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Foraging Behavior of Three Sympatric and Congeneric Tyrannid Flycatchers (*Tyrannus* spp.) in Western Arkansas

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With the recent establishment of the Western Kingbird (*Tyrannus verticalis*; WEKI) in Arkansas (Ellis and Kannan 2004), the northwestern part of the state now has during summer 3 sympatric kingbirds: the Eastern Kingbird (*T. tyrannus*; EAKI), the Scissor-tailed Flycatcher (*T. forficata*; STFL), and WEKI. This offers an opportunity to examine the phenomenon of competition and co-existence in these equal-sized congeneric Tyrannids. Because closely related species have similar ecological needs, there is the potential for competition for resources (Gause 1934) and resulting partitioning of ecological niches (MacArthur 1958). Although many studies have examined the resource use and niche partitioning in sympatric tyrant flycatchers none duplicate the specific 3 species design of our study. One study compared 2 of the species (EAKI and WEKI) we investigated (Mackenzie and Sealey 1981). Three papers included WEKI but in comparison to a western *Tyrannus* that was not a part of our effort (Hespenheide 1964, Ohlendorf 1974, and Blancher and Robinson 1984), and 2 investigators studied EAKI comparing it to several eastern USA flycatchers (Hespenheide 1971, Via 1979). We conducted our study because arrival of a new species can shift foraging niches of native species as a consequence of competition for resources (Morse 1971, 1980, 1989). Therefore, quantitative data on foraging niches of the new and the original species can provide insights on how they can coexist and whether the new species has the potential to displace existing species. Assuming that food is in limited supply, partitioning of the foraging niche in response to any competition between these 3 Tyrannids can be accomplished by foraging in different microhabitats on similar arthropod prey, or by capturing different kinds of arthropod prey (size and taxa) in the same microhabitat (MacArthur 1958, Schoener 1965, MacArthur and Pianka 1966, Beaver and Baldwin 1975).

We studied foraging behavior in the 3 sympatric kingbirds in and around Fort Smith (Sebastian Co.), Arkansas, in May-June of 2006. Our goal was to determine how WEKI coexists with the 2 indigenous species and to examine for any niche partitioning. There were 2 study areas; one on the campus of the University of Arkansas in Fort Smith, the other area was in downtown Fort Smith near an electrical power substation. The campus site comprised a largely open lawn area near the clock tower containing two concrete water fountains and several tall trees. Both STFL and EAKI occurred regularly there and were numerous. The downtown area near the electrical substation was surrounded by chain-link fences and scattered trees. WEKI nested on the substation structures. All 3 species occurred there but STFL was infrequently observed. WEKI was initially discovered there in 2002 (Ellis and Kannan 2004) at which time it was already well established nesting (Bernard W. Beall, *pers. comm.*).

Observations were performed early mornings (0700-0900) and late afternoons (1800-2100), which were the convenient times for field work, but the time for each observation was not recorded. From vantage points, foraging birds were observed and the following variables noted for each foraging observation: perch height from which the sally was launched; perch type (whether fence, wire, building, tree, etc.); sally distance; sally time; maximum height flown; height at which prey was captured; prey size (whether half the size of bill, same as bill, or double the bill size); and whether the bird returned to same perch (recorded as a 1) or different perch (recorded as a 2). (Measurements in feet were later converted to metric.) Size of prey in millimeters was estimated by multiplying the final ratios of prey size to bird bill size times the actual bill lengths of the respective bird species, which average approximately 18mm for male STFL and WEKI (Regosin 1998, Gamble and Bergin 1996) and 14mm for male EAKI (Murphy 1996). We recorded 474 observations: 214 for STFL, 132 for WEKI, and 128 for EAKI; for prey size sample sizes were 154 for STFL, 119 for WEKI, and 122 for EAKI totaling 395 observations. The reduced number is due to observations made in which prey size could not be determined. No more than three successive foraging bouts were recorded for an individual bird before finding another bird. Because the birds were not

marked, it was uncertain that on visits to the study areas specific birds were not sampled more than once producing an element of pseudo-replication in the data. The existence of ample populations of birds at the study sites contributed to lessening this effect. Also the absence of WEKI on campus confounded the comparison between species. (We did not note nature of capture substrate during foraging bouts, whether in air, on vegetation, or on ground.) Statistical analyses of the foraging parameters, consisting of analysis of variance employing Duncan's multiple range procedure, was performed using SAS-9.2 (SAS 2008).

The birds selected a wide variety of perches during their foraging activities (Table 1). Even though the 2 study areas did exhibit common perch opportunities, there still were differences. For example, the clock tower only existed at the campus location and the metal structures of the electrical substation only occurred at the other site. However, both sites had trees and other common structures but in differing proportions. Considering these differences and also that both sites did not contain all the species of kingbirds, striking differences in perch selection were evident (Table 1). EAKI showed a distinct preference for trees from data at both study areas. STFL, which predominated at the campus study area, favored perching on the clock tower and secondarily on trees. WEKI was present only at the off-campus site, and there they most commonly selected the openness of fence and utility pole wires, while none used trees. In the same off-campus area EAKI was not detected using wires but instead used the tree perches that may provide more protective cover. WEKI nested on the superstructure of the power substation and occasionally performed foraging flights from the metal beams.

All three species differed significantly from each other in perch height, height flown, and prey capture height, P=0.0001*)* with STFL preferring the highest and EAKI the lowest (Table 2). Also, STFL returned to a different perch (P=0.0001) compared to EAKI and

Table 1. Perch selection by the three species of sympatric kingbirds during foraging forays (STFL=Scissor-tailed Flycatcher, WEKI=Western Kingbird, EAKI=Eastern Kingbird). Data are shown as percentage perch occupancy, with number of observations in parentheses.

Species	Clock tower	Building	Tree	Fence wire	Fence post	Utility wire	Utility pole	Trash can	Metal beam	Fountain
STFL	67% (144)	8% (16)	14% (30)	3% (8)	4% (9)	1% (2)	2% (4)	1% (1)	0	0
WEKI	0	2% (3)	0	27% (36)	0	52% (68)	12% (16)	0	7% (9)	0
EAKI	4% (5)	3% (4)	77% (99)	0	0	0	9% (11)	6% (7)	0	1% (2)

Table 2. Analysis of seven variables in the foraging behavior of three sympatric Kingbirds in western Arkansas (STFL=Scissor-tailed Flycatcher, WEKI=Western Kingbird, EAKI=Eastern Kingbird).

Species	Perch height (m)		Height flown (m)		Same perch =1; different perch =2		Prey length (mm)		Prey capture height (m)		Sally distance (m)		Sally time (s)	
	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
STFL	19.4[a]	214	19.8[a]	214	1.37[a]	214	24.8[a]	154	14.8[a]	214	8.8[a]	214	3.5[a]	214
WEKI	11.5[b]	132	11.8[b]	132	1.21[b]	132	23.3[a]	119	8.2[b]	132	8.0[a]	132	3.2[a]	132
EAKI	4.0[c]	128	5.0[c]	128	1.14[b]	128	20.2[a]	122	3.6[c]	128	9.0[a]	128	3.5[a]	128

[a,b,c]Means with the same letter are not significantly different (alpha=0.05); Duncan's Multiple Range test.

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WEKI, which tended to return to the same perch after capturing prey (Table 2). The 3 species did not differ significantly from each other in prey size, sally time, or sally distance (Table 2). It should be noted that EAKI bill length averaged 4mm shorter than WEKI and STFL and that mean prey length for EAKI was 4.6mm shorter than for STFL and 3.1mm shorter than WEKI, but these prey length differences were not significant (Table 2, P=0.2181). The different heights exhibited in foraging behavior by the 3 kingbirds shown by our results (Table 2) supports the part of Schoener's (1965) hypothesis that states that congeneric bird species of similar size could feed on similar sized prey but in different microhabitats to coexist and avoid competition. Therefore, we conclude that these three species will continue to coexist in the Fort Smith region of Arkansas.

A study in Kansas (Dick and Rising 1965) found that WEKI and EAKI overlapped considerably in arthropods consumed but differed greatly from each other in different localities suggesting to the authors that the birds were coexisting by foraging "in significantly different parts of the available habitat" therefore supporting our conclusion. However, we do not have data for EAKI or STFL in our area before colonization by WEKI needed to detect for a shift in foraging niche space after the advent of the WEKI. Data for WEKI from a previous study conducted in an open riparian habitat in southeastern Arizona (Blancher and Robertson 1984), found that the mean foraging height (9.3m) is similar to that observed in the present study (8.2m; Table 2), but both foraging time and distance flown were approximately twice that found in our study. Sally time was 3s for EAKI (Murphy 1996), which is close to our finding for all three species (Table 2), but Gamble and Bergin (1996) report 8s for WEKI. A study in southwestern Virginia (Via 1979) showed that foraging flights for EAKI were mostly from tops of herbaceous vegetation, a category that we did not recognize. Our study showed EAKI flew mainly from trees (Table 1) which was second in frequency, nearly equal to foraging from fence and utility wires, in Virginia. In our study foraging flights from wires were commonly exhibited by WEKI and no flights from these structures where shown by EAKI (Table 1). Regosin (1998) and Murphy (1996) respectively for STFL and EAKI stated that both commonly used wires as perches, quite different from our findings (Table 1). For WEKI, Gamble and Bergin (1996) agree with our finding that power lines and fences are important. MacKenzie and Sealy (1981) found that WEKI selected larger trees for nesting than EAKI, and WEKI nest height was higher than EAKI, which corresponds to the higher foraging zone in WEKI when compared to EAKI that we found. Hespenheide (1971) analyzed beetles occurring in stomachs of EAKI and found the mean size was 9.078 mm in length, ranging from 3 to 20 mm, which is much smaller than the mean of 23.3 mm we found (Table 2) in actively foraging Kingbirds catching insects. Regosin (1998) and Murphy (1996) stated that small prey was consumed in flight while large prey was returned to usually the foraging perch of origin. We analyzed only the large prey.

Descriptions of habitats of the 3 Kingbirds are similar consisting of open country with some trees, open savannahs including agricultural lands and desert scrub (Gamble and Bergin 1996, Murphy 1996, Regosin 1998). Those that have evaluated differences in habitats find WEKI occurs in the most open habitats (Hespenheide 1964, Ohlendorf 1974, Blancher and Robertson 1984). Although we did not investigate habitat differences in the species it can be seen in Table 1 that EAKI foraged from trees the most and that WEKI never foraged from tree perches, and STFL was intermediate in tree usage. WEKI in performing foraging flights mainly from fence and utility wires was operating in a very open treeless environment. The tall clock tower on campus was by far the favored foraging perch for STFL and was seldom used by EAKI (Table 1) even though it was available. This disparity highlights the demonstrated differences in foraging zones in which STFL foraged higher than EAKI.

In summary, the three same sized species of co-occurring Kingbirds foraging on equal sized arthropod prey avoided competition by performing aerial foraging activities at different heights. This agrees with the part of Schoener's hypothesis that states that closely related co-existing birds consuming similar food items will occupy different microhabitats, in this case foraging at different heights in the air space.

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