Tracing the Roots of a Gypsy

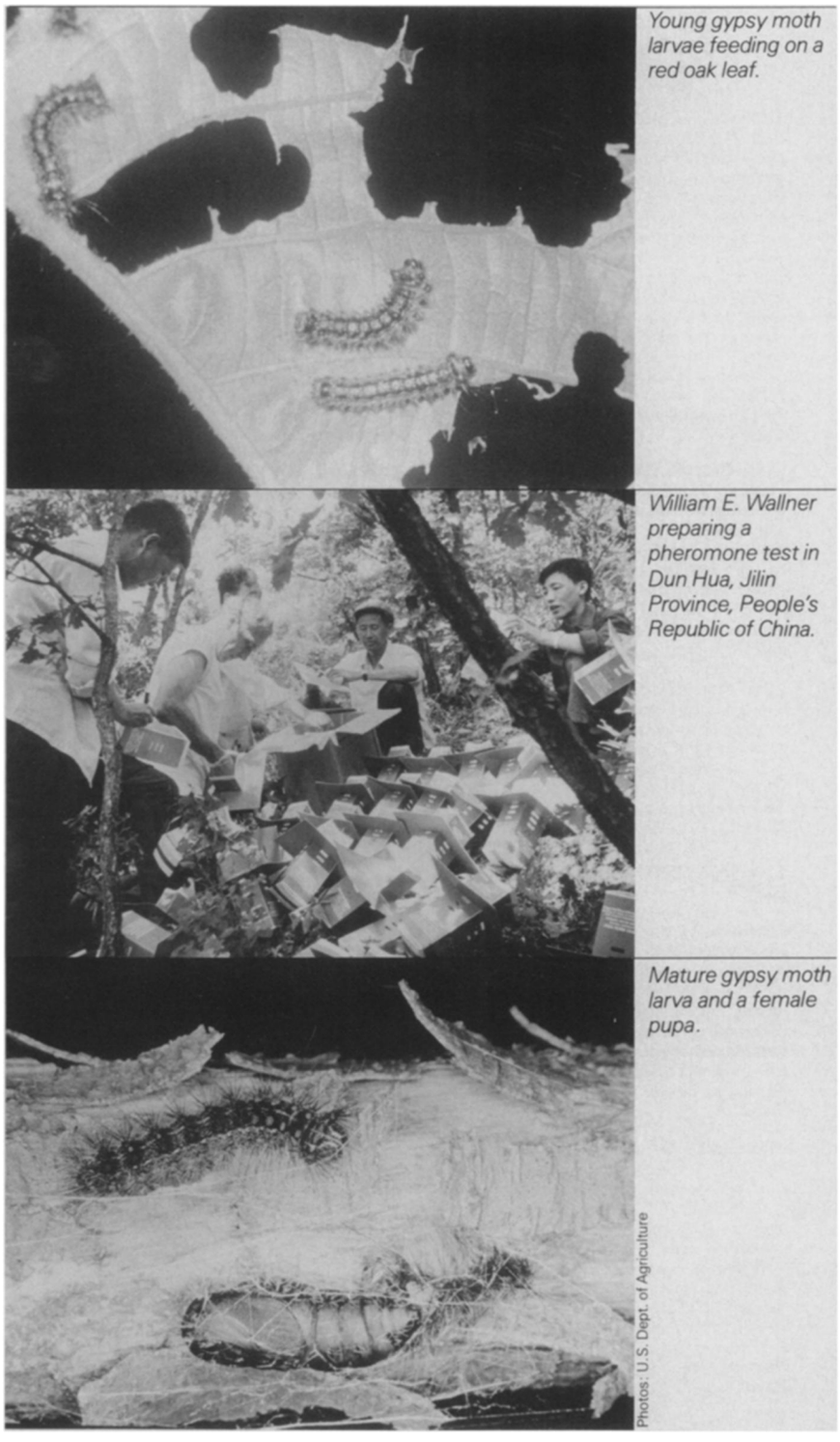
A U.S. scientific team recently trekked to China, where, research suggests, the troublesome gypsy moth may have originated

By LAURA TANGLEY

Early this summer, a team of U.S. scientists set out from Beijing, the capital of the People's Republic of China, and traveled for two months across 9,000 miles of the remote northeastern provinces of Jilin and Heilonjiang. Their schedule was a rigorous one — breakfast at 6:15 each morning, followed by several hours bumping over dusty dirt roads in a small jeep. The researchers, accompanied by their Chinese hosts, stopped for hours at a time to scour surrounding woodlands with their collecting nets and boxes. At nightfall, they stopped in tiny rural villages for supper. Then the researchers went back to work for another two or three hours before finally falling asleep.

Targets of this group's unusual search were the hundreds of large, hairy caterpillars they collected every day — larvae of the well-known ubiquitous forest pest, the gypsy moth *(Lymantria dispar)*. Caterpillars were collected from China to be scrutinized for natural enemies in that country — parasites, predators and diseases. "The gypsy moth is the major problem we have in northeastern hardwood forests today," says William E. Wallner, a U.S. Department of Agriculture entomologist and member of the scientific team that traveled to China. Last year the gypsy moth defoliated nearly 13 million acres in New England, according to the USDA. While the 1982 figures have not yet been fully compiled, a USDA Animal and Plant Health Inspection Service spokesman said that at least 7 million acres were defoliated, not counting New Hampshire or Vermont. While interest has peaked in the past two years — the greatest defoliation ever occurred in 1981 — the gypsy moth remains a chronic problem, says Ralph E. Webb, a research entomologist with the USDA's Agricultural Research Service. *Lymantria dispar* populations run in cycles, he says, and even if defoliation turns out to be half of what it was last year, 1982 "will probably be the second worst year in history."

In addition to the threat they pose to forest and ornamental trees, gypsy moth larvae are a human nuisance, covering roads, lawns, swimming pools and houses during heavy population outbreaks. Their



Young gypsy moth larvae feeding on a red oak leaf.

William E. Wallner preparing a pheromone test in Dun Hua, Jilin Province, People's Republic of China.

Mature gypsy moth larva and a female pupa.

Photos: U.S. Dept. of Agriculture

Adult gypsy moth female (right) and male (left).

long white hairs contain histamines that cause rashes and other allergic reactions in many people. Because the insect is seen as such a serious pest, the recent overseas gypsy moth expedition — arranged by agreement between the USDA's Office of International Cooperation and Development and the Chinese Bureau of Forestry — was chosen over several other applications for the rare opportunity to travel to China. In addition to Wallner, the team included Paul W. Schaefer of the ARS's Beneficial Insect Research Laboratory in Newark, Del., and Ronald M. Weseloh of the Connecticut Agricultural Research Station in Hamden, Conn.

China looks promising to U.S. scientists searching for a way to control gypsy moths, says Wallner. "It's the only place in the world we've never looked for natural enemies of the gypsy moth before," he says, and, in addition, the moth "seems to be less of a problem in China." Also, recent research indicates that *Lymantria dispar* — now classified as a single species throughout the world — probably originated in eastern Asia and, possibly, China.

Evidence for this hypothesis comes from Richard G. Harrison, of Yale University, Thomas M. Odell, of the U.S. Forest Service and Stephen F. Wintermeyer, of the ARS. These scientists compared genetic variation within gypsy moth populations by analyzing 20 enzyme-synthesizing loci from 21 populations in the United States, France, Austria, the Soviet Union and Japan. They found that genetic variation "was virtually absent" in the United States, "intermediate" in Europe (increasing as they went eastward) and "highest" in Japan. Genetic variability often declines when a species is introduced to a new region, says Odell, because of the "population bottleneck" that occurs. If the immigrants — called the founder population — are just a few closely related individuals, the new colony has nearly zero diversity. It takes hundreds of years for genetic variability to become established. The pattern of increasing variability in *Lymantria dispar* as one moves from the United States through Europe and into Asia indicates that the latter region is where the species began, suggest the researchers. Thus eastern Asia, including China, "is a good place to look for enemies of the gypsy moth," says Odell, "because there's been more time for them to have coevolved along with the moths."

Wherever the gypsy moth got its start, it came directly to the United States from France. In 1869, a French naturalist brought some moths to Medford, Mass., to start a silkworm factory there. Some of the insects escaped and within 20 years the species had created a local defoliation crisis. The moths spread quickly through New England, sailing with prevailing winds on the fine silken threads they spin.

Once settled in the Northeast, this notorious insect wanderer moved quickly throughout the United States. There are several reasons for its success. First, "when man introduces any species to a new location, if it survives at all it will usually run rampant," says John Burns, an evolutionary biologist and curator of Lepidoptera at the Smithsonian Institution in Washington, D.C. "This is because it won't have the whole battery of natural enemies with which it evolved." Another feature of *Lymantria dispar* — one that has helped it elude potential new natural enemies — is that its U.S. populations are characterized by tremendous cyclic epidemics and declines. Thus, new parasites and predators "cannot easily be established here because the gypsy moth is such an unreliable food source," explains Wallner. While he and his colleagues have imported hundreds of parasites from all over the world, only 11 have been successfully established here.

The gypsy moth is a highly adaptive insect as well, living in a variety of different climates and able to feed on a wide range of plant hosts. Although larvae clearly have food preferences (particularly oak), they can feed on more than 300 plant species. Today, *Lymantria dispar* is found from Maine to Florida and west to California. Long-distance travel is made easily when females deposit egg cases — each one containing up to 1,000 eggs — on cars, trucks and camping equipment bound for distant places.

In New England, two-to-three-year outbreaks in one location are generally followed by eight to 10 years when nearly no moths are seen. While there are a number of hypotheses to explain these extreme population dynamics — including food supply, predation and tree self-defense tactics — none have been totally satisfactory (SN: 7/17/82, p. 38). Gypsy moths have a single generation each year. Females lay eggs in late July or early August but they do not hatch until the following spring, the same time that oak leaves start expanding. Before pupating in early July, a caterpillar will grow from three-sixteenths of an inch to two or three inches in length and consume many times its weight in leaves.

"Attempts to control gypsy moth go right back to soon after it was introduced here," says Wallner. "Of course, the concept of control has been different throughout the years." The earliest tech-

nique was simply to scrape egg masses off of trees and destroy them. This method became a bit more sophisticated in the late 1800s when creosote was painted onto egg cases. After World War II, DDT was used until it was banned in 1958. Since then, dozens of other synthetic pesticides have been tested, all with limited success and some undesirable side effects such as health risks and high mortality of other, beneficial, forest insects like honeybees.

Today, the focus of gypsy moth control research is biological control. In addition to concerns for human health and the environment, "biological control is more economical in the long run," says Wallner. "Once the system is established it will continue to work for you without needing any new input." The USDA's recent commitment to biological control is reflected, he says, in the new name it gave in June to its Hamden, Conn., laboratory. The lab, now called the Center for Biological Control of Northeastern Forest Insects and Diseases, devotes most of its resources to gypsy moth control, says Wallner, who has worked there for more than six years.

So far, he and his co-workers have found a variety of promising and, at least partially, successful techniques. They have identified more than 200 predators of gypsy moth adults, larvae and pupae, for example. During gypsy moth infestations, Hamden researchers provide nest boxes and brush piles to some of these animals —birds, mice, shrews and other rodents— to protect them from predators of their own.

They have introduced eleven parasites, mostly flies and wasps, to the United States. An example is *Blepharipa pratensis,* a tachinid fly. When females lay eggs on leaves of gypsy moth host plants, those eggs are eaten by the moth larvae. Once inside a host's stomach, the maggot becomes inactive until the caterpillar pupates. Then it suddenly comes back to life, boring into the insect's gut and killing it before it becomes a moth.

More than 25 diseases (bacterial, fungal and viral) also infect gypsy moths. "By far the most important of these has been the nucleopolyhedrosis virus [NPV] that attacks larvae," says Wallner. Widespread in natural populations (especially during heavy outbreaks), NPV can now be produced in the laboratory and is registered for use with the Environmental Protection Agency under the name "Gypcheck." It is not yet commercially available, however. Unfortunately, what makes this disease especially effective and safe — its specificity to gypsy moths alone—also means it is less attractive to manufacturers. And since the gypsy moth problem comes and goes, there is no steady market. Another disease, *Bacillus thuringiensis* (BT), a bacterium, infects several pest insects in addition to gypsy moths. This disease is commercially available, yet for many homeowners it is still too expensive and, in order to be effective, timing and weather conditions must be perfect. When they are, however, BT has been successful in stopping local infestations.

Other more novel approaches to gypsy moth control include synthesizing and releasing sex pheromones to disrupt mating and sterilizing males with gamma radiation. When released, sterilized males still mate with wild females, but the eggs never hatch. "Research has demonstrated that we can reduce isolated populations over 99 percent by rearing and releasing sterile males," says Wallner. A newer variation of this technique is to give pupae just a partial dose of radiation. These males also mate with feral females and egg hatch is reduced by 50 percent. Although the eggs that do hatch produce apparently normal larvae and pupae, both male and female moths turn out to be sterile.

Despite their success so far, "we never expect to find a single solution to the gypsy moth problem," Wallner says. More likely, "we'll need to use different combinations of these approaches." Several look especially promising. Both mice and tachinid flies have been used — either in field or lab tests—to vector, or spread, the nucleopolyhedrosis virus between individuals and even populations. Mice spread NPV when they defecate after eating infected insects or eggs. Flies that come in contact with the disease place it on leaves when they "preen" themselves, a typical fly behavior. Disease, in turn, helps some parasites to operate more effectively. A sublethal dose of the bacterium BT weakens and retards the growth of caterpillars and makes them more vulnerable to an effective wasp parasite, *Rogas lymantriae,* imported from Japan by Wallner and his colleagues three years ago.

"In China, we stopped at 52 locations and collected 13 parasites, 14 predators, a virus and a fungus disease," Wallner told SCIENCE NEWS. But because of Chinese Bureau of Forestry regulations, the researchers were not allowed to bring living specimens back. "I was permitted to return with virus- and fungus-killed larvae, however," says Wallner. "We are now evaluating these to determine if they have the potential for use against gypsy moth in the U.S."

He also hopes that in the future U.S. researchers will be able to import living moth enemies from China. Plans are now underway for more exchanges of both scientists and biological specimens. A quarantine facility, essential for evaluating exotic species for potential damage to U.S. ecosystems before they are imported, is now under construction at an abandoned military installation near Hamden. Meanwhile, Wallner is not complaining about the Bureau's restrictions. "We were very privileged to be able to travel to China at all." Besides, he adds, "developing lines of communication and mutual confidence — which we did this year — are necessary first steps to all the work we would like to do." □

The adult tachinid parasite, Blepharipa pratensis, *which is an important biological control organism of gypsy moths.*

The white-footed mouse, Peromyscus leucopus, *is one of the more than 200 predators reported to feed on gypsy moths in North America.*