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From the Selected Works of Warren G. Abrahamson, II

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Insects raise some galling questions

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Plant and Insect Interactions

Gardeners tend to have a “love-hate” relationship with insects. We cringe when we watch our laboriously hand-raised plants shrivel under a siege of aphids; we pluck voracious Japanese beetles one by one off our roses; we struggle with the ethical dilemmas of spraying to arrest a gypsy moth outbreak. Do we pay as much attention, though, to the daily activities of the good guys—the gorgeous butterflies that pollinate our prize flowers or the praying mantises that eat the insects that would eat our plants? It’s the “little things that run the world,” in the words of entomologist E. O. Wilson, and this issue of Conservation Notes celebrates the scores of miraculous and largely unseen partnerships between insects and plants.

The articles to follow will delve deeply into the ecology of plants and insects (and some other many-legged friends) with a particular focus on New England. We’ve tapped a host of talented insect experts from around the country, who, through scientific studies, painstaking field observations, and skilled photography, are revealing a wealth of relationships that take place on a tiny scale but have landscape-scale effects. Insects and plants have coevolved for hundreds of millions of years; in fact, the diversity and success of seed plants owe much to insects. Insects are often the over-worked, under-paid vassals of plants; dispersing their seeds, moving their pollen about (even under water!), strengthening the flavors and medicinal qualities of edible plants by stimulating chemical defenses, and even—in the case of carnivorous plants—feeding plants themselves. A rich gallery of photographs of insects doing what they do best accompany each story.

Look for profiles of rare insects of New England, many of which have only been discovered in the past few years of sleuthing. We present tips for attracting insects using diverse plantings and a backyard experiment to learn your elusive night fauna using a sugary lure.

This issue also coincides with the “BIG BUGS” sculpture exhibition and web-of-life extravaganza at Garden in the Woods. Artist David H. G. Rogers fashioned gigantic sculptures of insects and spiders from found forest materials such as red cedar, black locust, black walnut and willow. Gracing the garden from July 17 to October 17, 2004, these really BIG bugs are the centerpiece of exploration and celebration.

We hope that by exploring this world and coming to Garden in the Woods to commune with a 15-foot-tall beetle or two, you’ll begin to cultivate the “love” end of that relationship you’ve had with bugs.

Elizabeth Farnsworth, Ph.D., NEWFS Senior Research Ecologist
and Greg Lowenberg, Ph.D., NEWFS Director of Education
Imagine living inside a succulent, green chamber whose edible walls provide both food and shelter. Such shelters are home to the myriad of insects who manipulate their host plants to produce abnormal growths called galls. Galls are produced by the host plant in response to the secretions and feeding of the larvae of these insects, which are known as “gall-inducers.” Galls are so distinctive that we can guess the identity of the insect that stimulated its production simply by looking at the outside of the gall.

Of the more than 1,700 species of gall insects known in North America, galls are found on plants in only three families—the oak/beech family, the sunflower/goldenrod family, and the rose family. This proliferation of insect species attacking so few host-plant families suggests that major obstacles exist to becoming a gall inducer, but also that once a related group of plants is exploited, there are many opportunities for diversification. Two insect families that have developed exceptional numbers of gall-inducing species are the gall midges and gall wasps. More than 600 species of cynipid wasps are known to attack North American oaks and we are still discovering new species of these wasps. My Hungarian colleague George Melika and I discovered 28 species of gall wasps previously unknown to science during a yearlong survey of Florida oak galls.

The conspicuous spherical stem swellings on tall goldenrod (Solidago altissima) are especially well-known to those of us who stroll through old fields in the Northeast during late summer, autumn, or winter. These galls develop in June and early July in response to the larva of the goldenrod gall fly (Eurosta solidaginis). Weeks earlier, in late May, the gall fly’s mother injected the larva’s egg into the terminal bud of the rapidly growing goldenrod. Not all goldenrods are suitable hosts, and if the gall fly’s mother chooses poorly, her offspring may perish due to host-plant defense. Even if the host plant is suitable, a gang of parasitic wasps, predatory beetles, and insectivorous birds may kill the gall fly larva. Larvae in large galls with thick walls are protected from wasp attack, but are attractive to downy woodpeckers. Small galls are ignored by woodpeckers, but are vulnerable to wasps. Consequently, in years when wasps are abundant, natural selection favors larvae in larger galls; however larvae in smaller galls have the advantage when severe winter weather causes birds to exploit galls for food. When the enemies are balanced, natural selection favors intermediate-sized galls.
In spite of the presence of over 100 species of goldenrods in North America, the gall fly selectively attacks tall goldenrod—with an interesting exception. Across southern Canada and northern portions of New England, New York, and Michigan, as well as most of Wisconsin and Minnesota, goldenrod ball galls also occur on late goldenrod (*Solidago gigantea*). However, late goldenrod is not attacked elsewhere across its widespread range. My colleagues and I have shown, through ecological, genetic, and behavioral studies, that the gall fly populations that attack tall goldenrod and late goldenrod are distinct host races. Host races occur within a species and become isolated from one another because of their association with different host plants. Many researchers contend that host races are incipient species.

Male and female gall flies strongly prefer to mate within their own host race even though they can mate with flies of the opposite host race. Females show a strong preference for injecting their eggs into the same species of goldenrod as that from which they emerged. Furthermore, gall flies associated with late goldenrods emerge nearly two weeks earlier than tall goldenrod gall flies, reducing the chance of the two host races meeting. These behavioral and ecological differences are likely responsible for the marked genetic differences that we’ve documented between the two host races. While the genetic differentiation of the host races is less than what we might expect between species, given sufficient time, it is very possible that these host races will become separate and distinct species.

**Oak acorn galls on myrtle oak caused by the cynipid wasp (*Adleria* weldi).** Young, green galls secrete honeydew, but at maturity galls turn brown and drop from their host.

**Cross section of an overwintering goldenrod ball gall showing the central chamber and exit tunnel (units are cm).**

**The parasitoid wasp, *Eurytoma gigantea*, injecting an egg through the wall of a goldenrod ball gall on tall goldenrod. The wasp’s ovipositor, which is used to inject eggs, extends from the wasp’s body to the gall.**

Warren Abrahamson is the David Burpee Professor of Plant Genetics at Bucknell University in Lewisburg, PA. Abrahamson and his colleagues have extensively studied the interactions of goldenrods, gall flies, and the natural enemies of gall flies for over 30 years. He also studies cynipid wasps and their oak hosts, plant population biology and community ecology, and fire ecology at Florida’s Archbold Biological Station where he is a Research Associate.