

Heat Tolerance in European Breeds of Cattle Exposed to High Environmental Temperatures

Messrs. A. L. Badreldin, M. M. Oloufa and M. Abdel Ghany have reported observations on heat tolerance of cattle at Giza (*Nature*, **167**, 856; 1951).

In the Singapore Dairy Farm, where more than six hundred head of Ayrshire, Holstein and Shorthorn cattle are kept as a commercial dairy herd, it has been possible to record rectal temperatures and respiration-rates of groups of fifty cows at hourly intervals for periods of seven days throughout the past nine months.

It is considered that the comparison of average air temperatures, etc., with average rectal temperatures and respiration-rate cannot produce information of much value. Clinical evidences of heat intolerance develop only when the rate of heat production within the body exceeds the rate at which heat can be lost to the exterior. The critical environmental temperature productive of a state of adverse heat exchange varies with the degree of air movement and ventilation. Further, the magnitude of the effects of exposure to high temperatures is dependent upon how far the critical temperature is exceeded and for how long.

In this herd, where normally air movement is negligible, rectal temperature commences to rise when that of the surrounding air reaches 78° F.; after one hour's exposure it averages 101.78° F. but after four hours exposure it averages 102.23° F. Two hours exposure to a byre temperature of 94° F. results in an increase to 104.45° F. If heat loss is assisted by hourly sprinkling with water and blast fans, byre temperatures of up to 89° F. cause no appreciable rise in rectal temperature.

Respiration-rate at all temperatures below 78° F. never exceeds 50 per minute; but above that temperature it rises progressively to 130 per minute at 94° F.

Accurate figures for pulse-rates of groups of cattle are extremely difficult to obtain, due to the disturbance necessitated during such mass examinations. However, indications are that pulse-rate is not depressed during heat stress unless it is severe, and that the converse is normally the rule.

It has been impossible to demonstrate any correlation between humidity and temperature regulation.

Preliminary findings on fifty-seven head of cattle would indicate that the chloride-level of the blood plasma rises during exposure to high environmental temperatures, tending to support the supposition that in European types of cattle water-loss is by evaporation through the lungs and diffusion through the skin rather than by direct sweating.

J. DOBINSON

Singapore Dairy Farm,
Bukit Panjang, Singapore. Sept. 20.

Tone Sensation produced by Repetitive Trains of Auditory 'Click' Stimuli

It is well known that a sensation of continuous tone may be produced by presenting to the ear regularly repeated trains of sinusoidal waves, although each train may consist of only a few oscillations followed by a relatively long 'blank' period¹. I have observed that a sensation of tone may arise by the presentation of trains of very short pulses, each pulse of duration of 0.20 m.sec., and each train consisting of two such pulses only. The pulse dura-

tion quoted is that measured on a cathode ray oscilloscope across the output of the amplifier, no suitable instrument being available to monitor the air pressure wave-form as produced by the loud-speaker. The pulses were derived from an electronic stimulator, and were locked to the time-base at predetermined times, each being independently adjustable. Hence, for each time-base two pulses were obtained, the separation of which in time could be varied from zero (coincidence) to 10 m.sec. The time-base repetition-rate could be varied from 10 to 100 per sec. Within this range, at any given rate of repetition, progressive separation of the pulses gave rise to a sensation of falling pitch, and approximation caused a rising pitch. At a separation of 1 m.sec., the sensation was that of a 1,000-cycle per sec. tone, as matched against a known frequency source; at a separation of 2 m.sec. the tone was 500 cycles per sec., at 4 m.sec. 250 cycles per sec., and so on. Since the tone sensation dependent on the pulse separation was heard against a background due to the frequency of repetition of each pulse (the time-base repetition-rate), only those derived tones of frequency considerably higher than the frequency of repetition could readily be detected and matched against the standard frequency source.

A simple theoretical interpretation of the phenomenon, based on the local resonator theory of auditory perception, may be offered. We assume that the first pulse of each pair, being of short time-duration compared with the tone sensation being studied, and having an abrupt initial rise, produces shock excitation of a wide band of resonators extending over the normal auditory spectrum. The second pulse arriving after an interval t will tend to augment the amplitude of resonators which have just completed integral numbers of complete cycles, that is, those of natural periods t , $t/2$, $t/3$, etc. Resonators of period $2t$ will be suppressed, having completed half a cycle and receiving the second pulse in anti-phase. Resonators of other periods will be either only partially or not affected. Since of those which are selectively augmented (periods t , $t/2$, $t/3$, etc.) the decrement due to frictional losses will be progressively higher for the higher harmonics, the fundamental (t) and lower harmonics will predominate, giving a tone sensation identified as of period t (frequency $1/t$). The theory predicts that inversion (phase reversal) of the second pulse should result in selective augmentation of resonators of period $2t$, and suppression of those of period t . Preliminary experiments indicate that this occurs, in that the tone sensation falls in pitch by an octave when the second pulse is suddenly inverted. Since the tone sensation derived depends upon repetitive presentation of trains of two pulses (that is, a single presentation gives no sensation of the tone described), the observation seems to suggest a relatively slow decrement of the energy stored in a given resonator, which is not completely dissipated before the arrival of the next train in a sequence. This offers further support to the view of Pumphrey and Gold that the resonator elements of the cochlea possess a high Q factor. It is intended to modify the apparatus in order to study the phenomenon over a wider range of conditions.

W. T. CATTON

Physiology Department,
Medical School, King's College,
Newcastle upon Tyne. June 12.

¹ Pumphrey, R. J., and Gold, T., *Nature*, **160**, 124 (1947); *Nature*, **161**, 640 (1948); *Proc. Roy. Soc., B*, **135**, 462 (1948).