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Preliminary hypotheses on migration of the Sedge Warbler (*Acrocephalus schoenobaenus*) in the Eastern Baltic.

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Sedge Warblers trapped in the Eastern Baltic in spring carry substantial fat loads. 23 to 32% of individuals were 'heavy' (i.e. their mass exceeded 13.0 g), thus a considerable proportion of birds making stopover at the Courish Spit are ready for long migration hops. Rybachy spring masses are obviously higher than in the west Europe probably due to the fact that many birds from the Eastern Baltic have a longer migratory journey ahead. Another possible explanation is that some SedgeWarblers may cross Baltic Sea during their spring migration, though no ringing recoveries supporting this suggestion are available.

Autumn masses and fat loads of adult Sedge Warblers are similar to spring ones. Juveniles are significantly lighter than adults. Baltic Sedge Warblers seem not to gain large fat loads near their breeding grounds but probably move to some fattening areas in Central Europe. It remains to be discovered whether this pattern is explained by the shortage in the preferred food or by the necessity to split the long journey from the Baltic area to Sahel zone.

Key words: Sedge Warbler, migration strategy, fat.

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1. Introduction

Autumn migration strategy of the Sedge Warbler (*Acrocephalus schoenobaenus*) in Western and Central Europe is being intensively studied. The work of BIBBY & GREEN (1981) revealed that the migration strategy of birds ringed in Britain, France and Portugal was dependent on their foraging ecology. These authors found that Sedge Warblers utilize for fattening-up mainly plum aphid *Hyalopterus pruni* which is patchily distributed and declining in abundance with the progress of the season. Such areas for quick fattening are reached by a dispersal of several hundreds of kilometres. Most Sedge Warblers fly a long stage to West Africa from feeding grounds in England and northern France overflying the dry Mediterranean basin, whereas Reed Warblers that use broaderbased diet split their journey by refuelling in Iberia. GRÜLL & ZWICKER (1982) found that in Austria in areas with good feeding conditions young Sedge Warblers do not undertake short- and medium-range movements but seem to start their autumn migration with a long hop.

KOSKIMIES & SAUROLA (1985) and KOSKIMIES (1991) report that autumn migration strategy of Finnish Sedge Warblers differs from that of their western conspecifics. Due to the long distance from Finland to West and Central African winter quarters Finnish birds have to make several stopovers. CELMINS (1990) found moderate mass and fat scores in Sedge Warblers ringed on autumn passage in Pape, Latvia, different from the situation found in West Europe (BIBBY & GREEN 1981, 1983). Celmins believes that Baltic Sedge Warblers move rapidly to some fattening areas in Central Europe.

This study aims to present data on spring and autumn passage of the Sedge Warbler in Eastern Baltic in order to enlighten questions of spring migration in this region and reveal peculiarities of Baltic birds' autumn migration strategy. In spring it may be advantageous to migrate quickly and gain large fat loads. It seems improbable that Baltic Sedge Warblers use in autumn the same strategy as English and French birds due to the much longer distance to the wintering areas from the

Eastern Baltic. They should probably split their journey and may not need large fuel reserves at the initial stage of their migration.

2. Methods, study area and site

The study was carried out on the Courish Spit, in the Kaliningrad Region of Russia (55° 12" N 20° 46" E). The Spit is 97 km long and is confined to the east by the Courish Lagoon (fresh water) and to the west by the Baltic Sea. The site of this study is a small reedbed on the Rybachy Cape, which juts out to the east-north-east into the Courish Lagoon. The Cape has long been known as a stopover site for migrating passerines (LYULEEVA 1967). Being the only reedbed for 20km around, it is very attractive for Acrocephalus warblers. The number of Sedge Warblers breeding in the area is negligible, nearest localities with a considerable breeding population are situated in some 20 km to the south at the spit and in 40 km at the eastern coast of Courish Lagoon.

The study was conducted from May 7 to June 15, 1992; from April 6 to November 4 1993, and from June 30 to November 4, 1994. In August and September 1992 additional trapping was conducted with a small number of nets but data were too scarce to compare them to the results of 1993 and 1994. In 1993 and 1994 summer and autumn trapping was conducted in the framework of the MRI-programme (BERTHOLD et al., 1991). Birds were trapped in mist nets. The total length of netting was 54 to 448 m, depending on number of ringers available. The nets were inspected every hour from dawn until dusk. Trapped birds were weighed, measured, and ringed. Body mass was determined using either a VKLT-500-M balance or a Sartorius MP9 electronic balance to the nearest 0.1 gram. Wing length was measured to the nearest 1 mm according to SVENSSON (1992) method 3. The amount of visible subcutaneous fat was classified according to an index scale suggested by BLYUMENTAL & DOLNIK (1962). The actual fat load was estimated by two methods. Method 1 followed DOLNIK & YABLONKEVICH (1985), while method 2 followed ELLEGREN (1989) and ELLEGREN & FRANSSON (1992). Both methods were used parallel. Being size specific, method 2 should be more accurate, but it needs larger sample size than method 1.

Spring passage was taken as to June 11 in both years. Autumn ringing sessions in both 1993 and 1994 were conducted from June 30 to November 4. Considerable passage was recorded from early August, so passage period was taken from July 30 (i.e. from the start of 43rd standard 5-day period according to BERTHOLD (1973)). Wing-lengths, masses and fat loads of birds trapped outside of the defined passage periods were excluded from the analysis.

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3. Results

Fig. 1 shows the timing of spring migration. Migration pattern was essentially the same in both years, considerable passage beginning in early May and finishing in early June. Numbers caught, average wing-lengths, body mass and fat loads calculated by both methods are shown in Tab. 1. Interannual variation of wing-length was insignificant. The mean body mass was lower in 1993 than in 1992 (t-test, $t=3.98$ $p<0.001$).

Body mass in spring was significantly correlated with wing length ($r=0.29$ in 1992 and $r=0.25$ in 1993, $p<0.001$). Thus the linear size of a bird contributed much in its mass variation.

The average mass per 5-day periods was constant throughout the spring in both years (Fig. 2). Though mean values for standard 5-day periods varied significantly (ANOVA: $F=2,92$ $p<0,05$ in 1992; $F=2,10$ $p<0,05$ in 1993), no trend was observed in either year. The relationship between body mass and trapping date was not significant. In 1993 the average wing-length declined with the season, $r=-0.24$, $p<0.001$, in 1992 this relationship was insignificant.

Individuals with mass exceeding 13.0 g were considered to be heavy (following BIBBY et al., 1976). Birds below the mean mass of lean birds (i.e. those without visible subcutaneous fat) were considered to be light. These criteria show how many birds were ready for migration flights of con-

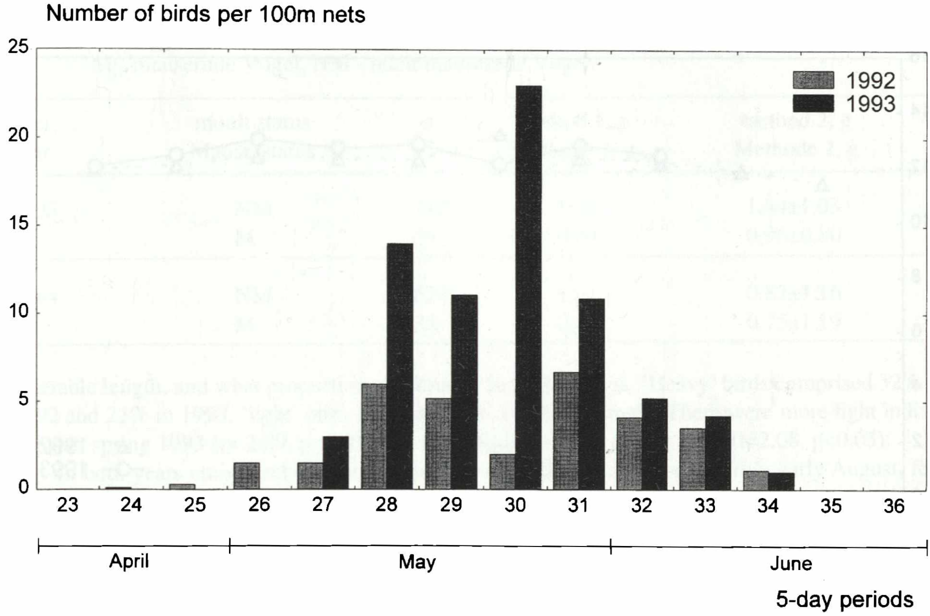

Fig. 1: Spring trapping pattern. Average numbers of Sedge Warblers trapped per 100 m per day in different 5-day periods. – Abb. 1: Frühlings-Fangmuster. Durchschnittliche Anzahl der gefangenen Schilfrohrsänger pro 100 m Netz und Tag in verschiedenen Pentaden.

Tab. 1: Biometrics. Means ± SD, n - sample size, ad - adult birds, 1y - first-year birds. Autumn data refer to individuals trapped from July 30 onwards. – Tab. 1: Biometrische Daten. Durchschnittswerte ± SD, n - Größe der Stichprobe, ad - nicht diesjährige Vögel, 1y - diesjährige Vögel. Herbstdaten beziehen sich auf Vögel, die ab dem 30. Juli gefangen wurden.

	year Jahr	age Alter	n	wing-length Flügellänge	weight Gewicht	fat load Fettdeposition meth.1	meth.2
Spring Frühling	1992		233	67.9±1.90	12.7±1.16	1.19	1.40±1.13
	1993		329	68.1±1.80	12.3±0,99	0.84	1.11±0.96
Autumn Herbst	1993	ad	7	67.6±1.51	12.6±0.82		
		1y	148	67.1±2.01	12.1±1.05		
	1994	ad	23	66.4±2.00	12.6±0.98		
		1y	575	66.9±2.06	12.1±1.19		

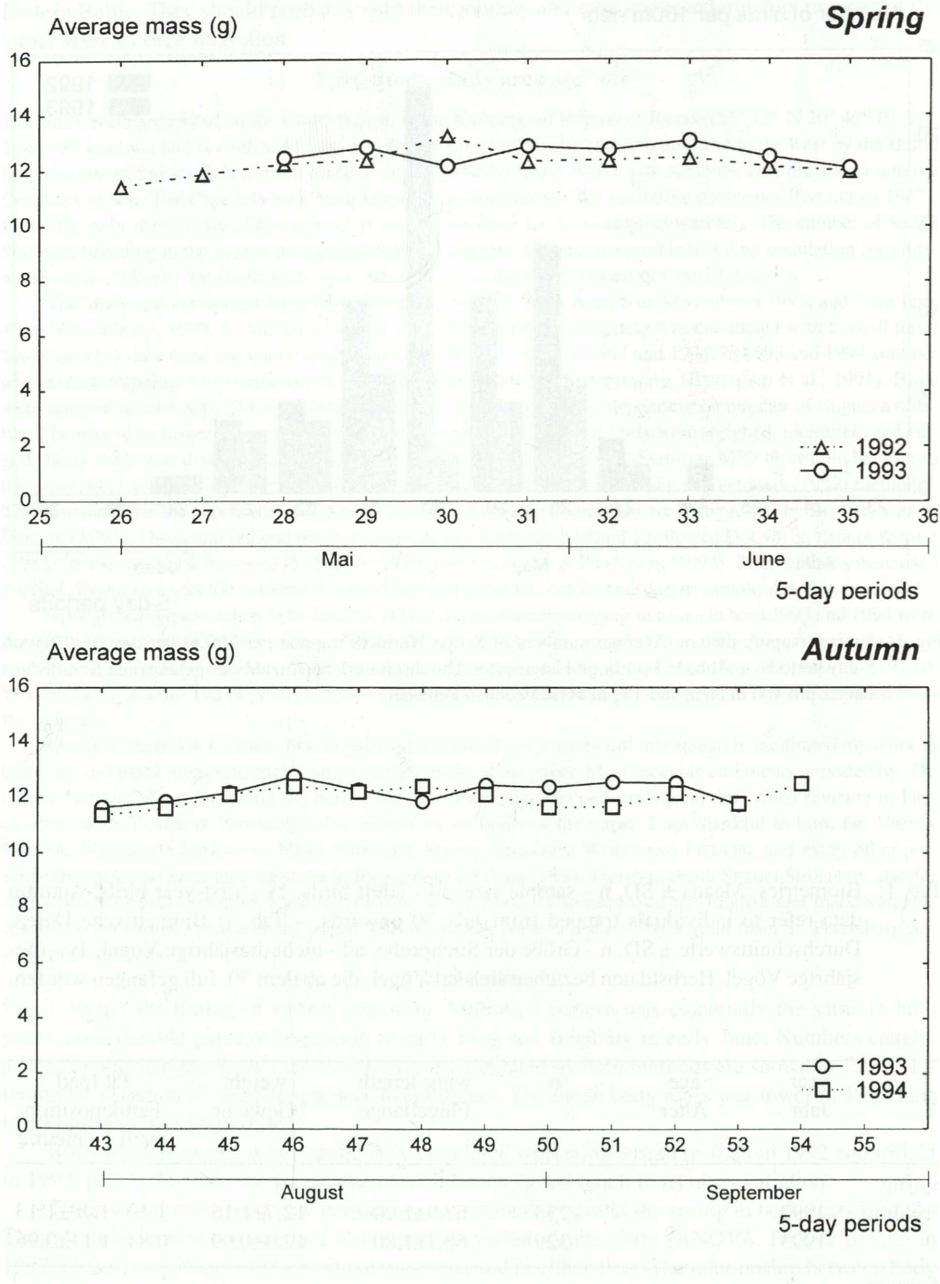

Fig. 2: Average mass of Sedge Warblers in different 5-day periods. – Abb. 2: Mittlere Körpermasse der Schilfrohrsänger in verschiedenen Pentaden.

Tab. 2. Fat loads of juveniles in autumn. M - moulting birds, NM - birds not in moult. – Tab. 2. Fettdeposition der diesjährigen Vögel im Herbst.
M - mausernde Vögel, NM - nicht mausernde Vögel.

year Jahr	moult status Mauserstatus	n	method 1, g Methode 1, g	method 2, g Methode 2, g
1993	NM	112	1,20	1,44±1,03
	M	39	0,69	0,96±0,80
1994	NM	527	1.01	0.82±1.16
	M	38	0.88	0.75±1.19

siderable length, and what proportion was unable to fly long legs. 'Heavy' birds comprised 32% in 1992 and 23% in 1993, 'light' ones 12% and 21%, correspondingly. There were more light individuals in spring 1993 (t= 2.89, p<0.01) and more heavy ones in spring 1992 (t=2.08, p<0.05).

In both years considerable autumn passage of 1y birds was recorded from early August, few birds being trapped before (Fig. 3). The data on adults are insufficient to speculate on the timing of their passage. In 1994 two peaks of passage were recorded - in early August and in September, in 1993 only the September peak was present. 1992 data (not included in this paper) are similar to 1994 pattern.

In 1993 adults comprised 19.6% of birds trapped in July, and 3.3% in later months. In 1994 percentage of adults in the same periods was 8.9% and 3.6%, respectively. Thus adults seem to migrate earlier than juveniles. Last adults were trapped on August 22, 1993 and on August 29, 1994 (retraps included), last juveniles on October 14, 1993 and on October 11, 1994.

Autumn mean wing-lengths and mass are shown in Table 1. Interannual and age-specific variation of wing-length was insignificant. Adults were heavier than juveniles in 1994 (t=2.54, p<0.05). Fat loads shown in Table 2 were computed separately for moulting birds and those not in moult.

Difference between spring mass and autumn mass of adults was insignificant. In autumn juveniles had obviously smaller mass than the adults (t= 1.99 p<0.05 in 1994, t=0.65, ns in 1993 due to small number of adults trapped).

In autumn there was no significant relationship between body mass and wing-length in either year. Body mass was positively correlated with the trapping date in 1993 (r=0.23, p<0.005) but not in 1994. Mass was also positively related to the time of day. This relationship was significant in 1993 only (r=0.474, p<0.005).

Proportion of 'heavy' birds varied from 10% in moulting birds in 1993 to 25% in birds not in moult in the same year. In 1994 'heavy' individuals comprised 12% in both groups. Proportion of 'light' individuals varied from 13% in Sedge Warblers not in moult in 1993 to 23% in moulting birds in 1994. All variations were statistically insignificant (chi-square test).

The average mass per 5-day periods was constant throughout the autumn in both years (Fig. 2). Variation was insignificant in 1993 (ANOVA: F=0,98 ns) and significant in 1994 (F=5,6 p<0,001) but no trend was observed in either year. The relationship between body mass and trapping date was not significant.

4. Discussion

Weights and fat loads of Sedge Warblers caught in spring and in autumn do not differ greatly. The percentage of heavy birds also was slightly the same in both seasons. Though similar mass and fat loads do not necessarily indicate similar migration strategies.

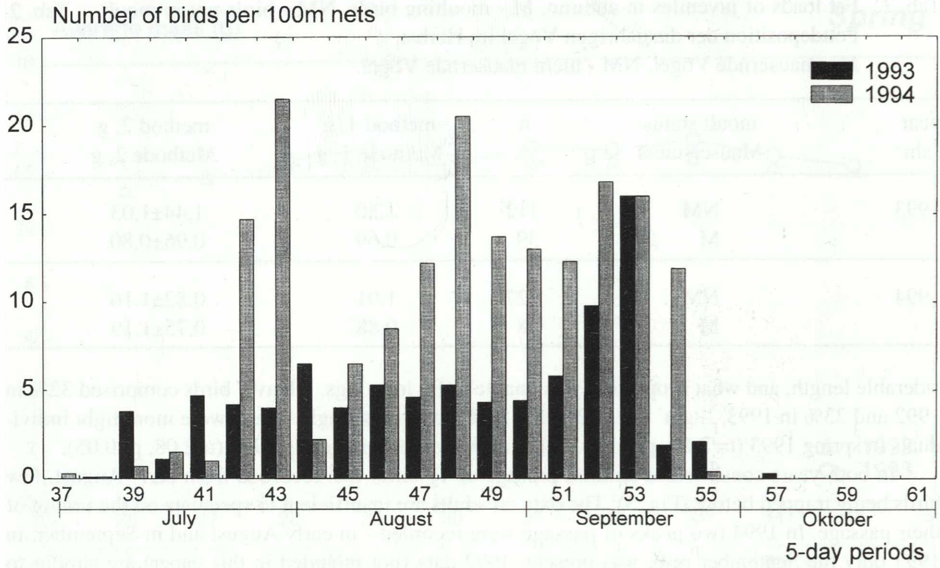

Fig. 3: Autumn trapping pattern of juveniles. Average numbers of Sedge Warblers trapped per 100 m nets per day in different 5-day periods. – Abb. 3: Herbst-Fangmuster der Jungvögel. Durchschnittliche Anzahl der gefangenen Schilfrohrsänger pro 100 m Netz und Tag in verschiedenen Pentaden.

Considerable proportions of heavy individuals in spring suggest that many Sedge Warblers present at the stopover site were ready for the migratory flight. The relationships between body mass and wing-length and between mass and fat load in spring indicate that body mass was dependent on size and the amount of deposited fat. The majority of Sedge Warblers were on passage and not terminating their migration. Though it is impossible to speculate about destinations of individual birds most of them are likely to originate from northern and north-eastern Europe (Table 3).

Ormerod (1990) reported spring masses of Sedge Warblers from Wales (11,8 g, SD=0,6, n=26). Data from both years pooled, Rybachy birds appear to be heavier than those ringed in Wales (t=3.34, p<0.001). Masses of Sedge Warblers killed by lighthouses in Wales (males: 12,16±0,20, n=8, females: 11,37±0,36, n=10, from Baggot 1986) and in the Netherlands (males: 12,3±2,84, n=19, females: 11,5±0,98, n=11, from Cramp et al. 1992) cannot be directly compared to the trapping data but also suggest lower mass of migrants in west Europe.

Several hypotheses could explain large spring mass of Sedge Warblers at the Courish Spit. Rybachy Cape may be an important fattening site for Sedge Warblers. This hypothesis seems to be improbable. The study area is a small (less than 0.5 sq km) reedbed where in some days in spring a large number of Acrocephalus warblers make a stopover. In such days there must be a strong competition for food. Better conditions for foraging are provided by a much larger reedbed at the eastern coast of the Courish Lagoon (several dozens of sq km).

Substantial part of Sedge Warblers in Wales and in the Netherlands are terminating migration and thus have restricted fat loads. Rybachy birds may be facing a long journey, as the Sedge Warbler's breeding range extends to 70° N and far to the east (Cramp et al, 1992). This hypothesis can explain material from Wales, but Dutch birds are likely to include a substantial proportion of migrants. Moderate mass of Sedge Warblers from the Netherlands is left unexplained. Though British

Tab. 3: Ringing recoveries. – Tab. 3: Ringfunde.

Mus. Z. HKI Finland V 290999	ringed 3.09.1986 1y Espoo, Uusimaa Finland 60° 12“ N 20° 49“ E recovered 14.05.1993 Rybachy Kaliningrad Reg. Russia 56° 12“ N 20° 46“ E
Mus. Z. HKI Finland V 637074	ringed 11.08.1988 1y Espoo, Uusimaa Finland 60° 12“ N 20° 49“ E recovered 09.05.1992 Rybachy Kaliningrad Reg. Russia 56° 12“ N 20° 46“ E
Mus. Z. HKI Finland X 299002	ringed 22.08.1992 1y Sarkisalo, Finby (Turku ja Pori), Finland 60° 05“ N 22° 53“ E recovered 29.05.1993 Rybachy Kaliningrad Reg. Russia 56° 12“ N 20° 46“ E
Riga F 263675	ringed 10.08.1990 1y Pape, Latvia 56.10 N 21.03 Erecovered 01.05.1992 Fringilla Kaliningrad Reg. Russia 56° 08“ N 20° 44“ E
Lithuania VL 6347	ringed 5.08.1991 1y Ventes Ragas, Lithuania 55° 20“ N 21° 11“ E recovered 2.06.1992 Rybachy Kaliningrad Reg. Russia 56° 12“ N 20° 46“ E
Moskwa O 612451	ringed 21.08.1992 1y Rybachy Kaliningrad Reg. Russia 56° 12“ N 20° 46“ E recovered 23.08.1992 Ventes Ragas, Lithuania 55.20 N 21.11 E
Moskwa O 639719	ringed 12.05.1993 Rybachy Kaliningrad Reg. Russia 56° 12“ N 20° 46“ E recovered 05.08.1993 Tagliamento/Fuine, Camino al Tagliamento, Udine, Italy 45° 55“ N 12° 55“ E

Sedge Warblers are known to be smaller than east European birds (Cramp et al. 1992), the size difference seems to be insufficient to explain all the mass difference.

Some Sedge Warblers may be caught before crossing a barrier (e.g. the Baltic) and thus need a considerable amount of fuel. It is not impossible, however as yet no recoveries supporting this hypothesis are available. Of five Sedge Warblers recovered in Rybachy, 3 had been ringed in southern Finland, 2 in the Baltic States (Table 3), suggesting that at least some birds passing through the Courish Spit in spring fly to the north-east along the eastern Baltic coast. In spite of extensive ringing in the Baltic states (see reports in Kastepold & Kastepold, 1990, 1991; Kazubiernis, 1987, 1989; Patapavicius, 1982, 1987, 1989) no evidence of other flight direction is available by now.

The average mass was lower in spring 1993 than in 1992. Interannual variations in mass of migrating sylviids are not unusual and may be due to weather, food supply on route etc. (Ormerod et al. 1991). Sedge Warblers use Rybachy Cape for foraging. It is noteworthy because in some days the site seems to be 'overcrowded' with Sedge Warblers and Reed Warblers (Acrocephalus scirpaceus). Nevertheless they manage to forage successfully at Rybachy Cape, as shown by mass increase during the day.

In autumn Sedge Warblers migrate mainly from late July until mid September, with adults departing earlier as was observed in other parts of Europe (Insley & Boswell 1978; Koskimies & Saurola 1985; Leivits & Vilbaste 1990) and Asia (Gavrilov, 1980). A large proportion of juveniles recorded at the Courish Spit has also been reported from South Finland (Koskimies & Saurola 1985) and Estonia (Leivits & Vilbaste 1990). Very high proportions of juveniles in some nocturnal migrants on the autumn passage (over 90%) are reported from several sites and are sometimes believed to be associated with coastal areas (see reviews in Murray 1966 and Payevsky 1985). At the English southern coast the proportion of juveniles and adults is about 4:1 (Insley & Boswell 1978) which is consistent with the population productivity. However, it is not the case in the Baltic coastal sites.

Small autumn trapping numbers in 1993 are probably explained by the low breeding success in this year due to weather factors. Summer 1993 was very rainy in the whole Baltic area, leading to low breeding success in Acrocephalus species (own observations; Feodorov, pers. comm; see also Fiedler 1994). August and September peaks probably reflect juvenile dispersal and true autumn migration, respectively. The lack of the August peak in 1993 may have to do with small numbers of juveniles taking part in the dispersal in the Baltic area.

Adult Sedge Warblers have considerable fat loads suggesting long migration hops and probably quick migration. They leave breeding grounds early and fast, their migratory strategy seems to be different from that of juveniles. Body mass of the latter was slightly lower than this of spring migrants, though in 1993 when both seasons were covered the difference was not significant. Fat loads of spring birds and juveniles in autumn were in the same range in both seasons.

No relationship between wing length and body mass was recorded in autumn. Both moulting birds with low fat reserves and birds in migratory state that had completed moult were present in the samples. Fat loads of moulting juveniles were lower than those not in moult. The process of moult affected the body composition of Sedge Warblers, though post-juvenile moult in this species in the Baltic area is recorded in minor part of individuals and involves small proportion of body feathers (Feodorov 1990, own observations). It is noteworthy, however, that the proportion of heavy individuals was not dependent on moult status, indicating that the effect of moult was not very profound.

Celmins (1990) reported the masses of Sedge Warblers from Pape, Latvia (11,43 g, SD=0,82, n=4014 when 4 years pooled). This figure is smaller than masses of our birds ($t=18{,}8$ $p<0{,}001$). Average masses from different Estonian sites reported by Leivits & Vilbaste (1990) were close to the Rybachy figures. At the site with the most comprehensive data, Haademeeste, average mass was 12,2 g, no SD available. Mass of birds trapped in Finland (Koskimies & Saurola 1985) was different in two sites (Laajalahti, SW Finland: 12,2 g SD=1,0, n=1740; Siikalahti, SE Finland: 11,5 g, SD=0,7, n=1124). Laajalahti birds were very slightly heavier than Rybachy ones ($t=2{,}15$ $p<0{,}05$), Siikalahti ones were lighter ($t=13{,}8$ $p<0{,}001$).

Average mass of Sedge Warblers from northern Italy reported by Spina & Bezzi (1990) (11,43 g, SD=1,55, n=464) was lower than the mass of our birds ($t=8{,}48$ $p<0{,}001$). Wing length of Italian and Estonian birds was the same as in Rybachy. Sedge Warblers from Wales and SW Germany were lighter than Rybachy birds (Wales: 11.2 g, SD=1,2, n=156, from Ormerod 1990; SW Germany: 11,8 g, SD=1,1, n=1196, from Kaiser 1993), differences being significant in both cases (Wales: $t=8{,}72$ $p<0{,}001$) (SW Germany: $t=5{,}67$ $p<0{,}001$).

Wing lengths were available only from Italy (66,9 mm, SD=1,80, n=409, from Spina & Bezzi 1990), and Estonia (66,9 mm, no SD, n=763, from Leivits & Vilbaste 1990). Size seems not to affect mass variation.

Sedge Warblers from several western and central European sites are slightly lighter than at least some Baltic birds. It seems that gaining large fat loads described by Bibby et al. (1976) does not occur everywhere in western Europe. Nevertheless, the difference is slight, and the statement of

CELMINS (1990) that Sedge Warblers do not fatten in the Baltic area, but move to a 'main fattening belt' in central Europe is probably correct. Apparently Sedge Warblers gain fat for autumn migration in favourable areas that are scattered in western Europe, no such areas are so far known in Baltic area.

Two explanations of moderate fat loads of Baltic Sedge Warblers (not mutually excluding) may be suggested. A single flight from the Baltic area to Sahel zone seems to be extremely dangerous if possible, and Baltic birds may need to split their journey. Other reasons may lay in the foraging ecology of the species. Plum aphid is believed to be the main food of Sedge warblers when they fatten-up for the autumn migration (BIBBY et al., 1976; BIBBY & GREEN, 1981). No special study of plum aphid distribution in the Baltic area was undertaken. According to brief observations, these insects are abundant in some Baltic sites (eg. in Haademeeste, Estonia - S. SHULEPOV, pers. comm.), in others they are not (Rybachy, own observations). Baltic Sedge Warblers may need to utilize a broader-based diet than their conspecifics in central Europe. Special study of the diet of Sedge Warblers when fattening-up in the Baltic area is required.

5. Zusammenfassung

Schilfrohrsänger, die im Ostbaltikum gefangen wurden, hatten bedeutende Fettdepots. 23% bis 32% der Vögel waren 'schwer' (d.h. ihr Gewicht lag über 13,0 g), d. h. ein ansehnlicher Anteil der Individuen, die auf der Kurischen Nehrung rasten, sind für lange Flugstrecken bereit. Das durchschnittliche Gewicht der Schilfrohrsänger in Rybachy ist höher als in Westeuropa; wahrscheinlich weil viele ostbaltische Vögel eine längere Zugstrecke vor sich haben. Eine andere mögliche Erklärung ist, daß einige Schilfrohrsänger beim Heimzug die Ostsee queren, obwohl keine Ringfunde, die diese Vermutung bestätigen können, bekannt sind.

Durchschnittliches Gewicht und Größe des Fettdepots der adulten Schilfrohrsänger im Herbst liegen ähnlich wie die Werte vom Frühling. Baltische Schilfrohrsänger legen vermutlich nahe der Brutgebiete keine große Fettreserve an, fliegen aber in mitteleuropäische Regionen, in denen die Fettdepots aufgebaut werden. Es bleibt noch herauszufinden, ob diese Strategie durch Mangel an geeigneter Nahrung oder durch die Notwendigkeit, die lange Strecke vom Baltikum bis zur Sahel-Zone zu unterbrechen, bedingt wird.

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