

### HEARING IN THE RAT AT HIGH FREQUENCIES

THE authors recently discovered that rats sometimes display epileptiform seizures when they are exposed to frequencies of 21 kilocycles and that they show, by their overt behavior, sensitivity to even higher frequencies. It therefore seemed clear to us that the rat hears higher frequencies than does man, but it became a matter of interest to know just what frequencies are audible and how well these frequencies are heard. No data concerning pure tones higher than 8 kilocycles could be found in the literature, so the following experiment was conducted.

Nine rats were taught to run from one part of a compartment to another whenever a tone of 8 kilocycles was presented. Their incentive was to avoid shock. When they had learned this, they were trained to react in similar fashion to other frequencies between 1 and 40 kilocycles. Then the intensity of the tones was reduced step by step until an intensity was reached at which a tone called forth responses from the animal only 50 per cent. of the time. This intensity was taken as the threshold, and it was determined for 1, 2, 4, 8, 14, 21 and 40 kilocycles. (40 kilocycles was the limit of our apparatus.) Except for 21 and 40 kilocycles, similar measurements were taken on eight human subjects.

The average thresholds of the human and animal subjects were compared at different frequencies with the following results. The rat's threshold is much higher than man's at 1 kilocycle, but the difference between the two diminishes as the frequency is increased, until in the neighborhood of 8 kilocycles the sensitivities of man and the rat are the same. At higher frequencies, however, the rat is more sensitive than man, and the discrepancy becomes larger as the frequency is increased. Thus rats are poorer than man below 8 kilocycles and better than man above this frequency.

Any attempt to state the audiogram of the rat in terms of acoustic energy must be based upon somewhat tenuous suppositions concerning the physical characteristics of our apparatus. Nevertheless, even when due account is taken of such considerations, we can state that the absolute sensitivity of the rat most certainly improves as the frequency is increased up to 20 kilocycles. It seems likely, furthermore, that the frequency most audible to the rat is as high as 40 kilocycles. At any rate, our rats hear 40 kilocycles very well, and the upper limit of hearing must, on this account, be a very high frequency indeed.

No animal in whom hearing has been studied at all adequately presents such a disposition of auditory sensitivity as this. Cats and dogs<sup>1</sup> hear best at a

higher frequency than man, and their upper frequency-limit is higher, but the rat surpasses them in both respects. Of other animals so far studied, only the bat<sup>2</sup> shows signs of possessing a similar range of auditory sensitivity; cochlear potentials have recently been observed in this animal up to 98 kilocycles. If more suitable sound-producing instruments than we had at our disposal are available in future experiments, it may be shown that the rat's hearing extends to and beyond this frequency; at least, so our data would lead us to expect.

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### THE GERMINATION OF MAIZE POLLEN

THE pollen of *Zea mays* is recognized as one of the difficult sorts to germinate under artificial conditions. In addition to its value in genetic and cytological studies, preliminary experiments have suggested that a reliable method for rapidly checking the viability of maize pollen will be necessary in studies of the effect of ecological factors on pollination and yield of maize.

A method has been developed which has given as much as 90 per cent. germination on nutrient medium within 30 minutes after inoculation. A solution containing 0.7 per cent. agar and 15 per cent. sucrose is held at 60 degrees C. in a water bath and transferred with a pipette to a microscope slide. Only enough solution is placed on the slide to form a shallow droplet of approximately 1 cm diameter. The droplet is allowed to harden for 60 seconds at 20 to 25 degrees C. before the pollen is dusted on from a knife blade held about 2 cm above. The slide is immediately transferred to a moist chamber at 23 degrees C. in which the relative humidity is maintained at 90 per cent. Germination counts can be made after 30 minutes, and, with good lots of pollen, should certainly be read within two hours, before a confusing mass of tubes has developed. In practice the tube growth has been arrested by transferring the slides after two hours to another moist chamber at 6 degrees C. in which the material can be preserved intact for two weeks for more leisurely observations.

The most serious problem in germinating maize pollen is the prevention of bursting. Apparently a near isotonic relationship between the nutrient medium and the cytoplasm is required, with the balance slightly on the hypotonic side so that the pollen grain may absorb water for tube growth, but not rapidly enough to cause bursting. With different lots of highly viable pollen the sucrose percentage showing maximum germination has varied between 10 and 15 per cent. Although no sugar determinations have been made for

<sup>1</sup> S. Dworkin, J. Katzman and G. A. Hutchison, *Jour. Exp. Psychol.*, 26: 281, 1940.

<sup>2</sup> R. Galambos, *SCIENCE*, 93: 215, 1941.