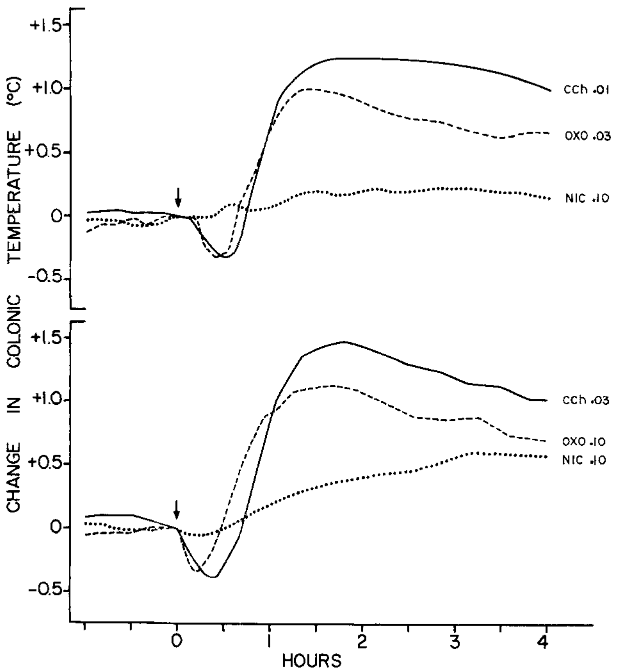
thermoregulatory responses. To determine whether the dual responses might be mediated by muscarinic and nicotinic systems within the AH/PO region, similar injections of nicotine and oxotremorine, specific nicotinic and muscarinic agonists, respectively, were performed. Nicotine, injected in concentrations ranging from 0.01 to 0.3 *M* produced either no effect or a delayed and gradual increase in temperature which bore no resemblance to the response to carbachol. Similar delayed, gradual temperature increases have been observed after control injections of artificial cerebrospinal fluid and may be attributable to pyrogen contamination or a pyrogenic tissue factor released by mechanical disturbance of the injection site. Oxotremorine, on the other hand, produced thermoregulatory effects which were remarkably similar to those evoked by carbachol, although somewhat higher doses were required. The thermoregulatory effects of injections of carbachol, nicotine and oxotremorine injected into 2 different AH/PO sites are illustrated in the Figure.

Further analysis of the nature of the biphasic carbachol response was carried out using 1-hyoscyamine, a specific muscarinic receptor antagonist and mecamylamine, a specific nicotinic receptor antagonist. One of these substances was injected into a site 20 min prior to the injection of a dose of carbachol which, when administered alone into the same site, evoked a biphasic response. At 6 sites, pre-injection of 0.012 *M* 1-hyoscyamine produced a 60–70% reduction in the magnitude of both the falling and the rising phase of the response evoked by 0.03 *M* carbachol. This reduction was significant at the 0.05 level. However, pre-injection of mecamylamine at a concentration of 0.13 *M*, 10 times the concentration of 1-hyoscyamine used, produced only a 29% reduction of the falling phase ($P > 0.05$) and failed to affect the rising phase. Injection of 1-hyoscyamine or mecamylamine alone had no consistant effect on body temperature, although mecamylamine occasionally produced a small increase.



Changes in colonic temperature evoked by injections into 2 sites within the AH/PO region of 1.0 µl of various molar concentrations of carbachol (CCh) nicotine (NIC) and oxotremorine (OXO).

These findings suggest strongly that both the fall and the rise in temperature produced by acetylcholine or carbachol injected into the AH/PO region of the cat brain are due to an action on muscarinic or muscarinic-like receptors and that stimulation of nicotinic receptors is not involved. The biphasic effect on body temperature evoked by injection of carbachol at some AH/PO loci is unlikely to be a result of sequential excitation and inhibition (or vice-versa) of a single muscarinic pathway because injection of a muscarinic antagonist at these same sites – which would presumably produce inhibition of function – failed to produce any major change in body temperature. Moreover, injection of carbachol at some sites within the AH/PO region evoked only one unitary effect, either a fall or a rise in temperature[3]. The most parsimonious explanation of these findings is that the AH/PO region of the cat contains partially overlapping heat gain and heat loss pathways, both of which are muscarinic in nature. Biphasic responses would occur when muscarinic agonists are injected into areas of overlap.

With respect to its lack of nicotinically sensitive synapses in the AH/PO heat loss pathway, the cat apparently differs from the rat and rhesus monkey. In these latter species, nicotinic stimulation of the AH/PO region evokes a decrease in body temperature[4,5]. However, the possibility that nicotinic synapses involved in heat loss may exist in the posterior hypothalamus or lower brain stem of the cat cannot be dismissed. Indeed, 2 recent reports that nicotine injected into the cerebral ventricles of the cat support this possibility[6,7].

Résumé. On a examiné la nature du changement biphasique de la température rectale produit par une injection de carbamylcholine dans l'hypothalamus du chat. Les phases d'augmentation et de diminution de la réponse ont été causées par des recépteurs hypothalamiques muscariniques.

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Pheromone and Host Odor-Stimulated Potentials in *Dendroctonus*

Electrophysiological investigations of antennal olfactory responsiveness to pheromones and host odors have been reported for several insect species[1]. Antennal olfactory response can be measured through action potentials from one to a few receptor cells[2] and through the electroantennogram (EAG)[3]. In general EAG records consist of the summation of several receptor potentials from olfactory receptors. However, with the indifferent electrode in the head of the insect, muscle potentials often appear in the records[3]. When the recording and indifferent electrodes were placed in the antenna and head of *Bombyx mori* L., respectively, action potentials, presumably from antennal muscles in the pedicel, occurred spontaneously and upon stimulation by odor[3].

In antennal-head preparations of *Dendroctonus* spontaneous and odor-stimulated action potentials have appeared frequently with the EAG. In addition, over 60 preparations have displayed the presence of other potentials (not action potentials) probably from antennal muscles in the pedicel, scape and head (Figure 1). The occurrence of these other potentials is significant in that they differ in response to pheromones and to host tree odors, which corresponds to the EAGs recorded from the olfactory receptors on the club of the antenna[4] (Figure 2).

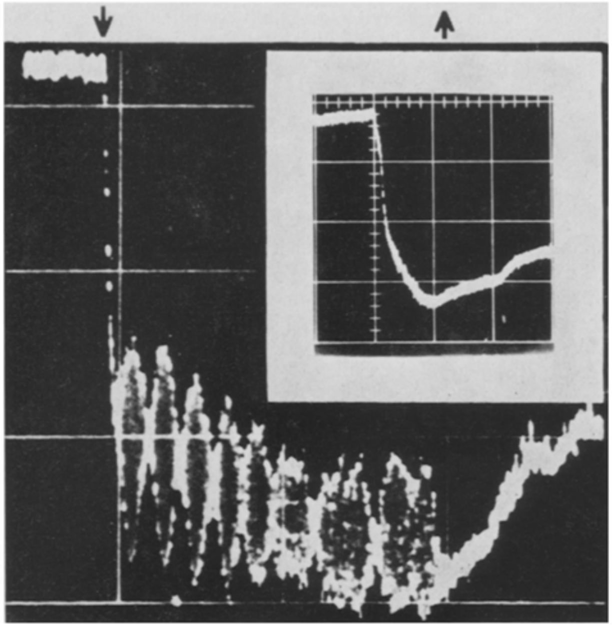

Fig. 1. EAG from *Dendroctonus frontalis* to ca. 10^3 μg of frontalin showing muscle potentials. ↓, stimulus on; ↑ stimulus off. Insert shows typical EAG to frontalin.

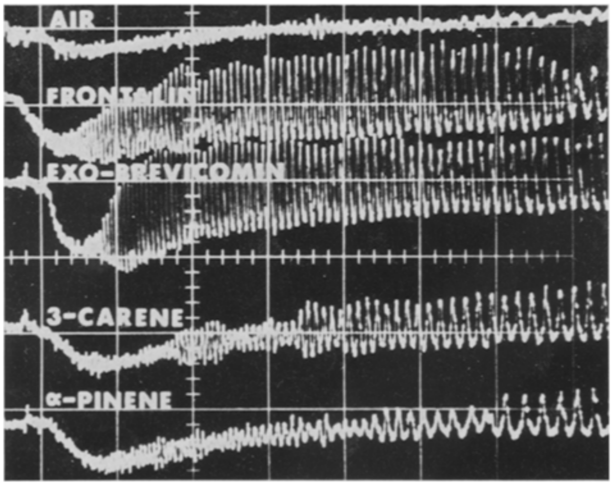

Fig. 2. Responses of *Dendroctonus brevicomis* recorded in AC mode showing differential muscle response to pheromones and terpenes (ca. 10^4 μg on filter paper). Air, control.

Electrophysiological recordings were made from males and females of *D. frontalis* Zimm. and *D. brevicomis* LeC. in response to the aggregation pheromones frontalin (1,5-dimethyl-6,8-dioxabicyclo [3.2.1] octane)[5], *exo*-brevicomin (5,7-dimethyl-6,8-dioxabicyclo [3.2.1] octane)[6] and the host tree terpenes α-pinene and 3-carene on filter paper. In nature, different combinations of some of these compounds are known to aggregate both species. Techniques for recording and odor sample presentation are reported elsewhere[6]. Glass capillary Ag-AgCl microelectrodes filled with 3 *M* KCl were used. The recording electrode was inserted in the terminal segment of the antenna (club) and the indifferent electrode was inserted in the head capsule at the base of the antenna. Records were made on Polaroid film.

Responses to the compounds recorded in the DC mode showed typical EAGs on which were superimposed potentials apparently from antennal muscle movement. Both EAG and muscle potential amplitude increase to stimulation by increased concentration of a compound (1-ca. 10^4 μg on filter paper). At high concentration the amplitude of response to pheromone was considerably greater than the response to terpene (Figure 2).

The potentials were only present in the recordings when the indifferent electrode was placed in the scape or in the head where it joins the antenna. EAGs however were recorded with the indifferent electrode placed elsewhere. The potentials were not considered as artifacts because: a) they were only recorded from specific areas of the insect, b) they varied in intensity and frequency with a given stimulus and concentration, c) they occurred only in response to biologically active compounds, and d) they were not recorded from excised antennae as were EAGs. The potentials were not considered to be action potentials from olfactory receptor cells because of the presence of oscillating amplitude.

Behaviorally, both *Dendroctonus* species display antennal raising and orientation movements when stimulated by the pheromones and terpenes. The responses recorded electrophysiologically are probably associated with that antennal movement.[7]

Résumé. Les possibilités de mouvement des muscles antennaires furent enregistrés simultanément par électroantennogramme chez deux espèces de *Dendroctonus* réagissant à la phéromone et aux odeurs des plantes sur lesquelles elles vivent. Dans les deux sexes de ces espèces, le potentiel moteur différa en raison de la phéromone et de l'odeur.

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