The Sex Pheromone of the Mediterranean Flour Moth

Sir:

In the previous paper, it was shown that two closely related species of pyralid moths, *Cadra cautella* and *Plodia interpunctella*, produce an identical compound, *cis*-9, *trans*-12-tetradecadienyl acetate (1), as their female sex pheromone.¹⁾ We report here that the female sex pheromone of the Mediterranean flour moth, *Anagasta kuehniella*, belonging to the same taxonomic subfamily (Phycitinae) to the almond moth, *C. cautella* and the Indian-meal moth, *P. interpunctella*, is also *cis*-9, *trans*-12-tetradecadienyl acetate (1).

The Mediterranean flour moths were reared on rice bran at 23~26°C and collected within 24 hr after emergence. As no trouble was encountered on a preliminary test for the isolation of the female sex pheromone without separating females from males prior to the extraction, about 566,000 moths including both males and females [the sex ratio; *ca.* 1:1] were extracted with methylene chloride (30 liters). After removing the solvent under reduced pressure, the residual oil (770 g) was extracted with cold methanol (1 liter, -20°C) to separate inactive less soluble lipids by monitoring the biological assay reported in the previous paper.¹⁾ This treatment was repeated further four times, and the combined methanol solution was evaporated. The residual oil (87.8 g) was saponified with 4% methanolic potassium hydroxide (500 ml) and then extracted with ether to remove acidic

components. The ether extract (20.3 g), showing no pheromone activity, was acetylated with acetic anhydride (60 ml) and pyridine (60 ml) to give an active oil (21.4 g). These treatments resulted in some hundreds-fold increase in the pheromone activity. The active oil was chromatographed repeatedly on silicic acid columns eluting with 25% benzene in *n*-hexane and with 0.25~5% ether in *n*-hexane, and also on 10% AgNO₃-impregnated silicic acid columns eluting with 1~10% ether in *n*-hexane. Thus, we obtained an extremely active fraction (2.2 mg) showing the pheromone activity of 10⁻¹⁰ mg/ml. However, its gas-liquid chromatographic analysis indicated that the fraction still contained some amount of inactive ingredients. To remove the inactive components, the active fraction was further purified by preparative gas-liquid chromatography using 15% PEG-20 M column at 170°C to give the pure sex pheromone (0.8 mg). The sex pheromone showed the extremely high activity to male moths not only of the Mediterranean flour moth but also of the almond moth and of the Indian-meal moth.

The sex pheromone of the female Mediterranean flour moth was identified to be *cis*-9, *trans*-12-tetradecadienyl acetate by the following experimental data. The product of its micro-ozonolysis using 20 µg of the pheromone was identified as *ω*-acetoxynonanal. The behavior on gas-liquid chromatography using a capillary column (45 m × 0.25 mm *i. d.*) coated with Ucon Oil LB-550 X at 160°C was identical with that of the synthetic *cis*-9, *trans*-12-tetradecadienyl acetate.²⁾

1) Y. Kuwahara, C. Kitamura, S. Takahashi, H. Hara, S. Ishii and H. Fukami, *Science*, **171**, 801 (1971).

2) Unpublished data.

In cooperation with the Entomological Laboratory, College of Agriculture, Kyoto University, we are indebted to Dr. F. Takahashi for the mass-rearing of the moths.

Yasumasa KUWAHARA
Hidetoshi HARA

*Pesticide Research Institute
College of Agriculture
Kyoto University, Kyoto*

Shoziro ISHII
Hiroshi FUKAMI

Received January 6, 1971