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Effect of cattle ear mite infestation on hearing in a cow

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RECENTLY, we were involved in determining the hearing abilities of cattle as part of a comparative study of mammalian hearing.[1] In the course of testing, however, it became apparent that one of our animals, an 18-month-old Simmental cow, had a serious hearing impairment, which at times was as much as 70 dB below normal limits. On otoscopic examination, it was found that both auditory canals were ulcerated, filled with pus, and infested with mites *(Raillietia auris)*.

Complete behavioral audiograms were obtained for the affected cow as well as for two 18-month-old Hereford cows without ear mite infestation. The animals' ability to hear tones was determined with a "go/no-go" procedure which has been described in detail elsewhere.[1,2] Briefly, a thirsty animal was led into an indoor stall and trained to place its chin on an "observing" plate in front of a loudspeaker (Fig 1). The animal was then rewarded with a drink of water for breaking contact with the observing plate and touching a "reporting" plate beneath the observing plate whenever it heard a tone.

Trials consisted of a 3-sec pulsing tone presented at random intervals from 3 to 27 sec apart. Each cow was rewarded by automatically delivering 250 ml of water into a bowl in front of it whenever it touched the reporting plate in the presence of a tone. Breaking contact with the observing plate when no tone was present resulted in a short wait or "time-out" (usually 15 sec), during which testing was halted momentarily. Because the cow could not obtain water during this period, the time-out acted as mild punishment. Failure to report the presence of a tone, however, had no consequence other than failure to obtain a reward.

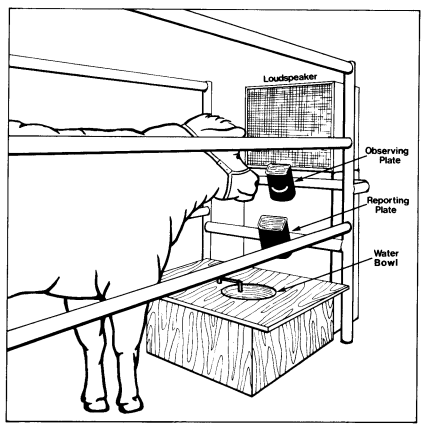

Fig 1—Stall and loudspeaker arrangement used to test hearing in cattle. The animal was trained to place its chin on the observing plate and listen for a tone. Tones were presented at random intervals and the animal was given a water reward for breaking contact with the observing plate and touching the reporting plate within 3 sec after tone onset.

Thresholds were obtained for pure tones at octave frequencies throughout the hearing range of the animals. Each threshold was determined by gradually reducing the intensity of the sound until the animal could no longer distinguish between its presence and absence. Threshold for each frequency was defined as the intensity at which the tone was perceived on half of its presentations.

The auditory stimuli used in this test were carefully generated and controlled to avoid artifacts, and the sound field was calibrated daily, using procedures described elsewhere.[1,3]

The auditory thresholds of the 2 normal cows were averaged at each frequency, and the resulting average cattle audiogram is shown along with the average human audiogram[4] in Figure 2. In this figure, each point represents the lowest intensity at which a particular frequency could be detected. Thus, large decibel values indicate that a tone had to be fairly loud before it could be detected, whereas small values indicate better sensitivity in which less intense sounds could be detected. (Because sound, like temperature, is measured on a relative scale, negative values indicate only that the intensity of a sound is less than the 0 dB reference level.)

The normal audiogram of cattle ranges from about 23 Hz to 35 kHz.[1] These values represent the lowest and highest frequencies that are audible to cattle when the sounds are at an intensity of 60 dB. As Figure 2 illustrates, auditory sensitivity of cattle increases gradually as frequency is increased to the point of their best hearing, at 8 kHz. Above 8 kHz, sensitivity decreases rapidly until

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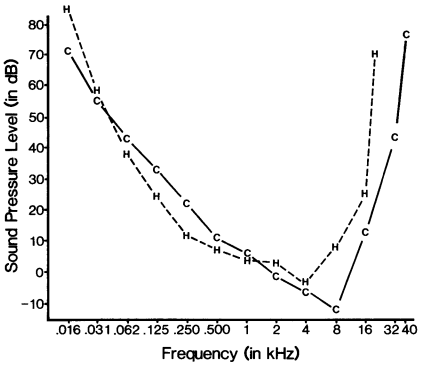

Fig 2—Normal cattle thresholds (C) as a function of frequency with human thresholds (H) shown for comparison. The individual letters indicate the lowest intensity at which a particular frequency is audible. Thus, beginning at 16 Hz, the auditory sensitivity of cattle gradually improves as frequency is increased until a point of best hearing is reached at 8 kHz. Above 8 kHz, their sensitivity decreases rapidly to an upper hearing limit of around 35 kHz. Notice that while the auditory sensitivities of human beings and cattle are similar for frequencies from 16 Hz to 4 kHz, above 4 kHz, cattle are clearly more sensitive. (The sound pressure level is referenced to a 0 dB level of 20 micronewtons/m^2, with negative values indicating intensities below this standard level.)

the animal's upper limit of hearing is reached.

Compared with most other mammals, cattle have exceptionally good hearing, both in the low-frequency range and at their point of best hearing at 8 kHz.[1] While the high-frequency sensitivity of cattle is not as good as that of many mammals, such as rodents and carnivores,[5,6] it exceeds that of human beings, as indicated in Figure 2. Overall, cattle appear to have good auditory sensitivity, especially in the low- and middle-frequency ranges.

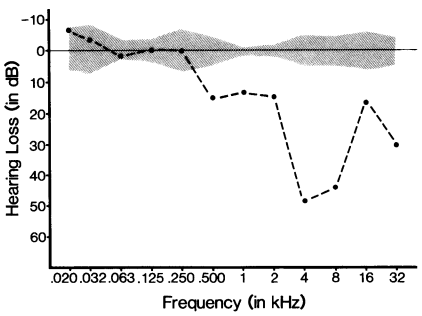

Fig 3—Average hearing loss in the Simmental cow with bilateral *Raillietia auris* infestation (dotted line). Shaded area indicates the variation in the hearing ability of 2 normal cattle. Notice that the hearing loss was most severe around 4 kHz and 8 kHz, where cattle are normally most sensitive. Below 500 Hz, no hearing loss could be detected.

The impaired hearing of the affected Simmental is shown in Figure 3. In this figure, the average hearing sensitivity of the affected cow is plotted in relation to the hearing ability of the 2 other cattle. The hearing ability of the affected cow began to decrease at 500 Hz, with the impairment being most severe at 4 kHz and 8kHz. Comparing Figures 2 and 3, it can be seen that the greatest hearing impairment was in the region of frequencies to which normal cattle are most sensitive (4 to 8 kHz).

An unusual feature of the affected cow's hearing was the variability in its thresholds for frequencies at which a hearing impairment was evident (ie, 500 Hz and above). Whereas the thresholds of normal animals generally fluctuate by no more than 3 dB after a session or two of practice, the thresholds of this animal varied on consecutive days by as much as 15 dB, even after weeks of practice. Yet, even on its best days, the affected cow's thresholds for 500 Hz and higher frequencies were never normal. On the other hand, its hearing impairment was occasionally much worse than the average shown in Figure 3, ranging from about 30 dB to 70 dB below normal at 4 kHz and 8 kHz. Thus, the cow had a hearing impairment in the midrange of the audiogram, which would be described in human beings as mild to severe impairment.[7]

The fact that the affected cow's hearing showed so much variation rules out certain types of deafness. Whereas a hearing impairment may arise from disease, trauma, and hereditary- and age-related factors, the majority of these causes result in a permanent and invariant hearing loss.[8] Instead of a stable hearing impairment, the fluctuation in the cow's auditory sensitivity suggests that its impairment was due to some variable obstruction of the transmission of the sound to the inner ear. Indeed, the pus found in the animal's auditory canal provides the most obvious cause of such an impairment.

Though the hearing impairment may have been caused in part by the mites burrowing into the middle ear, as they have been occasionally reported to do,[9,10] the pattern of the impairment suggests that it was attributable to the pus occluding the auditory canals. This conclusion is suggested by the similarity between the hearing impairment and the effect of ear plugs on human hearing. Typically, ear plugs attenuate middle frequencies more effectively than low and high frequencies.[11] Further, the variability in thresholds might have been related to daily variation in the amount and viscosity of the pus. Thus, while the exact attenuating properties of the pus would depend on such factors as its size, viscosity, and location, the hearing impairment would be consistent with the effect of an ear plug with attenuating properties that were constantly changing.

Hearing impairment caused by mite infestation in cattle represents cause for concern. The greatest impairment in this cow was at frequencies to which cattle are exceptionally sensitive and which may, therefore, be of special biological importance to them. For example, such hearing impairment may be sufficient to affect the use of sound as a means of maintaining cohesion of the herd, communication between a cow and her calf, or the detection of predators. Though such factors may not be critical to confined animals, they may play a role in the survival of free-ranging cattle.

Finally, it should be noted that the ear mite infestation in this cow was not an isolated finding. Indeed, we initially had some difficulty in locating cattle that did not have ear mites—of 44 live cattle whose ears we examined, 29 (66%) had similar ear mite infestations. This observation, coupled with reports of ear mite infestations from around the world, suggest that the problem of cattle ear mites is widespread.[9,10,12–18]

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