A New Technique for Studying Nocturnal Bird Migration

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Abstract

I followed nocturnal bird migration over central Israel by using an acoustic tracking system, which includes a sensitive Pressure Zone (PZM) Microphone, and a Hi-Fi VCR used to record bird calls sounded during migration. Identification of bird calls is performed both by an automatic computerized system (designed by the Acoustic Laboratory at Cornell University) and aurally by an experienced ornithologist using Canary software (written by the Acoustic Laboratory at Cornell University).

The automatic computerized system helped to identify 134 different spectrographs and the experienced ornithologist identified 15 different species. Research results showed two general differences between this project and similar studies conducted in North America. First, the number of calls recorded during spring and autumn migration in central Israel each night was lower than the number of calls recorded in North America. Second, the frequencies of the various bird calls during migration over Israel were much lower than the birds of North America.

Introduction

Nearly all birds that migrate at night give characteristic flight calls. Warblers, sparrows, cockoos, rails, and herons are among the species known to give night flight calls (Thorpe, 1961; Kroodsma et al., 1983; Ranft and Slater, 1987; Evans, 1994, Evans and Mellinger, 1995).

By aiming microphones at the night sky, a volume of sky (dimensions are dependent on microphone design) can be monitored for calls (Graber and Cochran, 1959). Species that regularly form flocks during the day have a night migration call apparently indistinguishable from the daytime call. Other species seem to have a night-time call so different from the daytime call, that it is often difficult to identify the calls (Hamilton, 1962).

The function of night calls apparently are: compensation for lack of visual communication (Kroodsma et al., 1982) to help birds maintain spatial association in flight (Hamilton, 1962), to organize their spacing in order to minimize collisions (Graber, 1968), to help birds estimate wind direction (Kroodsma et al., 1982), and to encourage birds in migratory condition to take flight (Hamilton, 1962).

This paper describes results and information on the species of birds flying over central Israel during the 1997 fall and 1998 spring migration. The results were compared data obtained in North America (Evans, 1994; Evans and Mellinger, 1995; Evans and Rosenberg, 1997).

Methods

Nocturnal flight calls of migrating birds were recorded during the 1997 fall migration and during the 1998 spring migration, for a total of 100 nights. The station was located in Yavne (34045'E, 31052'N), Israel.

The PZM microphone was used in conjunction with a high-fidelity video cassette recorder to enable directional sound pickup and inexpensive recording of avian night-flight calls over a long period. The microphone was designed to be especially sensitive to the 2 - 10 kHz range. The Hi-Fi VCR allowed for ten hours of continuous recording of sound from the night sky and could be programmed for regular nightly operation.

All the records (a 102-night total of 1,020 hours) were first analyzed automatically by a special detector (written by Mr. Harold Mills, Cornell University) to detect calls above 2 kHz (total of 9 hours). These calls contained background noises and bird calls. Analysis of the distinction between bird calls and background calls was carried out using the Canary Software Program (Charif et al., 1995) and using ShowGrams (a Matlab program). Spectrographs of calls presented in this paper were produced from calls digitized with a 22254 Hz sampling rate and processed using a 256 point FFT, 128-point frame size, 87.5% overlap, and Hanning window (frequency resolution 86 Hz, time resolution 0.72 msec, analysis bandwidth 700 Hz).

Mr. Amir Balaban, Mr. Adi Ganz, Mr. Gidon Perlman, and Mr. Rami Mizrachi, all experienced birdwatchers, identified the calls by aural comparison.

Results

For only 25 of in 40 nights (62.5%) I detected 742 calls during the 1997 fall migration. By using the Canary Software Program I identified 66 different spectrographs. Aurally I identified 7 species. During the 1998 spring migration I detected 1463 calls on 36 out of 62 nights (54.4%). Using Canary, I identified 90 different spectrographs and aurally I identified 14 species (Table 1). In total I detected 2,025 calls averaging almost 21 calls per night.

Of the 15 identified birds five species were transients and wintering birds, four species were resident, two species were transients and summering birds two transients one species was transient, wintering, and resident and one species was wintering (Table 2).

Table 1: *Summary of the number of spectrographs and identified calls recorded during 1997 fall migration and 1998 spring migration.*

Month/Year	8/1997	9/1997	10/1997	11/1997	3/1998	4/1998	5/1998
Total no. recording nights	19	6	10	5	10	30	17
Total no. detection nights	5	5	10	5	7	19	5
Total Calls	151	199	156	236	375	955	133
No. of spectrographs	9	7	28	23	36	51	7
No. of species identified aurally	2	3	5	5	3	7	3
No. of spectrographs and species identified aurally	11	10	33	28	39	58	10

Table 2: *Average frequencies and duration of the identified species (+ S.D.)*

Name of species	Avr. upper range of the calls (kHz+S.D.)	Avr. lower range of the calls (kHz+S.D.)	Duration (mS+S.D.)	No.
Galerida cristata	4.18 + 0.31	6.80 + 0.13	158.65 +42.78	4
Burhinus oedicnemus	3.09 + 0.16	5.71 + 0.12	96.75 + 8.73	270
Carduelis chloris	2.83 + 0.36	4.62 + 0.27	106.21 + 60.27	13
Vanellus spinosus	3.02 + 0.18	6.27 + 0.76	88.75 + 2.50	262
Merops apiaster	1.79 + 0.24	2.51 + 0.22	96.13 + 20.90	78
Apus apus	3.8	6.37	313	
Coccothraustes coccothraustes	2.94 + 0.02	6.48 + 0.29	7.79	2
Tringa ochropus	3.37 + 0.06	4.89 + 0.50	16.17 + 5.58	6
Motacilla alba	3.81 + 0.48	6.49 + 0.62	42.27 + 8.17	64
Phylloscopus collybita	3.01 + 0.52	4.84 + 0.19	54.30	2
Anthus pratensis	4.50 + 0.43	6.74 + 0.41	126.76 + 29.83	35
Emberiza hortulana	3.44 + 0.23	4.69 + 0.32	44.86 + 9.71	16
Motacilla flava	3.64	5.23	152.2	
Nycticorax nycticorax	1.78 + 0.24	2.41 + 0.29	91.04 + 0.29	26
Fringilla coelebs	2.70 + 0.51	4.68 + 0.22	74.73 + 18.26	64

Table 3: *Frequency changes of species no. 56 in relation to altitude and temperature during April 1998 in central Israel.*

Date	Recording hour	Altitude (above ground level)	Temperature (C0)	Frequency (kHz)
1/4/1998	01:33	760	10	3.36 - 4.43
7/4/1998	01:23	570	17	3.35 - 4.64
9/4/1998	23:56	570	12	3.40 - 4.52
10/4/1998	01:28	760	20	3.25 - 4.60
16/4/1998	01:32	570	32	3.69 - 4.67
17/4/1998	00:48	760	15	4.20 - 4.97
26/4/1998	01:15	570	25	3.79 - 4.92
30/4/1998	01:23	570	13	3.62 - 4.86

In an attempt to check the relationship between frequencies, altitude, and temperature, I selected species no. 56 whose calls were detected over 300 occurances during April 1998 in central Israel (Table 3).

There was no relationship between call frequencies of this species and any of the above parameters.

The numbers of calls recorded after sunset during fall migration 1997 and spring migration 1998 are shown in Figure 1.

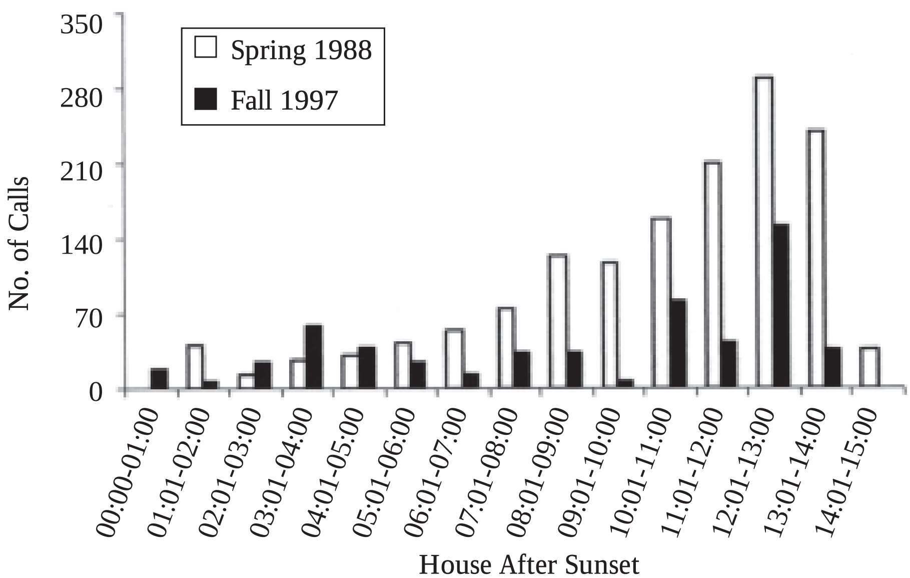

Fig. 1 *The numbers of calls after sunset that were detected during fall migration 1997 and spring migration 1998.*

The difference between the number of calls that were recorded was significant between the seasons (Wilcoxon Matched Pairs Test, p = 0.0097, z = 2.588). In both seasons I recorded most of the calls 12 to 13 hours after sunset. However, during the 1998 spring migration 12 to 13 hours after sunset means between 1 to 2 hours after sunrise (there is an average of 11:08 hours between sunset and sunrise), while during the 1997 fall migration 12 to 13 hours after sunset means up to one hour after sunrise (then is an average of 12:05 hours between sunset and sunrise).

Discussion

In general, research results showed two differences between this project and similar studies conducted in North America. First, the number of calls recorded during spring and autumn migration in central Israel each night was lower then the number of calls recorded in North America (Evans, 1994, Evans and Mellinger, 1995). Second, the frequencies of the various bird calls during migration over Israel were much lower than among the birds of North America ((Evans, 1994, Evans and Mellinger, 1995).

I cannot link the difference of the number of calls recorded during spring and autumn migration in central Israel to those of North America or the difference of frequencies of the various bird calls during migration over Israel and over North America to geometrical factors that depend on the range and volume of the microphone beam in which the birds can be heard (Black, 1997c) because I used the same microphone that Evans used in his research (Evans, 1994, Evans and Mellinger, 1995).

The vast number of unidentified calls might be explained as follows: part of the species have a night migration call so different from the day call that it is often difficult to identify the calls (Hamilton, 1962). In addition, and to emphasize the difficulty of identifying the night flight calls, I failed to compare spectrographs of the same species that were recorded in Europe to the same species that were recorded in Israel.

For example, I found that spectrographs of Tringa nebularia that were recorded in Europe were below 3 kHz for duration of 100 msec and spectrographs of the same species that were recorded in Israel were above 3 kHz for duration of 50 msec (Gal et al., 1998).

The difference between number of calls recorded each night between central Israel and north America might be explained as follows: Only 38 % of the nocturnal spring migration in central Israel was concentrated below 800 meters above sea level (results from the Latrun radar (Gal, 1999), the range at which the PZM microphone can not detect calls. In contrast to the Latrun radar result, most of the passerines in North America fly below 500 meters above sea level (Evans, 1994, Evans and Mellinger, 1995), the range at which the PZM microphone can detect calls.

Based on results from the Latrun radar (Gal, 1999) and from fig. 1, I can support the finding that flight level during the 1998 spring migration over central Israel during most night's hours was higher than 1,000 meters above sea level (the efficient range of the

PZM microphone). Moreover, after sunrise the birds started to land (meaning a lower flight level) to look for good habitat to rest with the result that I was able to detect more calls.

The differences between the frequencies from North America (Evans, 1994, Evans and Mellinger, 1995) and central Israel might be explained as follows: 1) the actual absorption of acoustic energy in the air increases in magnitude as the square of the frequency. The strong dependence of atmospheric absorption on frequency causes the atmosphere to act as a low-pass filter, the steepness of filter characteristics increases with the distance of transmission (Griffin and Hopkins, 1974; Kroodsma, et al,. 1982). Hence, the combination of high flight level of migrating birds during spring migration in central Israel (Gal, 1999) and atmospheric traits allows the detection of more low frequencies and less high frequencies calls. 2) DNA - DNA hybridization indicates that all the identified species from North America (Evans and Rosenberg, 1997) and from this research are close enough to form single family, comprising two subfamilies: Fringillinae and Emberizinae (Sibley and Monroe, 1990). Hence, all the species from North America that are mentioned in Evans and Rosenberg (1997) belong to Emberizinae. The identified species from central Israel belong to Fringillidae (Fringilla coelebs, Coccothraustes coccothraustes and Emberiza hortulana), Sylvidae (Phyllocopus collybita), and Passeridae (Motacilla alba, Motacilla flava and Antus pratensis).

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