Female Song in Willow Flycatchers (*Empidonax traillii*)

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Females of many avian species are able to produce more or less elaborate songs. In most passerines this behavior seems to be occasional or exceptional, and the quality of the songs produced is usually poor. Only in a few species is singing a regular feature of female behavior (e.g. Armstrong 1963, Van Tyne and Berger 1976, Ritchison 1983). The occurrence of singing by female Willow Flycatchers (*Empidonax traillii*) is reported here.

I studied the territorial behavior of sympatric Alder (*E. alnorum*) and Willow flycatchers in June and July 1985 near Brighton, Northumberland Co., Ontario (44°05'N, 77°45'W), and near Montreal, Quebec (45°20'N, 73°30'W). Alder Flycatchers from allopatric populations were studied near Lac-Carré, Terrebonne Co., Quebec (46°10'N, 74°30'W), and near Jonquière, Chicoutimi Co., Quebec (48°30'N, 71°15'W). Birds were identified by song, and playback experiments were conducted with the original intent of investigating their vocal responses toward both Alder and Willow flycatcher songs. Two playback tapes were prepared. The tape used to test Alder Flycatchers contained a series of Willow Flycatcher songs, lasting 90 s (about 20 songs); after a pause of 30 s, a series of Alder Flycatcher songs lasting 13 min followed. The tape used to test Willow Flycatchers was constructed in the same pattern, but it contained a series of Alder Flycatcher songs followed by a series of Willow Flycatcher songs. The three advertising songs of Willow Flycatchers were used on both tapes, arranged in the following sequence: 3 "fitz-bews," 1 "fizz-bew," and 1 "creet." In this paper, all onomatopoeias referring to specific songs and calls are taken from Stein (1963).

The tapes were played over the speaker of a Uher 4000 or a Sony recorder directed toward the test bird. The recorder was placed 3–5 m from the bird's song perch, and the observer was located 2–3 m farther away. Playback experiments usually lasted 15 min but were stopped whenever the test bird repeatedly directed aggressive behavior toward another flycatcher. No experiment lasted less than 5 min.

After playback, birds that engaged in aggressive response were collected and sexed by gonadal inspection. Specimens are deposited as study skins in the National Museum of Natural Sciences, Ottawa, under Accession No. 1986-7.

Twenty-one Willow Flycatchers were collected, four of which were singing females. All females had fully developed ovaries ranging in size from 5 × 5 to 8 × 6 mm. No female songs were recorded, but I judged them to have the same pitch, pattern of syllables, and duration as male songs.

Each female responded differently to playback experiments. Female 22-02 delivered only "pit" notes and 2 faint "fizz-bews" during the 10 min in which conspecific songs were played. The other three females responded more strongly to conspecific songs.

Female 21-06 appeared to be paired. Before the male was collected, this female was perched in dense alder bushes about 3 m from the speaker giving "pits" and a few "churrs." Immediately after the male was collected she flew as close as 50 cm from the speaker and gave 7 loud "fitz-bews" and 3 "fizz-bews." Playback continued for 5 min, during which time she gave numerous "pit," "zweeoo," and "churr" calls. In two instances she gave a combination of "churr-weeoo," recalling the "fee-bee-o" song of the Alder Flycatcher. Stein (1963: 45) similarly noted that Alder Flycatchers can produce a combination of calls that resemble the Willow Flycatcher "fitz-bew." Before the end of the experiment she uttered 5 more "fitz-bew" songs.

Female 25-01 was accompanied by another individual (presumably her mate) during the entire playback experiment. Both birds came repeatedly as close as 50 cm from the speaker, and each sang the three advertising songs of the species as well as most of the call notes.

Female 22-05 was approached while singing at the top of a 2.5-m-high willow bush. Before playback started, she was singing "fitz-bews" at a rate of 6–10 songs/min. She responded strongly to playback of conspecific songs by giving "pit," "weeoo," and "churr" calls, as well as many "fitz-bews" and "creets." This female had a fully developed ovary (8 × 6 mm), and the oviduct contained a 10 × 10-mm ovum. No other birds were seen or heard in the vicinity during the 10 min of playback.

I did not observe any singing by female Alder Flycatchers. A total of 45 singing individuals, none of which was a female, was collected from four different populations.

Kroodsma (1984) noted that newly fledged female Willow Flycatchers are able to give vocalizations resembling the adult "creet." He further demonstrated, by testosterone implantation, that adult females can produce all three advertising songs of the species. My observations indicate that female Willow Flycatchers also sing under natural conditions. Kroodsma (1984) showed that female Alder Flycatchers also can be artificially induced to sing, but my observations do not support the idea that singing occurs in nature.

Females of a fair number of tyrannid species are involved in duetting. Farabaugh (1982) listed 16 for

Panama alone. Thus, the potential for female Tyrannidae to sing seems to be generalized. It is then surprising that among nonduetting tyrannids, only Eastern Phoebe (*Sayornis phoebe*) and Willow Flycatcher females are known to sing (Smith 1969, this study). Ritchison (1983) reported that breeding females of the Gray-capped Flycatcher (*Myiozetetes granadensis*) also sing. This was based on a description of the species' nesting behavior by Skutch (1953). I believe, however, that Skutch described duetting. Farabaugh (1982) included *M. granadensis* in her list of Panamanian duetters.

The songs of female flycatchers are identical to those of males (Smith 1969; Kroodsma 1984, 1985; this study). Such similarity, and the absence of sexual dimorphism in Tyrannidae, may explain the scarcity of reports of female singing in that family. Careful observations on birds of known sex will be required to determine the extent of female singing in tyrannid species.

Several hypotheses have been proposed to explain the occurrence of song in female birds (e.g. Armstrong 1963, Van Tyne and Berger 1976). All singing females I observed sang during simulated territorial encounters, suggesting that territorial defense is one function of female song in Willow Flycatchers. Singing by female Willow Flycatchers may also serve other functions. Detailed behavioral studies will have to be conducted to completely understand the functional significance of female singing by this species.

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Limitations of Tetracycline in Tracing Multiple Maternity

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A central assumption in many studies of monogamous birds is that kinship or parentage can be inferred reliably from patterns of parental care (Gowaty and Karlin 1984). However, offspring in a single clutch or brood may have multiple parentage (Andersson 1984, Gowaty and Karlin 1984, Harvey 1985). In such cases, estimates of the reproductive success of the putative parents may be affected considerably (Harvey 1985). Methods therefore are needed to identify eggs or young that belong to individuals other than the male or female attending the nest. Maternity and paternity exclusion based on electrophoretic protein variation has met with only limited success (see Gowaty and Karlin 1984, Scott and Tan 1985). A second approach has used nonintrusive markers that are fed or injected into an individual, and can be detected subsequently in the resulting eggs or offspring (Appleby and McRae 1983, Dickman et al. 1983, Scott and Tan 1985).

Haramis et al. (1983) proposed that tetracycline could be used as a marker to trace maternity. When injected intraperitoneally, tetracycline chelates with calcium ions in the forming eggshell and can be detected by a characteristic fluorescence when exposed to ultraviolet light. Haramis et al. (1983) used tetracycline to identify eggs of individual female Wood Ducks (*Aix sponsa*) in several different nests. They did not detect any adverse side effects of tetracycline,