THE RING 32, 1-2 (2010) DOI 10.2478/v10050-010-0001-1

BODY MASS AND FAT SCORE CHANGES IN RECAPTURED BIRDS DURING THE AUTUMN MIGRATION AT THE CERNEK RINGING STATION IN TURKEY

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ABSTRACT

Erciyas K., Gürsoy A., Özsemir A.C., Barış Y.S. 2010. *Body mass and fat score changes in recaptured birds during the autumn migration at the Cernek ringing station in Turkey*. Ring 32, 1-2: 3-15.

The fat level and the body mass of recaptured birds ringed at the Cernek Ringing Station are presented in this study. Data from autumns of 2003-2005 were analysed. Species of different migratory and feeding habits are compared. A total of 351 recaptures of the Blackcap (*Sylvia atricapilla*), Garden Warbler (*S. borin*), Reed Warbler (*Acrocephalus scirpaceus*), Marsh Warbler (*A. palustris*) and Cetti's Warbler (*Cettia cetti*) were mist-netted and handled according to the South-East European Bird Migration Network (SEEN) standards.

The mean weight changes of the Reed Warbler and Marsh Warbler and those of the Blackcap and Garden Warbler were similar within each genus but higher in *Sylvia spp.* as compared to *Acrocephalus spp*. The recapture rate was the highest in the Cetti's Warbler but the mean weight increase was the lowest as this is essentially a sedentary species. The stopover duration differed among the species. The mean stopover length was similar within *Acrocephalus spp*. (8.5 days in the Reed Warbler, 6.4 days in the Marsh Warbler) and *Sylvia spp*. (5.6 days in the Blackcap, 5.4 days in the Garden Warbler) and different in the Cetti's Warbler (16.6 days).

Results indicate that migratory birds use Cernek location as refuelling station during the autumn migration and their fat level and body mass increase, but differ according to feeding and migrating habits.

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Publication appointed to the SE European Bird Migration Network

Key words: bird migration, body mass, stopover ecology, Kızılırmak delta

INTRODUCTION

During migration birds spend most of the time at the stopover sites, rebuilding their energy reserves; the flight itself lasts for relatively short time (Berthold 2000). Many birds prepare for migration by accumulating large stores of fat. These birds show considerable degree of seasonal fluctuations in body mass. In small migrating passerines most of the body mass variation is due to the deposition of fat (Zelenova 2001). The knowledge of the fattening status is an important part of the general knowledge on the migration strategy of the migrating population.

Migration is normally divided into several flight periods and between these periods the birds have to replenish fat stores at suitable stopover sites. Analyses of fat loads at stopover sites along the migration route may thus be useful for characterising migration strategies. Detailed analysis of the stopover phenomenon is essential to learn and understand migration of these species (Zelenova 2001).

According to current knowledge, the central and eastern Black Sea is located away from the main bird migration flyways running from Europe over the Bosphorus and the Dardanelles Straits and through southern or central Turkey. To cast new light on migration strategies and flyways of passerines in the region of the Black Sea, a new Turkish bird ringing station at Cernek began its work in 2002 (Fig. 1). Both the high number of captured birds and obtained ringing recoveries indicate that the Kızılırmak delta is an important stopover site on the migration route towards the winter-quarters in Africa, and further systematic work may enlarge our knowledge on bird migration in this region to a significant degree (Barış *et al.* 2005).

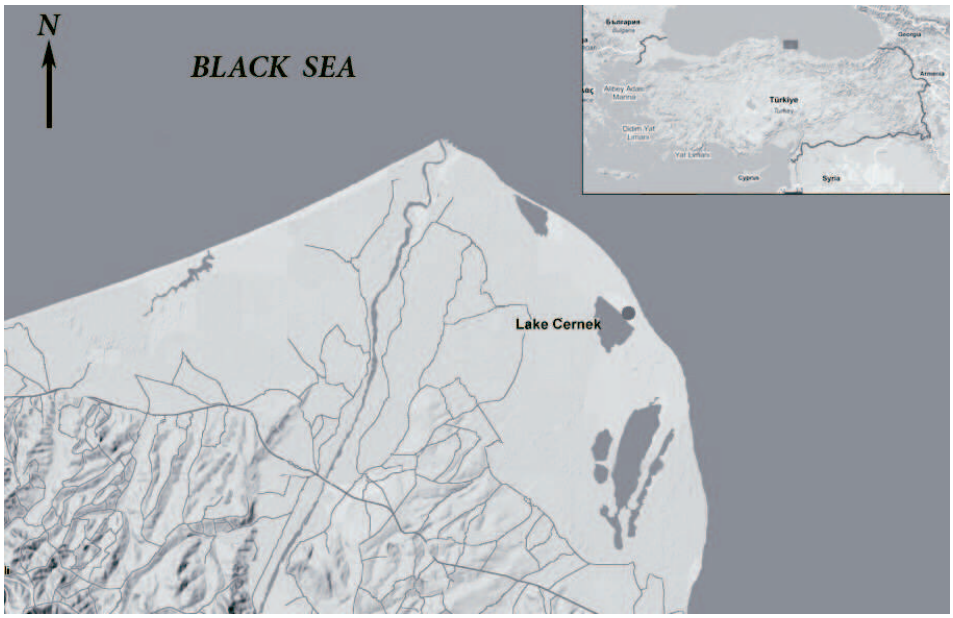

Fig. 1. Cernek Ringing Station within the Wildlife Protected Area (Ramsar Site) in the Kızılırmak delta

Resource availability at stopover sites is an important factor in individual (or populational) migration strategies. Recapture data are analysed to provide information about stopover length, body mass and fat score changes. We analysed four migrant species with different feeding (frugivore and insectivore) and migratory habits (long-distance and short-distance) as well as a resident species for comparison.

The aims of this study are: (1) to analyse changes in body mass, fat load and stopover duration between bird species of different feeding and migration habits, (2) to recognise the importance of the Kızılırmak delta as a stopover site.

MATERIAL AND METHODS

Data on the autumn migration at the Cernek Ringing Station between years 2003-2005 were analysed. The Cernek Ringing Station is located in the delta of the Kızılırmak within the Wildlife Protected Area (Ramsar Site), approximately in the middle of the southern Black Sea coast, near the town of Bafra in the Samsun Region of Turkey (41°36'N, 36°05'E) – see Fig 1. The delta is 0-15 m above the sea level and its total surface area is about 56 000 ha. The main wetland area is within the eastern delta, covering about 10 000 ha, and consists of several lakes, marshes, grasslands, dunes and seasonally flooded *Fraxinus* forest. A single lake in the western delta is surrounded by reeds and marshes.

The ringing station is located within the eastern part of the delta, at the shore of Lake Cernek, from which it derived its name. Detailed description of the station can be found in the paper by Barış *et al*. (2005).

Birds were caught in mist-nets (about 38 nets 7 and 12 m long). The SEEN standards (Busse 2000) were used in the work and they included: (1) species identification, ageing and sexing (if possible); (2) ringing; (3) measurements of the length of the folded wing, tail and wing formula; (4) weighing (electronic balance with the accuracy of 0.1 g); (5) assessment of the fat level (according to a 9-score scale); (6) record of recaptured birds (retraps) in the logbooks (they were not fully processed again but their fat score and weight was remeasured to track changes from first and subsequent captures); (7) additionally, orientation tests were performed.

Stopover phenomenon can vary between birds that have different diets during migration. The amounts of fruits eaten by Blackcaps and Garden Warblers noticeably increase during migration. Therefore, in this analysis the most numerous frugivore birds caught in the Cernek Ringing Station, namely the Blackcap (*Sylvia atricapilla*) and Garden Warbler (*S. borin*), were chosen and compared to two insectivorous warbler species, the Reed Warbler (*Acrocephalus scirpaceus*) and Marsh Warbler (*A. palustris*), for the differences in weight and fat load change and stopover duration. As a resident species the Cetti's Warbler (*Cettia cetti*) was also included for comparison.

Data on the captured birds are given in Table 1. It was assumed that all retrapped birds were present in the study area from their first ringing date until the date of their final capture.

Table 1
Number of birds ringed and retrapped

	Study period	Ringed	Retrapped	% Retrapped
A. scirpaceus	2003 (17 Aug. – 29 Oct.)	121	12	10
	2004 (16 Aug. – 25 Oct.)	97	7	7
	2005 (15 Aug. – 19 Oct.)	112	7	6
Total		**320**	**26**	**8**
A. palustris	003 (17 Aug. – 29 Oct.)	19	2	11
	2004 (16 Aug. – 25 Oct.)	60	8	13
	2005 (15 Aug. – 19 Oct.)	95	10	11
Total		**174**	**20**	**11**
S. atricapilla	003 (17 Aug. – 29 Oct.)	695	32	5
	2004 (16 Aug. – 25 Oct.)	762	18	2
	2005 (15 Aug. – 19 Oct.)	568	12	2
Total		**2025**	**62**	**3**
S. borin	003 (17 Aug. – 29 Oct.)	896	95	11
	2004 (16 Aug. – 25 Oct.)	860	64	7
	2005 (15 Aug. – 19 Oct.)	717	30	4
Total		**2473**	**189**	**8**
C. cetti	003 (17 Aug. – 29 Oct.)	49	13	27
	2004 (16 Aug. – 25 Oct.)	71	16	23
	2005 (15 Aug. – 19 Oct.)	70	25	36
Total		**190**	**54**	**28**

The stopover lengths, fat score and weight changes were analysed. To analyse stopover lengths the differences between all retrapped birds' first catch dates and the last catch dates were taken. Fat score and weight were also analysed to assess the changes between the first and last catches. For individuals retrapped more than once, only the data from their latest trapping were taken into account. Statistical differences among species and within each species were tested in these parameters. In all analyses $p < 0.05$ was accepted as significant.

The following formula was used to calculate relative body mass change between the first (initial) and the last (final) capture of an individual:

$$\Delta W_{\%} = [(W_f - W_i) / W_i] \times 100$$

where:
W_i – initial weight (weight of an individual on the day of its first capture),
W_f – final weight (weight of an individual on the day of its last capture).

RESULTS

At the Cernek Ringing Station the studied species, even when closely related, have different passage patterns during autumn migration (Fig. 2) and these may also be reflected in their stopover strategies.

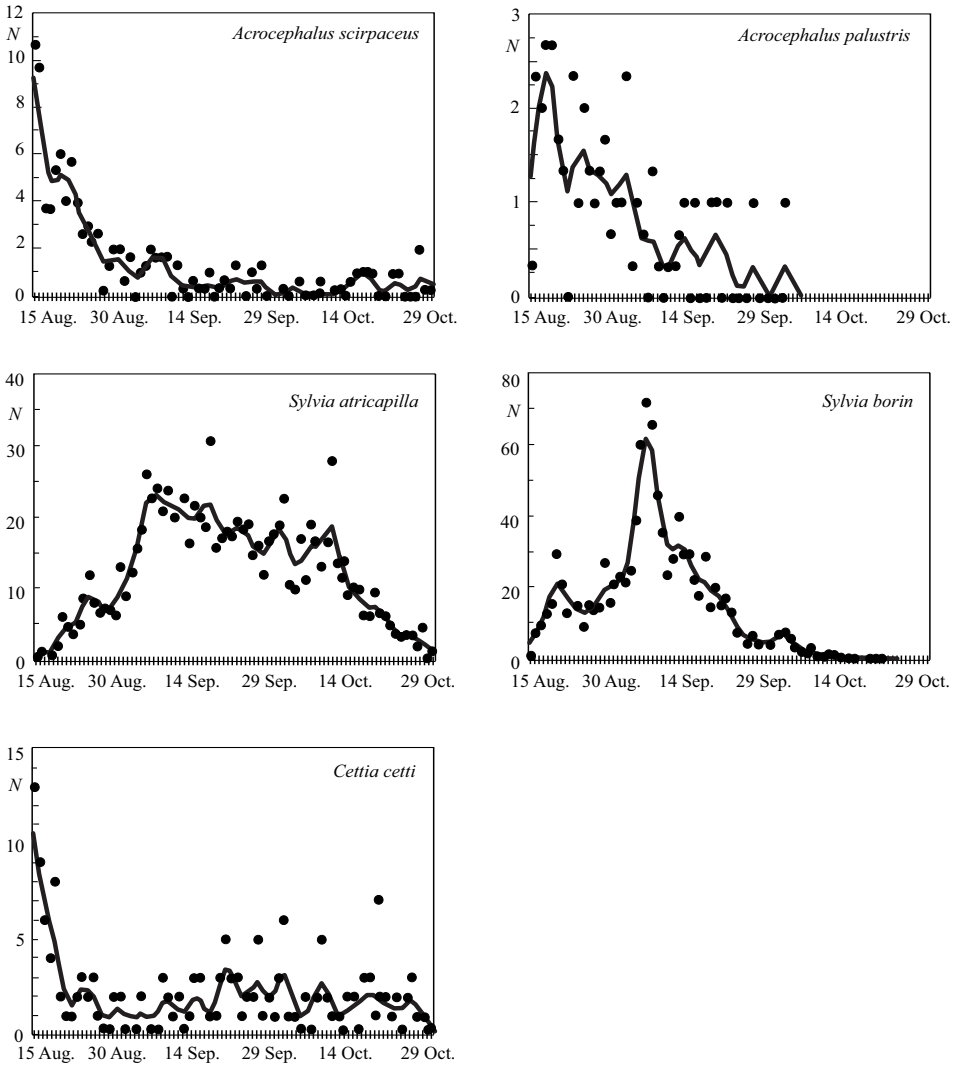

Fig. 2. Autumn passage of the Reed Warbler, Marsh Warbler, Blackcap, Garden Warbler and Cetti's Warbler. Dots – daily catches, line – smoothed by 5-day moving average.

Stopover

Total percentages of recaptured Blackcaps, Garden Warblers, Reed Warblers, Marsh Warblers and Cetti's Warblers were 3, 8, 8, 11 and 28%, respectively. The higher retrap percentage in the Cetti's Warbler was statistically significant (χ^2-test: $\chi^2 = 212.13$; $p < 0.05$). The differences among the other species were non-significant. As the Cetti's Warbler is a resident species the high retrap rate is as expected.

The mean and median stopover durations as well as stopover ranges are given in Table 2. The mean stopover lengths were similar within *Acrocephalus spp*. (8.5 days in the Reed Warbler, 6.4 days in the Marsh Warbler) and *Sylvia spp*. (5.6 days in the Blackcap, 5.4 days in the Garden Warbler) and different in the Cetti's Warbler (16.6 days). Only the Cetti's Warbler's stopover length was significantly different than in the other species (one-way ANOVA among groups: $F = 31.84$, $p < 0.05$). Stopover lasted longer in *Acrocephalu*s species compared to *Sylvia* species. There were significant differences between the stopover lengths of the Reed Warbler and Garden Warbler (Mann-Whitney *U*-test: $Z = -2.516$, $p = 0.012$) and the Reed Warbler and Blackcap (Mann-Whitney *U*-test: $Z = -2.336$, $p = 0.019$).

Table 2
Stop-over duration (days) of retrapped birds

	Range	Median	Mean ± *SD*	Mode
A. scirpaceus	1-26	7	8.5 ± 6.7	7
A. palustris	1-15	5	6.4 ± 4.6	1
S. atricapilla	1-21	4	5.6 ± 5.2	1
S. borin	1-20	4	5.4 ± 4.3	11
C. cetti	1-41	16	16.6 ± 12.5	7

Fat level

The mean fat levels for the first and last catches are presented in Table 3. Similar mean fat score changes are shown in each of *Sylvia* (Blackcap: 0.9 ± 1.8; Garden Warbler: 0.7 ± 1.8) and *Acrocephalus* (Reed Warbler: 1.3 ± 2.0; Marsh Warbler: 1.6 ± 2.0) species. The Cetti's Warbler had the lowest mean fat score change (-0.1 ± 1.4). There were statistically significant differences between the first and the last fat scores in the Reed Warbler ($t = -3.52$, $p < 0.02$), Marsh Warbler ($t = -4.11$, $p < 0.05$), Blackcap ($t = -3.55$, $p < 0.05$) and Garden Warbler ($t = -5.062$, $p < 0.05$). The difference was not statistically significant in the Cetti's Warbler ($t = 0.97$, $p = 0.336$). Differences between migratory species were not statistically significant (Mann-Whitney *U*-test: $p < 0.05$).

Changes in fat level were reflected by adequate changes of body mass, but there was quite a lot of variation in this relation (Fig. 3).

Table 3
Fat scores (mean ± *SD*) of retrapped birds

	First catch	Last catch	Change
A. scirpaceus	2.4 ± 1.7	3.8 ± 2.1	+1.3 ± 2.0
A. palustris	2.7 ± 1.7	4.3 ± 2.3	+1.6 ± 2.0
S. atricapilla	2.0 ± 0.7	2.9 ± 1.7	+0.9 ± 1.8
S. borin	2.1 ± 1.1	2.7 ± 1.8	+0.7 ± 1.8
C. cetti	1.4 ± 1.1	1.2 ± 1.1	-0.1 ± 1.4

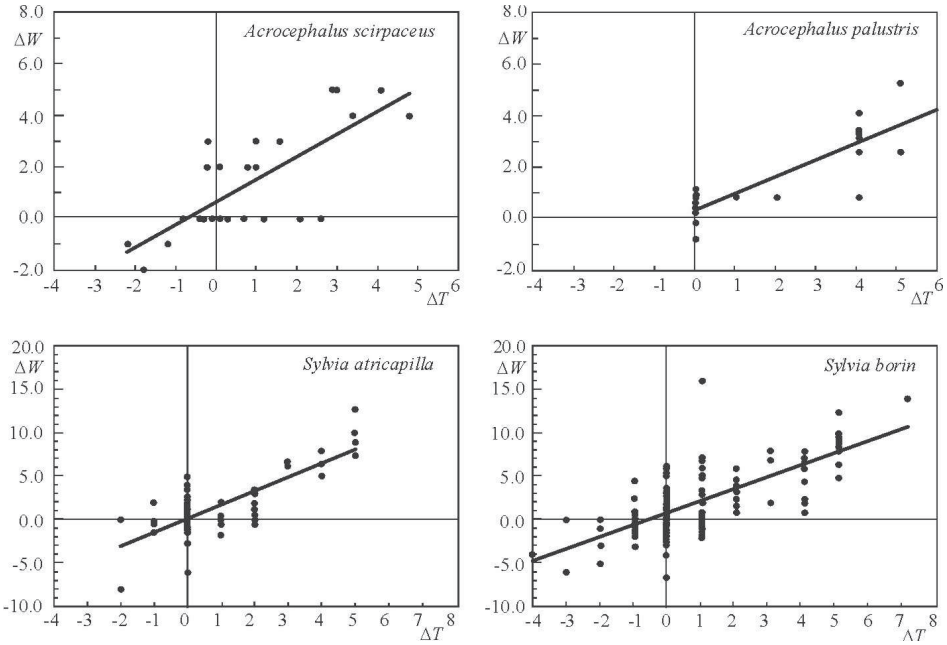

Fig. 3. Relationship of the body mass change (Δ*W*) to the fat score change (Δ*T*) – between the initial and final catch – for retrapped Reed Warblers, Marsh Warblers, Blackcaps and Garden Warblers

Fat score T_2 was the most frequent category in both retraps and birds caught only once. Proportion of high fat load (fat score T_5 and above) was on average higher in birds caught only once. The proportion of high fat load in *Acrocephalus* species was higher than in *Sylvia* species. In the Blackcap, Garden Warbler, Reed Warbler and Marsh Warblers caught only once this proportion reached 5, 7, 20 and 25%, respectively. In retrapped birds it was 0, 4, 8 and 10%, in that order. In the Cetti's Warbler there was no individual with fat score T_5 or above (Table 4).

Table 4
Percentage of fat scores of only one time caught (*NR*) and retrapped (*R*) birds

Fat level	*A. scirpaceus*		*A. palustris*		*S. atricapilla*		*S. borin*		*C. cetti*	
	NR	*R*	*NR*	*R*	*NR*	*R*	*NR*	*R*	*NR*	*R*
0-2	67	69	57	65	82	87	80	87	94	93
3-4	13	23	18	25	13	13	13	9	6	7
≥ 5	20	8	25	10	5	0	7	4	0	0

The changes in average fat scores of retrapped birds and of birds caught only once are shown in Figure 4. In the Blackcap and Garden Warbler the average fat scores by pentades showed not too big changes during the season while there were fluctuations in the Reed Warbler and Marsh Warbler. These fluctuations could be coincident with migration waves, if they exist as a consequence of differential migration of populations. But there is not a clear picture in this study.

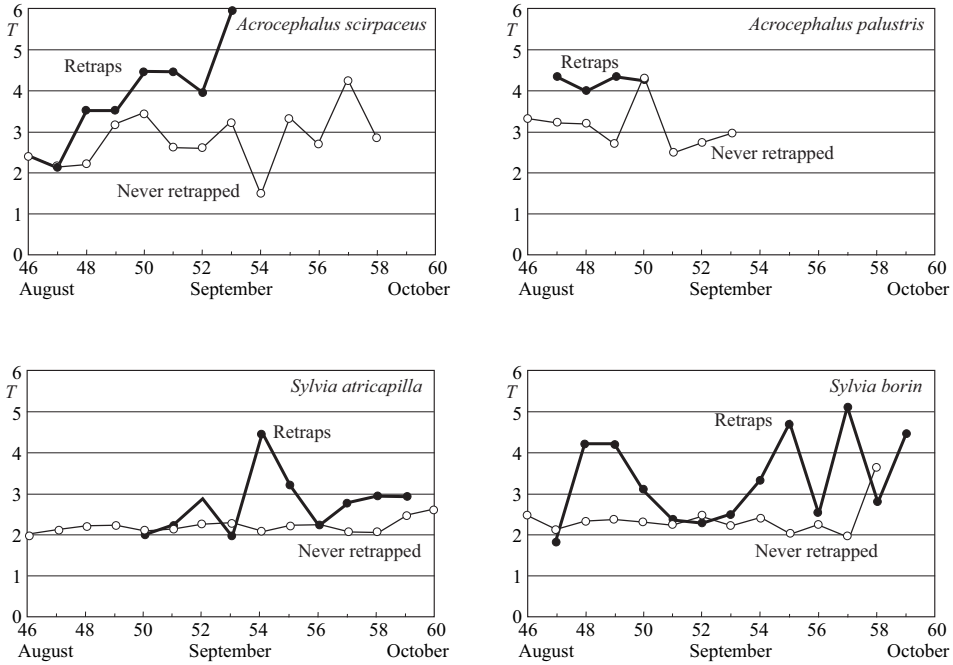

Fig. 4. Fat scores (by pentades) of only one time caught (never retrapped) birds and retraps in the course of migration season

At the end of the season it is expected that there should be an increase in the fat score of the retrapped individuals because of time restriction. But in this case there was a gradual increase only in the Reed Warbler (mid-September), while the fat score in the Marsh Warbler was stable. Initial weight and fat load of retrapped birds were on average lower than of those caught only once, which suggests that birds stopover to replenish their energy deficits – weight and fat changes were influenced by the stopover length.

Studying the stopover ecology of migrating birds one should look for relations between stopover duration and fat score changes. Stopover lengths and fat score changes had usually significant positive correlation (Fig. 5) in the studied species. The highest correlation was shown in the Marsh Warbler while the lowest – in the Cetti's Warbler.

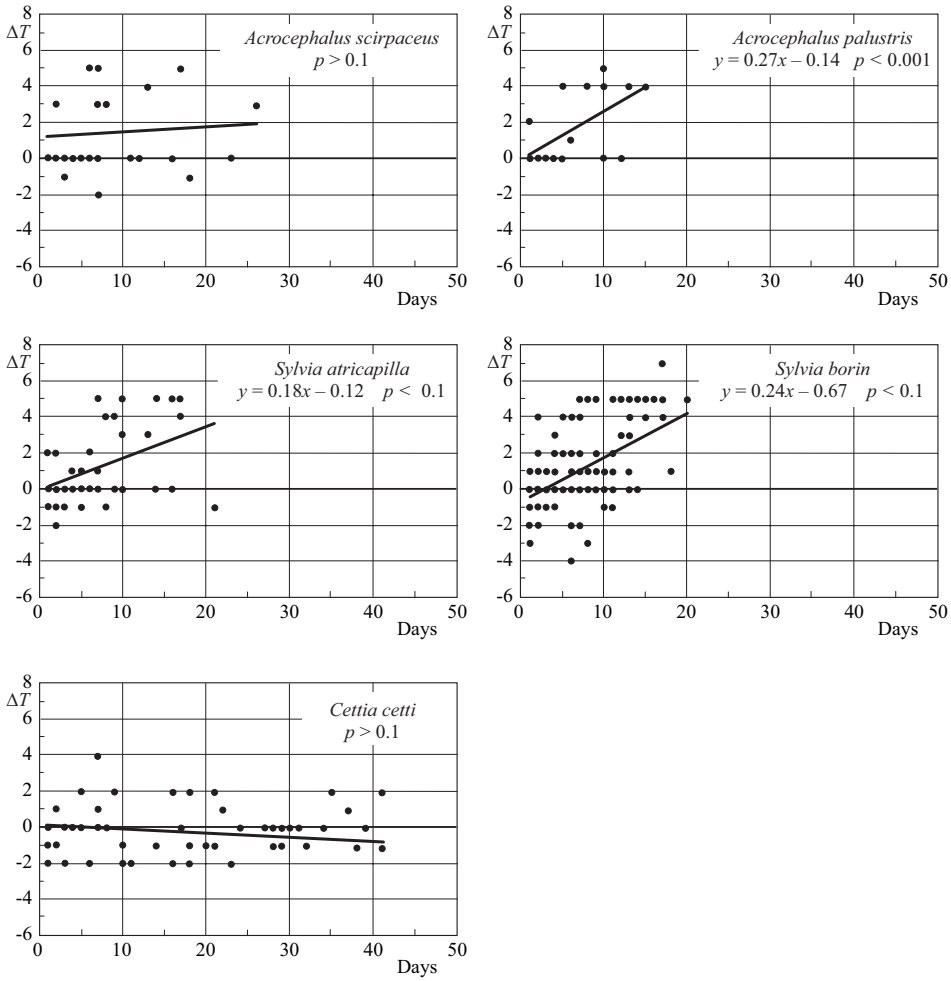

Fig. 5. Correlation of the fat score change (ΔT) with the stopover length

Body mass

The mean body mass changes are presented in Table 5. The highest weight change was shown by the Garden Warbler (1.7 ± 3.5) while the lowest – by the Cetti's Warbler (-0.2 ± 1.0). There were statistically significant differences between the final and initial weights in the Reed Warbler (t = -2.31, $p < 0.05$), Marsh Warbler (t = -3.56, $p < 0.01$), Garden Warbler (t = -6.49, $p < 0.001$) and Blackcap (t = -2.45, $p < 0.05$), while not in the Cetti's Warbler (t = 1.74, $p = 0.09$). There was statistically significant difference in the weight change between the Garden Warbler and Cetti's Warbler (F = 4.14, $p < 0.05$). There were no significant differences between other species.

Table 5
Body mass (mean ± *SD*) change of retrapped birds

	First catch	Last catch	Change	Rate of change
	(g)			(g/day)
A. scirpaceus	12.0 ± 2.3	12.9 ± 2.9	+0.9 ± 2.0	+0.1 ± 0.23
A. palustris	12.7 ± 2.3	13.9 ± 2.4	+1.3 ± 1.3	+0.2 ± 0.3
S. atricapilla	18.9 ± 2.0	20.3 ± 3.3	+1.4 ± 3.3	+0.0 ± 0.7
S. borin	19.1 ± 2.4	20.7 ± 3.8	+1.7 ± 3.5	+0.1 ± 0.8
C. cetti	13.1 ± 2.0	12.9 ± 2.1	-0.2 ± 1.0	-0.1 ± 0.3

In retrapped Reed Warblers, Marsh Warblers, Blackcaps, Garden Warblers and Cetti's Warblers the number of birds that increased weight reached 16, 18, 33, 118 and 17 individuals, respectively (the proportions were 62, 90, 53, 62 and 31%, in that order).

The mean weight increased between the initial and final catches similarly in all the migratory species, while in the resident species (the Cetti's Warbler) there was a decrease in mean weight. Differences between groups were not significant (one-way ANOVA: F = 1.486, $p > 0.05$). Although the weight increase of *Sylvia spp.* was higher than that of *Acrocephalus spp.*, differences were not statistically significant (one-way ANOVA: F = 2.259, $p > 0.05$).

Table 6
Relative (percent) body mass change

	Mean	*SD*	Minimum	Maximum
A. scirpaceus	+8.03	15.87	-16.50	+41.86
A. palustris	+10.62	10.82	-3.93	+35.04
S. atricapilla	+7.83	18.52	-25.64	+83.89
S. borin	+9.35	18.91	-27.31	+98.74
C. cetti	-1.71	7.39	-16.54	+22.22

Relative body mass changes ($\Delta W\%$) between the first and the last captures of birds are given in Table 6. Relative body mass change showed statistically significant differences among groups (one-way ANOVA: $F = 4.652$, $p < 0.05$).

DISCUSSION

Cherry (1982) showed differences in stopover length and fat stores gained by the White-crowned Sparrrow (*Zonotrichia leucophrys*) at different stopover sites. He supposed that these differences could be caused by environmental conditions (food availability, weather) and differences in the migration progress. In our study significant fat and weight changes between the first and last catch for all studied migratory species indicate that Blackcap, Garden Warbler, Reed Warbler and Marsh Warbler use Cernek location as a fuelling station during the autumn migration. In contrast to migratory birds, the Cetti's Warbler as a resident species showed no obvious extra fat deposition.

Diet differences of birds, depending on their physiological characteristics and age, result in varied stopover duration in the trapping area (Zelenova 2001). The fat level and body mass increase at a various rate, according to feeding and migrating habits. In the studied migratory species the diversity in stopover duration seem to be related with diet differences. Stopover lasted longer in *Acrocephalus* species (Reed Warbler – 8.5 days, Marsh Warbler – 6.4 days) compared to *Sylvia* species (Blackcap – 5.6 days, Garden Warbler – 5.4 days).

Reed Warblers eat a wide variety of insects, and can fatten at a wide range of sites until late in the season. Ringing recoveries show that they usually migrate through Europe in shorter stages, stopping at various localities on their southward journeys, and accumulating large body reserves only in North Africa, just before desert crossing (Newton 2008). In the Mediterranean region, at the time of autumn migration, frugivorous warblers increase in body mass about twice as rapidly as purely insectivorous ones, even though the fruit-eaters have to eat more than their own body mass per day (Ferns 1975, Izhaki and Scfriel 1989). Since the body mass change was not significantly different between frugivorous and insectivorous warblers at our study site, this might be related with sufficient food availability for both diets at the Kızılırmak delta. Additionally, the birds at the Kızılırmak delta do not need to cross an ecological barrier just after they leave the stopover site during their autumn migration, and therefore the insectivorous species can easily find food at a wider range on their way. The probability of the lack of food to accumulate enough fat at the next stopover site may force frugivorous warblers to increase body mass within a shorter stopover period than insectivorous warblers.

The autumn passage of Blackcaps lasts longer than that of Garden Warblers, but the percentage of retraps is higher in the latter species. In Cernek, similar numbers of individuals from both species are ringed, but the retrap rate is much higher for the Garden Warbler than for the Blackcap (8 and 3%, respectively). This could be explained by a shorter passage period for the Garden Warbler, meaning that the species density during its migration period is higher compared with the Blackcap. The high density passage may result in a higher retrap rate. Similar stopover duration of both

the species also supports that the higher retrap rate of the Garden Warbler is more likely to be density dependent.

Trans-Saharan migrants usually deposit high levels of fat to fly longer distances. In our study, the Cetti's Warbler is a resident species and therefore there is no significant increase in fat and weight. Some populations of the Blackcap do not cross the Sahara and may even winter in southern Turkey. Individuals from such populations may have low to medium levels of fat compared to trans-Saharan migrants. In the Blackcap, Garden Warbler, Reed Warbler and Marsh Warbler the proportion of individuals with fat score T_5 or above was 0, 4, 8 and 10 respectively. The Garden Warbler's, Reed Warbler's and Marsh Warbler's all populations are long-distance migrants. The high proportion of birds with higher fat levels indicates that they have to gain more fat than short-distance migrants. And there are some short-distance migratory populations of the Blackcap that are migrating through the Kızılırmak delta, so this can explain the low fat deposit in the Blackcap. In contrast, Keşaplı Can (2004) reported that Blackcaps caught in autumn 2002 comprised 11.5% individuals with fat score T_6 and above. The study was carried out in the METU campus field in Ankara (north-western part of Central Anatolia). The habitat mainly consisted of willows (*Salix spp.*), Black Poplar (*Populus nigra*), Dog Rose (*Rosa canina*). This might imply different fat gain strategies for different locations (different habitat?) or be an indication of different migratory populations (short- and long-distance migrants), therefore it needs further study.

The proportion of high fat levels (fat score T_5 and above) is higher in *Acrocephalus* species compared to *Sylvia* species. It is expected that long-distance migrants (Garden Warbler, Reed Warbler and Marsh Warbler) should deposit high levels of fat while the Blackcap as a short-distance migrant does not need high deposits of fat. Therefore, one should predict a higher average fat score also in the Garden Warbler – as in *Acrocephalus* species. This can be the reason of differential migration process in the Garden Warbler compared to the Marsh and Reed Warblers. Further elaboration on the Garden Warbler's fat and body mass change is needed (*e.g.* different seasons, different age classes).

Blackcaps and Garden Warblers consume plenty of fruits for fat deposition during migration (Snow and Perrins 1998). There are a lot of opportunities to consume large amounts of fruits in the Kızılırmak delta. Our data on large fat and weight increase in these species support such an explanation. Their stopover duration was shorter than in the Marsh and Reed Warblers but they gained more fat and weight compared to others. Fruit consumption is faster to replenish the fat stores compared to insect consumption (Berthold 2000). Thus, the shorter stopover might be the reason resulting in fast fat rebuilding in frugivorous *Sylvia* species. Or they might have different migration strategies depending on food availability and do not need to store big amounts of fat and can continue their migration with low fat deposition. This is also related with predictable/unpredictable stopover site restriction where fruit and insects are available.

ACKNOWLEDGEMENTS

The authors are grateful to all ringes and volunteers taking part in the ringing activities at the Cernek ringing station. We also thank Agnieszka Ożarowska for her comments on the script.

The study was financially supported by the Ondukuz Mayıs University Project Management Office (project number F-478).

REFERENCES

Barış S., Erciyas K., Gürsoy A., Özsemir A.C., Nowakowski J.K. 2005. *Cernek – a new ringing station in Turkey*. Ring 27, 1: 113-120.

Berthold P. 2000. *Vogelzug: Eine aktuelle Gesamtübersicht*. Wissenschaftliche Buchgesellschaft. Darmstadt.

Busse P. 2000. *Bird Station Manual*. SE European Bird Migration Network, Bird Migration Research Station, University of Gdansk.

Cherry J.D. 1982. *Fat deposition and length of stop-over of migrant White-crowned Sparrows*. Auk 99: 725-732.

Ferns P.N. 1975. Feeding *behaviour of autumn passage migrants in northeast Portugal*. Ring. & Migr. 1: 3-11.

Izhaki I., Safriel U.N. 1989. *Why are so few exclusively frugivorous birds? Experiments on fruit digestibility*. Oikos 54: 32-32.

Keşaplı Can Ö. 2004. *A study of passerine migration at METU (Ankara, Central Turkey) based on the mist-netting method*. M.Sc. thesis, METU, Ankara.

Newton I. 2008. *The Migration Ecology of Birds*. Acad. Press.

Snow D.W., Perrins C.M. 1998. *The birds of the Western Palearctic*. vol. 2: *Passerines*. Oxford Univ. Press.

Zelenova N. 2001. *Weight gain and diet changes in young Blackcaps (Sylvia atricapilla).* Ring 23, 1-2: 179-189.