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From Tiny Acorns...

Oaks (*Quercus* sp.) are declining in their dominance as canopy species in many midwestern hardwood forests. Even where oaks are still prominent in the forest canopy and acorn production appears normal, the proportion of oak seedlings and saplings in the understory does not seem adequate to maintain oaks as a dominant canopy species. Oak regeneration seems to be least successful on mesic sites where faster-growing, shade-tolerant species such as maples (*Acer* sp.) dominate the understory. Some researchers have predicted that slow-growing, mast-producing trees such as oaks and hickories (*Carya* sp.) will, in large part, be replaced in the canopy by mesophytes, particularly maples, within the next 50 years. A decrease in the abundance of oaks could have cascading negative ecological effects because acorns are one of the most important fall and winter foods to wildlife in many deciduous forests.

View of enclosures at one study site. Photo by John Taft, INHS Center for Biodiversity

Studies of oak regeneration have focused mainly on factors affecting the recruitment of saplings into the canopy. Considerable evidence has demonstrated how fire suppression and increased herbivory by white-tailed deer (*Odocoileus virginianus*) may play major roles in lowering the abundance of oak seedlings and saplings. Earlier stages of oak recruitment, such as acorn survival and germination, have received little attention from researchers. Some acorn consumers, particularly white-tailed deer, have become increasingly abundant in recent decades, and others, such as white-footed mice (*Peromyscus leucopus*) and many tree squirrels (*Sciurus* sp.), may reach higher densities in small forest fragments than in extensive forests. Estimates of the amount of the acorn crop consumed annually by these species are few and varied, but sustained increases in populations of these mast consumers could contribute to low rates of oak seedling recruitment.

INHS mammalogist Ed Heske digs for acorns in oak study enclosures. Photo by John Taft, INHS Center for Biodiversity

We conducted an experimental study of acorn survival, germination, and oak seedling recruitment at four study sites in east-central Illinois: Allerton Park, Hart Woods, Brownfield Woods, and the Vermilion River Observatory (VRO). At each site, we constructed 12 experimental exclosures made of steel and wood frames covered by hardware cloth. Three exclosures were designed to keep out all mammals, three contained small holes at ground level to allow entry by mice but no larger mammals, three had gaps at ground level to allow entry by squirrels and mice but not deer, and we left three plots open to all mammals. In the falls of 2001 and 2002, we buried 25 individual northern red oak (*Quercus borealis*) acorns in each plot to simulate squirrel caches, and we mixed 25 acorns with the leaf litter on the surface. We counted surviving acorns the following

Continued on back page

Evaluation of Dam Removal on the Fox River, Illinois

There are currently over 76,000 dams listed in the National Inventory of Dams. Many of these structures were built prior to World War II and have since fallen into disrepair. As these dams continue to age and as society's demands change, dam removal is increasingly becoming an option for river restoration. Unfortunately, there is a lack of empirical knowledge on the short- and long-term ecological effects of dam removal. Faced with uncertainty over the potential impacts of such actions, communities are increasingly wary of removing structures that are often viewed as permanent features of the landscape. As communities and resource managers are faced with decisions regarding the fate of aging dams, there is a critical need for information on the expected outcomes of dam removal.

Dams are known to drastically alter the physical, chemical, and biological components of river systems. Dams create slow-flowing depositional zones that trap sediment and nutrients in the upstream impoundment. Sediment deposition combined with the lack of habitat diversity results in areas unsuitable for many stream fauna. Additionally, small impoundments create conditions ideal for the production of high biomasses of planktonic algae, which can result in widely fluctuating dissolved oxygen levels that often reach lethal limits for many aquatic organisms. One of the most obvious effects of dams is the restriction of organism movement, thereby preventing various life stages from reaching critical spawning, nursery, feeding, or over-wintering habitats. Furthermore, dams fragment river systems, leading to reproductive isolation and local extinction of some species.

Two dams on the Fox River, a tributary of the Illinois River in northeastern Illinois (Fig. 1), are currently being considered for removal. The North Batavia Dam was built in the early 1900s to provide water power to the Challenge Windmill Company and the South Batavia Dam was constructed in 1913 to provide cooling water to a plant that powered the Chicago, Aurora, and Elgin Railroad. In the mid-1900s, the mills and factories were decommissioned and the dams were allowed to fall into disrepair. After several years of review, the Illinois Department of Natural Resources (IDNR), with the support of the Fox River Ecosystem Partnership (FREP), presented the City of Batavia with a variety of alternatives regarding the fate of the North Batavia Dam. In 2002, complete removal of the structure was chosen as the preferred alternative, and IDNR is currently planning to begin removal in late 2004 or 2005. The South Batavia Dam, which is currently owned by the Kane County Forest Preserve District (KCFPD), is also scheduled for removal sometime in 2004 due to a large breech in the structure during an autumn 2002 flood.

The Illinois Natural History Survey is investigating the effects of these two dam removals on the Fox River ecosystem through funding from the IDNR Division of Water Resources. Whereas previous studies have focused on the effects of dam removal on physical habitat and/or a portion of the biota, this investigation is examining multiple ecological components of dam removal. Reference sites above and below dams not expected to be modified during the course of this study are being monitored in order to control for other changes in the water-

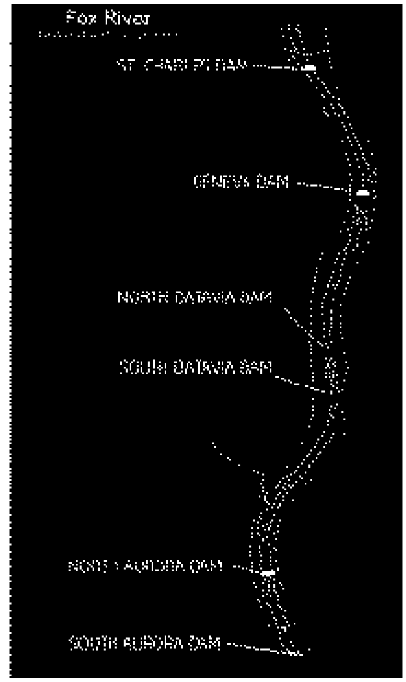

Figure 1. Location of the Fox River and sites sampled for evaluation of dam removals.

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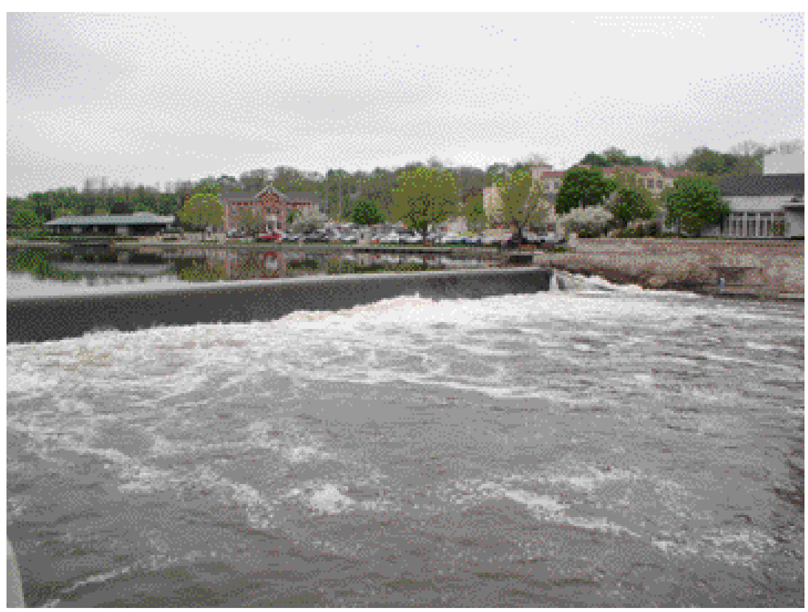

Dam on the Fox River at St. Charles, IL. Photo by Hope Dodd, INHS Center for Aquatic Ecology

Dam Removal

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Steve Butler and Hope Dodd measure fish and prepare it to receive an elastomer mark on its operculum. Photo by Jeff Butler, INHS Center for Aquatic Ecology

shed (climate, flow patterns, etc.) not associated with the treatment (dam removal) effects. This design results in three impacted reaches (areas affected by dam removal) and two reference reaches (areas unaffected by dam removal, Fig. 1), which are to be monitored closely both before and after dam removal.

The current study is monitoring short- and long-term changes in physical/chemical habitat, invertebrate and fish community structure, and fish movements associated with dam removal or modification. Water chemistry variables (i.e. temperature, dissolved oxygen, pH, and conductivity) are monitored above and below the two Batavia dams and above and below the Geneva dam (reference). Physical habitat is measured at all sites using both qualitative and quantitative methods. Following dam removal, we anticipate water chemistry variables that currently fluctuate widely at impounded sites to stabilize and assume patterns similar to those observed at free-flowing sites. Decreased depth, increased flow, and increases in sediment size are expected to be observed at impoundment sites, as well as increases in qualitative habitat scores.

As a result of changes in habitat and water chemistry associated with dam removal, the biotic community is expected to change substantially. Due to their short life cycles and high growth rates, the response from aquatic invertebrates in particular is likely to be rapid. During the summer and fall of each year, aquatic insects are being sampled from shallow substrates at every site using kicknets and Hess samplers. At impounded sites, deep sediments are sampled for invertebrates using Ponar grabs. Mussels are also being surveyed at each impacted and reference site. Fish assemblages are evaluated at each site during summer using both boat and backpack electrofishing. Species richness and abundance will be determined based upon these samples and an Index of Biotic Integrity (IBI) will be calculated. This metric gives an overall stream quality rating to each site based on the composition of the fish community. The IBI at impounded sites is expected to increase following dam removal as more intolerant species colonize these areas. Growth rates of selected fish species will also be examined to ascertain the effects that changes in habitat and prey availability may have on the growth of fish.

As a component of our evaluation of the effects of dam removal on fish communities, fish movements are being monitored using two methods. In spring, summer, and fall, eight species (smallmouth bass, channel catfish, common carp, walleye, and four redhorse species) are given site-specific marks using colored elastomer tags (injectable plastic dyes visible through the skin). Fish are marked and then released, with later sampling allowing us to recapture marked fish and determine the extent to which fish are capable of passing dams. This will provide a measure of the movement within a specific river reach. The second method for tracking fish movements is radiotelemetry. Smallmouth bass, channel catfish, and common carp have been surgically implanted with radio-transmitters in two impacted (below the South Batavia Dam and above the North Batavia Dam) and one reference (above the Geneva Dam) reach. Weekly tracking will ascertain individual home range sizes, seasonal movements, and habitat preferences.

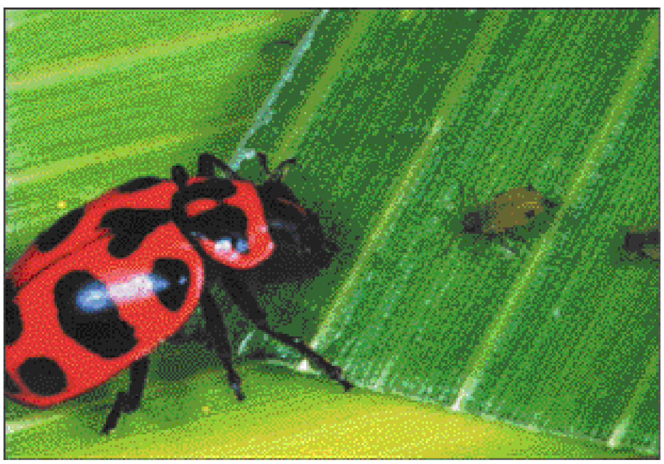
Baseline data collected during 2002–2003 indicate that impoundments in the Fox River provide lower habitat quality than free-flowing sites. They also contain less diverse and more tolerant invertebrate and fish communities than free-flowing sites. Sport fish (smallmouth bass, walleye, and channel catfish) are less abundant in impoundments. The South Batavia sites have undergone dramatic changes since this dam was partially removed by a flood in autumn 2002. The impoundment has become shallower and flow has greatly increased. Much of the fine sediment previously located in the upstream impoundment has been transported downstream and gravel bars are beginning to form at this site. The invertebrate community is beginning to respond to these changes, and a more diverse fish community was observed at this site during 2003. Further study will provide additional insight into the ecological effects of dams, and results of our study will help guide management decisions regarding removal of other dams throughout Illinois.

Steven E. Butler, Hope R. Dodd, and David H. Wahl

Biological Control and Genetically Modified Crops

Biological control, or the use of beneficial predatory insects to control crop pests, is an important practice that helps to reduce pesticide use. Often, insecticides and biocontrol don't mix very well because many insecticides are as effective at killing beneficial insects as they are at killing crop pests. However, there are circumstances when insecticides and biological control (and other control tactics) are melded together to form an integrated pest management (IPM) program that reduces insecticide use and is friendlier to human and environmental health. One of the goals of IPM is to reduce the over-reliance on any single pest control tactic in favor of coordinated approaches that are less likely to cause insect resistance and environmental harm. In response to the increasing availability of insecticidal genetically modified (GM) crops as new pest management tools, scientists at the Illinois Natural History Survey (INHS) are developing a framework to assess the potential for GM crops to put beneficial insects at risk. The INHS studies are focused on a familiar native beneficial insect: *Coleomegilla maculata*, or the 12-spotted ladybeetle (this is not the ladybeetle that hangs out in your house during the winter—that is another article altogether!). If GM crops are compatible with biocontrol, then the combination of control tactics will mean that even less pesticide will be needed to control insect pests.

Genetically modified crops, such as corn and cotton, express genes coding for insecticidal proteins from a bacterium named *Bacillus thuringiensis* (*Bt*) to control specific insect pests. These *Bt* crops are effective at reducing insect damage and, according to biotech industry proponents, are virtually harmless to human health, unlike many conventional insecticides. A hotly debated question related to GM crops is whether they are equally harmless to beneficial insects. *Bt* insecticidal proteins specialize at killing specific groups of insects, and so potentially they could be less harmful to insect communities than broad-spectrum insecticides. Also, *Bt*, when sprayed as an insecticide, quickly degrades in the environment and exposure times are limited. However, when genes from *Bt* are expressed in GM crops, the insecticidal proteins can persist in plant tissues for an entire season, increasing the opportunity for biocontrol agents, like the 12-spotted ladybeetle, to be exposed to GM plant tissues.



The beneficial and native 12-spotted ladybeetle about to feed on an aphid. Photo courtesy of Jon Lundgren, INHS Center for Economic Entomology

The 12-spotted ladybeetle is one of the most abundant predatory insects in Illinois cornfields, and is an important predator of aphids and the eggs of the corn earworm and the European corn borer. In addition to feeding on pests of GM plants, this predator is also exposed to the insecticidal protein directly when it eats corn pollen from the GM plants that contain the insecticidal *Bt* protein. Because the 12-spotted ladybeetle acts as a predator and also feeds on GM pollen, it is exposed to the insecticidal protein by two routes.

The INHS research has revealed that the distinct *Bt* insecticides expressed by different GM corn hybrids affect the survival of the 12-spotted ladybeetle differently. For example, pollen from GM corn hybrids currently used to resist damage from the European corn borer and the corn rootworm does not hurt 12-spotted ladybeetles when they eat it. However, the pollen from one unregistered hybrid was found to kill a majority of ladybeetles that fed on it, and could have serious consequences for biological control if it were ever commercialized. In addition to testing the toxicity of different insecticidal GM corn hybrids to ladybeetles in the laboratory, INHS scientists are trying to measure the amounts of pollen (and insecticidal protein) actually ingested by the 12-spotted ladybeetle in Illinois cornfields.

To date, the GM corn varieties planted in Illinois appear to be safe for the 12-spotted ladybeetle, and could be used in conjunction with biocontrol as a component of IPM programs to manage corn insect pests. Nevertheless, as new GM crop hybrids bearing different insecticidal properties are introduced and move toward federal registration, careful screening for unintended effects on beneficial predatory insects must continue. Using research methods developed at the INHS, federal regulators will more effectively address the risk that new GM crop hybrids pose to biological control agents and the environment we all share.

Jonathan G. Lundgren, Center for Economic Entomology

Measuring the Precision of Volunteer Stream Monitoring Methods

The Critical Trends Assessment Project (CTAP) provides an assessment of the Illinois environment using biological data collected by both volunteers and professional researchers. The volunteer component of CTAP is called the Illinois EcoWatch Network and encompasses monitoring of streams, forests, and prairies. RiverWatch (RW) is the largest program within the EcoWatch Network. More than 1,500 dedicated RW volunteers monitor over 200 streams annually. Many volunteer programs, including RW, survey aquatic macroinvertebrates. These organisms are visible to the naked eye and have no backbones. Examples of such organisms include mayflies and snails. These organisms display varying tolerances to pollution, making them ideal candidates for gauging trends in stream quality over time.

RW developed its monitoring design before any national protocols were developed. By 1997, when the U.S. Environmental Protection Agency published its first volunteer stream-monitoring protocols, RW already had over three years of data. RW methods do vary from those of U.S. EPA, making it important to assess the accuracy and precision of its methods. RW data accuracy was addressed in Dr. R.E. DeWalt's study, *Congruence of RiverWatch and CTAP Stream Bio-monitoring Data*, comparing volunteer data with those of the CTAP biologists (1999). However, until now, RW method precision has not been examined.

The EcoWatch Quality Assurance (QA) Officer, Alice Brandon, enlisted over 30 volunteers from 16 sites for participation in this study. For the study, volunteers and the QA Officer collected duplicate samples from the same stream site for comparison with one another. Metrics used by RW to measure stream quality were derived for both samples (QA and volunteer) and compared using correlation and descriptive statistics.

RiverWatch volunteers meaure a stream. Photo courtesy of Judy Fitchett, The Conservation Foundation

There was a positive, significant correlation between volunteer and QA Officer data for five of six metrics used to assess stream condition, including taxa richness, % worm taxa, % EPT taxa, EPT taxa richness, taxa dominance, and the Macroinvertebrate Biotic Index. Results for EPT taxa richness were particularly positive with high correlation detected. EPT measures the number of stonefly, mayfly, and caddisfly taxa in a sample. These taxa are typically sensitive to pollution in their environment. Traditionally, RW has used the % composition of EPT in a sample rather than EPT taxa richness. However, this study along with DeWalt's results indicate that using EPT taxa richness instead has some advantages. For example, hydropsychid caddisflies are often highly abundant in degraded streams (DeWalt 1999). Therefore, having high percentages of these pollution-tolerant EPT taxa and concluding "good" stream health is not necessarily accurate. In contrast, EPT taxa richness will not be skewed by abundances of pollution-tolerant EPT taxa.

Mean taxa dominance (percent of the sample comprising the three most abundant taxa) varied by approximately 9% between volunteer and QA Officer samples and there was no statistically significant correlation. This resulted in the two groups rating streams differently using this metric. The study also found sample abundance to vary widely between the QA Officer and the volunteers. This was not of great concern since RW does not use sample abundance to measure stream quality; but, it appears to have repercussions for using taxa dominance since this metric is derived from sample abundance.

Results supported the use of RW methods even though they vary from those espoused by the U.S. EPA. However, there is always room for improvement. Staff are aware of the issue of low sample abundance and there has been much discussion concerning what to do about it. Currently, data from samples with abundances of < 25 organisms are discarded. It may be time to revisit this issue and consider options for increasing the number of organisms collected, which may be as simple as having volunteers sample three rather than two habitats as currently instructed.

Volunteers are doing a good job of following monitoring procedures as indicated by this study. Results here support the assertion that RW methods have a reliable measure of precision, making the data useful for collecting basic information on streams.

For more information on RW metrics and results from this or Dr. DeWalt's report, please access the EcoWatch Web site at: http://dnr.state.il.us/orep/ecowatch/

Alice Brandon, EcoWatch Quality Assurance Officer

Species Spotlight

Mantispid

Susan Post

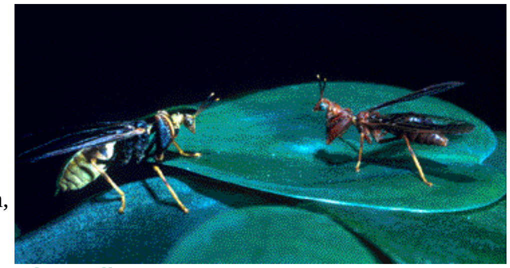
Mantispa uhleri. Photo by Michael Jeffords, INHS Office of the Chief

My front legs resemble a preying mantis, my prothorax a giraffe, my wings a green lacewing, and my larvae have never met a spider egg sac they didn't like. What am I?

Does this seem like some bizarre creature from the land of Dr. Seuss or a real insect? The answer is—a mantispid from the insect order Neuroptera, family Mantispidae, and subfamily Mantispinae.

Mantispids, or false mantids, resemble miniature preying mantids. Their two front legs are enlarged, equipped with spines, and are raptorial (folded) just like the mantis. In a recent nature center newsletter, a lengthy article was devoted to the preying mantis only to show a photo of a mantispid! Even early taxonomists confused the two as they described new species of mantispids as mantids. The mantispid/preying mantis confusion is an example of convergent evolution, e.g., insects that are not closely related but have evolved similar adult structures due to similar selective pressures.

While the two species may have similar front legs, they differ in their wing structure, size, and life cycle. Mantispids have two pairs of membranous wings criss-crossed by a network of nervelike veins that they hold tentlike over the body. The Order name "Neuroptera" is Greek and means "nerve wing." Mantids, on the other hand, have forewings that are leathery in appearance and the hind wings are folded underneath the forewings. Both sets lie flat on the insect's body. Mantispids are small, 20–35 mm, while preying manitids are larger, 70–120 mm. Perhaps the greatest difference is in their life cycle. Mantispids undergo complete metamorphosis—egg, larva, pupa, and adult—while a mantis has incomplete metamorphosis—egg, nymph (that looks like a miniature adult), and adult.



Climaciella sp. Photo by Michael Jeffords, INHS Office of the Chief

A female mantispid will lay numerous stalked eggs randomly on leaves and wooden structures. The newly hatched larvae, less than a millimeter in size, are very active and begin the search for spiders. They find their spider hosts via one of two ways. Either they actively seek a previously constructed spider egg sac that they enter through direct penetration, or they climb onto a female spider and enter the egg sac as the female builds it. While the mantispid is waiting for the female spider to build an egg sac, it will enter the spider's book lungs and feed on the spider's blood. The mantispids will not molt until they enter an egg sac. If the larva happens to board a male instead of a female, it will eventually die or it can transfer to the female during mating. The mantispid will enter the egg sac before the female spider can finish spinning the silken protective case. Once in the egg sac, the mantispid will dine on spider eggs and undergo three molts. After two to three weeks, the mantispid spins a cocoon inside the egg case and emerges as an adult one to two weeks later.

Manitspa viridis. Photo by Michael Jeffords, INHS Office of the Chief

There are 300 species of mantispids worldwide, with approximately 10 species found in North America. In Illinois, they are generally found in weedy fields, brushy areas, and woodland openings and are usually ignored by the casual observer. The next time you think you've found a miniature preying mantis, take a closer look, it could just be the strange but equally fascinating mantispid.

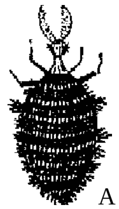
The Naturalist's Apprentice

Insect Adaptations

Carolyn Nixon

Insects are the most adaptable group of animals on earth. They are adapted to almost every type of habitat, and there are more species of insects than all other types of animals combined. Look at the pictures shown to the right and below and see if you can match them with the behaviors described on the left.

1. I hop.
2. I'm a predator that grasps its prey.
3. I burrow in the ground.
4. I sit in vegetation under the water, but breath air from a snorkel.
5. I swim through the water, much like a rowboat.
6. I have a soft body, so I build a protective case.
7. I drill a hole into wood to lay my eggs.
8. I lay flat against the surface of rocks under water.
9. I bury my body at the bottom of a pit in the sand and capture insects that fall into my jaws.
10. I drink nectar from deep-throated flowers.
11. I swim on the surface of the water and have eyes that see both above and below the water.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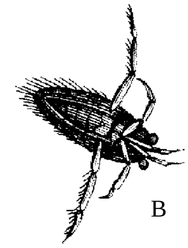
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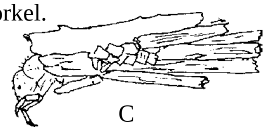
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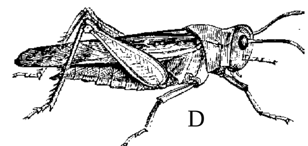
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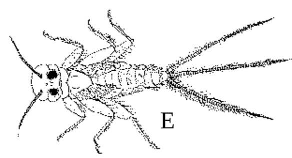
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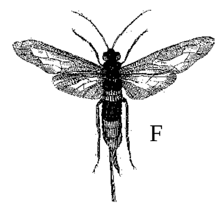
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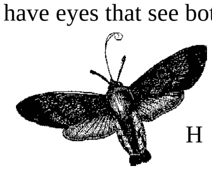
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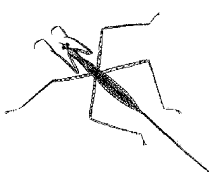
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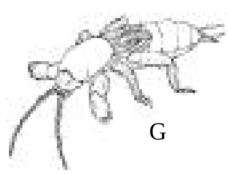
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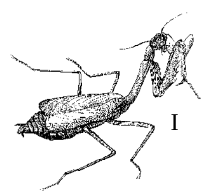
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Additional activities:

1. Closely examine several different insect specimens and see if you can determine how they live.
2. Invent a new insect. Draw it to show its adaptations to its habitat and the way it makes a living. (For example, what would an insect look like that lived on the surface of hard ground frequented by herds of bison, and it made its living by capturing crawling insects?)

Answers: 1) D–grasshopper; 2) I–praying mantis or J–water scorpion; 3) G–mole cricket; 4) J–water scorpion; 5) B–back swimmer; 6) C–caddisfly larva; 7) F–horntail; 8) E–mayfly nymph; 9) A–antlion nymph; 10) H–sphinx moth; 11) K–whirligig beetle

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Oaks

continued from front page

springs and recorded how many surviving acorns had germinated by the end of April. We revisited each plot in September to count oak seedlings that had survived the summer. In addition, we counted natural acorn fall, trapped small mammals, searched for squirrel nests, and recorded winter browsing by deer at each site to provide background ecological data.

We found that mammals had a compensatory effect on survival of acorns on the soil surface, with nearly all acorns being removed from all plots where deer, squirrels, or mice had access. More buried acorns survived when squirrels were excluded, probably due to a poorer ability of mice to exploit buried acorns. In addition, buried acorns showed a much higher rate of germination than acorns on the surface, demonstrating the importance of mammal caching behavior on seedling production. As a result, possibly combined with herbivory by deer during the spring and summer, almost no seedlings were recruited on plots where squirrels and deer had access, whereas 3–12 seedlings were recruited to each of our total-exclusion plots in the following fall.

Two interesting observations were made as well. First, in fall 2001, acorn production was moderate, whereas very few acorns were produced naturally at our sites in 2002. Survival of buried acorns was high in our "mouse only" plots in 2001, but mice must have foraged for buried acorns more intensively in 2002, as survival of buried acorns on many of those same plots was much lower that year. Thus, annual variation in acorn production likely has a strong influence on acorn survival, as predicted by many explanations of why oaks show "masting cycles." Second, exploitation of buried acorns by squirrels was lower on several of our plots at Allerton Park and the VRO than at Hart Woods and Brownfield Woods in 2001. The latter two sites are smaller forest fragments and seemed to us to have higher densities of tree squirrels. In future studies, we plan to examine selective herbivory by deer, quantifying their preference for and impact on oak seedlings. For now, our preliminary experiments suggest that high levels of acorn consumption may compound the effects of fire suppression and deer herbivory on oak regeneration. As oaks become less abundant in the canopy of hardwood forests, seed limitation will become increasingly pronounced, especially if some consumers such as deer remain at high densities through years of low and high mast production.

Edward J. Heske and Jared P. Haas, Center for Wildlife Ecology

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