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21 January 1970

Antennal Receptors: Reactions to Female Sex Attractant in Periplaneta americana

Abstract. *In* Periplaneta americana, *olfactory receptors on the antennae of male adults and nymphs respond at low threshold to the specific natural odorous attractant produced by virgin females. There are no receptors for that odor on the antennae of female adults or nymphs of any instar.*

An extract of sex attractant of *Periplaneta americana* (L.), claimed to be pure, was reported to stimulate antennal receptors of both males and females and preadult instars (*1*). Our results contradict the above findings. We used an attractant extract which was obtained by the elution of filter paper that had been exposed to a group of virgin females; the extract was purified by distillation and by more rigorous chromatographic procedures than those used previously (*1*). Traces of this extract elicited a vigorous, specific, sexual response in adult males (*2*).

For the electrophysiological tests, the cockroaches were fastened with tape to a piece of cork, and responses from antennal receptors [electroantennograms (EAG's)] were recorded by means of capillary electrodes placed between the base and the tip of the antenna (*1*, *3*). Olfactory stimuli were presented by blowing air (400 liter/hour) through a glass cartridge containing different concentrations of the odorant in 0.2 ml of amyl acetate on filter paper; filter paper alone or impregnated with the solvent served as control. Amyl acetate (0.2 ml) elicits a consistent response from the olfactory receptors in adults of both sexes and in nymphs. Female extract (about 0.1 μg) in the cartridge evoked a response of higher amplitude in the male antenna than 0.2 ml of the amyl acetate (Fig. 1). Even about 0.001 μg of extract in the cartridge elicited a response which was clearly above that of the control. Because one load of 0.001 μg could be used several times as a suprathreshold stimulus, the amount of odor leaving the source per stimulus was but a small fraction of the original dose. However, the number of molecules leaving the source is unknown.

With increasing amounts of odorous material on the filter paper, the amplitude of the EAG rose over a range of at least two orders of odor concentration (Fig. 2). In the EAG test the female extract was effective also in male nymphs, at least in the last preadult instar (Fig. 1). Here the reaction is well above that of the control, but the EAG amplitudes are lower than those elicited by amyl acetate. No response to the female extract could be detected in the antennae of female adults or nymphs (Fig. 1).

Because there is not very much difference in the number of sensilla on the antennae of the two sexes, the difference in response to the attractant extract is presumably due to specificities of the receptor cells as is the case in the silk moth *Bombyx mori* (*3*). Although the smaller number of antennal sensilla in nymphs may be partly responsible for the smaller EAG response in the nymphal stage, the fact that receptors for the attractant become apparent in late instar nymphs suggests that the receptors develop along with sexual development and that their reactivity may possibly depend on hormonal concentrations. The possible connection of the sex attractant receptors with, or their derivation from, receptors for other odors is an open question.

In light of these results and the fact that the 1963 sample had a typical cockroach odor, while our sample is apparently odorless, it is evident that

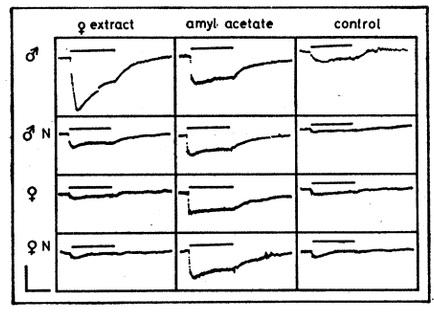

Fig. 1. Electroantennograms recorded from antennae of *Periplaneta americana* adults and nymphs (*N*). About 0.1 μg of female extract and 0.2 ml of amyl acetate on the filter paper were used.

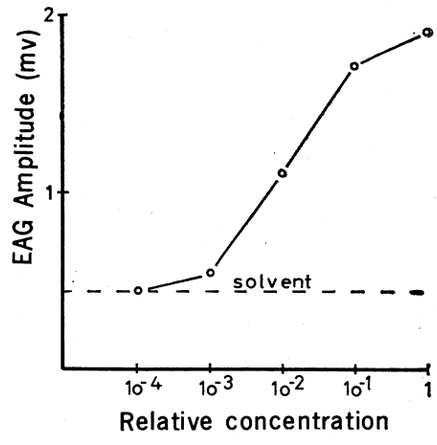

Fig. 2. Amplitude of EAG response of male antennae as a function of the amount of female extract. The relative concentration of the female extract is expressed as the log concentration (1 equals about 0.1 μg).

the earlier sample contained a fraction other than that of the sex attractant. Our sample is highly specific for male antennal receptors and also serves as a powerful trigger for sexual behavior.

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