AUDIO-SPECTROGRAPHIC ANALYSIS OF THE SONGS OF THE ALDER FLYCATCHER[1]

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IT IS generally recognized that Alder Flycatchers (*Empidonax traillii*) in the eastern United States have more than one song. Differences in song types have been described, but McCabe (1951) indicated that while two song types exist, there is very little agreement about the verbal description of these songs. These differences in description McCabe attributed primarily to differences in human interpretation. We would further suggest that there may be a basic difference in what individuals hear, which points up North's (1950) suggestion that all observers should check their response to audio-frequencies as a means of obtaining a better understanding of descriptive differences. A third possibility, as suggested by McCabe, is that there may be more than two recognizable song types used by Alder Flycatchers. Snyder (1953) agrees that there are two distinct types of regular song east of the Rockies and that each covers a broad geographic range.

In beginning this preliminary study, we selected four songs from the bird song collection at Cornell, one each from four different Alder Flycatchers, two of the *fee-be-o* type and two of the *fitz-beu* type. With the two songs of each type, an effort was made to select samples separated as far as possible in both time and space, since this would give us the best opportunity to observe differences. With the *fee-be-o* song, one example chosen was recorded at Ithaca, New York, May 30, 1952, probably of a migrating bird, and the other was recorded at Bay Pond in the Adirondack Mountains of New York on June 22, 1941, a separation of 200 miles in distance and 11 years in time.

One of the *fitz-beu* songs was recorded on June 7, 1947, at Ithaca, while the other was recorded at the Lower Souris National Wildlife Refuge, North Dakota, on June 12, 1949, a separation of 1200 miles in distance and two years in time.

The four songs thus chosen were analyzed with an audio-spectrograph and the results are shown in Figures 1 and 2. This technique is described and discussed by Potter (1945, 1947) Koenig *et al.* (1946), Joos (1948), and Bailey (1950).

The clear-cut differences between the songs of different types and the surprising similarities in the songs of widely separated individuals singing the same type of song, suggest the possibility that this method of study may have much use in clarifying the confusion concerning this group of birds.

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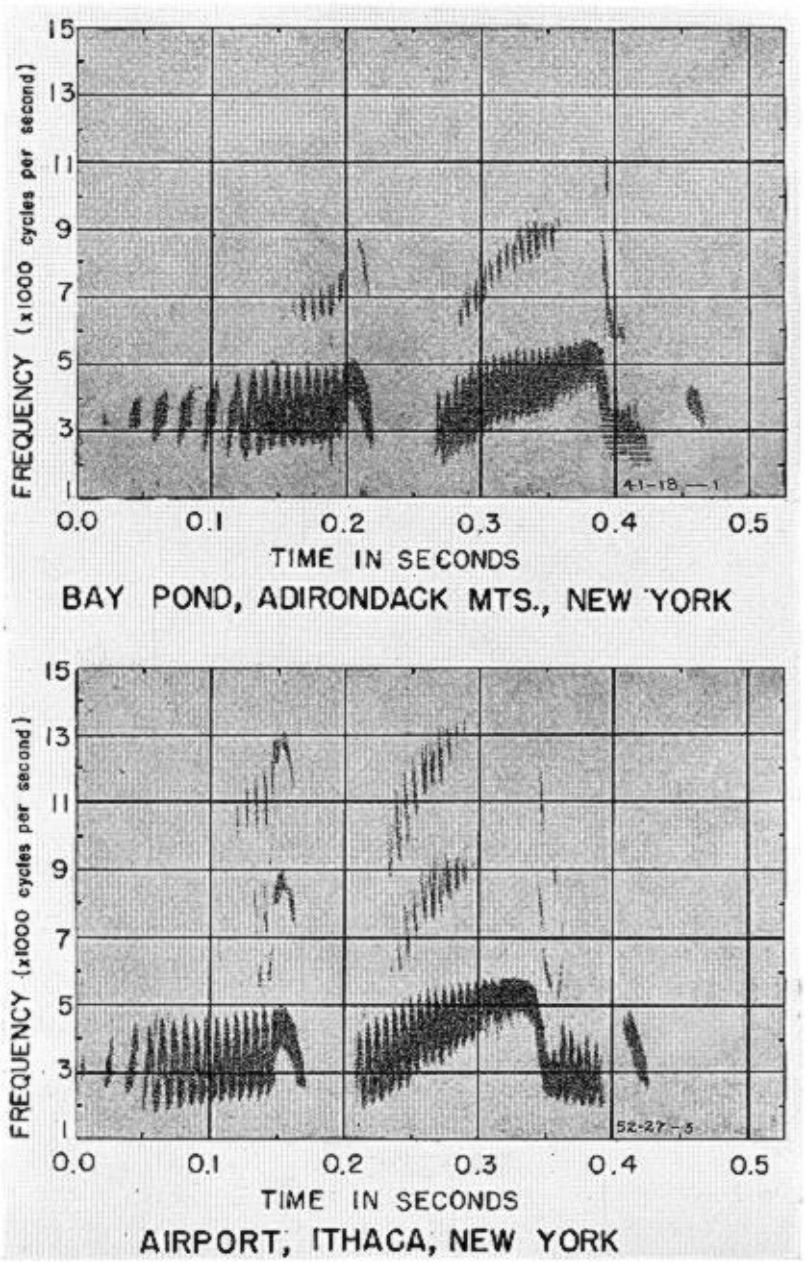

FIG. 1. Audio-spectrographs of the *fee-bee-o* song of the Alder Flycatcher.

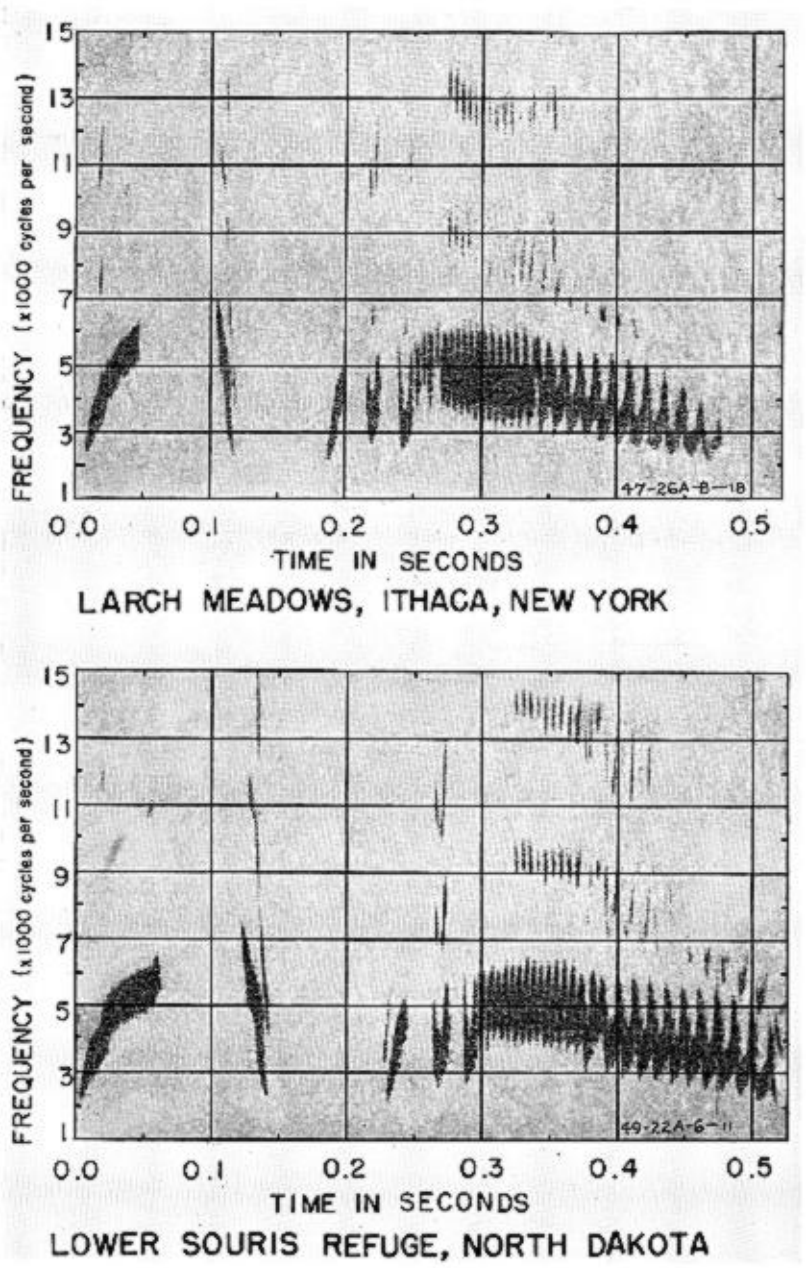

FIG. 2. Audio-spectrographs of the *fitz-beu* song of the Alder Flycatcher.

The following observations on the spectrograms should be of interest:

1. *Frequency Scale.* This vertical scale is linear rather than the logarithmic musical scale. While accurate, this scale appears to distort the musical values of the recording. This is especially noticeable in the harmonics or overtones which are shown as faint replicas of the song at double or triple the fundamental frequencies. These harmonics appear to change pitch faster than do the fundamentals. In a musical scale these octaves would all be equal and the lines of harmonics would all be parallel.

2. *The horizontal time scale* shows that the songs presented vary in length from a little over 0.4 seconds to a little over 0.5 seconds. The *fitz-beu* type of song is slightly longer than the *fee-bee-o* type, but there is considerable individual variation in the length of notes and in spacing.

3. *Filter Band Width.* These spectrograms were made by inspecting each song over and over again with a variable filter. This filter passed a band of frequencies 300 cycles wide at the half-power points. This filter band width results in a picture of the frequencies present slightly wider than it actually should be. However, this broadening of the picture is not serious and seldom amounts to as much as 1/16 of an inch added to the top and bottom of the trace, as presented here.

4. *Volume or Loudness Range.* This method of presentation does not give a good indication of the intensity of different parts of the song. To some extent intensity is indicated by a difference in the grayness or blackness of the trace. Other techniques of indicating the intensity range are available and will probably be combined with the present technique in some manner as this study progresses.

5. *Similarities of Song Types.* Both songs are characterized for the most part by a very rapid succession of tones (notes), alternating between a higher and lower frequency or pitch. These changes in pitch take place in short time intervals; from about 40 or 50 changes per second to nearly 200 changes per second. The pitch changes of these rapidly uttered notes may be as much as an octave, and probably account for the rough or reedy quality of the songs. These pitch changes are not necessarily perceived by the human ear as individual notes, since they occur so rapidly.

Both songs begin and end on a frequency close to 3000 cycles per second.

6. *Differences of Song Types.* In the *fee-bee-o* type song (Fig. 1), the first note is long, gradually increasing in frequency as much as three or four musical intervals, and finally terminating in an abrupt downward slur to about the starting pitch. The second note, clearly separated from the first, begins on about the same pitch as the first, but rises more rapidly, traversing about

six full intervals of the musical scale and then drops abruptly to the starting point and continues in what is probably interpreted as a third short note of gradually descending pitch. A fourth, very brief note or click of descending frequency is obvious on all of our spectrograms. This final note is probably not of audible importance but it may prove to be of interest in critical analyses.

In the *fitz-beu* type of song (Fig. 2), the first note appears to be sharp and short, rapidly rising in pitch about a full octave. This first note is followed by one of descending pitch with a drop of more than an octave. These two short notes, taken together, probably produce the sound usually referred to as *fitz*. Or should we say, *fitz-it*? The next note, usually thought of as the second, begins in a ragged or buzzy manner with the pitch increasing rather rapidly three or four full tones and then gradually decreasing in pitch to about the starting point or slightly below and becoming more buzzy towards the end.

7. *Differences in Individual Songs of a Type.* These differences are observable and may later prove useful in the study of individual variation. At present they appear to be over-shadowed by the similarity in songs of the same type.

8. *Harmonics or Overtones.* These are observable in all of the recordings as fainter partial repetitions of the song at double or triple the original frequency. Since it would be possible to produce these effects by a distortion of song at any of the several steps between the original song and the final trace on the spectrograph, further study and a better understanding of the equipment will be necessary before much confidence can be placed in any interpretation of these harmonic traces. It is of interest, however, that the Bay Pond spectrogram (see Fig. 1) shows fewer harmonics than any of the other traces. A possible explanation of this is that the recording equipment used in 1941 did not respond well to frequencies above 9000 cycles per second.

As an aid to further study of the songs analyzed in this paper, the actual recordings are, or will be, made available on phonograph discs. The song presented from Bay Pond is the first Alder Flycatcher song appearing on record 1-B of Volume 1, "American Bird Songs" (Kellogg and Allen, 1941). The other three songs will be published in a revision of Volume 1, or tape copies for study can be obtained from the Laboratory of Ornithology at Cornell University.

The preliminary nature of this study should be emphasized. Plans are being made for an intensive study of the songs of the eastern forms of this species in the near future. Cooperation in the form of recordings from any part of of the United States or Canada is invited.

Summary

Songs of four individuals of *Empidonax traillii* were recorded and analyzed on an audio-spectrograph. The four spectrograms, two of the *fitz-beu* type and two of the *fee-bee-o* type are presented. The spectrograms show great similarity in the songs of different birds singing the same song type and conspicuous differences in the two song types. The actual recordings on tape are available from Cornell for further study, and these are, or will presently be, published on phonograph discs.

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