

song types (e.g., Fig. 2D in Lein 1978 and Fig. 4B in Kroodsma 1981), just as this male Common Yellowthroat did. Other than the slightly modified "c" note (song component c' in Fig. 1C), this is a perfect copy of a Chestnut-sided Warbler Accented Ending song type.

Other suggestive evidence of vocal learning as a normal process in the Common Yellowthroat comes from song development in the nestling male which was tutored simultaneously with the experimental Chestnut-sided Warbler male discussed above. This male developed a highly abnormal, simple song syllable, which was repeated in typical Common Yellowthroat fashion. The repeated song component consisted of a single note, however, not the typical three to six note syllable of wild birds (Borror, *Living Bird* 6:141-161, 1967). Such simplification of song syllables typically occurs in isolated birds where conditions for vocal learning are not sufficient for the normal complex song of the species to develop (e.g., Kroodsma, *Anim. Behav.* 25:390-399, 1977).

Other than the micro-geographical variation of Unaccented Ending songs (or Type II songs) in the Chestnut-sided Warbler and the Blue-winged Warbler (*Vermivora pinus*) (Kroodsma 1981), the only other possible evidence of vocal imitation in the Parulinae had involved disputed examples of interspecific mimicry by the Yellow-breasted Chat (*Icteria virens*) (Grinnell et al., *Univ. Calif. Publ. Zool.* 35, 1930; but compare Saunders, pp. 592-593 in Bent, *U.S. Natl. Mus. Bull.* 203, 1953). The evidence in our report is unequivocal, however, and confirms the presence of vocal learning in the Parulinae. Such vocal learning among species where different song types are used in different contexts raises interesting questions not only about what males learn to sing but also about how they come to use these learned signals in an intriguing vocal communication system.

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Factors affecting the performance of flight songs and perch songs in the Common Yellowthroat.—Flight songs have been reported for 11 species of wood warblers (Parulinae) (Ficken and Ficken, *Living Bird* 1:103-121, 1962; Meanley, *Wilson Bull.* 80:72-77, 1968), including the Common Yellowthroat (*Geothlypis trichas*). The flight songs are given as the singer ascends to 10 m above the ground in slow, bobbing flight. The ascent is accompanied by a series of sputtering notes ending with a portion of the perch song; the descent is silent (Bent, *U.S. Natl. Mus. Bull.* 203, 1953). Hann (*Wilson Bull.* 49:145-237, 1937) presents data showing that most flight-singing by the Ovenbird (*Seiurus aurocapillus*) occurs late in the day and late in the season, and other workers have described a similar tendency in yellowthroats (Bent 1953; Stewart, *Wilson Bull.* 65:99-115, 1953; Hofslund, *Proc. Minnesota Acad. Sci.* 27:144-174, 1959). In this paper I examine factors influencing the relative frequencies of yellowthroat flight song and perch song, and suggest a possible function for the flight song in this species.

Yellowthroat singing behavior was studied on two oldfield study areas located in northern Bartholomew Co., Indiana, from 26 April-22 July 1970, and from 28 April-19 Sept. 1971. In 1970 these areas supported seven yellowthroat territories and in 1971, six territories. In 1970 temperature and wind velocity 1 m above the ground were measured during observation periods, and all songs were counted. Notes on behavior were taken during both field seasons.

Data from 1970 yielded 92 hour-long periods during which songs were counted. Multiple

TABLE I
EFFECTS OF TEMPERATURE, TIME OF DAY, WIND VELOCITY, AND TIME OF YEAR ON
YELLOWTHROAT PERCH-SONG AND FLIGHT-SONG PERFORMANCE

Variable	F	P	Multiple r	Simple r	Overall F	P
Perch-song						
Temperature	2.62445	<0.11	0.29370	-0.29370	5.39101	$P < 0.002$
Time of day	10.97765	<0.002	0.38927	-0.26873		
Wind velocity	0.03232	<0.86	0.39807	-0.14282		
Time of year	4.36068	<0.05	0.44568	-0.20977		
Flight-song						
Temperature	1.67341	<0.20	0.11536	0.11536	11.61800	$P < 0.001$
Time of day	8.73007	<0.005	0.12683	0.05796		
Wind velocity	0.82027	<0.37	0.16265	0.12716		
Time of year	42.94080	<0.001	0.59007	0.51611		

regression analysis was used to examine the relative effects of four independent variables (temperature, time of day, wind velocity, and time of year) on the performance of flight and perch songs. Behavioral data from 1970 and 1971 were used to examine the effect of apparent motivational state on singing behavior. The numbers of perch-song and flight-song bout initiations were counted, and the birds were assessed as "undisturbed" or "disturbed" at the time of bout initiation. The term bout as used here refers to a series of songs, with the elapsed time between songs being less than 2 min. A silent period of more than 2 min was considered to mark the end of a bout. A bird was regarded as undisturbed if during the observation period it: (1) experienced no displaying or singing by any neighboring males, and (2) had not engaged in any territorial encounters during the preceding 5 min. A disturbed bird was one which did not meet these constraints. Of a total of 3139 min of observation, 1645 min were spent watching undisturbed birds and 1494 min were spent watching disturbed birds. Expected frequencies used in a Chi-square test for goodness-of-fit were based on the proportion of time birds of the two classes were under observation and the frequencies with which they began to sing one song type or the other. The breeding status of the birds was unknown.

During June of 1977 I recorded flight songs from a population of yellowthroats in eastern Monroe Co., Indiana. In only two instances was I able to record both the perch song and flight song from the same individual. The two pairs of sonograms from these birds showed that the portion of perch song incorporated in the flight-song performance was of the same phrase type (*sensu* Borror, *Living Bird* 6:141-161, 1967) as was used in that individual's perch-song performance.

Table I presents the results of the regression analysis of the 1970 song counts. Temperature, time of day, wind velocity, and time of year together explain 19.8% and 34.8% of the variation in the perch-song and flight-song count data, respectively. Of these four variables, only time of day and time of year had a significant effect on perch-song and flight-song performance. In general, perch-song performance decreased later in the day and later in the season. Flight-song performance increased with time of day and time of year, with the time of year being by far the more important variable.

The apparent motivational state of a bird was strongly related to the number of perch songs given. Undisturbed birds were seen to initiate 58 perch-song bouts, while disturbed birds initiated 114 perch-song bouts ($\chi^2 = 24.08$, $df = 1$, $P < 0.001$). Initiation of flight-song bouts was not significantly different between undisturbed and disturbed birds.

The relationship of flight song frequency to time of year is interesting, especially in light of the fact that the reproductive stage of the singers was unknown. Territorial boundaries were well defined early in the season, and after the first week of May in both field seasons intense territorial encounters became uncommon. This decline in territorial disputes may have been the result of resident males having established territorial boundaries and learned the songs of their immediate neighbors (Wunderle, *Auk* 95:389–395, 1978). The analysis of the yellowthroat flight-song recordings showed that the perch-song portion incorporated in the flight-song vocalization is characteristic of the individual, making individual recognition on the basis of the flight song performance possible. Song without visible displays has been shown to be sufficient to maintain territorial boundaries (Peek, *Anim. Behav.* 20:112–118, 1972; Krebs, *New Scient.* 70:534–536, 1976), and the increased visibility of a yellowthroat in flight song would further enhance the deterrent effect of the vocalization. I therefore suggest that the yellowthroat flight song functions to maintain territorial boundaries, once these boundaries have been established. The relative infrequency of flight songs at all times during the season (Stewart 1953) may reflect the fact that this vocalization serves primarily to discourage trespassing by other males, unlike the perch song, which is used during the initial setting up of territories and territorial disputes, as well as for advertising for, and maintaining a pair bond with females (Wunderle 1978).

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Vocalizations and behavior of Violet-green Swallows in the Chiricahua Mountains, Arizona.—The Violet-green Swallow (*Tachycineta thalassina*) has been largely ignored by ornithologists. The only published accounts of its basic biology date from the 1940s (Bent, U.S. Natl. Mus. Bull. 179, 1942; Edson, *Auk* 60:396–403, 1943) or must be gleaned from generalized state bird-books (e.g., Bailey, *Birds of New Mexico*, New Mexico Dept. Game Fish., 1928; Phillips et al., *The Birds of Arizona*, Univ. Arizona Press, Tucson, Arizona, 1964). Virtually nothing has been reported about its vocalizations.

In May–July 1980 I studied Violet-green Swallows and recorded their vocalizations in the Chiricahua Mountains, Cochise County, Arizona. Recordings were made with Uher 4000 Report L and 4000 Report IC tape recorders and Uher M517 and Electrovoice Soundspot microphones, the former mounted in a 60-cm parabolic reflector. Tape speeds were 19 and 9.5 cps. Sonagrams were made on a Kay Elemetrics Corp. Sona-Graph Model 6061-B using wide-band pass setting and linear scale. All observations and recordings were made near Rustler Park (elev. 2545 m) and at the Southwestern Research Station (elev. 1636 m). I tape-recorded approximately 35 different individual swallows.

Violet-green Swallow vocalizations can be grouped into two broad classes, *chee-chee* and “twitter” calls.

Chee-chee calls.—These calls are generally mono- or disyllabic (syllable defined as a con-