NEW COMPREHENSIVE SYSTEMATIC DATA CONCERNING THE TIME OF NOCTURNAL DEPARTURE IN SOME PASSERINE MIGRANTS IN AUTUMN

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ABSTRACT

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Time of nocturnal departures of some passerine migrants (Robin – *Erithacus rubecula*, Song Thrush – *Turdus philomelos*, Blackbird – *T. merula*, Redwing – *T. iliacus*, Goldcrest – *Regulus regulus*, and a pooled group of long-distance migrants, mainly warblers, flycatchers and redstarts) from a stopover site on the Courish Spit of the Baltic Sea was studied by searchlight method throughout the whole night from sunset to sunrise. Timing of take-off activity are subject to broad-scale variation between different species, during the season and from night to night. Overall departure period comprises at least 7 hours in long-distance migrants, 9 h in Robin, Song Thrush and Goldcrest, and as much as 11 h in Blackbird and Redwing. Median departure time in different species varies from 152 to 386 min after sunset.

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Key words: nocturnal departure, take-off activity, passerine nocturnal migrants, searchlight method, autumn migration

INTRODUCTION

Diel timing of two most important behaviours of migrating birds – flight and stopover – is a very fascinating and promising field of research. Current views concerning the diel timing of flight and stopover in different avian taxa are however based on hypothetical models, with few exceptions (Kerlinger and Moore 1989, Alerstam 1990, Berthold 1993). In numerous passerine nocturnal migrants the current generalised model suggests the following temporal pattern of flight: (1) simultaneous take-off during the evening twilight; (2) flight during several hours; (3) ceasing flight after midnight; (4) no inter- or intra-specific variation in the temporal pattern of flight. All deviations from this pattern are usually explained by landscape peculiarities of sections of migratory routes, for example crossing seas, arid and moun-

tainous regions. The analysis of available published data shows a need for more factual information, especially on the specific level (Åkesson *et al.* 1996, Bolshakov and Bulyuk 1999). The exception is formed by few telemetric studies concerning a limited number of species and individuals (Cochran *et al.* 1967, Cochran 1987, Åkesson *et al.* 1996, Moore and Aborn 1996).

In this contribution, we present the results of our long-term studies of one of temporal parameters of migratory flight – take-off activity. Up to now the available information about the timing of nocturnal departures was obtained mainly by radar and visual observations (Drury and Nisbet 1964; Casement 1966; Parslow 1968; Gauthreaux 1971; Hebrard 1971; Lindgren and Nilsson 1975; Bolshakov and Rezvyi 1975, 1982, 1998; Alerstam 1976; Richardson 1978). They are largely restricted to dusk and beginning of the night. The dark period itself is insufficiently studied. Due to methodical difficulties, very few information is available about the take-off activity on the specific level (Bolshakov and Bulyuk 1999).

METHOD AND MATERIAL

For studying take-off activity in the darkness we applied a method similar to that suggested by Hebrard (1971). Taking-off birds were observed when they were crossing an area over the tops of trees illuminated by two searchlights (Bolshakov 1992, Bolshakov and Bulyuk 1999).

Regular observations were conducted during each hour of the whole night from sunset until sunrise during five years (1990-1995). They covered entire period of autumn migration of passerines on the Courish Spit between 1 August and 1 November.

In large illuminated space, take-off with subsequent climbing could easily be distinguished from other flight behaviours, including horizontal flight, reducing altitude, and landing (Bolshakov and Bulyuk 1999). Birds were identified by shape, flight, and colour. Frequently birds of some species were identified by their characteristic calls. In this report, we analysed only behaviour of birds positively identified, including Robin (*Erithacus rubecula*), Song Thrush (*Turdus philomelos*), Blackbird (*T. merula*), Redwing (*T. iliacus*), Goldcrest (*Regulus regulus*) and a pooled group of long-distance migrants, mainly *Sylvia*, *Acrocephalus* and *Phylloscopus* warblers, flycatchers and redstarts.

Up to now, there is no evidence of any impact of the light on birds' behaviour under clear and cloudy skies and normal air humidity. During a special study of take-off activity with night vision binoculars we failed to detect any difference in birds' behaviour in the absence of illuminated area. Similarly, up to date, no evidence is available that a bright light area which is formed during humid conditions, fog and rain, influences take-off activity in nocturnal migrants (Bolshakov and Bulyuk 1999).

In this paper, we analyse three temporal parameters of take-off activity in passerine nocturnal migrants in autumn: (1) the time of first departures, (2) the overall

duration of take-off activity, (3) the temporal distribution of take-off activity from sunset to sunrise.

RESULTS

Time of first departures reflects the onset of nocturnal migration and corresponds to first echoes at radar screen or first silhouettes against the face of the Moon or across the vertical ceilometer beam. It is generally assumed that in different passerine nocturnal migrants the timing of first departures is restricted to 30-45 min after sunset (Drury and Nisbet 1964; Casement 1966; Parslow 1968; Gauthreaux 1971; Lindgren and Nilsson 1975; Alerstam 1976, 1990; Richardson 1978; Bolshakov 1981; Kerlinger and Moore 1989).

In all species studied we found variation in the time of first departures of 4 to 8 hours. Only in long-distance migrants and in the Song Thrush in 50% of cases migration began during a restricted twilight period, 32 to 51 min after sunset. In four short- and middle-distance migrants in one-half of cases mass migration did not start until third hour after sunset (Table 1).

Table 1
Commencement of nocturnal migration (first take-offs)
in some passerine migrants in autumn

	Level of take--off activity, birds/night	Number of nights	Earliest take--off, min after sunset	Variation, hours after sunset	Median, min after sunset
Long-distance migrants	10-44	46	35	1-4	51
T. philomelos	10-88	33	32	1-5	47
T. merula	5-24	8	26	1-7	136
T. iliacus	5-18	11	26	1-8	131
E. rubecula	10-39	41	56	1-6	132
R. regulus	5-11	22	32	1-7	155

The analysis of data for long-distance migrants reveals that no significant seasonal change occurred in the time of onset of migration when take-off activity is high ($\lambda = 0.27, p > 0.05$). Medians in the first and the second half of the season were 45 and 50 min after sunset, respectively. When motivation to depart was low, birds took off significantly later, in one-half of cases more than 90 min after sunset ($\lambda = 1.42, p < 0.05$).

No seasonal change in the time of mass migration's onset was recorded in the Song Thrush either ($\lambda = 0.74, p > 0.05$). In one-half of cases migration started during a short twilight period, 32 to 52 min after sunset. At nights with low take-off activity, Song Thrushes started to depart significantly later than when activity was high, in one-half of cases more than 104 min after sunset ($\lambda = 1.38, p < 0.05$). First Robins also departed significantly later at nights with low take-off activity. However, the difference in the time of migration's onset was significant in the first half of the season only ($\lambda = 1.42, p < 0.05$).

At present, it is widely assumed that birds ready for migratory flight depart nearly simultaneously during a limited period of dusk. Moreover, this behaviour is believed to be typical for various species of passerine nocturnal migrants (Kerlinger and Moore 1989, Alerstam 1990). Results of our studies during the whole period between sunset and sunrise are shown in Table 2. They allow to draw the following conclusions:

1. Overall departure period in autumn comprises at least 7 hours in long-distance migrants, 9 h in Robin, Song Thrush, and Goldcrest, and as much as 11 h in Blackbird and Redwing.
2. During the so-called „main departure period" in the first and second hour after sunset only 20 to 40% of birds depart. This value is the highest in long-distance migrants. In Robin and Goldcrest percentage of individuals departing during this period is negligible, less than 10 %.
3. Median departure time in different species varies from 152 to 386 min after sunset. One-half of short- and middle-distance migrants take off 4 or even 5 h after sunset.

Table 2
Temporal patterns of nocturnal departures (take-off activity) in some passerine migrants in autumn

	Season of mass migration	Duration of night, hours	Number of identified birds	Duration of take-off activity, hours after sunset	Median, min after sunset	Percent of birds in first two hours after sunset
Long-distance migrants	12 Aug.-1 Oct.	8.7-12.4	752	1-8	152	40.7
T. philomelos	10 Sept.-12 Oct.	10.9-13.3	745	1-10	172	30.2
T. merula	12-23 Oct.	13.3-14.1	63	1-12	386	24.7
T. iliacus	4-21 Oct.	12.7-14.0	102	1-12	250	20.5
E. rubecula	4 Sept.-23 Oct.	10.5-14.1	741	1-10	283	4.6
R. regulus	13 Sept.-23 Oct.	11.1-14.1	62	1-10	306	8.1

Timing of take-off activity in some species are subject to variation along the season. As shown in Table 3, the seasonal difference in the temporal distribution of departures was significant at least in long-distance migrants and the Song Thrush. In the second half of the season during longer nights birds departed on average later in respect to sunset than in the first half of the season.

Timing of take-off activity is subject to broad-scale variation from night to night, at least in some passerines. Data presented in Table 4 suggest that departure period varies from 2-3 to 8-9 hours from night to night. Median time of take-off was not constant. It varied broadly from night to night, variation being at least 3 h in long-distance migrants, 5 h in the Song Thrush, and as much as 8 h in the Robin. In 60% of nights with mass departures, median time of take-offs of long-distance migrants and Song Thrushes was in the second or third hour after sunset. In the Robin in 40% of nights median departure time was in the fifth hour after sunset.

Table 3
Seasonal changes in temporal pattern of nocturnal departures (take-off activity) in some passerine migrants in autumn

	Season	Duration of night (hours)	Number of identified birds	Duration of take-off activity (hours after sunset)	Median, min after sunset	Significance
Long-distance migrants	12 Aug.-5 Sept.	8.7-10.4	281	1-8	123	$\lambda = 2.17$, $p < 0.001$
	6 Sept.-1 Oct.	10.4-12.5	216	1-8	169	
E. rubecula	4-28 Sept.	10.4-12.3	383	1-10	287	$\lambda = 0.79$, $p > 0.05$
	29 Sept.-23 Oct.	12.3-14.0	240	2-10	273	
T. philomelos	10-25 Sept.	10.9-12.1	272	1-10	142	$\lambda = 3.32$, $p < 0.001$
	26 Sept.-12 Oct.	12.1-13.3	385	1-10	201	

Table 4
Variation in timing of take-off activity from night to night

	Level of take--off activity (birds/night)	Season	Number of nights	Duration of take-off activity (hours)	Median, min after sunset
Long-distance migrants	21-44	18 Aug.-21 Sept.	12	2-8	88-237
T. philomelos	21-88	10 Sept.-8 Oct.	12	3-9	76-385
E. rubecula	21-39	4 Sept.-11 Oct.	12	5-8	207-432

DISCUSSION

Our results do not support the view that in many passerines the time of nocturnal departure is restricted to a certain twilight period after sunset (Kerlinger and Moore 1989, Alerstam 1990). On the other hand, our data are consistent with the results of few radio-tracking studies on several species of European and North American passerine nocturnal migrants (Cochran *et al.* 1967, Cochran 1987, Åkesson *et al.* 1996, Moore and Aborn 1996). As applied to autumn migration, our results can by summed up as the following conclusions.

Firstly, temporal pattern of the onset of flight in passerines is consistent with the current view only for the earliest departures. In studied species, earliest take-offs occur 26 to 35 min after sunset. However, our published data, as well as radio-tracking and radar studies show considerable variation in the time of earliest departures between autumn and spring at the same site at least in European thrushes and the Robin (Bolshakov 1992, Åkesson *et al.* 1996, Bolshakov and Rezvyi 1998, Bolshakov and Bulyuk 1999).

Secondly, the time of onset of nocturnal migration is not restricted to a certain twilight period. In different passerines, migration may begin in the interval from 4

to 8 h after sunset. Even in long-distance migrants and the Song Thrush, which in one-half of cases start migration within a limited period of dusk from 32-35 to 47-51 min after sunset, the time of migration onset is not fixed.

Thirdly, in a number of short- and middle-distance migrants there is an obvious trend to start migration on average later in respect to sunset than in long-distance migrants. Thus, there is a considerable inter-specific difference in the timing of onset of nocturnal migration in autumn.

Fourthly, our data do not support the view of the „main departure period", confined to a restricted part of evening twilight and similar in different species. The overall period of take-off activity reaches 7 to 11 h in all studied species.

Fifthly, the temporal pattern of departures shows very high intra-specific scatter. Nearly all parameters of take-off activity show variation, frequently significant, along the season, from night to night, between adjacent dates. In the bulk of studied species there is a trend to start flight during the pauses of mass migration later in respect to sunset than when migratory activity is high.

Sixthly, in both short- and long-distance migrants, a half of birds stays on the ground during first four or even six hours after sunset. A small fraction of short and middle-distance migrants begin flight in autumn only 2-3 h before sunrise, some birds even later. In some species that migrate under varying length of night, there is a trend to start migration on average later in respect to sunset when nights are longer.

Large scatter in temporal patterns of departures does not support the idea of trigger function of environmental factors in the control of take-off behaviour in passerine nocturnal migrants (Kerlinger and Moore 1989, Alerstam 1990, Berthold 1993). We suggest that it most probably reflects interactions between individual endogenous circadian rhythms of activity and light-dark ratio, changing along the season (Bolshakov and Rezvyi 1998, Bolshakov and Bulyuk 1999).

These peculiarities of temporal pattern of take-off activity appear to be advantageous for passerine nocturnal migrants. Firstly, birds have a chance to use the first half of the night for utilising food. It is especially important after intensive evening foraging and short day in the autumn. Secondly, birds may respond to changes in the weather and begin flight immediately when favourable synoptic situations arise. If the dial pattern were rigid, this would have been hardly possible. Thirdly, it is optimal to use the whole amount of celestial cues available not only during sunset and twilight, but also during the first half of the night. It could be especially important under considerable cloud cover limiting access to celestial cues.

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