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HEARING RANGES OF FOUR SPECIES OF BIRDS

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IN continuing the experiments on the hearing of birds which the late Albert R. Brand and Prof. P. P. Kellogg began at Cornell University in 1938, observations have recently been made on the frequency range of hearing of four other species of wild birds in captivity. The apparatus used in the earlier experiments was placed at the author's disposal for the present experiments, and has made up a major part of the equipment used.

This series of experiments was begun in March, 1941, and is still in progress. The object of the work is to determine the frequency ranges of sounds to which different birds will respond. Observations have been completed on six captive individuals representing four species whose hearing ranges had not theretofore been investigated. These are as follows: one Canvas-back (*Nyroca valisineria*); one Great Horned Owl (*Bubo virginianus*); three Prairie Horned Larks (*Otocoris alpestris praticola*); one Snow Bunting (*Plectrophenax nivalis*).

An electric shock was used in teaching the birds to give a definite response when the sound stimulus was applied. Within one second after a pure tone was sounded close to the bird's cage, the bird was given an electric shock, and it soon learned that when the tone was sounded, a shock was imminent. Therefore, after a number of trials (usually 30 to 60) the bird began to respond to the sound as it did to the shock—by jumping or fluttering.

A beat-frequency oscillator was used to produce sounds with no overtones. Tones with frequencies from 20 to 17,000 vibrations per

second, or cycles per second, could be obtained from the oscillator. A small induction coil with movable secondary coil was used to control the force of the shock. The shock was applied through a bracelet around the bird's leg or through a specially wired cage floor.

In this sort of experiment it would be advantageous for us to be able precisely to control and measure the loudness level of the tones as they are received by the ear of the subject. However, only by intricate and tedious calculations can the loudness of a sound for any particular position of the subject be determined. Provided such a determination were made, even a slight movement on the part of the bird being tested would bring about a great enough change to render the determination valueless.

In view of the great difficulty of controlling the loudness at the ear of the subject, even under the most unnatural conditions, the author concerned himself only with maintaining the same loudness level at the loudspeaker for each bird tested. The distance from loudspeaker to cage was the same in each case, and the greatest volume obtainable from the apparatus was used as the limits of the range were closely approached. Thus all of the birds were tested under very nearly identical conditions.

The Canvas-back, a male, was caught in the wild and tested within a month of its capture. It responded to tones the frequencies of which were from 190 to 5200 cycles per second. Thus the lower limit was about half an octave below middle C, and the upper limit was a few notes above the highest note on the piano.

The Great Horned Owl, which was thought to be a female because of its large size, had been in captivity for only a few weeks before tests of its hearing range were completed. It responded to tones from 60 to 7000 cycles per second. This range extends more than an octave below the hearing range of any of the other birds tested in this investigation.

The three Horned Larks tested had almost the same frequency ranges among themselves. The arithmetical averages of their lower and upper limits were 350 and 7600 cycles per second respectively. Two females showed lower limits of 300 and 340 cycles per second and both were insensitive to tones above 7500. The male bird responded to sounds of frequencies between 420 and 8000 cycles per second.

The Snow Bunting, which was a male bird, was observed to respond to almost the same range of frequencies as did the male Horned Lark. In fact, the hearing ranges of these two individuals were more nearly

coincident than those of different sexes of the Horned Lark. The frequency range of hearing of the Snow Bunting was approximately 400 to 7200 cycles per second.

The range of frequencies which human beings normally are able to hear has usually been considered to be approximately from 20 to 17,000 cycles per second. Thus we see that man's hearing range is much more extensive than that of any birds thus far tested, especially in the lower frequency range. Similarly, other mammals which have been tested respond to a much wider range of frequencies than do these birds.

The results of these experiments as compared with the original investigations of Brand and Kellogg (1939 a, b) show an extension of the known range of bird hearing. The Great Horned Owl responded to tones of 60 cycles per second—more than an octave and a half below the former low of 200 for the Domestic Pigeon. The upper limit of 15,000 previously established for the Starling was not reached by any of the birds tested more recently.

SUMMARY

The approximate frequency ranges of hearing of the individuals tested are as follows:

1. Canvas-back—190 to 5200 c.p.s.
2. Great Horned Owl—60 to 7000 c.p.s.
3. Horned Lark (av.)—350 to 7600 c.p.s.
4. Snow Bunting—400 to 7200 c.p.s.

The frequency ranges of these birds are greatly exceeded in man, chimpanzee, monkey, dog, and cat.

These results extend the known hearing range of birds by more than one and one-half octaves at the lower end of the frequency scale.

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