Reports

Duplex Nature of Reception of Simple Sounds in the Scape Moth, Ctenucha virginica

Moths of a number of families have been shown to possess tympanal organs sensitive to sounds of high frequencies which may enable the insects to escape capture by bats (*1*). Reactions to sounds are of both excitatory and inhibitory types, without obvious relationships to species or habits. Destruction of the tympanal organs abolishes most of the responses to sounds, but some individuals respond occasionally even after destruction of the organs.

In a study of reactions of the scape moth, *Ctenucha virginica* (family, Amatidae), to "pure" tones (*2*), we have found a possible explanation for responses of moths with the tympana destroyed. Briefly, *C. virginica* showed a duplex pattern of response to simple sounds: at frequencies of 150 to 15,000 cy/sec and median sound pressures of 95 to 100 db (*re* 0.0002 μbar), the reactions were generally excitatory in nature; at frequencies above approximately 15,000 cy/sec and median sound pressures of 80 to 85 db, the reactions were either inhibitory or, if excitatory, were different from those at lower frequencies. Destruction of both tympana abolished the responses to frequencies above 15,000 cy/sec, but did not affect the reactions at lower frequencies.

The methods used for testing the reactions of these moths to sounds were like those reported by us earlier (*3*). The animals were tested individually either in small cubical cages (15 cm on a side) or affixed to small wax blocks on the ends of glass rods by the dorsal wall of the thorax, with the wings free. Sounds pressure thresholds for reactions to 1- to 2-second bursts of "pure" tones of 150 to 40,000 cy/sec were determined by stimulating the insects at different sound pressures, using innate reactions to the sounds as indicators of reception. Frequencies below 150 cy/sec were produced by the equipment at intensities too low to stimulate; 40,000 cy/sec was the highest frequency that the apparatus could produce. Thus, actual frequency limits for the responses were not determined. A total of about 3000 threshold determinations were made with 21 individuals (16 males, 5 females).

At frequencies of 150 to 15,000 cy/sec, free moths usually responded by tilting the body to bring the anterior end nearer the substrate. Fixed moths jerked the antennae or legs. At 20,000 cy/sec and higher, free animals responded only occasionally and then by flicking the wings. Fixed animals, on the other hand, responded quite consistently: if not flying, they flicked the wings slightly; if flying, they usually stopped almost immediately when stimulated by the sound, as Treat (*1*) also found for this species. For 19 frequencies between 150 and 15,000 cy/sec, there were no significant differences in median sound pressure thresholds. Any sound within this wide frequency range, if it achieved sufficient intensity (above 85 to 90 db), was stimulating. At 20,000, 30,000, and 40,000 cy/sec, median sound pressure thresholds were significantly lower than at lower frequencies and essentially the same (84 to 85 db). At 15,000 cy/sec, some moths responded as at lower frequencies, others as at higher frequencies. All responded as at lower frequencies below 12,000 cy/sec and as at higher frequencies above 18,000 cy/sec. It is almost certain that frequencies above 40,000 cy/sec would stimulate the moths, for reactions occurred at that frequency at just as low intensities as at 20,000 and 30,000 cy/sec.

Bilateral destruction of the tympana abolished the responses above 15,000 cy/sec, but did not affect those at lower frequencies. With or without tympana, removal of the following parts of the body, individually or in most possible combinations, did not significantly alter the responses or thresholds at lower frequencies: antennae, legs, two-thirds of the wings, head, and abdomen. In fact, isolated heads responded by antennal movements at only slightly higher intensities than whole animals. The results, which are like those reported for the butterfly, *Cercyonis pegala* (*3*), suggest that the receptors are widespread on the body, possibly tactile hairs or chordotonal organs in the body wall.

These observations show clearly the necessity for specification of the frequencies and intensities of sounds used in studying acoustical reactions of insects. There are a number of mechanoreceptors on the insect body which are at least theoretically susceptible of stimulation by sounds. Careful control of intensities and frequencies may enable one to determine the relationships within this galaxy of receptors which enable the insect to react to its acoustic environment.

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References and Notes

1. A. H. Swinton, *Entomol. Monthly Mag.* 14, 121 (1877); *Insect Variety* (Cassell, Petter, Gulpin, and Co., London, 1880); F. Eggers, *Z. vergleich. Physiol.* 2, 297 (1925); "Die stiftführenden Sinnesorgane," *Zool. Bausteine* 2 (1928); J. v. Kennel and F. Eggers, *Zool. Jahrb., Abt. Anat. Ont. Tiere* 57, 1 (1933); F. Schaller and C. Timm, *Z. vergleich. Physiol.* 32, 468 (1950); A. E. Treat, *Ann. Entomol. Soc. Amer.* 48, 272 (1955); K. D. Roeder and A. E. Treat, *J. Exptl. Zool.*, in press.
2. This work was supported in part by research grant No. E-802 from the National Microbiological Institute, National Institutes of Health, U.S. Public Health Service.
3. H. Frings and M. Frings, *Ann. Entomol. Soc. Amer.* 49, 611 (1956). "Pure" tones were produced by a Hewlett-Packard (200-A) audio oscillator activating a Jensen (NF-101) loudspeaker for frequencies of 150 to 4000 cy/sec and an Altec (633-A) microphone for 4000 to 40,000 cy/sec. The animals were tested in a small anechoic chamber, where they were placed 15 cm from the transducers. Sound pressures at that distance were measured for 150 to 10,000 cy/sec with a calibrated Scott (410-B) sound-level meter, and for higher frequencies by a substitution method using specially calibrated equipment of the Acoustics Laboratory of Pennsylvania State University by Fujio Oda, to whom we express our appreciation.

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Chlorpromazine and Reserpine Prevention of Myocardial Damage by Histamine and Serotonin

Blood-cell disintegration during clotting is accompanied by release of serotonin (*1*) and histamine (*2*). In myocardial infarction, these two agents could become active within the musculature of the heart. In order to determine whether they are liberated in quantities sufficient to cause damage, the effect of whole blood and serum, as well as of serotonin