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SHORT COMMUNICATIONS

Song types of Black-throated Green Warblers on migration.—It is widely known that passerine birds of many species sing while on migration (Armstrong 1973), yet little attention has been paid to the role that their songs might play. In common with some other vocalizations given outside of the breeding season, they might be used as "practice" for the breeding season (e.g., Nottebohm 1975). Alternatively, since some migrating birds hold temporary territories (Rappole and Warner 1976), their songs might serve a defensive function. However, many New World warblers (Parulinae) that remain at migratory stopover sites only briefly, and are therefore unlikely to establish territories (see Rappole and Warner 1976), may sing as well. The role of song in these birds is uncertain. The Black-throated Green Warbler (*Dendroica virens*), a species that sings during migration, has two distinct songs, which are presented in different contexts on the breeding grounds (Morse 1967, 1970, 1989a). There, one has a basically intrasexual role and the other an intersexual role (also see Highsmith 1989, Kroodsma et al. 1989). Thus it is of interest to know which songs they give on migration, since this information might provide insight into the role that song plays at this time. I report here on the song types given by Black-throated Green Warblers on spring migration in Maryland and Rhode Island. The Rhode Island site lies about 500 km northeast of the Maryland site and is closer to the breeding grounds than the latter.

Methods.—I counted song types in Prince George's Co., Maryland, during the spring migrations of 1976–1978, and E. S. Morton and R. Greenberg did so for me in neighboring Washington, D.C. (8 km southwest), in 1986–1987. I subsequently refer to these two locations as the Maryland sites. I also tabulated song types in Providence, Providence Co., Rhode Isand during the 1983–1988 spring migrations. Since Black-throated Green Warblers do not nest in the immediate vicinity of either study area, all of the birds can be classified as migrants. Song types were counted on the breeding grounds (Bremen, Lincoln Co., Maine) during late May of 1966 and late June–early July of 1971.

All observations were made in the morning, from 0700 to 0900 in clear or partly cloudy weather. Songs were identified as to type, and for most birds the number of songs given over two minutes was recorded. Sound spectragrams of the Black-throated Green Warblers' two song types, here called Accented Ending and Unaccented Ending songs, appear elsewhere (Morse 1967, 1970, 1989a). The former plays an important intersexual role on the breeding grounds, and the latter a basically intrasexual role (see Kroodsma et al. 1989). Individuals were counted only once at a site during a morning, and since conspecifics were seldom present at a site on successive days, the number of individuals listed is unlikely to differ appreciably from the actual number of individuals. The birds were not marked, however.

Results.—Unaccented Ending Songs dominated in Maryland, both in numbers of birds singing and in total songs (Table 1). In contrast, Accented Ending Songs were most frequent in Rhode Island, although their relative dominance did not match that of Unaccented Ending Songs in Maryland. The difference between the two sites was significant, both for the number of birds singing the two songs ($G = 8.45$, df = 1, $P < 0.01$) and for the total number of songs of the two types given in the sample available ($G = 34.45$, df = 1, $P < 0.001$). The singing Black-throated Green Warblers that I observed occurred at low densities, with only a single individual noted on most days (Table 1) and more than one singing bird in the same area noted only twice.

This difference in song types could have resulted either from the later dates of observation in Rhode Island, or in the time remaining to reach the breeding grounds. Observation dates for Rhode Island birds (May 13.5 ± 4.7 days) ($\bar{x} \pm$ SD) averaged 6.2 days later than those in Maryland (May 7.3 ± 7.7 days), presumably reflecting differences in migration times.

TABLE 1

ACCENTED ENDING SONGS (AES) AND UNACCENTED ENDING SONGS (UES) GIVEN IN MIGRATION BY BLACK-THROATED GREEN WARBLERS

Site and year	Number of birds[a]			Number of songs		AES/ UES	Songs/ min
	AES	UES	Both	AES	UES		
MD, 1976–1978	1	7	1	2	29	0.1	1.7
MD, 1986–1987	3	10	0	—	—	—	—
RI, 1983–1988	11	6	0	64	37	1.7	3.0

[a] The birds were observed on seven different mornings in Maryland (MD) (1976–1978) and 11 different mornings in Rhode Island (RI). The data are not available for Maryland (1986–1987).

Overlap of times was inadequate to compare song types in the two areas on given days, but Rhode Island birds did not differ in the dates on which they sang the two song types (Accented Ending = May 13.4 ± 5.5 days ($\bar{x}$ ± SD), Unaccented Ending = May 13.8 ± 3.2 days; $P > 0.8$ in a two-tailed Mann Whitney *U*-Test). Too few birds sang Accented Ending Songs in Maryland to make this comparison; unfortunately, singing dates were not recorded in 1986–1987. The ratio of Accented to Unaccented Ending Songs is even higher on the breeding grounds in late May, however. In 1966, the ratio of Accented to Unaccented songs was 4.2 to one between 18 and 27 May, at which point Unaccented songs became dominant.

The migrants repeated songs more slowly (Table 1) than birds on the breeding ground during the middle of nesting, which averaged 4.3 ± 1.1 songs/min, N = 25, for Accented Ending Songs, and 5.6 ± 1.1 songs/min, N = 20, for Unaccented Ending Songs. However, the rates of Accented Ending Songs in Rhode Island more closely approximated birds on the breeding grounds than did those singing Unaccented Ending Songs in Maryland.

Although observations on quality of notes or volume are difficult to quantify under field conditions, in several instances songs varied grossly from those typical of the breeding grounds. Specifically, of the 26 birds on which I made such observations, four gave songs missing one or more ending notes. Additionally, four birds gave only songs commonly characterized as "reedy" (2) or "buzzy" (2), highly atypical of songs given during the middle of the breeding season. None of the 40 birds that I timed during the breeding season (five sang both types of songs) gave atypical songs during the periods of measurement. Admitting the possible subjectivity of this sample the difference in frequency of atypical songs between the migrating and breeding-ground song samples is highly significant ($G = 16.66$, df = 1, $P < 0.001$).

Discussion.—The difference of song types in the two study areas is of interest, because as the birds move closer to their breeding grounds they increase the frequency and proportion of Accented Ending Songs. On the breeding grounds the Accented Ending Song is the song given when males are with females (Morse 1967), and it also prevails during the early part of the season, apparently before pair formation (Morse 1967, 1970). The data do not address whether time to the breeding ground or time of the year is associated primarily with this shift, but the similarity of singing dates for the two songs in Rhode Island is consistent with impending arrival on the breeding ground assuming primary importance.

Songs on migration were infrequent and intermittent in comparison to those on the breeding grounds, but the frequency of Accented Ending Songs in Rhode Island more closely resembled that of the breeding grounds than did Unaccented Ending Songs in either location. This is consistent with the birds' approaching the condition attained on the breeding grounds at the beginning of the year.

The increase in frequency of vocalizations between Maryland and Rhode Island suggests that the birds are bringing their singing patterns to a frequency resembling that of the breeding season. I do not have comparable singing rates of individuals when they first reach their breeding grounds; however, high rates may not always characterize their arrival. In the congeneric Prairie Warbler (*D. discolor*), Nolan (1978) noted that some recent arrivals showed little tendency to sing or exhibit other signs of territorial proclamation, which he attributed to inadequate physical condition resulting from migration.

Taken together, these results suggest that over the migration period, song is changing in a way that comes to resemble the patterns predominant at the beginning of the breeding season. In the absence of any observations of close contact between singing males and females on migration during this study, it does not seem appropriate to attribute the vocalizations at this time directly to courtship activities. Although the migratory periods of male and female Black-throated Green Warblers do overlap, substantial numbers of males may precede most females (see Morse 1989b). The absence of females resembles the males' arrival on their breeding grounds, since they generally precede females (Morse 1989b). Thus, although considerable information suggests that Accented Ending Songs play an important intersexual role, it is likely that they assume predominance in the immediate absence of the females. Their use, both in the absence of females and other males, is consistent with Kroodsma et al.'s (1989) hypothesis that Accented Ending Songs can act as "default" songs as well as ones with a direct intersexual message. It is more difficult to fit the contexts of Unaccented Ending Songs, as well as the differences in proportions of the two song types, into this argument, especially the predominance of Unaccented Ending Songs in Maryland in the absence of other males.

These observations were notable for the number of abnormal songs in comparison to the middle of the breeding season, both in the number of incomplete songs, an easily quantifiable character, and in "qualitative" differences that could not be quantified without acoustical analysis. These variations also increase in relative frequency at the end of the nesting season on the breeding grounds (Morse 1967). The relatively high frequency of imperfect and incomplete songs during migration resembles that reported for a wide variety of both Nearctic and Palearcitc species (see Armstrong 1973).

Several species of paruline warblers give two or more songs that differ in context in a way that appears similar to the Black-throated Green Warbler (e.g., Ficken and Ficken 1969, Lein 1978, Nolan 1978, Morse 1989a). Therefore, it is possible to expand this approach and perhaps cast additional light on the role of song in migration. Such investigations should ideally also include songs given on the wintering grounds, since a number of species sing prior to leaving (Armstrong 1973, Morse 1980).

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Avoidance of song matching in the Wood Thrush: a field experiment.—Song matching is a common form of vocal interaction in oscine species. It occurs when one bird, typically a territorial male, answers the song of another bird with a similar song. Matching has been reported for many species in which males sing with "eventual variety," uttering one version of the territorial song a number of times before switching to another version: AAAA . . . BBBB . . . (e.g., Hinde 1958; Gompertz 1961; Lemon 1968a, b; Kroodsma 1971; Krebs et al. 1978). In contrast, matching has been reported for only a few species that sing with "immediate variety:" ABCDE . . . (e.g., Todt 1970, Verner 1975, Kroodsma 1979). It is not possible to say from present evidence whether matching is truly less common in birds that sing with immediate variety, but there is a clear need for studies of these species.

Wood Thrushes (*Hylocichla mustelina*) sing with immediate variety. My objective in the study reported here was to determine whether the results of an earlier study (Whitney and Miller 1983, see also Whitney 1985) of song matching in captive Wood Thrushes could be generalized to free-ranging birds. In the earlier work I presented each male with recordings of songs that were structurally similar to one of his own songs but that varied systematically from it in frequency (Hz). The results indicated that matching is related inversely to song similarity: the more similar the stimulus song was to the bird's own song, the less it was matched, to the extent that subjects avoided matching their own songs and songs very similar to them.

Materials and methods.—A typical Wood Thrush song has three phrases, referred to as the A, B, and C phrases. The introductory A phrase consists of one or more low-pitched sounds, the middle B phrase is of loud flute-like notes, and the ending C phrase is usually a trill. B phrases are learned from conspecifics (Whitney and Miller 1987b) and can be classified into discrete types (Whitney and Miller 1987a, Whitney 1989). Use of the term "song type" in this paper refers to these B phrases. Each male has a repertoire of 2–8 B phrases, several of which may be different versions of the same type.