GEOGRAPHIC PATTERNS OF SONG SIMILARITY IN THE DICKCISSEL (A A CA A)

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A .—Song sharing among neighboring males is a well-known, frequent outcome of song learning in oscine passerines and some other groups, but only limited investigations of the spatial scale of this phenomenon have been pursued. On the basis of recordings of , individuals, we investigated song sharing in Dickcissels ( ) at local and regional scales at sites from northern Kansas to northern Oklahoma. Classification of song elements revealed decreasing song similarity with increasing distances between individual birds at small to intermediate scales, to ~ km. At the largest spatial scales (– km between sites), there was very little similarity among sites and no obvious tendency for a decrease in similarity with increasing distances among our sites. At our intensively sampled site, analyses of quantitative measurements showed that, at least for our most widely shared song element, frequency and duration were more similar in closer birds. us, distance between birds influences both quantitative and qualitative song similarity in Dickcissels. Variability existed among sites in the shape of the song-sharing decay curve, which indicates that other

I songbirds, songs produced by males in the same area are more similar to each other than to the songs of more distant conspecifics (Lemon , Krebs and Kroodsma , Baker and Cunningham). Such patterns of song sharing have often been termed "dialects," though some researchers limit this designation, for instance, to song sharing at the scale of kilometers or included ungrazed native prairie, prairie grazed by cattle, mowed hay meadows, and Conservation Reserve Program fields (former agricultural fields planted with native grasses). Sites were all in a grassland landscape matrix.

To investigate small- and intermediate-scale sharing, in we recorded birds in a ~ -km portion of the Konza Prairie Biological Station (KPBS; Fig.), a , -ha tract of tallgrass prairie in northern Kansas (

allowed us to assess the consistency of song structure throughout the season and the suitability of our method of using brief recordings of unbanded birds to describe their song.

We attempted to relocate returning banded males at KPBS in May . We found and recorded songs of of the original banded birds, all on or near the sites of their territories. is allowed us to determine whether males returning to the same breeding site alter their song structure between years.

ANALYSES AND RESULTS

[illegible].—We could readily distinguish songs from di erent locations by ear, but some of the more subtle within-site variation was detectable only by examining sound spectrograms. We visually assessed sound spectrograms from all recordings using RAVEN, version . (Cornell Lab of Ornithology). We separated each song into multiple phrases. Complex phrases were further subdivided into multiple elements, but simple phrases type from the library or, if we encountered an element type that did not fit into any existing category, we added a new entry to the library. P.J.W. classified the recordings, and D.M.S. classified the recordings. Because of the di erent geographic locations of these recordings, we used independent libraries. Final library sizes were as follows: = , = , = , = , trill = ; and = , = , = , = .

To determine whether elements are recognized as distinct by the birds requires playback experiments (Horn and Falls), and we did not conduct such experiments. However, when playback experiments are conducted, birds of other species appear to classify song elements and often do so in a manner similar to the classification schemes of the humans studying them (Horn and Falls). Further, qualitative comparison of song elements is the most common method used to describe song sharing (e.g., Miyasato and Baker , Tracy and Baker , Nelson , Shieh). However, even if classifications are recognized by the birds themselves, by limiting analyses to song categories, researchers overlook quantitative variation, which may be an important component of geographic variation in song sharing.

.—Grouping song elements into types facilitated quantitative measurements within element types that shared the same notes and structure. We measured duration and frequency of notes (or groups of notes) to quantitatively ana-

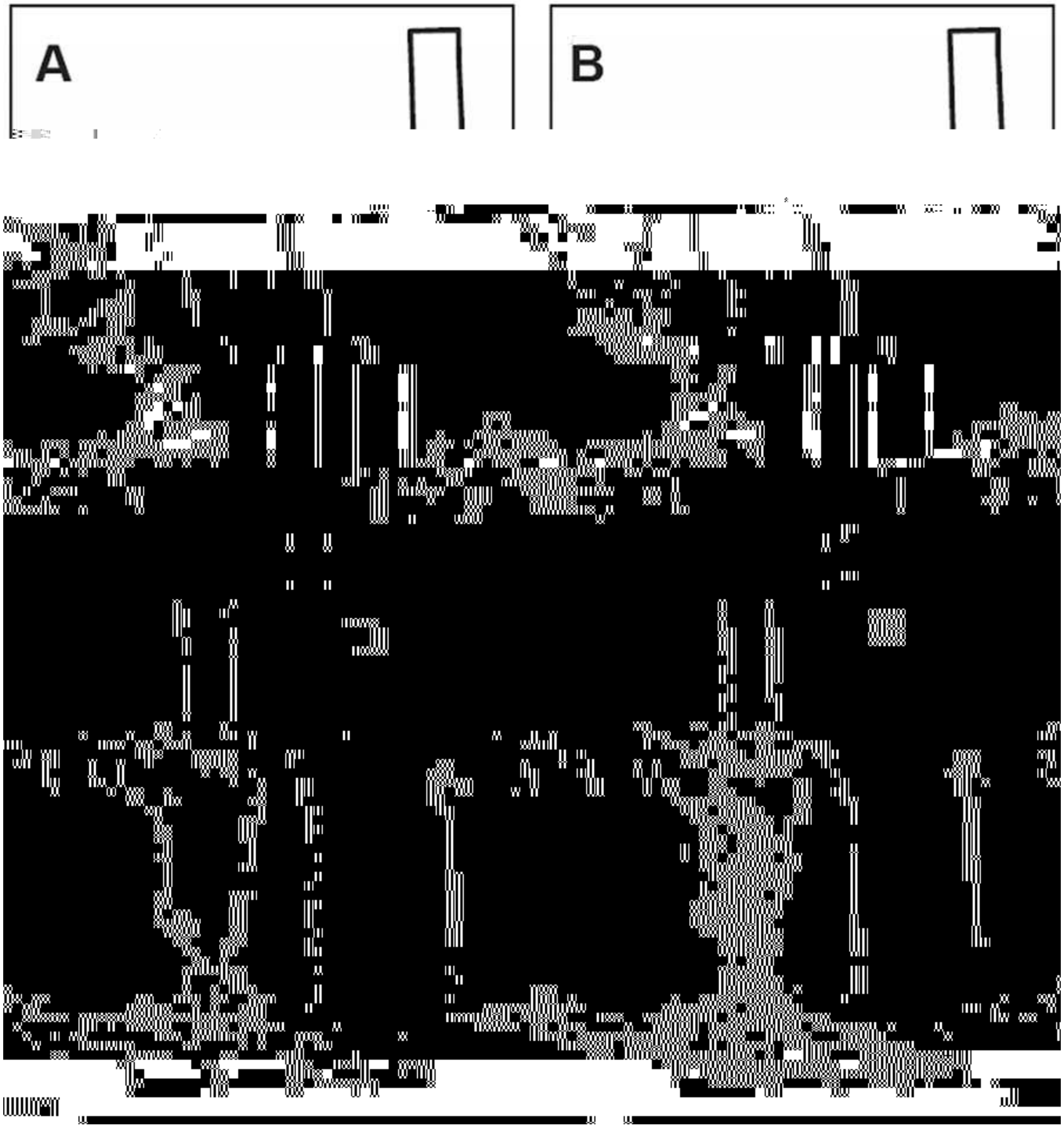

FIG. 6. Distribution of element types recorded at Konza Prairie Biological Station (KPBS) in 2006 for (A) *ci e* element 1, (B) *ci e* element 2, and (C) *ci e* element 3. Thick black lines indicate approximate geographic boundaries between element types. The fourth map (D) shows the partial congruence of dividing lines between element types for all three *ci e* elements. Map D also depicts the locations of all recorded birds.

song are highly consistent. is result justifies our use of single recordings to describe an individual's song, our comparisons of songs recorded on di erent dates, and our use of quantitative measures of note characteristics. Banded males returning in did not appear to change their song structure between years. Each male's song elements belonged to the same categories in both years.

—We found no evidence of age e ects on song in Dickcissels. Because we identified very little change in songs of males throughout the breeding season (see above), no di erence was detected between SY and ASY birds in terms of changes in qualitative song-element classification. We also compared the coe cient of variation (CV) for measured song traits between SY and ASY individuals. For this analysis, we summed the CVs across song traits for each banded bird of known age class and compared these sums between SY and ASY birds using Student's test, but there was no di erence (SY: mean = . ± . [SE]; ASY: mean = . ± . ; = . , = .).

—To determine whether song neighborhoods had sharp boundaries, we examined maps of the distributions of element types for the KPBS data (Fig.). First we produced three maps, one each for the first, second, and third element of the phrase. We used ARC-GIS

(ESRI, Redlands, California) to place Thiessen polygons around the coordinates for each individual, and we colored each polygon according to the song-element classification of that bird. Thiessen polygons encompass the area falling closer to a given point than to any other points. We selected this method because it produced maps that were much easier to read than ones in which element-type locations were coded by colored dots or

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less than di erences in other measurements on the basis of scale
of variability, we standardized all measurements in units of stan

or elements are shared across dialects (Baptista), there is both qualitative (Baptista) and quantitative (Bell et al.) variation within putative dialect areas, and dialect boundaries are not completely discrete (Baptista). In Dickcissels, definition of the boundary of a discrete dialect area would depend on which components of the song we chose to designate as diagnostic of the dialect and the degree to which we split or lumped song-element categories. However, high local conformity across song elements, ready detection by human ear of song similarity at moderate spatial scales (multi-kilometer), and relatively discrete boundaries between element types suggest that shared songs in Dickcissels could be referred to as "dialects."

Both element turnover and quantitative within-element changes contribute to formation of distinct vocal neighborhoods. Variation in song is often described in terms of element categories, and these descriptions have proved useful (e.g., Marler and Tamura , Tracy and Baker); however, exploring within-element variation may produce di erent insights. e presence of quantitative variation supports the hypothesis that copying errors lead to changes in song elements and, presumably, ultimately to the creation of new elements (Lemon , Slater). We should point out, however, that only one of our three quanti-

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