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Differential spring migration of Ortolan Bunting *Emberiza hortulana* by sex and age at Eilat, Israel

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The Ortolan Bunting in Europe is considered vulnerable and large declines have been reported. However, there is little information pertaining to the wintering grounds and the migratory part of the annual life cycle of the Ortolan Bunting across most of its range. We analysed data collected during 1984–2000 at the only long-term ringing station in the Middle East — at Eilat, Israel. Difference in passage dates between sexes was significant, but small in comparison to differences reported on the breeding areas. However, we found no differences in arrival dates between age classes. We found significant differences in wing chord length between the four sex and age classes (adult males, 1st year males, adult females and 1st year females). Also significant differences in body mass were found between the four age and sex classes. Young females were lighter than other birds. Wing length and body mass did not affect arrival date of birds. We suggest that the discrepancy of arrival dates between the sexes at Eilat and at the breeding grounds can be explained because males are time-minimizer migrants that attempt to reach the breeding grounds in the shortest time possible. On the other hand, females appear to be energy maximizers and try to reach the breeding grounds in good physical condition. It is possible that the males make fewer stops while on migration between Israel and the breeding grounds in Eurasia.

1. Introduction

The breeding range of the Ortolan Bunting *Emberiza hortulana* stretches from West Europe to western Mongolia. To date, the wintering areas of the Ortolan Bunting remain poorly known (Stolt 1977, Zink 1985). In the breeding range, the species is declining and gives cause for concern (review in Tucker & Heath 1994, Stolt 1997a). Agricultural practices, habitat destruction and hunting are the major reasons suggested for the population declines (cf. Tucker & Heath 1994, Kuźniak *et al.* 1997, Stolt 1997a). However, we cannot discount the wide range of problems that the species face while on migration or on their wintering grounds (Kuźniak *et al.* 1997, Stolt 1997b).

The problem is complicated by the fact that there is little information pertaining to the species' over-wintering biology or migration (cf. Olsson *et al.* 1995, Stolt 1997a). Information published to date pertaining to the migration of the species is unclear (e.g., Stolt 1977, Ojanen *et al.* 1994, 1997, Väisänen 1994, Gawroński 2001) or relates only to the northwestern flyways of the western Palearctic (Ojanen *et al.* 1994, 1997, Stolt 1997b). Hence, we analysed the data collected at the only long-term ringing station in the Middle East — at Eilat, Israel (Yosef 2001). Here we present data to further our understanding of the migratory habits and patterns of the Ortolan Bunting on the eastern, circum-Mediterranean flyway of the western Palearctic. We focused on sex- and age-related differences in migration pattern and biometric characteristics. We hypothesized that if males occupy territories on breeding grounds before the females, this would exert ecological pressure on males to migrate earlier from the wintering grounds. We further reasoned that birds in better physical or physiological condition would migrate earlier than conspecifics in reduced body condition.

2. Material and methods

2.1. Study area and period of study

Israel in general, and Eilat in particular, is an important site for migrating passerines because it is located on the northern edge of the Saharan-Arabian desert belt. It is critical for many migrant species because it is reached after a flight of almost 2000 km of continuous desert regions of the Sahel, Sahara and Sinai deserts (Safriel 1968). To the North and North-East there are still 650 km more of the Syrian Desert, and due East the vast Arabian desert. Hence many birds, even broad-front migrants, are enticed to land in the green areas that surround Eilat and to rest before (in autumn) or after (in spring) crossing the deserts (Morgan & Shirihai 1997).

Table 1. Numbers of Ortolan Bunting ringed during spring passage over Eilat, Israel

Year	Male	Female	Unsexed	Total
1984	448	432	49	929
1985	231	82	44	357
1986	7	0	0	7
1988	4	3	0	7
1989	6	0	0	6
1990	35	49	41	125
1991	3	0	0	3
1992	4	5	1	10
1993	1	6	0	7
1996	15	35	1	51
1998	14	18	1	33
1999	1	0	0	1
2000	12	10	6	28
Total	781	640	144	1565

Ringing by the International Birding & Research in Eilat (IBRCE) was initiated in 1984. However, owing to changes in agricultural practices and political pressures, the ringing location has changed in the area three times to date (Morgan & Shirihai 1997). Between the springs of the years 1984–1990 (except 1987) ringing was conducted in agricultural fields 3 km north of Eilat. Up to 1987 the major crop comprised mostly of alfalfa (*Medicago sativa*) and from 1987–1989 was changed to melons and other cash crops. Between autumn 1990 to autumn 1995 the ringing station was relocated 1.5 km east of Eilat to a natural area of mixed saltmarsh vegetation, dominated by sea-blite (*Suaeda monoica*). In early 1996 the research area was ploughed for agricultural purposes. Hence, since spring 1996 the ringing program has been relocated 2 km north of Eilat in the boundaries of the "Bird Sanctuary" that is owned by the IBRCE. We think that the changes in locations of the ringing station has resulted in a great variance of trapping between years and between seasons, but for at lest three years we obtained representative data that allow analyses of the spring migration characteristics of the Ortolan Bunting over Eilat.

2.2. Catching and biometrics

Birds were mist-netted during the day only (average 4.6 ± 1.2SD h, 500m of mist-nets). Birds were ringed, sexed and aged. We classified the birds into four age or sex classes based on plumage characteristics — adult male, first-year male, adult female, first-year female (e.g. Olsson *et al.* 1995). Flattened maximum wing cord was measured to the nearest millimetre, and body mass was determined with a Pesola 50-g spring balance to the nearest 0.5 g (details according to Svensson 1992).

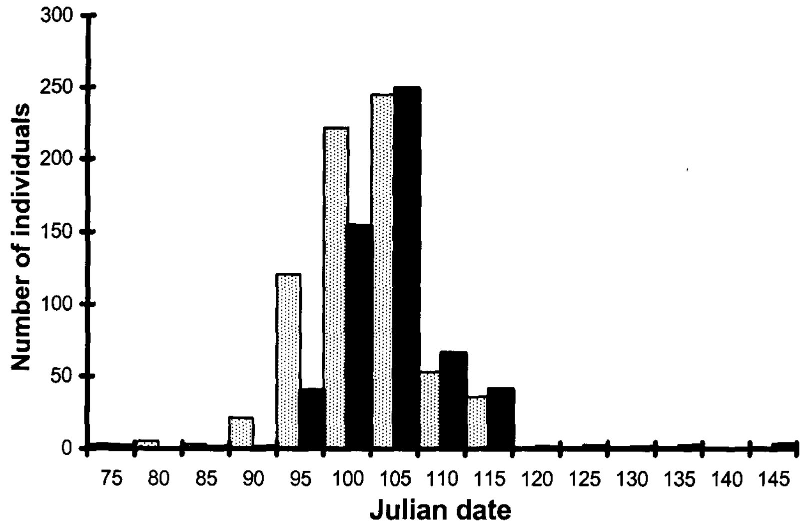

Fig. 1. Spring migration phenology of male (shadow bars, N = 714) and female (black bars, N = 563) Ortolan Bunting at Eilat. Only data from representative years were used in analyses.

2.3. Statistical procedure

Arrival time is presented in Julian dates. We standardized arrival time across years by subtracting the median Julian date of arrival time of a year from each arrival date in that year.

In general we analyzed the whole data set to understand the migratory strategies of the Ortolan Bunting. However, for a better understanding of some of the biological phenomena we analysed only data obtained in the springs of 1984, 1985 and 1990 (hereafter we use the term "representative years" for these years), because only during these springs was a large enough sample size caught and ringed (Table 1). However, data on wing cord length and body mass were not available for all individuals and this has resulted in a large variation in sample sizes. Moreover, individuals not ascribed to one of these classes were not included in the biometric analyses.

Standard statistical methods were used to describe and analyse the data (Sokal & Rohlf 1995). Calculations were conducted using the SPPS package (Norusis 1986). All statistical tests were two-tailed.

3. Results

3.1. Trapping success and sex-ratio

A total of 1565 Ortolan Bunting was trapped in 13 spring migration seasons. Great variance in trapping success was found between years for sexes (Table 1). No individuals of the study species were trapped in 1987, 1994, 1995 and 1997.

There was no difference in male and female numbers between years (pooled data, sign test, $P = 0.58$, representative years, sign test, $P = 1.0$).

3.2. Phenology

According to the pooled data, the arrival dates of males and females significantly differed (11 April vs 15 April, Mann-Whitney U-test, $U = 182906.5$, $P < 0.00001$). Also, during three representative years 1984, 1985 and 1990, males arrived significantly earlier than females (12 April vs 15 April; Mann-Whitney U-test, $U = 152791.0$, $P < 0.00001$; Fig. 1). However, differences within the representative years were only up to 1 day (Table 2) and only "year" was the most important factor that affected arrival time of males (median test, $\chi_2^2 = 310.15$, $P < 0.0001$) and females (median test, $\chi_2^2 = 98.49$, $P < 0.0001$). We found no differences between the four age classes (comparisons between pooled years and representative years, median test, $P > 0.2$ in all comparisons).

3.3. Differences in wing length and body mass in relation to sex and age

During representative years, significant differences in wing cord length were found between the four sex and age classes (Table 3, ANOVA, $F_{3, 207} = 28.97$, $P < 0.0001$). However, post-hoc Student-Newman-Keuls test showed that only differences between sexes were significant at $P < 0.05$. Significant differences in body mass were also found between the four age and sex classes (Table 3, ANOVA, $F_{3, 205} = 8.41$, $P < 0.0001$). In contrast to wing cord, only young females had lighter body mass than the other age and sex classes (post-hoc Student-Newman-Keuls test, $P < 0.05$).

3.4. Wing length and body mass in relation to date of passage

Both in pooled and representative years, for both sexes, when arrival time was standardised to the median value of that season, wing lengths did not change with the date of arrival (Fig. 2).

For both sexes, body mass did not change with the date of arrival, both pooled years data set and representative years data set (Fig. 3). However, this relation was statistically significant for birds caught in 1985 (males $r = -0.16$, $P = 0.034$, $n = 185$; females $r = -0.31$, $P = 0.016$, $n = 60$). In representative years data set a significant correlation was noted for both sexes between wing length and body mass (males $y = 0.145\ (0.029)\ x + 0.227$, $t = 5.031$, $P < 0.0001$; females $y = 0.166\ (0.032) + 0.272$, $t = 5.208$, $P < 0.0001$, respectively). However, when the effect of wing length (which represents body size) was controlled in partial correlation, the results were not statistically significant (males $P > 0.2$ and females $P > 0.9$).

4. Discussion

The Ortolan Bunting is obviously a species that conducts a loop migration (Stolt 1977) i.e., that they migrate south in autumn via an as yet unknown flyway (cf. Zink 1985). Ringing recoveries from North and Western Europe (Stolt 1977, Zink 1985) suggest a southwesterly migration. However, visual observations from France do not confirm this conclusion (Classens 1992). Zink (1985) suggested that the species returns to the breeding grounds in spring on a broader front than in autumn across the Sahara desert, and probably many birds via Eilat and the rest of Israel (Yosef 2001, Gannes 2002). This is also deduced by the circumstantial evidence that only a small proportion (n = 41, ca. 2% of birds from spring route) of the Ortolan Bunting are ringed at Eilat in autumn.

Difference in passage dates between sexes was significant, but small (on average ca. 1 day) in comparison to differences reported on the breeding areas (8–14 days in Spaepen 1952 and ca. 7 days in Stolt & Fransson 1995). This suggests that although both sexes might start the spring migration together, that the males and females differ in the overall duration of the migration. This may have resulted from different evolutionary pressures on the sexes. Male Ortolan Bunting need to arrive early in order to set up individual territories. The first individuals are known to occupy territories of better quality, and hence are probably heavier in body mass. Individuals with longer wings are known to arrive earlier in Northern Europe (Stolt & Fransson 1995). Møller (1994), for the Barn Swallow *Hirundo rustica,* and Kokko (1999) used theoretical speculations to argue that

Table 2. Spring passage (median, first and last date ringed) of Ortolan Buntings in Eilat, Israel. All years is the average of all seasons 1984–2000.

	Median		Range	
Year	Male	Female	Male	Female
1984	14 April	15 April	18 March–24 May	18 March–24 May
1985	7 April	8 April	28 March–11 April	3 April–11 April
1996	17 April	17 April	2 April–13 May	2 April–13 May
All years	12 April	15 April	18 March–24 May	18 March–24 May

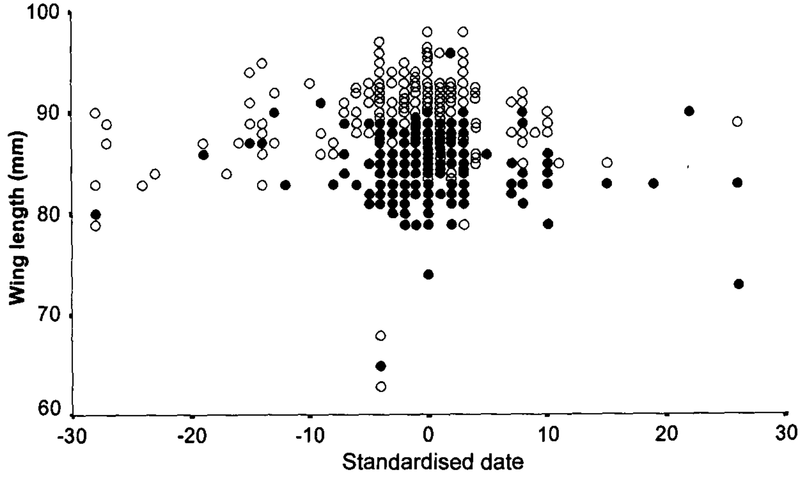

Fig. 2. Wing length of Ortolan Buntings in relation to date of passage, expressed as standardised value of year, with 0 in median value. Open circle = males (r = 0.083, NS, n = 500) and closed circle = females (r = –0.015, NS, n = 356). Only data from representative years were used in analyses.

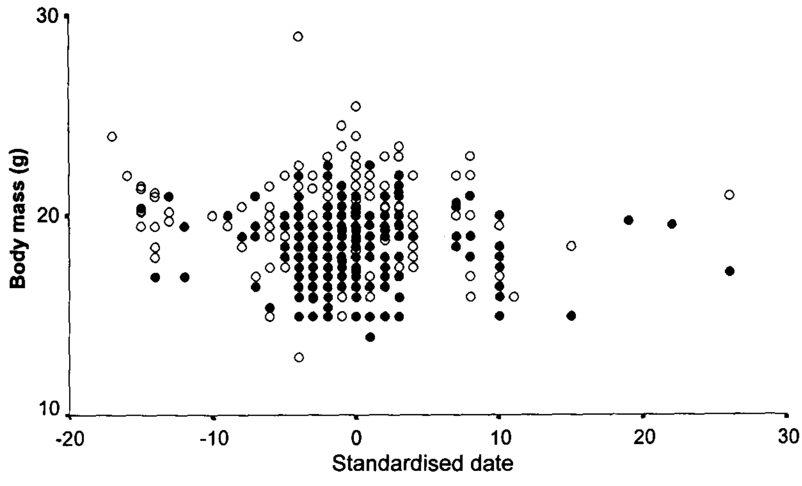

Fig. 3. Body mass of Ortolan Buntings in relation to date of passage, expressed as standardised value of year, with 0 in median value. Open circle = males (r = –0.048, NS, n = 478) and closed circle = females (r = –0.007, NS, n = 350). Only data from representative years were used in analyses.

the first males to arrive not only occupied the best territories but were also preferred by females as breeding mates. Therefore, at least for males, spring migration should be completed as rapidly as possible. However, staging was obvious in birds retrapped in subsequent days (range 1–11), which increased body mass the longer they staged at Eilat (Yosef 2001). Unfortunately, owing to a small sample size, we found no differences in staging time between the sexes.

In contrast, females can migrate more slowly and arrive later on the breeding grounds. More importantly, they have the possibility to increase their body condition by spending more time foraging while on migration. However, the speed of migration of an individual or a flock depends not

Table 3. Wing length (mm) and body mass (g) of Ortolan Bunting on spring migration in Eilat, Israel. All values presented as mean ± SD, sample size in parentheses.

	Wing	Body mass
Male adult	89.12±3.65 (39)	19.88±2.32 (39)
Male 1st yr	89.03±2.91 (92)	19.32±1.96 (91)
Females adult	85.19±3.56 (29)	20.05±2.25 (29)
Females 1st yr	84.97±2.31 (51)	18.05±1.86 (50)

only on the time spent in flight between the breeding and wintering grounds, but also by the amount of time spent at the stopover sites (Gannes 2002), and rate of fuel deposition and power consumption during flight that is linked to gender-related morphological differences (Hedenström & Alerstam 1998). However, owing to lack of data pertaining to the previously mentioned parameters we can only speculate as to the reasons behind the discrepancies. Sandberg and Moore (1996) considered fat stores to be an especially important consideration for females when they arrive at the breeding areas. Hence, we suggest that the discrepancy of arrival dates between the sexes at Eilat and at the breeding grounds can be explained by opposite, strong evolutionary pressures that are exerted on the sexes. Therefore, it is possible that the males make fewer stops while on migration between Israel and the breeding grounds in Eurasia. However, owing to a lack of ringing stations on this migratory flyway we have no data with which we can either confirm or refute our conclusions.

We found no difference in the average wing length of the birds measured at the ringing station in Eilat and those on the breeding areas (Eilat 87.4 vs 85–90; Isenmann 1992, Stolt & Fransson 1995, Glutz von Blotzheim & Bauer 1997). However, buntings from Eilat were ca. 4–5g lighter, i.e., about 20% of body mass, than breeding birds (Eilat 19 vs 24; Isenmann 1992, Stolt & Fransson 1995, Glutz von Blotzheim & Bauer 1997). This discrepancy is most probably the result of overcoming the hardship of crossing the inhospitable expanses of the Sahel, Sahara and Sinai deserts. It corroborates the findings of Alerstam and Lindstrom (1990), who stated that in passerines on migration, 15–20% of the body mass is comprised of fat but that it varies between species, time, and location.

If indeed males are faster migrants, and it is phenotipically (as suggested by Møller 1994) dependent, individuals with larger body size should start migration, and subsequently arrive on breeding areas, earlier. However, these relationships are not significant for the Ortolan Buntings caught in Eilat. It can be reasoned that differences between ringers between years could give rise to such a discrepancy. However, we consider biological differences to be the major contributing factor when we compare our data to North European studies that were conducted during the same years. Stolt and Fransson (1995) show that male Ortolan Buntings with longer wings arrived earlier than birds with shorter wings. However, in Eilat, the range of variation in male wing length was 19 mm. This is 7 mm greater than in Sweden and suggests that several geographically different populations migrate through this bottleneck region and are trapped and ringed simultaneously at Eilat. However, the difficulties in separating between the various subspecies and races make it impossible to statistically separate between wing length and date of passage. It is of interest that we found no differences in the phenology of migration between the different age groups and which is supported by the lack of correlation (with only one exception) between wing chord and the time of migration (see above). This similarity between the sexes suggests that birds may initiate migration together, i.e., independent of sex and age, and the differences develop during the passage. This subject requires a more in-depth study in the future.

In conclusion, although we have elucidated certain patterns in the migratory habits of the Ortolan Bunting at Eilat, our study stresses our almost complete lack of knowledge of the migratory routes and strategies of the study species. Future studies must stress in greater detail the Ortolan Bunting in order to be able to help in the conservation of this declining, and persecuted, species.

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Selostus: **Sukupuolen ja iän vaikutus peltosirkun kevätmuuton etenemiseen Israelissa**

Peltosirkkukannat ovat vähentyneet monin paikoin Euroopassa ja laji kuluu nykyään uhanalaisten lintulajien joukkoon. Vähenemisen syyt voivat liittyä ongelmiin lajin pesimäalueilla, talvehtimisalueilla tai muutonaikaisilla levähdysalueilla. Kirjoittajat analysoivat Eilatin lintuasemalla Israelissa vuosien 1984–2000 keväinä kerätyn peltosirkkuaineiston. Lintuja pyydystettiin päivisin noin viiden tunnin ajan ja käytössä olleiden lintuverkkojen yhteispituus oli noin 500 metriä. Kiinni saaduista linnuista määritettiin sukupuoli ja ikä sekä mitattiin siiven pituus ja linnun paino. Aineisto koostui 1565 keväällä rengastetusta peltosirkusta. Koiraita oli 781 yksilöä ja naaraita 640. Sukupuolta ei määritetty 144 yksilöstä. Koiraspeltosirkut saapuivat Eilatiin keskimäärin 11. huhtikuuta ja naaraat 15. huhtikuuta. Ero saapumisajankohtien välillä oli huomattavan pieni verrattuna pesimäalueilta raportoituihin tuloksiin. Lintujen ikä ei vaikuttanut saapumisajankohtaan. Koiraiden siivet olivat pitempiä kuin naaraiden siivet. Nuoret naaraat olivat kevyempiä kuin vanhat koiraat, nuoret koiraat tai vanhat naaraat. Lintujen siiven pituudella tai lintujen painolla ei ollut vaikutusta lintujen saapumisajankohtaan. Kirjoittajat esittävät, että sukupuolten välinen pieni ero muuttoajankohdissa Eilatissa voisi selittyä koiraiden ja naaraiden erilaisilla muuttostrategioilla. Koiraat pyrkivät minimoimaan muuttoon käyttämänsä ajan ja siis saapumaan pesimäalueilleen mahdollisimman nopeasti. Ensimmäisinä saapuvat koiraat valtaavat parhaat pesimäreviirit. Naaraat puolestaan yrittävät saapua pesimäalueille mahdollisimman hyvässä kunnossa. On mahdollista, että koiraat pysähtelevät muuttomatkallaan harvemmin kuin naaraat. Peltosirkun muuttoreiteistä ja muuttostrategioista tarvitaankin lisätutkimuksia.

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