Letters to the Editor

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NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 998.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Sensitivity of Insects to Sound

IN the course of experiments directed to another end, we have had occasion to determine the sensitivity at different stimulus frequencies of certain structures in the cricket (*Gryllus domesticus*) and the locust (*Locusta migratoria migratorioides*). These structures are (*a*) the long hair-sensilla on the *cercus* of the cricket, recently shown to subserve a partially acoustic function[1], (*b*) the tympanal organ of the locust and (*c*) receptor organs which we believe to be identical with the short hair-sensilla generally distributed over the body of the locust.

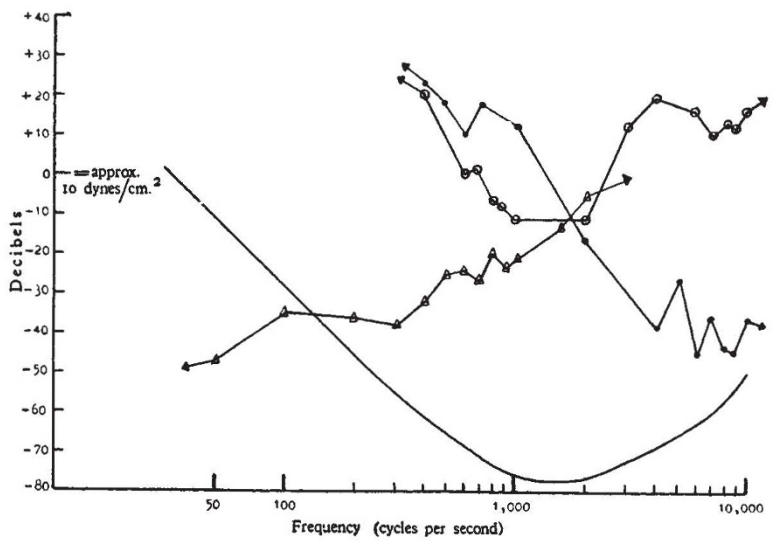

FIG. 1. Graphs showing the threshold of the electrical response in the associated nerve as a function of frequency of stimulation, for three typical insect receptor mechanisms. Wegel's figures for the normal human threshold are shown for comparison. △—△, *Gryllus*, anal cercus; ● — ●, *Locusta*, tympanum; o — o, *Locusta*, sensilla; ——, Wegel's figures (1932) for the normal human threshold.

The audiograms shown in the accompanying graph (Fig. 1) were obtained by a method somewhat similar to that of Derbyshire and Davis[2]. The decapitated insect was enclosed in a sound-proof room, and the appropriate nerve was connected by means of fine electrodes to an amplifier feeding a cathode ray oscillograph and loudspeaker, so that the activity in the nerve could be made to give both a visible and an audible sign of its occurrence. The acoustic organ was stimulated by pure tones from a loudspeaker fed from a beat oscillator and amplifier. The output from the former could be varied over a frequency range of 50–10,000 cycles per second, and could be attenuated by 130 db. in 2 db. steps below a maximum of about 100 microwatts per sq. cm. at the point of stimulation. This stimulator was previously calibrated with sufficient accuracy for our purpose by reference to five 'normal' ears. Waveform and frequency monitoring was carried out with a cathode ray oscillograph, the time-controlled 50-cycle A.C. mains forming the primary frequency standard. The threshold of the organ under investigation at any given frequency was taken to be that intensity which produced a just perceptible activity in the associated nerve. The records of two observers were found to agree within ±2 db.

In Fig. 1 the threshold intensities of representative animals have been plotted in decibels above and below a sound pressure of 10 dynes per sq. cm., and, in order to emphasise the relatively high sensitivity of two of the groups of receptors at the two extremes of the human auditory spectrum, the readings on the five human observers, reduced to Wegel's classical figures[3], have been plotted on the same graph. The curves clearly indicate that the significance of a sound to these insects cannot possibly be judged by its apparent loudness to the human ear; a response from the cercus may be readily elicited by a low-frequency stimulus quite inaudible to man, whilst the slope of the curve for the tympanal organ appears to show that its sensitivity would very greatly exceed that of the human ear at frequencies above 10,000 c.p.s., the present limit of our apparatus.

The presence of scattered receptors sensitive to sound at quite low intensities in an insect which is also provided with a specialised acoustic organ is a matter of some interest, though their existence has been indicated in insects of certain other orders. We believe, however, that no quantitative measurements have previously been made on any of these receptors, with the exception of those of Wever[4] on the tympanal organ of the grasshopper. These are in fair agreement with ours on the similar organ of the locust.

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[1] R. J. Pumphrey and A. F. Rawdon-Smith, *J. Physiol.*, **86** (1936). (*Proc. Physiol. Soc.*, March 14, 1936.)
[2] A. J. Derbyshire and H. Davis, *Amer. J. Physiol.*, **113**, 2, 476 (1935).
[3] R. L. Wegel, *Ann. Otol.*, **41**, 770 (1932).
[4] E. G. Wever, *J. Comp. Psychol.*, **20**, 17 (1935).