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MALE PHEROMONES

by

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Pheromones, male

If Rachel Carson's book *Silent Spring* did nothing else, it served to stimulate research in areas other than insecticides for the control of insect pests. One of these areas, the identification of sex pheromones, has dealt principally with female-produced pheromones. (Pheromones are substances secreted by an animal that influence the behavior of other individuals of the same species.) The isolation and identification of compounds produced by males to attract females should have as much practical significance as the identification of female pheromones. In spite of the recent upsurge in research on sex pheromones of insects few have been identified. The reason for this failing is that the insects produce only minute quantities of attractant. Only 5.3 mg of sex attractant of the silkworm moth was obtained from 313,000 females; 500,000 females were used to obtain 20 mg of attractant from the gypsy moth.

Sex pheromones. A recent compilation from behavioral studies has indicated that males of about 50 species belonging to at least 8 insect orders produce an attractant for the female. No naturally occurring male sex pheromone has yet been identified chemically although a few compounds which may prove to be sex pheromones have been characterized. The principal component of a secretion from dorsal glands of males of the giant water bug has been identified; it is claimed to be a sex attractant, but there is no behavioral evidence that this is true. A number of compounds have been synthesized which apparently act as male-produced sex attractants: that is, they attract females.

Butterfly. The male of the queen butterfly, *Danaus gilippus berenice* (Cramer), pursues the female and rapidly brushes her head with two scent-disseminating hair pencils extruded from the end of his abdomen. This behavior induces her to land, and the scent producing secretion is considered a pheromone which acts as a chemical arrestant of the female's flight. Presumably, the pheromone also serves to keep the female quiescent after alighting. The hair pencil secretion of males of a Trinidad butterfly, *Lycorea ceres ceres* (Cramer), perhaps serves a function similar to that in *Danaus*. Recently three major components, 2,3-dihydro-7-methyl-1H-pyrrolizin-1-one, cetyl acetate, and *cis*-vaccenyl acetate, have been identified in extracts from male hair pencils. Whether or not these compounds are involved in the courtship behavior of the male butterflies

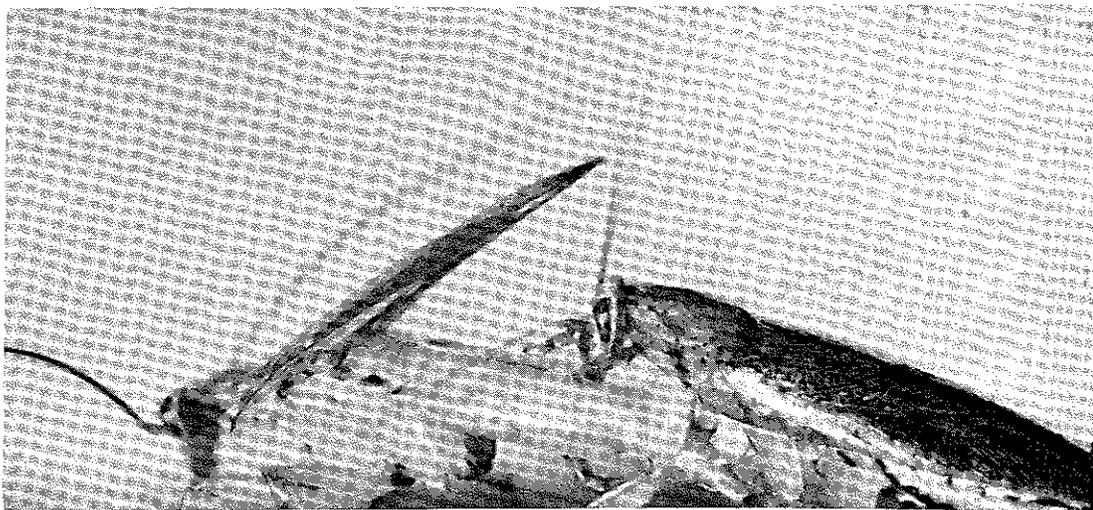


Fig. 1. Female of the cockroach *Ectobius pallidus* (Olivier) feeding on a secretion on the male's back

just prior to mating. The secretion is produced by the tergal gland.

remains to be determined. But identification of the major components is a first step in characterization of the male pheromone in *Lycorea*.

Cockroach. The behavior of at least 25 species of cockroaches indicates that receptive females are attracted to the male's back by an odorous substance. She then palpates or feeds on a secretion which may be produced in distinctive tergal glands (Fig. 1). In the cockroach shown, *Ectobius pallidus* (Olivier), the male has raised his wings to expose the tergal gland. In the ovoviparous cockroach *Nauphoeta cinerea* (Olivier), the attractant, called seducin, acts from a short distance and functions as an arrestant, keeping the female in the proper position long enough (an average of about 6 sec) for the male to make connection. During copulation, the male inserts a spermatophore into the female's bursa copulatrix. Stimuli from the stretched bursa reach the brain via the nerve cord, and the female becomes unreceptive; she will not mate again until after she gives birth about 45 days later.

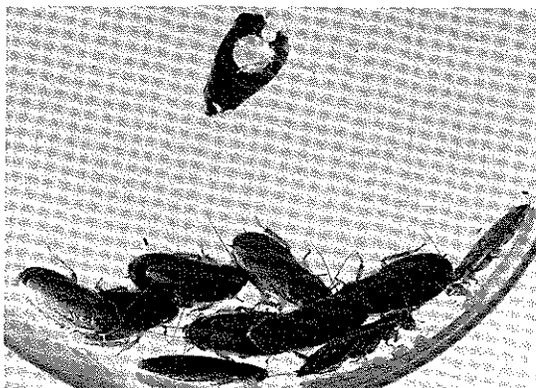


Fig. 2. Females of the cockroach *Nauphoeta cinerea* near a glass dummy male.

A bioassay has been developed to follow purification of extracts obtained from the bodies of thousands of males of *N. cinerea*. Small discs of filter paper, inserted on the "backs" of dummy males (Fig. 2), are impregnated with 6 microliters of the extract to be tested. If the test material is active, the females are attracted to the disc of filter paper and palpate it. As seen in Fig. 3, several seconds after impregnating the disc of paper with male extract, six females have been attracted to the dummy and are attempting to palpate the paper. The pheromone is highly active. A 6-microliter sample derived from 6.7×10^{-5} part of a male *N. cinerea* has an active residue of 1.3×10^{-9} g and elicits a 50 per cent response from females.

Female cockroaches mate periodically. The production of female sex attractants is cyclical, and it is initially controlled by the corpora allata, a pair of endocrine glands attached to the brain. After the female mates, the production of attractant is sharply reduced and eventually ceases, until she becomes receptive again. The mechanisms controlling the formation of male sex attractants in cockroaches are unknown. In general, male sexual activity is not cyclical, and repeated mating does not stop the production of pheromone.

Other male pheromones. Not all pheromones produced by males are concerned with attracting or stimulating the female sexually. The mature male of the desert locust, *Schistocerca gregaria* Forsk., produces a volatile substance all over the body which accelerates the sexual maturation of adults of both sexes. The corpora allata controls the production of this male pheromone.

In termite colonies of *Kalotermes flavicollis* Fabr., males and females live together, and when they die, new supplementary reproductives are produced to replace them. The excrement of both

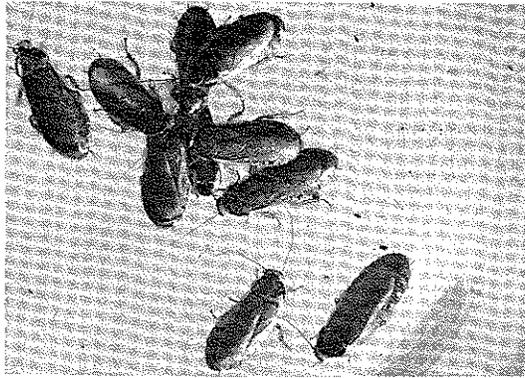


Fig. 3. Six female cockroaches attempting to palpate the dummy male after sex attractant was placed on it.

male and female reproductives contains pheromones which are inhibitory substances which act synergistically to prevent the production of supplementary reproductives. In addition, the male reproductive produces a pheromone which stimulates the production of female supplementaries if female reproductives are absent in the colony.

For background information see INSECT PHYSIOLOGY; SOCIAL INSECTS in the McGraw-Hill Encyclopedia of Science and Technology.

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