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## Generator Potential of Insect Chemoreceptor

*Abstract.* Depolarization of the receptor membrane was recorded in labellar chemosensory hairs of flies upon stimulation by sucrose or NaCl. On the other hand, hyperpolarization was recorded in the case of $CaCl_2$, quinine, and acetic acid, all of which had an inhibitory effect on the initiation of chemosensory impulses.

It is now generally believed that in all kinds of receptors sensory impulses are initiated by changes in graded local potential (generator potentials) which are evoked by adequate stimuli. As for taste receptors, generator potential has not been recorded in either vertebrates or invertebrates (*1*). Labellar chemosensory hairs of flies have a structure which makes it possible to record this primary physiological process of chemoreception.

The recording arrangement is shown at the top of Fig. 1. This is an improvement over earlier methods (*2*). The hair wall near the tip of a labellar chemosensory hair of *Calliphora vomitoria* was pierced with a microneedle. At this point the fluid surrounding the sensory fibers inside the hair made contact with the 0.125*M* solution of NaCl contained in a capillary, whose diameter was about 30 $\mu$. Through a platinum wire inserted into this capillary, the electrical activities of the sensory fibers near the hair tip were fed into a direct-coupled amplifier. After these procedures, a stimulating solution contained in another capillary was brought into contact with the hair tip. Movements of this capillary were controlled by an electromagnet and synchronized with sweeps of an oscilloscope.

Figure 1*A* is the record obtained by stimulating a chemosensory hair with a 0.25*M* solution of sucrose. It may be observed that after a brief upward surge, a negativity (downward deflection) is sustained during the stimulation, accompanying a train of impulses. We conclude that this negativity, as well as the impulse, represents a physiological event but that the initial surge is an artifact, since the negativity and the impulse almost disappeared but the initial surge was still recorded after the hair was crushed at the recording point (Fig. 1*B*). In no hairs was a *train* of impulses without a sustained negativity ever recorded; the negativity increased in magnitude with increase in the strength of the stimulus. Thus, it can be assumed that this negativity is the generator potential (depolarization of the receptor membrane). Such a potential was also obtained with NaCl.

It is interesting to note, on the other hand, that a positivity (hyperpolarization of the receptor membrane) was

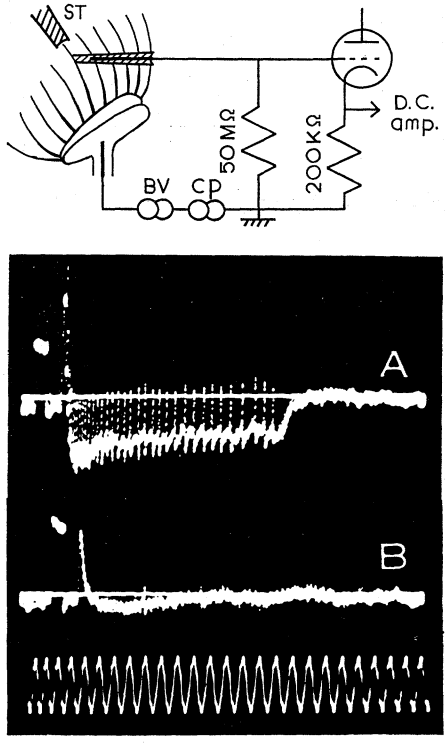


Fig. 1 (Top). Recording and stimulating arrangement. *ST*, Capillary containing a stimulating solution; *BV*, voltage source for balancing the potential difference between electrodes; *CP*, calibration pulse generator. (Bottom) *A*, Response to 0.25*M* sucrose; *B*, application of 0.25*M* sucrose after the same hair was crushed. Just before chemical stimulation, a rectangular calibration pulse of 1 mv (positive with reference to the ground) was applied. Time base, 60 cy/sec.

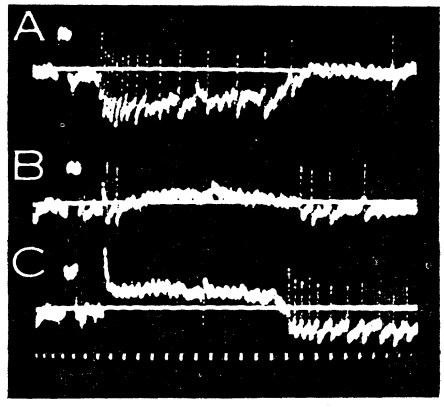


Fig. 2. Response of a hair to 0.25*M* sucrose (*A*), 0.25*M* sucrose + 0.05*M* $CaCl_2$ (*B*), and 0.05*M* $CaCl_2$ (*C*). Time, 1/60 sec.

produced by application of $CaCl_2$, acetic acid, quinine, and other compounds. These chemicals inhibited the initiation of impulses which might be evoked by sucrose or NaCl. One of these results is shown in Fig. 2. In Fig. 2*A*, a chemosensory hair responded to 0.25*M* sucrose in the same way as in Fig. 1*A*. When a mixed solution of 0.05*M* $CaCl_2$ and 0.25*M* sucrose was applied, a slight negativity with a few impulses was induced during the initial period of stimulation, but the negativity soon changed to a positivity, and the impulses disappeared. After the test solution was withdrawn, the positivity turned into a slight negativity, and impulses recurred (Fig. 2*B*). When a plain 0.05*M* $CaCl_2$ solution was used, the positivity and the afternegativity accompanied by the discharge of impulses were clearly observed (Fig. 2*C*). Enough other results have been obtained to show that the membrane potential of the chemoreceptor surface at the hair tip controls the initiation of impulses somewhere near the hair base (*3*).

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### References and Notes

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