Penn State Chemist's Findings Contradict Current Theories

A PENN STATE chemist has found evedence that plants control mating in insects — a finding that contradicts current theory and sheds new light on evolution in insects and the sense of smell in man.

The finding also casts serious doubt on the value of pest control programs involving sex lures to disrupt mating. Funding for such programs currently runs into the billions of dollars and includes efforts against the gypsy moth, oak leaf roller moth, corn borer and boll weevil.

Such programs are based on the assumption that female insects manufacture their own lures and that there is a single attractant unique to each species to which the male will respond.

But Dr. Lawrence B. Hendry, assistant professor of chemistry, claims the attractants originate in the plants on which the insects feed.

He believes that the female insect simply stores the attractants, called pheromones, and apparently does not change them in any way. Hendry has found the attractants in plants in concentrations that correspond to the amounts found in females and also has evidence that the males of a single species can be sensitive to as many as 20 different chemicals, depending on their diet.

According to Hendry, the females probably learn which pheromone to store and the male learns which one to seek while the insects are still in the egg or larval stage. He theorizes that the brain of the insect becomes imprinted or programmed to respond to whatever pheromone is present in its earliest food. Thus, only male and female insects which feed on the same plants as larvae would be imprinted with the same attractant and mate as adults.

The unpredictability of the field response to laboratory-prepared lures has only mystified researchers. A chemical that produced excellent results in the laboratory would sometimes produce mediocre or negative field results. The apparent contradictions, Hendry said, were the result of the different diets of the laboratory-reared and wild insects. For example, a pheromone that worked as an attractant for oak leaf roller moths reared in the laboratory on wheat germ would not work for the same insect raised in the wild on oak leaves. The attractants would even be different for one set of oak leaves and another raised on later-leafing black oak leaves.

"It could be that the receptor site is non-specific and can be taught to respond to many substances," he said.

If this guess proves true, Hendry said that pest control programs based on sex lures might still be possible, such as a program based on spraying a field with some chemical the insect larvae would eat and imprint. Later the same chemical could be used as a sex-lure to confuse the males and prevent mating.

One reason the finding is so startling, Hendry said, is the fact that insect species have been defined according to their ability to react to specific attractants. Now, he said, this definition may have to be changed. Theories of insect evolution based on the idea that insects from different species will not mate, may also have to be changed, according to Hendry.

In addition, he has found what may be a chemical link between the sense of smell in insects and in man. He has discovered that the chemical structure of the sexual excitant of the oak leaf roller moths closely resembles musk, a common constituent of many perfumes. To Hendry, this finding hints that man may also respond to some smells through imprinting rather than through a set of specialized receptors on the olfactory nerve. This could be interviewed to mean that diet affects mating selection, and, over the long haul, evolution — or, you are what you eat.

One of the first major clues to the discovery of the plants' role in insect reproduction came when Hendry saw a group of oak leaf roller moths attempting to copulate with some oak leaves that had been damaged by larvae. He decided to examine the oak leaves for evidence of pheromones and assigned one of his students, Joseph Wichmann, a senior chemistry major, to the task. Wichmann found evidence of the pheromone and Hendry, stunned by the news, accused him of accidentally contaminating the samples.

David Hindenlang, Ph.D. candidate in chemistry, was then drafted to analyze the material Wichmann had isolated from the plants. Hindenlang's verdict: it was the oak leaf roller sex attractant. Hendry's response this time was to question the accuracy of the instrument used. He bought a new instrument 100 times more sensitive and it gave the same answer.

Both students, along with junior chemistry major Mary Elizabeth Anderson, who did earlier work on the oak leaf roller's sensitivity to various suspected attractants, are included with Hendry as authors of the report.

So far, the chief insect that Hendry and his research group has studied is the oak leaf roller. But, he has also found the pheromones of 20 apple-feeding insects in apple trees, those of cabbage-feeding insects in cabbage and those of mushroom-feeding insects in mushrooms.

The research program was supported, in part, by a grant from the Research Corporation. Hendry was also aided by Ralph O. Mumma, professor of pesticides.