and Nohra Mateus-Pinilla, INHS

Table 1. Parasite prevalence for Wood Ducks, Canada Geese, Mouring Doves, and Wild Turkeys from Illinois birds sampled in 2010 and 2011.

Order and Species	No. Sampled (n)	Infected n [%])	Prevalence of infection by parasite genera (%)		
			H.	P.	L.
Anseriformes Wood Duck *Aix sponsa*	111	6 (5.4%)	3.6	2.7	0
Canada Goose *Branta canadensis*	17	2 (11.8%)	0	11.8	0
Columbiformes Mourning Dove *Zenaida macroura*	77	34 (44.2%)	36.4	10.4	2.6
Galliformes Wild Turkey *Meleagris gallopavo*	15	11 (73.3%)	53.3	60.0	13.3
Total	222	23.9 (%)	18.0	10.0	1.8

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