was collected from the skin of the scapular area of patients and control subjects during thermal stimulation of the sweat glands. Because the sodium concentrations of the sweat from patients and controls were different, the sodium concentrations of all solutions used for retrograde perfusion of the rat parotid were corrected to 140 to 145 mEq/liter by addition of proper amounts of NaCl. The methods of preparation of the rats and retrograde perfusion of the parotids have been described previously (*7, 8*). Male albino rats of the Sprague-Dawley strain were used. Sodium concentrations in samples of rat parotid saliva (1 to 5 μl) were measured with a flame photometer (Instrumentation Laboratories) with an internal lithium standard.

Following stimulation of the rat parotid with pilocarpine, the sodium concentration of the saliva was related to the salivary flow rate (Fig. 1). At low flow rates, the gland excretes saliva with very low sodium concentrations. At progressively higher flow rates, the salivary sodium concentration gradually increases. This relationship is accounted for by the limited sodium reabsorptive capacity of the striated ducts of the rat parotid gland (*7*). As the production of a plasma-like primary fluid increases, the sodium reabsorptive mechanism becomes saturated and the salivary sodium concentration increases. When the duct system of the gland was perfused with sweat from normal children, there was no effect on the reabsorption of sodium (Fig. 2). When sweat from patients with cystic fibrosis was used for the retrograde perfusion, there was a marked increase in the salivary sodium concentration at all flow rates (Fig. 3). Since the rat parotid gland reabsorbs sodium mainly in the striated ducts, it may be concluded that the sweat of patients with cystic fibrosis contains a factor (or factors) that inhibits sodium transport in the striated ducts of the rat parotid.

Although the exact nature of this factor is not yet clear, we have determined some of its physicochemical properties. The factor is heat labile; heating of the sweat at 100°C for 5 minutes resulted in the disappearance of the sodium transport inhibitory activity. This activity also disappeared when the sweat samples were frozen and thawed. Storage of the sweat at 4°C for 24 hours caused a reduction in the activity by 30 to 40 percent. The activity remained in the dialysis chamber when the sweat was dialyzed against 0.154*M* NaCl solution at 4°C for a period of 3 hours.

We propose the following mechanism that may be responsible for the sodium transport abnormality in cystic fibrosis: The secretory process of the sweat gland is normal, and a plasma-like primary fluid is produced in the secretory coil of the gland; this fluid, however, contains the sodium transport inhibitory factor. When the primary fluid reaches the duct of the gland, the site of production of hypotonicity, this factor inhibits sodium reabsorption; thus, the final sweat emerges from the sweat pore with a sodium concentration higher than normal. It is hoped that final identification of this factor may lead us closer to the detection of the molecular defect of cystic fibrosis.

JOHN A. MANGOS
NONA R. MCSHERRY
Department of Pediatrics, University of Wisconsin Medical School, Madison 53706

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Antennae and Sexual Receptivity in Drosophila melanogaster Females

Abstract. *For the female to be normally responsive to the display of wing vibrations by males, the arista and funiculus of the female's antenna must be intact and able to move freely. The arista probably acts as a sail, twisting the funiculus and thus stimulating units of Johnston's organ at its base.*

Female *Drosophila* whose antennae have been removed mate less readily than normal females do. The wing vibrations, which are a conspicuous element in the courtship of many *Drosophila* species, may serve to waft a current of scented air over the female's antennae; that there are air-current receptors at the antenna's base has been suggested (*1*). Petit (*2*) made a more detailed analysis of the sense organs involved by amputating different antennal segments in *D. melanogaster.*

The *Drosophila* antenna has three main segments (*3*): the basal scaphe; the pedicel, containing Johnston's organ; and the distal flagellum or funiculus, attached to the pedicel by a stalk whose movements can stimulate the elements of Johnston's organ directly. Projecting from the outer margin of the funiculus near its proximal end is the branched arista, which together with small sclerites at its base probably represents the three reduced terminal segments of the antenna.

Petit (*2*) measured the sexual receptivity of females after four different operations: (i) removal of both antennae, (ii) removal of one antenna, (iii) removal of the funiculus and arista on both sides, and (iv) removal of the arista on both sides. The control value for receptivity was 88 percent; that of the operated groups was (i) 8 percent, (ii) 62 percent, (iii) 30 percent, and (iv) 43 percent, respectively. She concluded that the most important receptors were the arista, "receptor for tactile and chemical stimuli," and Johnston's organ, "the vibration receptor."

Petit did not watch courtship but scored the number of inseminated females after a 48-hour confinement with males. Since one can tell whether a female is receptive or not within 15 minutes of her being courted, this technique has drawbacks if one wishes to record different degrees of reduced receptivity. Further, after long periods of confinement with males, forced matings are common. My experiments avoid these difficulties and provide further evidence on the way in which the antennal sense organs operate in the perception of courtship stimuli.

Receptivity was measured by direct observation of single pairs of flies in small observation cells. More than 95 percent of females either accept males within 15 minutes of courtship (that is, are receptive) or are unreceptive and refuse to accept for long periods. In practice 30 minutes of more or less continuous courtship is a suitable criterion (*4*).

The same operations as in Petit's experiments were performed on females anesthetized with ether on days 2 or 3

Table 1. The receptivity of *D. melanogaster* females following various treatments of the antennae.

Treatment	Receptive	Unreceptive
Etherized but unoperated	72	3
Both antennae removed	23	57
One antenna removed	68	25
Funiculus and arista removed from both sides	23	59
Arista removed from both sides	22	64

(day 0 being the day of eclosion); the animals were tested for receptivity on the following day at an age when almost all normal females are receptive (*4*). The results agree with those of Petit to the extent that the loss of both antennae reduces the number of receptive females much more drastically than the loss of one does ($\chi^2 = 33.9$; $P < .001$), although the latter operation also has a marked effect (compared with controls, $\chi^2 = 15.6$; $P < .001$) (Table 1). However, in contrast to her findings, there is no significant difference between females whose antennae have been totally removed, those which have lost the funiculus and arista, and those which have simply lost the arista. This latter result is striking because removal of the arista involves very little damage or disturbance to the rest of the antenna; in particular, Johnston's organ and the olfactory receptors on the body of the funiculus remain unaffected.

This result suggests that the presence of the arista is essential for the normal perception of wing vibration and that an intact Johnston's organ is not sufficient. There are two ways in which the arista might operate. Hertweck (*3*) describes a single sensory neuron running from the arista, and a male's wing vibration might induce movements of the arista with respect to the funiculus. Alternatively the arista may act as a lever arm or "sail" which causes the whole funiculus to oscillate in response to wing vibration, thus stimulating Johnston's organ. Burkhardt and Schneider (*5*) have shown that the arista does act as a sail when the antenna of *Calliphora* is exposed to air currents.

For the perception of courtship stimuli one can distinguish between these two alternatives with fair confidence by fixing the funiculus so that it cannot move while still allowing free movement of the arista itself. This was done by running tiny drops of Eastman 910 adhesive from a fine glass needle onto the lower side of the distal end of the funiculus, and then gently pressing it back into the antennal socket. If successful, this held the funiculus fast without the adhesive's affecting the pedicel, and it left the arista projecting normally, though admittedly rather less exposed to air currents because of the backward position of the funiculus.

Drosophila females proved to be extremely adept at freeing their antennae within a few hours of such treatment, but this enabled about half the treated group to be used as controls. Flies were treated with adhesive, and their receptivity was tested on the next day. They were then examined to see how far the treatment had been successful. All the flies showed extensive areas of dried adhesive on the funiculus, but in more than half the cases at least one antenna was free from its socket. Most females with one or both antennae free were receptive; few were if both antennae remained fixed, although in this latter group the arista was free to move (Table 2).

Table 2. The receptivity of females whose antennae have been treated with adhesive. Results are given for females that were found after testing either to have one or both antennae free or to have both antennae fixed. (χ^2 with Yates's correction = 19.7; $P<.001$).

	One or both antennae free	Both antennae fixed
Receptive	18	1
Unreceptive	2	13

This finding suggests that a female's perception of wing vibration depends on the arista and funiculus acting as a unit that twists and thus stimulates Johnston's organ. Recently, Bennet-Clark and Ewing (*6*) have shown that the wing vibration display has two components which are, at least in part, synergistic. The vibration serves to drive a stream of air—a tonic component, and it also provides a phasic auditory stimulus with brief pulses repeated 30 times per second whose frequency within pulses is 180 to 350 cycle/sec. Burkhardt and Schneider (*5, 7*) found both tonic and phasic receptor units in *Calliphora* antennae, but they report no behavioral response to auditory stimuli. It seems most likely that the antenna's responsiveness to sound is important in courtship for a variety of sounds are also produced during the brief sexual displays of related flies such as *Sarcophaga* (*8*).

If the mechanical properties of the arista and funiculus in *Drosophila* are "tuned in" to resonate at the male's courtship sound frequency, it should be possible to hamper their action by loading or clipping the arista. In fact, preliminary experiments indicate that neither operation has much effect on receptivity. This finding suggests that, rather than following precisely the frequency within pulses of the male's vibration, the important stimulus may be the frequency of pulse repetition. So long as some kind of a sail is present to move the funiculus, there is adequate pickup of the pulse train, and the antennal nerve transmits a signal which is registered by the central mechanisms responsible for sexual acceptance.

AUBREY MANNING

Department of Zoology,
University of Edinburgh,
Edinburgh, Scotland

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Decay of Visual Information from a Single Letter

Abstract. *If the trace of a letter can be matched more rapidly with a physically identical letter (as in the pair AA) than it can be with a letter having only the same name (as in the pair Aa), then the trace must preserve the visual aspect of the letter. The visual information from a single letter decays in about 1.5 seconds if the task provides little incentive for preservation.*

A number of studies have found that information from complex arrays of visually presented items shows rapid decay in the 1st second after presentation (*1*). Such studies have led to the notion of a storage system for visual information which holds material for a brief period during the process of naming the stimuli (*2*). In this paper we present a technique which makes