

ASPECTS OF BREEDING BIOLOGY AND SOCIAL ORGANIZATION IN THE SCISSOR-TAILED FLYCATCHER¹

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Abstract. We studied Scissor-tailed Flycatchers (*Tyrannus forficatus*) in southwestern Oklahoma during 1991 and 1992. In spring, males arrived earlier than females, and the sex ratio remained biased toward males for at least four weeks after the first birds arrived. Males defended large, dispersed territories, individual males paired with single females, and all observed copulations were between females and the males on whose territories they nested. From a behavioral perspective, the mating system can be categorized as socially monogamous. There was, however, some behavioral evidence that extra-pair copulations may occur: males displayed in groups to females early in the nesting season and both males and females intruded onto territories. Males did not engage in nest building, incubation, or brooding of young, but both males and females fed nestlings and responded aggressively to potential predators near the nest. Clutch size averaged 4.6 eggs, the incubation period lasted an average of 14.8 days, and an average of 88.0% of eggs that were fully incubated hatched. The majority of pairs (23 of 30, 76.7%) fledged young in 1991, but not in 1992 (12 of 31, 38.7%) possibly because of weather-related nestling mortality. Successful pairs fledged an average of 3.7 and 2.8 young in 1991 and 1992, respectively. Approximately half (37 of 87, 42.5%) of the adults but none of the young ($n = 108$) banded in 1991 were sighted again in 1992. Adults exhibited a high degree of site fidelity between years.

Key words: *Tyrannus forficatus*; Scissors-tailed Flycatcher; social organization; breeding biology; mating system; birds.

INTRODUCTION

The genus *Tyrannus* comprises 13 species of small to medium-sized New World flycatchers (Sibley and Monroe 1990). The nine species that breed in North America are generally similar in their habits, but exhibit important differences in their life histories that appear related to their foraging ecology and migratory habits (Murphy 1989). The Scissor-tailed Flycatcher (*T. forficatus*) and Fork-tailed Flycatcher (*T. savana*) are unique among kingbirds (*Tyrannus* spp.) in that males and females of these species exhibit a striking dimorphism in their tail length, with males having greatly elongated and forked tails. The relationship between this dimorphism and the species' matings systems is unknown but is likely to be interesting considering the association between tail-length dimorphism and sexual selection in birds (Winquist and Lemon 1994).

We have studied sexual dimorphism and sexual selection in *T. forficatus* and here present data

on their nesting phenology and breeding biology in an effort to provide a preliminary analysis of their social organization and mating system. Previous research on this species has been limited to life-history studies (Bent 1942; Fitch 1950; Murphy 1988, 1989), an analysis of their foraging behavior (Tatschl 1973, Foreman 1978) and a description of their vocalizations (Smith 1966). Detailed observations involving marked birds on the breeding grounds have not been published.

STUDY AREA AND METHODS

This study was conducted on the range of Fort Sill Military Reservation in Comanche County, southwestern Oklahoma in the mixed-plains biotic district (Blair and Hubbell 1938). We worked in four non-contiguous zones covering a total of approximately 8 km² of mesquite (*Prosopis juliflora*) savannah dominated by little bluestem (*Andropogon scoparius*) and 1 km² of landscaped area with mowed grass and planted trees including hackberry (*Celtis reticulata*), American elm (*Ulmus americana*), and honey locust (*Gleditsia triacanthos*).

The field work was conducted from mid-March through mid-August in 1991 and 1992. Birds

¹ Received 8 March 1994. Accepted 29 August 1994.

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were captured with mist nets set around nest trees during or after the incubation period. Birds were banded with a numbered aluminum band as well as a unique combination of three plastic color bands. We banded a total of 148 adult and 162 nestling Scissor-tailed Flycatchers (Table 1). Our study population consisted of 36 breeding pairs in 1991 and 39 pairs in 1992 in which at least one of the adults was banded (Table 1).

To quantify seasonal changes in numbers of individuals, we conducted a population census in 1992 by driving on a fixed 28.8 km route through the study area during the mid-afternoon and recording all flycatchers seen. As far as possible, we made an effort to count each individual bird only once. Scissor-tailed Flycatchers exhibited marked sexual dimorphism in wing and tail length and adult birds could often be reliably categorized as either male or female based on these traits and the extent of notching in the outer primary feathers (Pyle et al. 1987; Regosin, unpubl. data). There is, however, overlap in male and female wing and tail length and we only assigned an individual to a given sex when we could confirm our assignment through behavior. In every case of a breeding pair, the putative male had a longer tail than the putative female, and this difference was clearly visible to us. This pattern emerged, in part, because of positive assortative mating by males and females according to tail length (Regosin and Pruett-Jones, unpubl. manuscript). In no case was the longer-tailed member of a pair observed to lay eggs, incubate eggs, or engage in nest building. Only the longer-tailed member of a pair was observed to engage in singing behavior, and to perform the tumble-flight display described by Bent (1942) and Smith (1966). Thus, for paired birds, it was easy to determine the sex of each member of the pair.

It was also important to attempt to determine the sex of unmarked, free-ranging birds during the population censuses. In the study population, tail length of females never exceeded 18.5 cm and only three out of 56 females had tails in excess of 17.0 cm in length (Regosin and Pruett-Jones, unpubl. manuscript). In contrast, male tail length ranged from 14.0 to 26.3 cm. Long-tailed birds could therefore be categorized as males, but shorter-tailed birds could not be reliably classified as to sex. During censuses, we counted long-tailed birds (birds judged by eye to have tail lengths in excess of 20 cm) as "putative males," and counted shorter-tailed birds as "putative fe-

TABLE 1. Study population of Scissor-tailed Flycatchers at Fort Sill, Oklahoma.

Study populations	1991	1992	Total
Number of birds banded			
Males	28	23	51
Females	34	23	57
Unknown adults	25	15	40
Nestlings	108	54	162
Number of pairs under observation			
Both adults banded	16	17	33
One adult banded	20	22	42
Both adults unbanded	12	24	36

males." Young of the year were easily separable from females by their tail length and plumage characteristics and were not counted during the censuses.

Nests were located through searches on foot and by car and were visited either daily or every second or third day until the clutch was complete. Nests were again visited regularly during the hatching and fledging periods. For each nest we recorded the height, tree species, egg-laying dates, clutch size, egg dimensions and mass, hatching date, brood size, and fledging date. The incubation period was recorded as the time between completion of the clutch and the date of hatching. The nestling period was recorded as the time between the date of hatching and the date the young left the nest and were capable of independent flight. Complete seasonal reproductive data were gathered on 30 pairs in 1991 and 31 pairs in 1992. Additional, partial reproductive data on unbanded pairs (12 in 1991, 24 in 1992) were also gathered.

At one nest during 1991 and at four nests during 1992, observations were made on feeding visits by the resident male and female. Each nest contained 2-4 young and was observed on two or three days during the nestling period for a total of 4 hr at each nest. Observation periods lasted 1 hr in the morning or afternoon. For a subset of nests in 1992, the distance to the nearest neighboring nest was measured using a rangefinder and compass, or by plotting nests on a 1:200 topographic map which showed individual trees and then calculating the distances from the map.

RESULTS

BREEDING PHENOLOGY

T. forficatus was first sighted on the study area on 24 March in 1991 and on 28 March in 1992

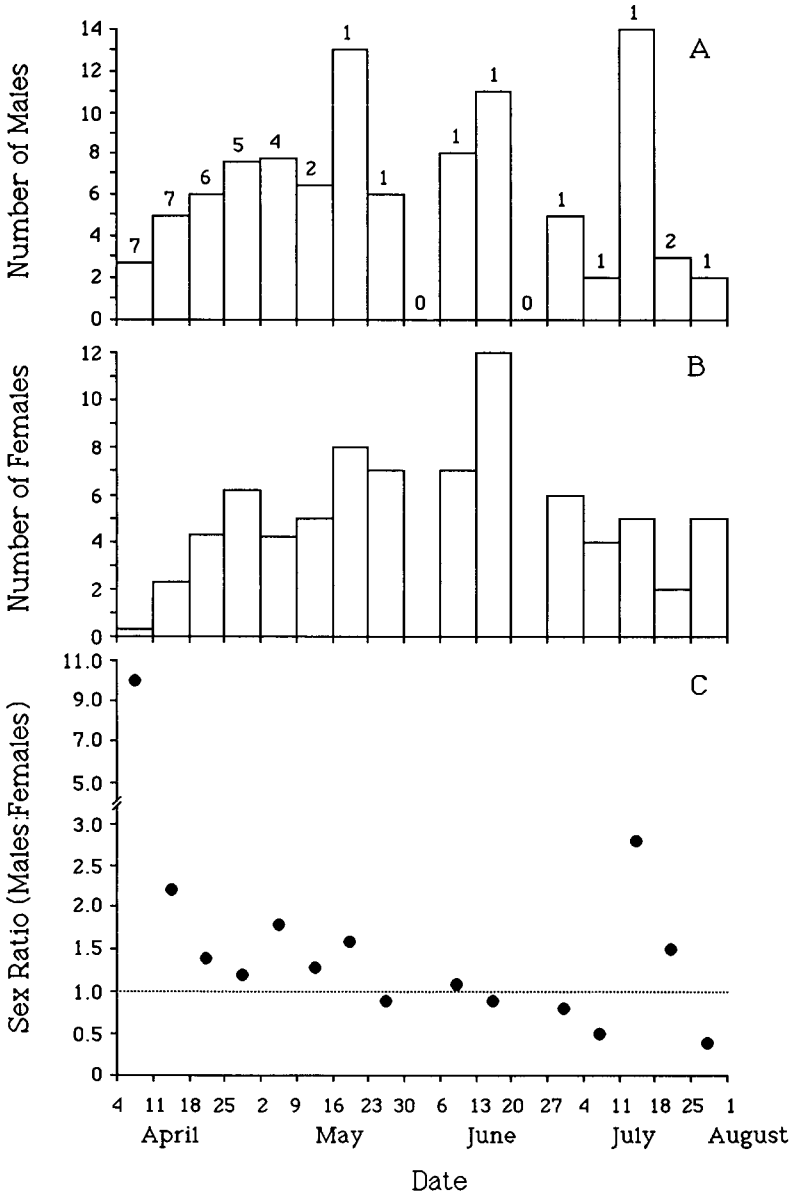


FIGURE 1. Seasonal change during 1992 in numbers of (A) male and (B) female Scissor-tailed Flycatchers and (C) the resultant sex ratio. The numbers above the bars in A are the numbers of censuses conducted during the given time period. For periods in which more than one census was conducted, the mean number of individuals is shown.

(Table 2). In both years, the first birds seen were long-tailed putative males. The numbers of individuals increased steadily after their arrival, peaked between mid-May and mid-June, and then began to decline in mid to late July (Fig. 1). Our census in 1992 did not continue after 28 July, but *T. forficatus* is known to remain in

southwestern Oklahoma until mid-October (Sutton 1967, Tyler 1992).

The first putative females were sighted on 12 April and 8 April in 1991 and 1992, respectively (Table 2). During 1992, for the first 10 days after the arrival of females, the sex ratio remained strongly biased towards males (Fig. 1). As more

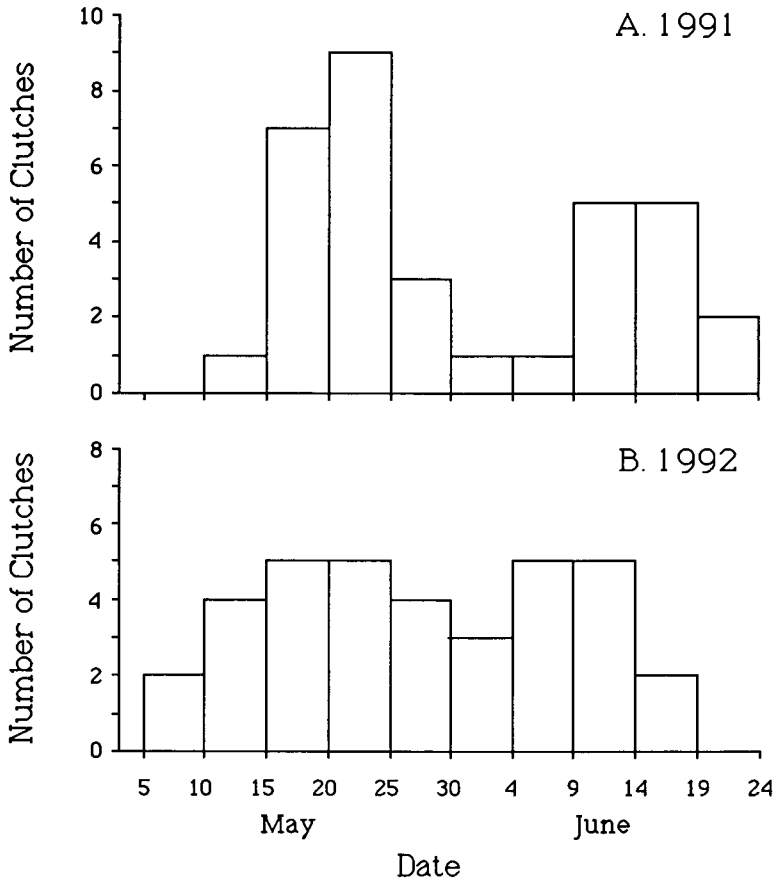


FIGURE 2. Initiation dates for first clutches by female Scissor-tailed Flycatchers.

females arrived, the sex ratio approached and fluctuated around 1.0 until the censuses ended. The values for sex ratio (Fig. 1) are minimum estimates since some of the short-tailed birds classified as putative females may have been males.

Temporal changes in the sex ratio are shown more conclusively by records of banded birds returning to the study area in 1992. Using the

date of first sighting of a returning banded bird as an estimate of date of arrival, and calculating the sex ratio for banded birds of known sex on each date that at least one banded bird returned, there was a strong negative correlation between arrival date and sex ratio ($r_s = -0.867$, $n = 14$, $P < 0.001$). The sex ratio was 5.0 (males: females) on 10 April, the date the first banded female returned. The sex ratio remained above

TABLE 2. Breeding phenology of Scissor-tailed Flycatchers.

Event	1991	1992
Earliest male	24 March	28 March
Earliest putative female*	12 April	8 April
Initiation of nest building	24 April	16 April
Clutch initiation dates	7 May–13 July	6 May–6 July
Hatching dates	2 June–29 July	25 May–23 July
Fledging dates	19 June–28 July	23 June–8 August

* See text for explanation.

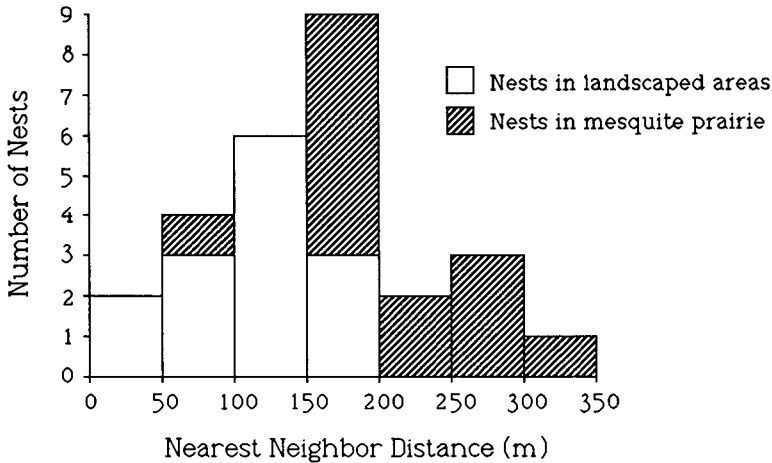


FIGURE 3. Nearest-neighbor distances of 20 Scissor-tailed Flycatcher pairs nesting in landscaped areas and natural mesquite prairie during 1992.

2.0 until 20 April and it was not until 5 May that the sex ratio dropped to 1.1.

There was considerable consistency in the timing of breeding between years (Table 2, Fig. 2). Median clutch initiation dates differed by only two days between the years (24 May in 1991, 26 May in 1992). Considering dates of first sighting in 1992 for birds banded in 1991, the date of arrival was strongly correlated with clutch initiation date for females ($r = 0.85$, $n = 11$, $P = 0.001$). The correlation between arrival date of males and clutch initiation date for the females with whom they paired approached but did not reach statistical significance ($r = 0.612$, $n = 10$, $P = 0.06$).

The incubation period averaged 14.7 days in 1991 ($n = 26$, range = 13–16) and 14.9 days in 1992 ($n = 15$, range = 13–22). The large range for incubation period in 1992 was due to a single nest at which incubation lasted 22 days, with two eggs of a clutch of four hatching on day 23; the other two eggs did not hatch. The female at this nest was incubating during a period of exceptionally cold and wet weather. There was no evidence that this nest represented a case of intraspecific brood parasitism.

The duration of the incubation period was negatively correlated with clutch initiation date in both years (1991: $r = -0.432$, $n = 26$, $P = 0.03$; 1992: $r = -0.589$, $n = 15$, $P = 0.02$); eggs in earlier nests took longer to hatch than eggs in later nests. We did not systematically mark eggs, but it appeared to us that the eggs in each nest

hatched synchronously within 24–36 hr. The average duration of the nestling period was 15.4 days in 1991 ($n = 26$, range = 14–17) and 15.3 days in 1992 ($n = 16$, range = 14–17).

SPACE USE AND NESTING DISPERSION

Scissor-tailed Flycatchers nested in two distinct habitat types: mesquite, mixed-grass prairie, and landscaped areas with mowed grass and planted trees. Birds nested from 3 to 7 m above the ground, most commonly in mesquite, hackberry, elm (*Ulmus* sp.), or honey locust trees.

Males dispersed over the study area on arrival in spring and defended territories. Territorial boundaries were not mapped, but males regularly engaged in zig-zag flight displays incorporating a flight song as described by Fitch (1950) and Smith (1966). These flight displays occurred on what appeared to be territorial boundaries. Also, males regularly chased each other, especially early in the breeding season. Flight displays by one male were usually followed by similar displays by neighboring males. Flight displays were also occasionally observed after a bird mobbed a raptor as reported by Fitch (1950).

During 1992, nearest neighbor distances for 27 nests ranged from 16–308 m (mean = 151.5, SD = 78.7). Nests in landscaped areas (mean = 99.7, $n = 14$, SD = 46.0) were significantly closer than nests in the mesquite prairie (mean = 207.2, $n = 13$, SD = 68.2, $t = 4.84$, $df = 25$, $P = 0.0001$, Fig. 3).

SOCIAL INTERACTIONS AND PARENTAL CARE

Male *T. forficatus* sang during display flights but seldom sang from perches on their territory unless a female and/or other males were present in the immediate vicinity. In these circumstances the other males were tolerated by the resident male, and the group of males displayed simultaneously. Such aggregations occurred early in the season, both on and off recognized territories. In 1991, we recorded four such display aggregations during the period 8–23 April, and in 1992 we observed 14 aggregations during the period 7 April–8 May. These dates put the occurrence of the group displays generally after the first females had arrived but before the initiation of nest building and egg laying.

Each group display involved 2–5 males (mean = 3.5 for 11 instances where the number of males was unambiguously counted) perched within 1 m of each other. The males displayed and sang simultaneously. Males also exhibited wing fluttering, exposing the salmon-colored patches under the wing. With the exception of a single aggregation involving only males, all such events took place in the presence of one, or occasionally two, putative females. On two occasions where we identified the female present, it was the female that later nested on the territory where the display occurred. Females did not take part in the display, but rather appeared to watch the displaying males. Also, the females generally perched below the group of displaying males such that when the males exhibited wing fluttering, the females could see the males' salmon-colored under-wing patches. During the displays, if the female moved to another perch, the males would follow her and resume their singing. The males also frequently chased the female(s) during the displays. No copulations were observed during or after group displays but in five cases the displays terminated with the putative female remaining at the site with one of the participating males.

Given the dates of their occurrence, the group displays likely played a role in the process of mate choice and settlement onto territories by females. Regardless of the exact function of the group displays, however, the process of pair-formation appeared to occur rapidly. Soon after females were first seen on territories, the females initiated nest building. Mated individuals were observed to copulate at dawn on, or immediately

adjacent to, the nest prior to and during the egg-laying period. At least five copulations were observed and none were seen away from nest sites.

Males followed females closely during nest building, but the females alone built nests, incubated eggs, and brooded nestlings. Both males and females fed nestlings. At the five nests where feeding rates were quantified, males averaged 0.69 feeding visits per hour (SD = 0.76) and females averaged 4.38 feeding visits per hour (SD = 3.35). These differences were not statistically significant (paired $t = 2.18$, $df = 4$, $P = 0.095$). We observed adults of both sexes feeding recently fledged young and leading them around the territory, but the extent and duration of post-fledging parental care was not recorded. Both sexes responded aggressively to potential predators and also to observers that approached nests.

Both males and females intruded onto other birds' territories. Intruders were observed near nests on territories and in one case a female was observed to fly to and inspect the contents of another female's nest.

SURVIVORSHIP AND SITE FIDELITY

Twenty three of the 28 males and 33 of the 34 females banded in 1991 bred on the study area. The other six birds were either non-breeders or they bred off the study area. Eleven (47.8%) of the 23 males and 19 (57.6%) of the 33 females breeding on the study area in 1991 returned in 1992. Considering all banded birds, 37 (42.5%) of the 87 adults banded in 1991 were sighted in 1992. None of the 110 nestlings banded in 1991 were sighted in 1992.

For seven of the pairs in 1991 in which both adults were banded, both the male and female returned in 1992. Four of these pairs remained intact in 1992, and in the other three pairs the males and females mated with different individuals in 1992. For the pairs that remained intact, in two cases the birds were seen together when first sighted in 1992 and in the remaining two cases, the males were observed on the study area from five to seven days before the females. Success at fledging young in 1991 did not appear to influence whether the pairs remained intact in 1992.

Males banded in 1991 that returned to the study area in 1992 held territories in the same general locations, with only three of 11 returning males moving their territories more than 100 m. Banded females returning in 1992 nested very

TABLE 3. Measurements of eggs and nestlings of Scissor-tailed Flycatchers.

	1991			1992		
	Sample size*	Mean	SD	Sample size*	Mean	SD
Egg mass (g)						
Clutch 1	34	3.4	0.9	31	3.4	0.3
Clutch 2	4	3.5	0.3	5	3.4	0.4
Clutch 3	—			5	3.3	0.2
Nestling mass (g), Day 5	29	11.1	1.7	—		
Nestling mass (g), Day 9	28	23.7	2.4	14	24.0	2.6

* Sample size is the number of clutches in which eggs or nestlings were measured.

close to where they had nested in 1991. For 15 returning females, six (40.0%) nested in the same tree they used in 1991, five (33.3%) nested within 100 m of their 1991 nest site, and the remaining four (26.7%) nested greater than 100 m away from their 1991 nest site.

REPRODUCTION

Mean clutch size for first attempts was 4.7 in 1991 ($n = 32$, $SD = 0.52$) and 4.5 in 1992 ($n = 26$, $SD = 0.51$). Clutch size for second nesting attempts, including replacement clutches after the first set of eggs was lost, averaged 4.0 ($n = 4$, $SD = 0.82$) in 1991 and 4.4 in 1992 ($n = 5$, $SD = 0.55$). These data were tabulated only for those females that had completed a first clutch. Combining data from 1991 and 1992, and deleting those females from 1992 for which data were also available in 1991, females produced significantly larger clutches in their first nesting attempt than in their second and third nesting attempt (Paired $t = 3.8$, $df = 12$, $P = 0.002$). Clutch size was negatively correlated with clutch initiation date in both years (1991, $r = -0.515$, $n = 38$, $P = 0.001$; 1992, $r = -0.467$, $n = 42$, $P = 0.002$). Considering only first attempts, however, clutch size declined as clutch initiation date increased in 1991 ($r = -0.378$, $n = 30$, $P = 0.04$), but not in 1992 ($r = -0.200$, $n = 26$, $P = 0.327$). Thus, females that initiated clutches later in the season tended to lay smaller clutches than early-nesting females, and reneating females laid smaller clutches in their second or third attempts regardless of when they began nesting.

No female made more than two nesting attempts in 1991 or four nesting attempts in 1992. Two banded females laid three clutches during 1992; both females laid five eggs in their first two clutches and four eggs in their third clutches for a total of 14 eggs per female. For one of these

females we measured egg mass and the eggs totaled 45.3 grams, slightly more than the female's own body mass.

We recorded three instances of females initiating egg laying after fledging young from earlier nests, and all three attempts occurred in 1991. In two of these three instances, there was premature fledging of some of the young in the first nest due to human disturbance. In both cases the second nesting attempt failed. In the third case of reneating by a female, four nestlings fledged from the pair's first nest, and an additional four nestlings fledged from the second nest. We were unable to follow the fate of the young from this pair's two nests and do not know whether all of the young survived.

Summary data on egg and nestling mass are presented in Table 3. Considering first clutches only, clutch size was not correlated with mean egg mass in either year (1991: $r = 0.143$, $n = 31$, $P = 0.443$; 1992: $r = -0.215$, $n = 25$, $P = 0.302$). The number of eggs laid in first clutches was not correlated with female tarsus length in either year (1991: $r = 0.025$, $n = 26$, $P = 0.905$; 1992: $r = 0.088$, $n = 18$, $P = 0.729$).

Hatching success of eggs that were fully incubated (i.e., present on the day of hatching) averaged 88.9% (96 of 108) in 1991 and 85.7% (72 of 84) in 1992. For the pairs of birds closely studied, 76.7% (23 of 30) fledged young in 1991 and 38.7% (12 of 31) fledged young in 1992. Successful pairs produced an average 3.7 fledglings in 1991 ($n = 23$, $SD = 1.5$) and 2.8 fledglings in 1992 ($n = 12$, $SD = 1.5$). The average seasonal fledging success (i.e., all nests of a given female combined) was 2.8 fledglings in 1991 ($n = 30$, $SD = 2.1$), and 1.1 fledglings in 1992 ($n = 31$, $SD = 1.7$, Fig. 4). The decline in 1992 was statistically significant ($t = 3.6$, $df = 59$, $P = 0.001$). Seasonal fledging success was not correlated with

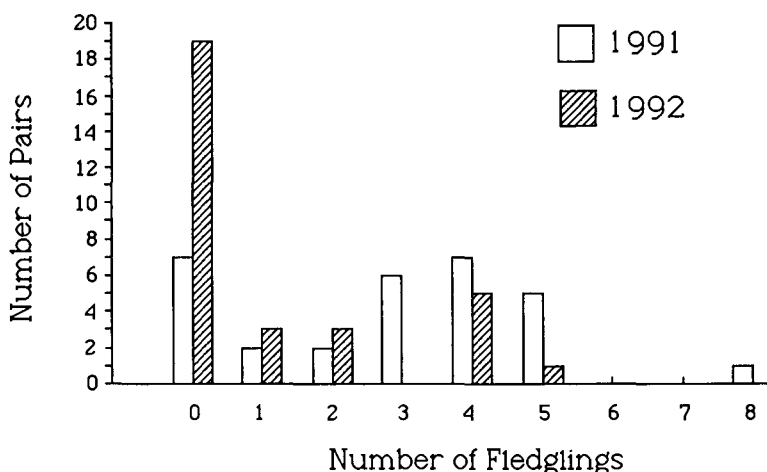


FIGURE 4. Seasonal fledging success of Scissor-tailed Flycatcher pairs during 1991 and 1992.

egg-laying date in either year, but was positively correlated with clutch size in 1991 ($r = 0.426$, $n = 27$, $P = 0.03$; 1992: $r = 0.203$, $n = 21$, $P = 0.38$).

The difference in fledging success between 1991 and 1992 can be largely accounted for by a marked increase in weather-related nest failures in 1992. In 1991, 5% and in 1992, 34% of nests were dislodged and subsequently failed (Table 4). While it is possible that a predator occasionally knocked down a nest, in 31 of the 38 (81.6%) cases of dislodged nests, severe thunderstorms or unusually strong winds occurred within the 24 hr preceding our discovery of the broken nest. In fact, 71.4% ($n = 25$) of the nests dislodged in 1992 were discovered immediately after a severe

thunderstorm on 21 June. This single storm destroyed 25 of 40 (62.5%) active nests. In many cases the entire tree or tree limb upon which the nest was located had fallen.

Assuming that nests from which eggs or nestlings disappeared represent cases of predation, nests were equally likely to fail as a result of predation in 1991 ($n = 26$, 44.8%) and 1992 ($n = 37$, 36.2%; $\chi^2 = 1.13$, $df = 1$, $P = 0.287$). Combining cases of partial nestling reduction and nestlings found dead in the nest as estimates of the occurrence of nestling starvation, nestlings in 7 (12.0%) nests in 1991 and 9 (8.8%) nests in 1992 starved. These figures for nestling starvation are likely to be overestimates as they include cases of predators removing some, but not all,

TABLE 4. Outcome of nesting attempts by Scissor-tailed Flycatchers.

Sample/outcome	1991	1992
Pairs under observation ¹	48	63
Nesting attempts monitored ²	58	102
At least one fledgling	25 (43.1%) ³	19 (18.6%)
Failures	33 (56.9%)	83 (81.4%)
All eggs disappeared ⁴	16 (27.6%)	29 (28.4%)
All nestlings disappeared ⁴	10 (17.2%)	8 (7.8%)
Eggs abandoned	2 (3.4%)	7 (6.9%)
Nestlings dead in nest	2 (3.4%)	4 (3.9%)
Nest dislodged	3 (5.2%)	35 (34.3%)
Partial clutch reduction	3 (5.2%)	3 (2.9%)
Partial nestling reduction	5 (8.6%)	5 (4.9%)

¹ All breeding pairs for which some reproductive data were gathered.

² The total number of nesting attempts for which the outcome was determined; these nests include those of unbanded pairs not part of the focal study group.

³ All percentages are of the total number of nesting attempts monitored.

⁴ Nests for which all the eggs or nestlings disappeared are assumed to have been depredated.

of the nestlings. In one case, a Cooper's Hawk (*Accipiter cooperi*) was seen to take just a single nestling out of a nest.

Three nests were observed to contain single Brown-headed Cowbird (*Molothrus ater*) eggs (Regosin 1994). In two of these cases, the cowbird's egg was ejected by the breeding pair. The third nest was destroyed during a storm within 24 hr of the cowbird egg's appearance.

INTERSPECIFIC INTERACTIONS

Scissor-tailed Flycatchers were frequently observed to chase raptors and other potential avian predators from their territories. Birds would often mob a predator together. In addition, nesting Scissor-tailed Flycatchers chased Western Kingbirds (*T. verticalis*) within their territories. Western Kingbirds occasionally removed nesting material from Scissor-tailed Flycatcher nests and, in one case, forced a pair from their nest and used the nest themselves. Scissor-tailed Flycatchers otherwise often share nest trees with a variety of other avian species (Bent 1942, Fitch 1950, Regosin 1993).

DISCUSSION

Although breeding by Scissor-tailed Flycatchers showed very similar patterns both years of the study (Table 2), breeding by females within a given year was asynchronous; clutch initiation dates for first nesting attempts ranged over 38 and 41 days in 1991 and 1992, respectively (Fig. 2). Murphy (1986) reported similar results for Eastern Kingbirds (*T. tyrannus*) nesting in Kansas, but also found significant year-to-year variation in timing of breeding in that species. Nesting asynchrony in *T. forficatus* is likely a result of asynchronous arrival by females on to the breeding grounds rather than a shortage of males or variation in clutch initiation dates for paired females. As females arrived on the study area, there was an excess of males and all paired females appeared to quickly initiate nest building and egg laying. It is also possible that some degree of asynchrony could be induced by the destruction of nests by predators. If a nest was destroyed before egg-laying without our observing it, the new nest of the female would be delayed and we would have recorded it as a first nesting attempt.

Because female arrival date was correlated with clutch initiation date, males who paired with early-arriving females initiated nesting earlier and

may have had an indirect fitness advantage. Although we did not find a correlation between clutch initiation date and seasonal fledging success, earlier nesting females did produce larger clutches that were associated with increased fledging success in 1991. Murphy (1988) similarly reported a seasonal decline in clutch size in Scissor-tailed Flycatchers in eastern Kansas.

We observed a negative relationship between incubation period and clutch initiation date. This correlation may be an artifact of how we determined incubation period (see METHODS). If females began incubating their eggs earlier in the egg-laying period as the season progressed, incubation period as we calculated it would be shorter for later clutches. Nevertheless, a seasonal change in the initiation of incubation by females would lead to hatching asynchrony in later clutches and, if this occurred, it was not obvious to us. Hatching asynchrony would also indicate that our measure of incubation period is an underestimate as we calculated incubation to the first day of the nestling period, not to when individual eggs hatched.

Female Scissor-tailed Flycatchers lay larger clutches and breed earlier than do females of any of the other nine species of kingbirds (*Tyrannus* spp.) breeding in North America (Murphy 1989). Comparing all species of tyrant flycatchers, there is a negative, significant relationship between breeding date and clutch size (Murphy 1989); species breeding earlier lay larger clutches. Furthermore, within two given species, the Scissor-tailed Flycatchers (this study) and Eastern Kingbirds (Murphy 1986; Blancher and Robertson 1985), earlier nesting females lay larger clutches. A number of factors may play a role in the evolution of relatively large clutch sizes in Scissor-tailed Flycatchers including a relatively long breeding season, variable weather, and a diet consisting largely of Orthopterans and Coleopterans (Beal 1912), prey that are less spatially clumped and more predictable than the aerial insects that other kingbirds utilize as prey. More predictable prey resources may permit *T. forficatus* pairs to reliably raise more young and have led to larger average clutch sizes. One possible consequence of the large clutch size in *T. forficatus* is reduced survivorship in females. The values for survivorship for female Scissor-tailed Flycatchers that we recorded (see RESULTS) are substantially lower than those for Eastern Kingbirds (Murphy, pers. comm.).

The large difference in fledging success of Scissor-tailed Flycatchers between years (Table 4) appeared to result from an increase in weather-related nest failures in 1992. Weather patterns and severe storms may also influence long-term population trends in this species and specifically may have played a role in a significant population decline of *T. forficatus* in the United States during the 1970s (Sauer 1990). Severe weather can cause nest failure directly through the actual destruction of nests and indirectly through a reduction of food resources that adults have available to feed nestlings. Murphy (1983a) reported that weather-induced resource scarcity is responsible for wide variance in reproductive success in the Eastern Kingbird. Murphy (1983a, 1989) suggested, in fact, that variation in resource abundance due to weather patterns has been a major factor in the evolution of life-history patterns in tyrant flycatchers.

Although severe weather may have reduced fledging success in *T. forficatus* during 1992, predation on eggs and nestlings had the greatest negative impact on reproduction during both years of the study (Table 4). Predation on eggs and nestlings has also been shown to be an important factor reducing reproduction in other kingbirds as well (Murphy 1983b, Blancher and Robertson 1985).

The interactions between Scissor-tailed Flycatchers and Western Kingbirds are interesting in light of the fact that Western Kingbirds have only bred in the general area where we worked since the 1920s (Moore and Strucher 1929 as cited in Tyler 1979). Western Kingbirds exhibited a range expansion at that time and moved eastward into the Fort Sill area. The aggressive interactions between these species may be an indication that these species actively compete with each other for suitable habitat now that their ranges partially overlap. In a study of sympatric Western Kingbirds and Cassins Kingbirds (*T. vociferans*), Blancher and Robertson (1984) concluded that those species did not compete for food resources.

Unlike males of many other kingbird species, male Scissor-tailed Flycatchers do not regularly sing during the day except during tumble flight displays (Fitch 1950, Smith 1966). The group displays by males that we observed are particularly interesting because they occurred on recognized territories and almost always involved one or two females. The group displays were seen

after males had settled on territories but generally before nest building by females. The function of these group displays is unknown but we suspect they are important for females in deciding on which territory to settle.

The mating system of *T. forficatus* is best described as socially monogamous; pair-bonded males and females breed on territories held by the male. Categorization of the mating system from a reproductive standpoint cannot be made until data from a DNA fingerprinting study that is currently underway (Pruett-Jones and Regosin, unpubl. data) are available. All observed copulations were between mated males and females near nests. Nevertheless, the occurrence of the group displays by males and the intrusions onto territories by both males and females suggest that complex interactions between males and females also occur and that there is the opportunity for extra-pair copulations. In light of the finding of multiple paternity in Eastern Kingbirds (McKittrick 1990), additional study of the reproductive patterns of Scissor-tailed Flycatchers with respect to settlement on territories by females, mate choice, and group displays by males should prove extremely interesting.

ACKNOWLEDGMENTS

We thank Randi Berkowitz and Jeremy Sarnat for assistance in the field and Hans Landel, Michael Murphy, Melinda Pruett-Jones, and an anonymous reviewer for comments on the manuscript. The United States Army and the United States Fish and Wildlife Service at Fort Sill, Oklahoma helped make this research possible by allowing us access to an outstanding study site. Our work was funded in part through grants to JVR from the Frank M. Chapman Memorial Fund of the American Museum of Natural History, Sigma Xi, the Oklahoma Ornithological Society, and the Hinds Fund of the Committee on Evolutionary Biology, University of Chicago; SP-J was supported by NSF Grants IBN-9207609 and IBN-9407988.

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