Differences Between the Spring and Autumn Migration of the Red-Backed Shrike Lanius collurio: Record from the Eilat Stopover (Israel)

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INTRODUCTION

All Eurasian breeding bird populations that winter in sub-Saharan Africa have to cross the Saharan-Saudi Arabian Desert belt. Most passerines cross the desert on a broad front, however with higher densities in the eastern and western parts of the Sahara desert belt (Biebach 1995, Bruderer & Liechti 1995). A great proportion of these birds stop in Israel because it is the last favourable stopover area for migratory birds during autumn, before crossing the Sahara on their way to East Africa (Frumkin et al. 1995, Shirihai 1996). Eilat is the southernmost point in Israel and plays an important role as a stopover place for passerine species and is an important refuelling site for migrants (Safriel 1968, Frumkin et al. 1995, Morsan & Shirihai 1997).

Red-backed Shrike is the most numerous of the shrike species to migrate through the Middle East, as well as to breed in the Western Palearctic. To date, many papers have focused on the density and breeding ecology during the reproductive season (review in van Nieuwenhuyse et al. 1999, Harris & Franklin 2000), as well as in the wintering areas (e.g. Bruderer & Bruderer 1994, Herremans 1997). However, data on migration strategy, stopover sites and behaviour during migration are relatively scarce (review in Harris & Franklin 2000, but see Biebach et al. 1983, Nikolaus 1990). Some theoretical predictions (Sutherland 1996, Webster et al. 2002) and speculations about the Red-backed Shrike (Nikolaus 1990, van Nieuwenhuyse et al. 1999) suggested that migration time could be a critical period for...
determining the population size, and consequent-
ly a period to focus on when developing conser-
vation programs for this declining and endan-
gered species. Therefore, the aim of this study is
to provide the basic data on the migration strate-
gy of the Red-backed Shrike. We analyzed data of
birds trapped at the ringing station of the
International Biriding and Research Centre in Eilat
(IBRCE), Israel, just before and after their transit-
ion of the Sahara desert belt. We hypothesised
that during the spring migration, when in transit
from their wintering grounds in sub-Saharan
Africa, Red-backed Shrike must stage at Eilat prior
to accomplishing the second half of their migra-
tions to their breeding grounds to the north.

STUDY AREA AND METHODS

Eilat (29°33′N 34°57′E), at the northern tip of the
Gulf of Aquaba/Eilat, is an important site because it
is located on the northern edge of the Saharan-
Arabian desert belt and is critical for many migra-
tory species because birds reach it after a flight of
almost 2000 km of continuous desert regions of the
Sahel (Safriel 1968). To the northeast there are still
650 km more of the Syrian Desert and to east the
vast Arabian Desert. Hence many birds are attract-
ted 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).

Owing to changes in locations of the ringing
station within a 5-km radius in the region, a great
variation in trapping results between years and
between seasons was evident. However, we
analysed the data cumulatively for all years, but
separately for seasons — spring and autumn —
from spring 1984 to autumn 2001 assuming that
the changes in location of the ringing station did
not affect the results attained pertaining to the
migration patterns and the biometrics of the
study species.

Birds were mist-netted and each bird was aged
and sexed by plumage and ringed. Flattened maxi-
mum wing chord and tail were measured using a
wing-ruler (± 1 mm), and body mass was deter-
mined with a Pesola 50 g (± 0.5 g) spring balance.
Visible fat was quantified according to the ordinal
scale (Fry et al. 1970), and fat scores ranged from 0
(no fat) to 3 (bulging fat). Additionally, a measure of
bird condition was used wherein wing-length was
taken as an index of body size (Pearson 1971) and
factored the effect of size on mass by calculating the
mass/wing-length ratio (e.g. Safriel & Lavee 1988).

However, biometric data were not available for all
individuals, which resulted in a large variation in
sample sizes between years. In autumn, we classi-
ﬁed the birds into three age and sex classes — adult
male, adult female, and juvenile. In spring, due to
moulting during winter (Jenni & Winkler 1994) birds
were classiﬁed only into two categories, males and
females. Individuals not ascribed to one of the
above mentioned classes were not included in the
biometric analyses. In order to avoid pseudorepli-
cation only data from the ﬁrst captures were used
to calculate the biometrical characteristics.

Allowing that our migration study point was
not designed especially for the estimation of the
duration of the stopover period, we computed
only the average stopover duration period
derived from the ad hoc method (Kaiser 1999).
Hence, there was obtained only the minimum
stopover period that is usually shorter than the
real period established by the new method devel-
oped by Kaiser (1999). All retraps were weighed
with the same accuracy, and data from the ﬁrst
and the last catching were used in the analyses.
Because of insufﬁcient data from spring, we used
only the data from autumn for in-depth analyses.

The phenology of the spring and autumn
migration was computed using Julian dates.
Because migration time, as well as ringing loca-
tion, differed between seasons, for comparing
arrival dates between sexes and age classes we
assigned the median date of arrival, deﬁned as
the day when 50% of individuals were captured.
Standardised day of arrival was established in
relation to median date expressed as 0.

Throughout the text, values are reported as
means ± SD. Calculations were conducted using
the SPSS for Windows package (Norusis 1986).
However, since we conducted statistical tests for
each age and sex group separately, but addressed a
common null hypothesis for the data from all
groups (multiple comparisons), we adjusted all p-
values with the use of the sequential Bonferroni
test to control for group-wide type I error (α = 5%).

RESULTS

During the 18 years of the study period (1984-
2001) a total of 1031 Red-backed Shrikes were
captured and ringed, yearly 0–204 individuals. Of
these 187 (18%) were males and 126 (12%) females.
The remaining individuals were birds whose sex
was undetermined (n = 36; 3%) or juveniles (n =
682; 66%).
Spring transients were trapped in Eilat between late March and late May. On average, males arrived ten days earlier than females (U-test, $U = 2864, df = 174, p = 0.02$). In autumn juveniles arrived significantly later than adults of both sexes (Kruskal-Wallis ANOVA, $\chi^2 = 56.7, df = 2, p < 0.0001$, Table 1), but within adults, the differences between sexes was not significant ($U = 2213.5, ns$).

### Differences in wing length and body mass in relation to sex and age

In spring we found no differences in wing chord length ($t = -0.65, df = 166, ns$, Table 2) and body mass ($t = -0.42, df = 164, ns$, Table 2) between the sexes. In autumn, significant differences in wing length were found between the three sex- and age-classes (ANOVA, $F_{2,716} = 4.98, p = 0.007$, Table 2) with adult males having longer wings than juveniles (post-hoc Student-Newman-Keuls test, $p < 0.05$). However, no significant differences in body mass were found between the three age- and sex- classes (ANOVA, $F_{2,771} = 1.56, ns$, Table 2).

<table>
<thead>
<tr>
<th></th>
<th>Spring</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male adult</td>
<td>1 May ± 14 (110)</td>
<td>14 Sept ± 16 (77)</td>
</tr>
<tr>
<td>Female adult</td>
<td>11 May ± 14 (66)</td>
<td>21 Sept ± 15 (60)</td>
</tr>
<tr>
<td>Juveniles</td>
<td>29 Sept ± 16 (685)</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Median capture date (with 95% confidence interval in days, $n$ in parentheses).

### Differences in body mass and fat scores between seasons

In autumn, males consistently had longer wings than in spring and the difference was 1.3 mm ($t = -3.1, df = 179, p = 0.003$, Table 2). This tendency was also observed for females, however, the difference was smaller, 0.8 mm, and is statistically insignificant ($t = -1.9, df = 120, p = 0.1$, Table 2; in both comparisons p-values adjusted by the sequential Bonferroni technique).

### Body measurements in relation to date of passage

In spring, wing length, body mass, as well as condition did not change significantly with date of capture for both sexes (correlation analyses, $p > 0.15$ in all cases). Similarly, in autumn we did not find a correlation between wing length, body mass and body condition for juveniles and females ($p > 0.2$ in all cases). Among males correlation between arrival date and wing length was also insignificant ($p = 0.9$), however relationships between date of capture and body mass ($r = 0.20, n = 75, p = 0.09$) and condition ($r = 0.21, n = 74, p = 0.08$) approached the significance. This suggests that heavier birds in better condition have a tendency to migrate earlier.

In spring, birds were lighter than in autumn, and differences in categories varied from 4.7 to 5.3 g ($t = -10.72, df = 178$ and $t = -7.38, df = 119; p <$ 0.001).

### Differences in wing length between seasons

In spring, males consistently had longer wings than in autumn and the difference was 1.3 mm ($t = -3.1, df = 179, p = 0.003$, Table 2). This tendency was also observed for females, however, the difference was smaller, 0.8 mm, and is statistically insignificant ($t = -1.9, df = 120, p = 0.1$, Table 2; in both comparisons p-values adjusted by the sequential Bonferroni technique).
0.001, for both males and females, respectively; p-values adjusted by sequential Bonferroni technique, Table 2). Birds of both sexes had greater fat reserves in autumn than in spring (U = 1461, df = 156, and U = 789, df = 108, for males and females respectively, p < 0.0001 in both cases Fig. 1).

Retraps

Twelve (6.0% of caught birds) and 87 (10.5%) Red-backed Shrikes were retrapped within the spring and autumn seasons at Eilat. However, the difference in the number of retraps between seasons only approached significance \((\chi^2 = 3.07, df = 1, p = 0.08)\). Birds stayed for one to 33 days (median values 1 ± 1.5 and 5 ± 6.5 days in spring and autumn, respectively) and the minimum stopover period differed significantly between seasons (U = 295.5, df = 97, p = 0.014). On recapture, birds were heavier than at first capture (27.1 g ± 3.3 vs 25.5 g ± 3.0, respectively, paired samples t-test, \(t = -5.43, n = 87, p < 0.0001\)) and differed significantly in body condition (0.275 ± 0.034 vs 0.293 ± 0.038, Wilcoxon matched-pairs test, \(Z = -5.19, n = 87, p < 0.0001\)). Consequently, we found correlation between retrap condition and condition at the first capture (Fig. 2). Change in body mass was affected by the duration of time stayed at the stopover site (\(r = 0.456, n = 87, p < 0.001\), Fig. 3). The median gain in body mass per day was 0.3 ± 0.7 g (range: -2.5 to 2.0). A strong correlation we found between changes in body mass of individuals between first capture and subsequent recaptures and initial body mass (\(r = -0.352, n = 87, p < 0.001\)) was most probably an statistical artefact (cf. Ruf 2000).

DISCUSSION

General migratory pattern

The Red-backed Shrike is a common passage migrant in spring at Eilat, with smaller numbers recorded in spring than in autumn (Morgan & Shirihai 1997, Yosef 1998, this study). However, evidence for the reverse exists for a wide range of species that migrate through Israel in general and Eilat in particular (Frumkin et al. 1995, Shirihai 1996, Morgan & Shirihai 1997). In spring, the Red-backed Shrikes return from Africa to their breeding grounds on a broad front and in autumn the populations (including West European) migrate via the eastern Mediterranean flyways (Biebach et al. 1983).

Another explanation of the differences in number of birds between seasons is migration speed. Drost (1934) showed, that in spring, a Red-backed Shrike ringed at Helgoland (Germany) was retrapped 700 kilometres to the north after 20 hours. Also, our analysis of data from retrapped birds showed that in spring Red-backed Shrike stayed at Eilat on average four days shorter than in autumn. On the other hand, the stopover period may be related to the variation in food supplies, and consequently in opportunities to obtain sufficient food need just after (in spring) or before (in autumn) crossing the Saharan-Arabian deserts. Moreover, the two spring and autumn seasons could differ in capture probability of birds, which strongly influenced the average stopover duration (Schaub et al. 2001).

In spring the Red-backed Shrike males arrived on average 10 days before females. This concurs with data for island males in Italy (Spina et al. 1994) as well
as for sex differences of arrival time to the breeding grounds in Poland (Tryjanowski & Sparks 2001).

In autumn the adults of both sexes arrived at Eilat significantly earlier than juveniles. Morgan & Shirihai (1997) also found that in autumn adults pass earlier than juvenile Red-backed Shrike. We speculate that there are two possible factors that may account for this pattern. First, younger males may remain on their natal territories for a longer period of time in order to learn its properties for future use. Second, and not mutually exclusive, explanation is that later passages of juvenile birds represent a strategy to avoid competition with adults. However, a more detailed comparison of our results with data outside of Israel is impossible owing to the scarcity of information (cf. Harris & Franklin 2000). Moreover, on the breeding grounds juvenile have to perform at least a partial post-juvenile moult before they start the autumn migration.

Differences in measurements and condition

Older birds did not have significantly longer wings than juveniles which is a well-established phenomenon in many bird species (Alatalo et al. 1984), including the Red-backed Shrike (Jakober & Stauber 1989). Lack of age-related differences in wing length in our study may be connected to the fact that the Eilat is a bottleneck region, where birds from different geographical populations and/or subspecies are known to concentrate. Hence, differences between birds of the different age-classes may be masked by the inter-population variability. Interestingly, males had significant longer wing length in autumn than in spring. This is surprising because wing moult occurs on the wintering grounds in Africa (Jenni & Winkler 1994, Harris & Franklin 2000) and we expected the birds to have longer wings in spring, with fresh, unworn primaries. However, after moultling on the wintering grounds, first-year and adults cannot be separated in spring and the data were lumped into one category. This should not account for this result however, as the adults in younger age-classes are included among autumn adults as well. Hence, we speculate that it is possible that population(s) that migrate through Eilat in spring is different from the population(s) in autumn (e.g. birds from subspecies L. c. collurio and L. c. pallidirostris). Unfortunately, no Red-backed Shrike ringed in Israel in general, and at Eilat in particular, has been recovered on the breeding grounds.

The significant differences in body mass and fat scores between the spring and autumn seasons can be explained by the differences in hardships of the migration flyway. The pattern found at Eilat, that birds are heavier and have larger amounts of fat in autumn than in spring is probably the result of the necessity to accumulate sufficient nutrient reserves that are used for crossing the inhospitable expanses of the Sahara and Sinai deserts. These results corroborate the findings of other studies that have described a similar situation for other passerines (Baierlein 1995, Biebach 1995), including differences in the body mass in Red-backed Shrike (Moreau 1969).

At Eilat, the Red-backed Shrikes, in line with the situation found in other passerine birds at stopover sites, improved their body condition and gained mass. Changes in body mass were linked to the minimum stopover period. The pattern of improvement in body condition during autumn stopover time was very similar to that described for other passerines (e.g. Bairlein 1995). Shrikes gained on average 6% of its body mass during this short stay at Eilat and accumulated a relatively large amount of fat prior to their attempting the desert crossing.

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REFERENCES

STRESZCZENIE

[Migracje gąsiorka na obrzeżach pustyni: badania w Eilat, Izrael]

Badania wędrowek gąsiorka prowadzono w latach 1984–2001 w punkcie obrączkowania ptaków w Eilat, leżącym w Izraelu, nad Morzem Czerwonym. Jest to duża oaza oferująca wędrującym ptakom możliwość zatrzymania się i uzupełnienia materiałów energetycznych tuż po (wiosną) i tuż przed (jesienią) przekroczeniem pasa pustyń w drodze na zimowiska w Afryce. Wędrujące gąsiorki ląpano w sieni, obrączkowano, ustalano poziom zapasów tłuszczowych, ważono i mierzono (n = 1031 osobników). Ponieważ część ptaków łapała się kilkakrotnie, celem uniknięcia pseudoreplikacji do analizy włączano tylko informacje z pierwszych złowień. Ponadto wykonano dodatkowe analizy dla retrapów, których celem była ocena jakości lokalnego miejsca zatrzymywania dla wędrujących gąsiorków. Rocznie łapano 0–204 osobników, aż dwie-trzecie wszystkich ptaków stanowiły osoby młode. Wiosną samce przylatywały wcześniej od samic (Tab. 1), a jesienią ptaki dorosłe w wcześniej od młodych (Tab. 1). Stwierdzono istotne różnice wiekowe i płciowe w długości skrzydła, natomiast przypadkują masy ciała różniące się nie były istotne (Tab. 2). Wiosną nie stwierdzono spodziewanych istotnych negatywnych korelacji pomiędzy terminem wędrówki, a długością skrzydła i masą ciała dla żadnej z wyróżnionych grup wiekowo- płciowych. Jesienią te korelacje też nie były istotne, choć zauważono marginalnie istotne trendy sugerujące, że ptaki w lepszej kondycji mają tendencję do wcześniej wędruje na zimowiska.

Szersza analiza i dyskusja różnic (a właściwie ich braku) pomiędzy grupami wiekowo-płciowymi jest bardzo utrudniona, gdyż przez badany punkt przelatują gąsiorki z wielu populacji i co najmniej dwóch podgatunków L. c. collurio i L. c. pallidirostris, co skutecznie może maskować różnice, mające wynikać z płci czy wieku (np. to, że starsze samce z dłuższym skrzydłem, jak to się dzieje w wielu innych wróblowych, wiosną powinni migrować wcześniej).

Znacznie lepiej zarysowane są różnice sezonowe w masie ciała i zapasach tłuszczowych. Wiosną ptaki są wyraźnie lżejsze i w mają słabiej odłożony tłuszcz niż jesienią (Fig. 1, Tab. 2). Jest to konsekwencją wyczerpującej wędrówki wiosennej przez pas pustyń, a jesienią przygotowaniem się do jej podjęcia.

Gąsiorki wiosną zatrzymują się w Eilat na 1, a jesienią na 5 dni. Analizując dane jesienne (z wiosny są one zbyt ubogie) stwierdzono, że poprawienie masy ciała (przeciętnie 0.3 g dziennie) koreluje z długością czasu postoju. Znaczy to, że zapewnienie gąsiorkom odpowiednich warunków na miejscach postoju w czasie wędrowki może być ważne dla ochrony tego gatunku.