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Singing behavior of American Robins in linear and non-linear habitats. — This study documents a difference in singing behavior between two populations of American Robins (*Turdus migratorius*) inhabiting neighboring but dissimilar areas. To our knowledge, significant interpopulation differences in response to playback have not been reported previously.

In the northern plains of the United States, trees and shrubs growing along creeks and rivers or in shelterbelts provide the only natural nesting sites for tree-nesting birds such as

robins (Yahner 1982, Haas, pers. obs.). Shelterbelts typically are planted as long, narrow rows of trees. We term this "linear" habitat because the average width is considerably less than the average diameter of territories of robins studied in other localities (Young 1951, Pitts 1984).

We observed that robins in shelterbelts sang less frequently than those in riparian woodlands. We hypothesized that the reduced singing by shelterbelt-inhabiting robins indicated less defense of the linear habitat which they occupy, compared with woodland-inhabiting riparian robins. Average territory size for robins in New York, Tennessee, and Wisconsin ranged from 0.11 to 0.21 ha (Pitts 1984). Territories of the same size in shelterbelts would need to be much longer than wide, a theoretically uneconomical shape for a bird's territory (Covich 1976), although Johnston (1956) observed Song Sparrows (*Melospiza melodia*) defending 30 × 150-foot territories along tidal sloughs. Reduced territoriality should result in a lower response to playback, and we predicted that robins breeding in linear habitat would show this reduced response.

Methods. — We collected data from May through July 1987 and June and July 1988, in Sioux and Morton counties, North Dakota. The shelterbelts were located in mixed-grass prairie, range, and farmyards on an 8 × 11-km area of private land. The riparian habitat studied was part of Fort Abraham Lincoln State Park, 8 km south of Mandan, North Dakota, and 35 km from the shelterbelts.

Local shelterbelts—trees and shrubs planted in one to eight rows as windbreaks around farm buildings and fields—consisted primarily of green ash (*Fraxinus pennsylvanicus*), American and Siberian elm (*Ulmus americana* and *U. pumila*), box-elder (*Acer negundo*), Siberian pea-shrub (*Caragana arborescens*), and Russian olive (*Eleagnus angustifolia*). Trees in these shelterbelts were 3.3–15 m tall, and most of the shrub layer had been destroyed by livestock. The average width of this habitat type was 10 m. The woodland or non-linear habitat type occurred along the Missouri River. This floodplain forest consisted of mature cottonwoods (*Populus deltoides*), box-elder, American elm, and green ash, and it had an abundant shrub layer, including *Cornus* sp., *Rosa* sp., and *Lonicera* sp. Most of the canopy trees reached heights of approximately 20 m. Width of this area was 400–1000 m.

Adult robins were mist-netted, color banded, tail-painted, and released. We observed a total of 26 males at the riparian site and 23 in shelterbelts, almost all associated with known nests. All robins used in playback experiments had active or recently fledged nests. We confirmed identification of the male robin associated with a nest by repeated observations. Nesting phenology did not differ significantly between the two habitats. Using 1 May as day 1, the mean hatching date of 18 riparian nests was 41.42 and of 26 shelterbelt nests was 42.67 ($Z = 0.28$, $P > 0.3$). For robins in shelterbelts, we determined number of neighbors by referring to daily maps of sightings and nests of marked individuals. We defined a neighbor as a male with a territory contiguous with that of the male of interest.

For both focal observations and playback experiments, we recorded time of day, nest stage, initial behavior of bird, color-band combination of bird, location, and date. Focal observations never followed playback trials.

Songs from birds in each habitat type were recorded using a Marantz 221 recorder and a 15″ parabola. These birds were not tested in later playback trials. Tapes of two robins from New York (Newfield and Library of Natural Sounds) also were used in playback experiments. During the experiments each of these four recordings elicited song in response to playback from at least two individuals. Use of different songs reduces the possibility of obtaining biased responses as a result of playing tapes from atypical males (Kroodsma 1986). We used each tape with the following frequencies in riparian and shelterbelt habitat respectively: Newfield 3,3; Library of Natural Sounds 4,3; Fort Lincoln 3,3; shelterbelt 1,7. Only one song was played during each playback trial. Individual males were used in one or

two trials. Individual birds were not tested more than once in a two-day period so as to reduce acclimatization to song. At each site, approximately one-third of the playback experiments were conducted during each of three time periods: morning (0600–1000 CDT), mid-day (1001–1400 CDT), and late afternoon (1401–1800 CDT). For playback, we placed a Realistic C.B. Extension speaker connected to a Realistic Minisette IV cassette player from ground level to 2.4 m high on fences or trees. The speaker was located within 30 m of the nest of the experimental male. In one of the four trials using birds with recently fledged nests, the speaker was located 52 m from the fledged nest. For each trial, the song used was that of a non-neighboring individual. We located the target male prior to beginning the tape and recorded changes in his behavior after playback began. We noted times of beginning and ending response, latency to first response, closeness of approach, and singing behavior. These measures are considered accurate indicators of aggression levels (at least one aspect of territoriality) (Catchpole 1977). To determine singing rates, we initiated observations immediately after a marked male was located. Most observations were of birds located by sight in both habitat types. Males were followed for as long as possible (up to 15 minutes), and the number of minutes in which each sang was recorded.

Results and discussion.—Robins in the riparian habitat sang in response to playback in significantly more instances (9 of 11 trials) than did robins in the linear habitat (5 of 20 trials) (Fisher's exact test, $P = 0.01$). These results indicate that robins in the non-linear riparian habitat are more likely to respond with song to intruders than are robins in linear shelterbelts. Robins in both habitat types were equally likely to orient or move towards the speaker (10/11 in riparian habitat, 10/17 in shelterbelts; $\chi^2 = 3.36$, 1 df, $P > 0.10$), and exhibited similar closeness of approach to the speaker (10 m in riparian habitat, 9 m in shelterbelts; $t = 0.45$, 15 df, $P > 0.5$).

There were no significant differences between robins in the two habitats in latency to response or length of response to playback. Ten males at each site responded to playback. Including only these birds, mean latency to response in riparian habitat was 51.2 seconds and 58.8 seconds in shelterbelts ($t = 0.40$, 18 df, $P > 0.5$). The mean length of response was 140.7 seconds in riparian habitat and 81.7 seconds in shelterbelts ($t = 1.58$, df = 18, $P > 0.1$).

When we compared the results of focal observations of only those birds known to have active nests, robins in the riparian habitat sang significantly more frequently (in 34 of 195 minutes) than did robins in shelterbelts (in 38 of 353 minutes) ($\chi^2 = 4.9$, 1 df, $P < 0.05$). When we included all birds in the comparison, the significance of the difference increased. Riparian robins sang significantly more frequently (in 92 of 337 minutes) than did robins in shelterbelts (in 58 of 444 minutes) ($\chi^2 = 25.1$, 1 df, $P < 0.001$). There are two possible explanations for the less significant differences observed when using only data from robins known to have nests. The change may be due simply to the change in sample size or due to a propensity of robins without nests to sing more often. Unmated male passerines may sing more frequently than mated males (Catchpole 1977). The status of males for which we could not find nests in the riparian habitat is uncertain. These males may have had active nests that we were unable to locate, but more probably they were not nesting at that time. We believe that unmated males are rare in shelterbelts, because territories where a bird is known to have died are rarely reoccupied, and because we find nests for almost all males in shelterbelts.

The more open structure of shelterbelts may make visual contact between birds easier, thereby decreasing aggressive interactions and the need for song to maintain territories or attract mates. Alternately, riparian robins may defend their territories or mates more actively than do shelterbelt robins because their territories are of higher quality or because intrusion presents a greater risk. In shelterbelts, robins with no neighbors sang significantly less in

response to playback (0 of 8 trials) than did robins with one or more neighbors (5 of 7 trials) (Fisher's exact test, $P = 0.014$). Because of the geometry of the habitat, riparian birds could be surrounded by neighbors, and encounters between males should be more frequent. Males in shelterbelts, however, rarely can have more than two neighbors. The lower singing rates and response to playback indicate that robins breeding in shelterbelts exhibit reduced territorial defense, probably due to the small number of neighboring males.

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Early experience and vegetation preferences in Common Tern chicks.—The importance of physiognomic features in habitat selection has been studied in both the field and laboratory (Klopfer 1963, Gluck 1984). Noseworthy and Lien (1976) studied the ontogeny of nesting habitat preference in neonatal Herring Gull (*Larus argentatus*) chicks in nature. Herring Gull chicks preferred the nest site during the first week; thereafter this preference waned but never disappeared. However, Noseworthy and Lien's (1976) tests were conducted in the field where colony sounds and the presence of parents could affect the outcome. Although field studies are very useful in developing habitat recognition paradigms, laboratory studies under controlled conditions are necessary to isolate the effect of particular factors. Wiens