27 September 1985, Volume 229, Number 4720 SCIENCE

Use of and Research on Pheromones

This editorial was written in response to the stimulus of an interesting symposium on pheromones and to stories in the media about a large-scale infestation of gypsy moths in northeastern United States. The symposium, held at the annual meeting of the AAAS, dealt with some of the current frontiers of research on the physiology and regulation of pheromones.* Enthusiasm of the participants was contagious and led to a scan of some of the literature and to a telephone stroll to tap the knowledge and judgment of some of the leaders in the field.

During the past 20 years, more than 1000 insect sex attractants have been identified. Many have been synthesized in the laboratory and tested. The pheromones of some of the insects are single, optically active compounds. Other pheromones are made up of closely controlled mixtures of several compounds. Sometimes both enantiomers of a compound are employed, but in other cases a racemic mixture is ineffective.

The early enthusiasm about the use of pheromones to control insect populations has dwindled. Although there is a consensus that pheromones are excellent baits for traps, their successful application has been largely confined to monitoring, for which they are highly useful. Experience with the gypsy moth in the Northeast is illustrative. In the area of maximum infestation, populations of moths greater than 10,000 per hectare have been noted. When a female moth emerges, she is close to a large number of males. Under these circumstances, almost all the females are mated before they can begin to emit pheromones. Therefore, the use of the attractant in traps is of little help. In contrast, when populations of gypsy moths are limited, the attractant has a major role. Today the Department of Agriculture maintains 400,000 traps in areas of the country that are currently not infested. These have served an alerting function that has led to eradication or control of local infestations.

A notable success in control of agricultural pests has involved the use of a pheromone for monitoring and trapping coupled with application of pesticides. In North and South Carolina, cotton farmers participate in a program against the boll weevil. The numbers of insects are monitored in 250,000 traps, and insecticides are applied only when needed to hold down the population. As a result, the amount of fertilizer used has been decreased by about 70 percent, and costs of control have dropped.

Infestation of conifers by beetles leads to large-scale destruction of trees. In forests, the use of pesticides is not practical, and the best hope is trapping, disruption of the beetles' behavior by the use of attractants or repellents, or fostering natural enemies of the beetles, including predators and pathogens. Large-scale use of pheromones in about a million traps in forests in Norway and Sweden during a massive infestation by spruce beetles was accompanied by a decrease in the number of insects, but experts are unsure about the relative roles of traps and natural enemies.

Some of the current research frontiers include studies of modes of biosynthesis of pheromones, mechanisms of their modes of action, and attempts to discover amines that mimic in structure natural neuroamines employed by insects. Some of the questions being asked are: What are the pathways of synthesis of pheromones? How do genes regulate specific blends? What are the genetic controls on reception and perception? Is the system tightly controlled or plastic? Can the pheromone system mutate? When a male moth is flying on the plume of a pheromone emitted by a female, the sensory detection apparatus must be very efficient, and once a molecule has been detected, the molecule must be destroyed if sensitivity is to be maintained. Studies with a moth that uses an ester have shown that the sensors contain an esterase that quickly degrades the ester. Are related phenomena active in other insects?—PHILIP H. ABELSON

*"Bio-organic Chemistry of Insect Hormones and Pheromones," symposium arranged by G. D. Prestwick at the AAAS annual meeting, Los Angeles, Calif., 29 May 1985.