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Autumn migration strategies of the Sedge Warbler *Acrocephalus schoenobaenus* in northern Italy

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Autumn migration strategies of the Sedge Warbler Acrocephalus schoenobaenus *have been investigated through standardized mist-netting in two reed-beds in Northern Italy (Val Campotto and Palude di Cona) between 1988-90. Data gathered from a total sample of 2,113 birds indicate a clear Scandinavian origin of staging migrants and a consistently earlier passage of adults. Adult birds are larger and seem to be at more advanced stages of fat accumulation than juveniles, which show body mass values well below those proposed for birds ready to take off for long flights. Most birds are trapped during the first hours after dawn; the extremely low local retrapping rate in both sites suggest that freshly landed migrants may soon leave these reed-beds, which seem to be particularly poor in food. The fattening strategy adopted by Sedge Warblers migrating through the Central European flyways surely deserves further investigation in order to clarify how the birds gain adequate reserves to cross the Mediterranean and the Sahara.*

The Sedge Warbler *Acrocephalus schoenobaenus* is a long-distance Palearctic migrant wintering in a vast area of sub-Saharan Africa; the migratory strategy of the species has been quite intensively investigated (Bibby & Green 1981, Koskimies & Saurola 1985). Birds belonging in particular to the British populations migrate to Iberia on their way to the Sahel zone with few long flights; before leaving, they concentrate in key resting reed-bed areas where they largely rely on a single prey species (the Plum Reed Aphid *Hyalopterus pruni*, Bibby *et al.* 1976) to put on large amounts of fat. A strong relationship between density of reed aphids and numbers of fattening Sedge Warblers has been reported also from reed-bed habitats of Southern Finland.

Scandinavian and central-European birds follow a southeasterly route across the Balkans (Christmas *et al.* 1978, Koskimies & Saurola 1985); large numbers of birds fly along a more southerly route, which leads them to cross central Europe, the Italian peninsula and the Mediterranean (Zink 1973).

The Sedge Warbler is a scarce and scattered breeder in Italy, although the species is quite common as a passage migrant both in spring and autumn (Pollo 1992, Meschini & Frugis 1993, Spina *et al.* 1993). Data collected in Val Campotto (Ferrara) have already offered material for a first contribution to the study of the autumn migration of this species in Northern Italy (Spina & Bezzi 1990).

Since 1981 the Sedge Warbler has been the main target species of the EURING Acroproject, a large-scale coordinated project aimed to clarify the role played by reed-beds as staging areas for long-distance migrants (Koskimies & Saurola 1985). The Acroproject started in Italy in 1986 through the coverage of four different sites. Given the drastic reduction suffered by Italian wetlands and reed-beds especially in this century (Cazzola 1987), we aimed to analyse the importance of Italian wetlands for migrating Sedge Warblers, and to investigate the strategy used by birds resting in our country before crossing the Mediterranean and the Sahara.

In this paper we describe and compare the situation recorded in two important reed-bed sites in Northern Italy, where contemporary and standardized ringing has been carried on between 1988 and 1990.

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Study sites

Val Campotto-Vallesanta Nature Reserve (44°35'N, 11°51'E) is one of the most important freshwater wetlands of continental Italy. It is a 1,800 ha protected site under the Ramsar Convention; for a detailed description see Piccoli (1976) and Santucci (1978). A pure reed-bed of *Phragmites australis* has been completely cut across with a 300m board walk to set the nets; a further 162m of nets were set at right angle along the edge of the reed-bed through riverine shrubs.

The Palude di Cona (45°31'N, 12°24'E) is an unprotected marsh at the northern edge of the Venice lagoon, placed between intensively cultivated land and the open lagoon system. The otherwise brackish water of the lagoon has very low levels of salinity thanks to the freshwater supplied by the river Dese, allowing the presence of almost pure reed-bed formations, with scattered alophytic *Limonium serotinum*, *Juncus maritimus* and *Aster tripolium*. A total of 285m of nets were set in the reeds.

MATERIALS AND METHODS

Bird ringing was based on continuous and standardized mist-netting following the methods described by Berthold & Schlenker (1975). Between 1988 and 1990, the nets were operated from dawn to dusk on both sites during the whole month of August, selected as the peak migratory period of Sedge Warblers at our latitudes (Spina & Bezzi 1990). All birds were aged and measured by four highly experienced and calibrated ringers. The main measurements were: wing length (third primary, Berthold & Friedrich 1979, Jenni & Winkler 1989, as well as maximum wing chord, Svensson 1984), tarsus and bill length (Svensson 1984), fat index (0 to 5, Busse 1974), body mass (at 0.1g accuracy).

Seasonal patterns are shown on the basis of standardized 5-day periods (Berthold 1973); overall samples collected during the three years from each of the two stations have been considered in the analysis. Daily trapping patterns are shown on the basis of one-hour periods, although their comparisons are based on two-hours periods, in order to avoid, on statistical grounds, sample units with less than five cases.

A Kolmogorov-Smirnov goodness-of-fit test has been used to check the distributions related to the linear variables considered. Although in most cases these differed from the normal, we relied on a parametric statistical approach, given the large sample size (Fowler & Cohen 1993). A Chi-square test has been used for fat load scores, as well as for comparisons of seasonal and daily patterns. For all tests the SPSS-PC package has been used.

RESULTS

A total of 2,113 Sedge Warblers were ringed in the two stations during the three study seasons. The numbers of juveniles and adults ringed in the different years are reported in Table 1. In all years a higher percentage of juveniles has been recorded in Campotto.

Biometrics

Mean values recorded for the different biometrical variables and referred to the two stations and age classes are reported in Table 2. Adults are in general significantly larger than juveniles (Table 3) which is consistent with the hypothesis of the latter being still in the final stages of development during their first migration. None of the morphometric variables considered differs in a comparison of the data sets collected in the two stations, while both adult and juvenile Sedge Warblers ringed in Cona are significantly heavier and show larger amounts of visible subcutaneous fat than those staging in Campotto (Table 4). Given the geographical cline reported for the species (Williamson 1976, Røstad 1986), the absence of any kind of biometrical difference may suggest a common origin for the birds resting in our two study sites.

Seasonal trapping patterns

The overall trapping patterns in the two sites (Figures 1, 2) show an earlier passage of adults with respect to juveniles in both stations; the relative median dates of passage recorded in our study period for the two age classes from the total as well as yearly samples are reported in

Table 1: Ringing totals

No of trapped birds	*Val Campotto*		*Palude di Cona*	
	juveniles	*adults*	*juveniles*	*adults*
1988	243	73	183	79
1989	216	124	343	218
1990	206	52	253	123
1988-1989-1990	665	249	779	420

Table 2: Biometrical data

Biometrical variables		*Val Campotto* n	mean	SD	med	min	max	*Palude di Cona* n	mean	SD	med	min	max
Maximum wing Chord	juv	644	66.77	1.79	67	61.5	72	740	66.75	1.8	67	60	72
	ad	230	67.19	1.86	67	61.5	72	372	67.12	2.01	67	61	72.5
3rd primary	juv	664	50.43	1.56	50.4	43.5	55	776	50.48	1.47	50.5	45.5	55
	ad	233	50.77	1.54	51	46.5	55	358	50.53	1.71	50.5	45.5	57
Tarsus	juv	659	21.42	0.73	21.5	19	24	684	21.36	0.66	21.5	18.5	24
	ad	246	21.55	0.61	21.5	19.5	23.5	364	21.46	0.68	21.5	18.5	24
Bill	juv	658	14.77	0.59	15	12	17	684	14.78	0.66	15	11	18.5
	ad	248	15.03	0.56	15	13	17	363	15.02	0.6	15	12.5	16.5
Body mass (g)	juv	651	11.05	0.93	10.9	9.2	18	772	11.52	1.13	11.3	8.7	17
	ad	246	11.73	1.35	11.5	9.1	20.4	419	12.02	1.52	11.8	9.2	21.2
Fat (aft. Busse)	juv	666	2.26	1.29	2*	0	5	779	2.56	1.36	2*	0	5
	ad	249	2.61	1.39	2*	0	5	420	2.61	1.54	3*	0	5

* Mode

Table 3. Within-station comparisons between age classes (pooled data)

	Val Campotto		*Palude di Cona*	
Maximum wing Chord	$z = 2.96$	$P < 0.01$	$z = 3.10$	$P < 0.01$
3rd primary	$z = 2.91$	$P < 0.01$	$z = 0.43$	N.S.
Tarsus	$z = 2.47$	$P < 0.05$	$z = 2.20$	N.S.
Bill	$z = 6.08$	$P < 0.01$	$z = 5.77$	$P < 0.01$
Body mass (g)	$z = 8.59$	$P < 0.01$	$z = 6.53$	$P < 0.01$
Fat	$\chi^2 = 14.37$	$P < 0.05$	$\chi^2 = 18.21$	$P < 0.01$

Table 4. Within-age-class comparisons between sites (pooled data)

Z test	*Juveniles*		*Adults*	
Maximum wing chord	$z = 0.28$	N.S.	$z = 0.42$	N.S.
3rd primary	$z = 0.70$	N.S.	$z = 1.77$	N.S.
Tarsus	$z = 1.43$	N.S.	$z = 1.61$	N.S.
Bill	$z = 0.32$	N.S.	$z = 0.30$	N.S.
Body mass (g)	$z = 8.40$	$P < 0.01$	$z = 2.50$	$P < 0.05$
Fat	$\chi^2 = 54.60$	$P < 0.01$	$\chi^2 = 24.00$	$P < 0.01$

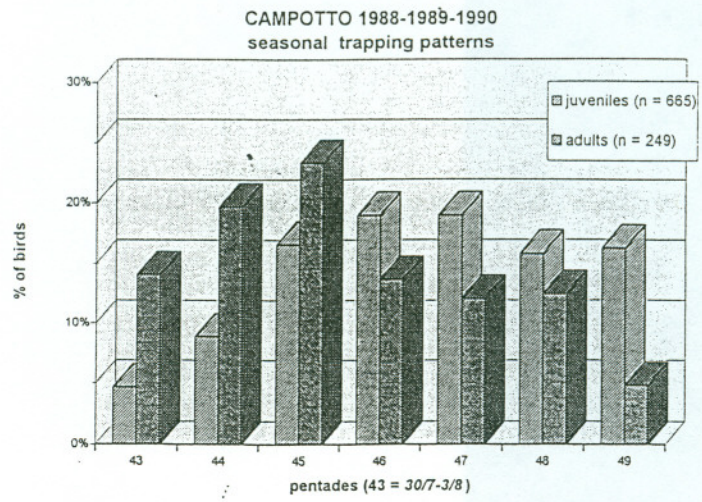

Figure 1. Campotto 1988-1989-1990 Seasonal trapping patterns

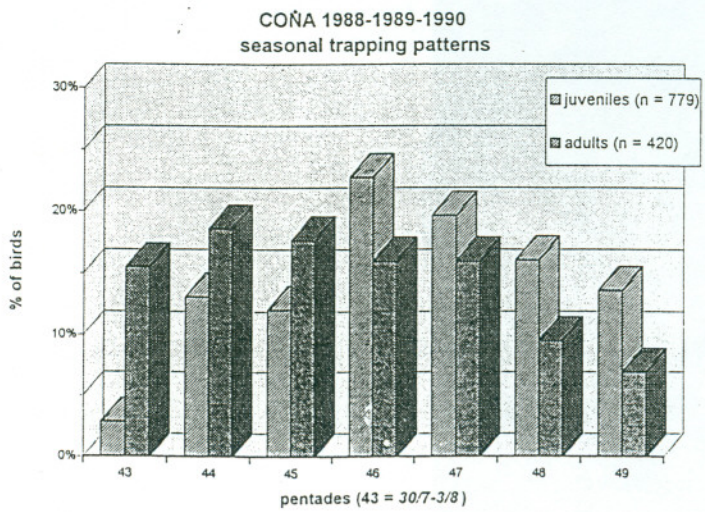

Figure 2. Cona 1988-1989-1990 Sesonal trapping patterns

Table 5. In all cases adults precede first-year birds in their southward migration through northern Italy (Campotto, χ^2 ad. vs juv. = 70.88, $P < 0.001$; Cona, χ^2 ad. vs juv. = 99.15, $P < 0.001$).

When comparing the seasonal trapping pattern for a same age class in the two stations, a significant difference is found in juveniles (χ^2 Campotto vs Cona = 18.82, $P < 0.01$), but not in adults (χ^2 Campotto vs Cona = 7.42, $P = 0.28$).

Although an earlier departure of adults from the breeding grounds is a general feature, in Northern Europe the phenology of adults and juveniles does not show important differences (Bibby & Green 1981), while in more southern latitudes adults have an earlier and more concentrated passage (Bibby & Green 1981, Koskimies & Saurola 1985, Spina & Bezzi 1990). Juveniles also seem to be characterized by less oriented movements in Southern England and in Val Campotto (Insley & Boswell 1978, Spina & Bezzi 1990): this is suggested in our case also by a single bird ringed in Cona and controlled after two weeks at 87km NE.

Table 5. Median date of passage

Median date of passage		*Juveniles*	*Adults*
Val	1988	17 August	13 August
Campotto	1989	17 August	10 August
	1990	21 August	19 August
	88-89-90	19 August	12 August
Palude	1988	24 August	19 August
di Cona	1989	16 August	12 August
	1990	20 August	13August
	88-89-90	18 August	13 August

Daily trapping patterns

The daily trapping patterns of adults and juveniles in the two stations are shown in Figs. 3a - b, 4a - b; the median trapping hour for adults is the second after dawn in both sites, while it is still the second for juveniles in Campotto and the third in Cona.

When testing the hourly distributions of captures of the two age classes in each station, no difference is found in Campotto (χ^2 ad. vs juv. = 7.54, $P = 0.27$), while at Cona adults are significantly earlier than first-year birds (χ^2 ad. vs juv. = 21.03, $P < 0.01$). Significant differences are found also when comparing the trapping patterns of a same age class in the two stations (χ^2 ad., Campotto vs Cona = 18.03, $P < 0.01$; χ^2 juv., Campotto vs Cona = 70.69, $P < 0.001$).

A strong concentration of captures in the first few hours after dawn is quite evident in both stations. In Cona relatively more birds are trapped also later in the day, including the central hours, with a further slight increase before dusk, which might account for the observed differences. Such activity patterns are similar to those reported by Brensing (1989) from three German stations; also in that case one site showed a higher incidence of captures before dusk. The pattern recorded in Campotto does not differ from that already described for 1986 (Spina & Bezzi 1990).

Daily variations in body mass values

A positive regression of body mass during the day has been found for both age classes in Cona (ad. $r = 0.275$, $P < 0.001$; juv. $r = 0.257$, $P < 0.001$); in Campotto only juveniles show a slight tendency to the increase (juv. $r = 0.108$, $P < 0.01$; ad. $r = -0.029$, $P = 0.648$).

This low but significant daily increase recorded in Cona can be the explanation for the observed difference in mean body mass values calculated from the overall samples collected in the two stations (Table 2); as a matter of fact, if we only take into account birds trapped within the first hour after dawn (ie most likely freshly landed migrants, given the very low retrapping rate, see below), no difference in mean body mass is recorded for either of the two age classes (ad., $z = 0.78$, $P = 0.435$; juv., $z = 1.69$, $P = 0.0914$).

Fat loads

The values of mean fat scores in the two stations and for the two age classes are reported in Table 2, while Figure 5 a - d shows the seasonal pattern of this variable related to the distribution of captures. In both sites adults show higher mean values than juveniles (χ^2 Campotto, ad. vs juv. = 14.37, $P < 0.05$; χ^2 Cona, ad. vs juv. = 18.21, $P < 0.01$). When comparing the two stations, significantly higher fat levels are recorded in Cona for both age classes (χ^2 ad., Campotto vs Cona = 24.00, $P < 0.01$; χ^2 juv., Campotto vs Cona = 54.60, $P < 0.01$). As for seasonal patterns, no significant trends have been observed either for the two stations or age classes. The larger

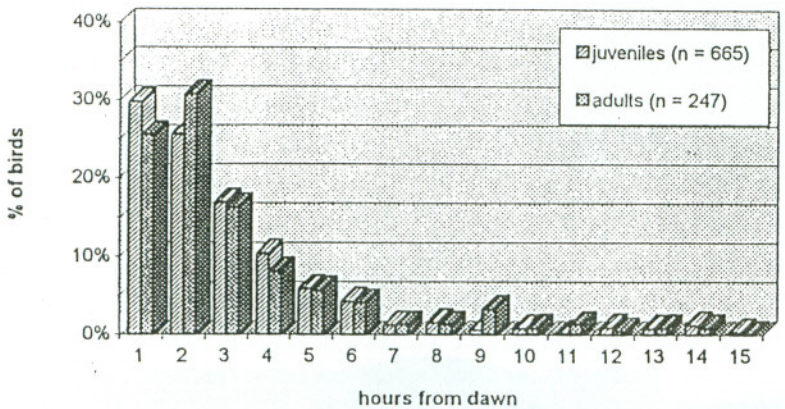

Figure 3a. Campotto 1988-1989-1990 Daily trapping patterns

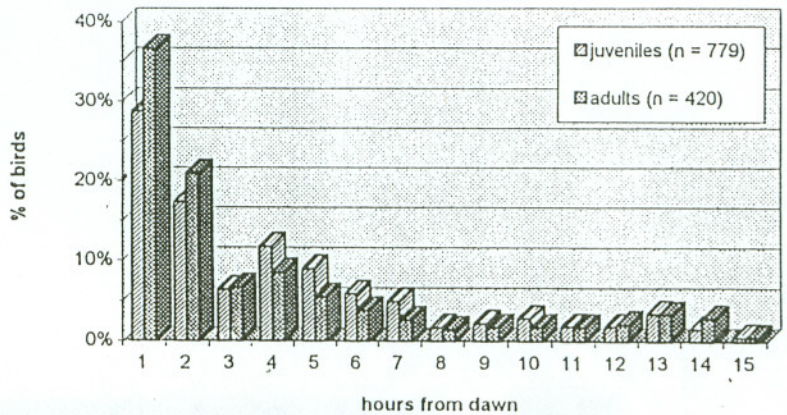

Figure 3b. Cona 1988-1989-1990 Daily trapping patterns

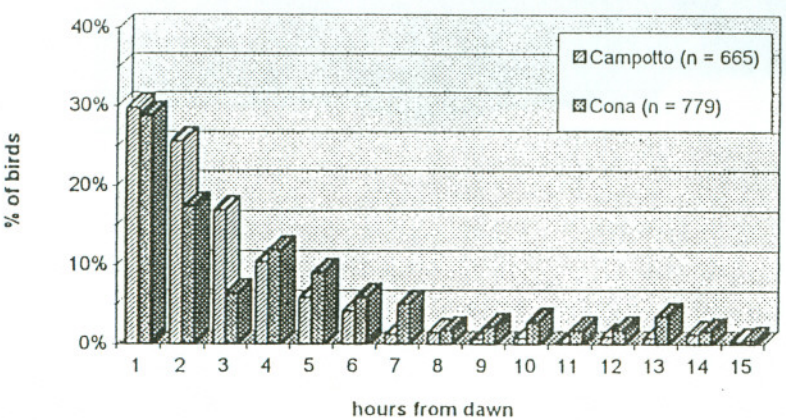

Figure 4a. Young Sedge Warblers 1988-1989-1990 Daily trapping patterns

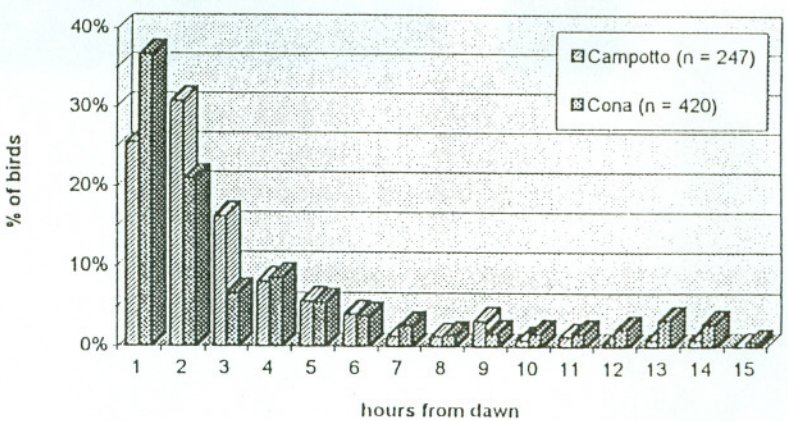

Figure 4b. Adult Sedge Warblers 1988-1989-1990 Daily trapping patterns

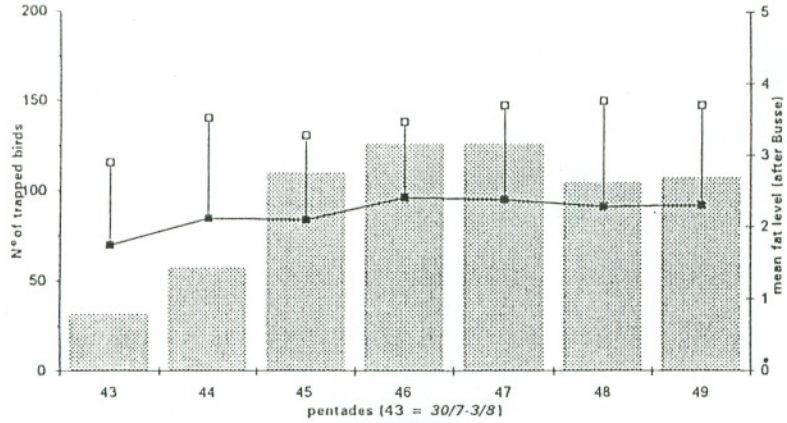

Figure 5a. Campotto 1988-89-90 Young Sedge Warblers

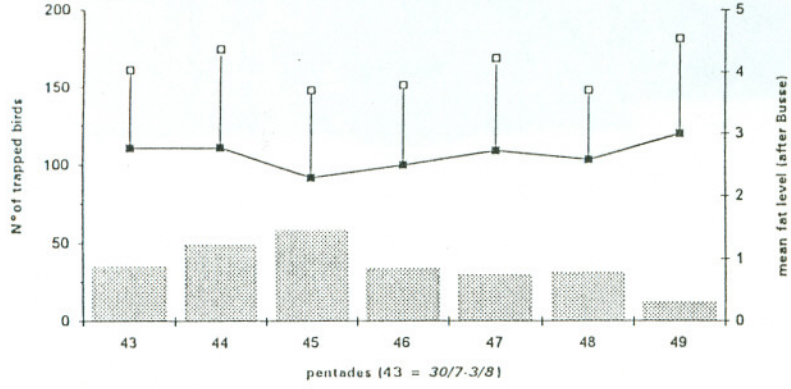

Figure 5b. Campotto 1988-89-90 Adult Sedge Warblers

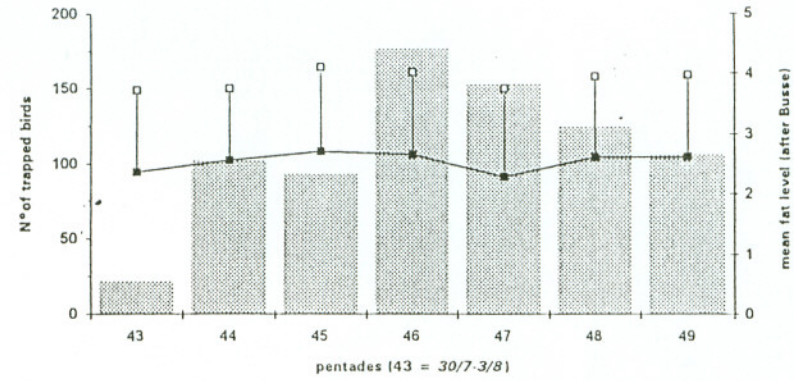

Figure 5c. Cona 1988-89-90 Young Sedge Warblers

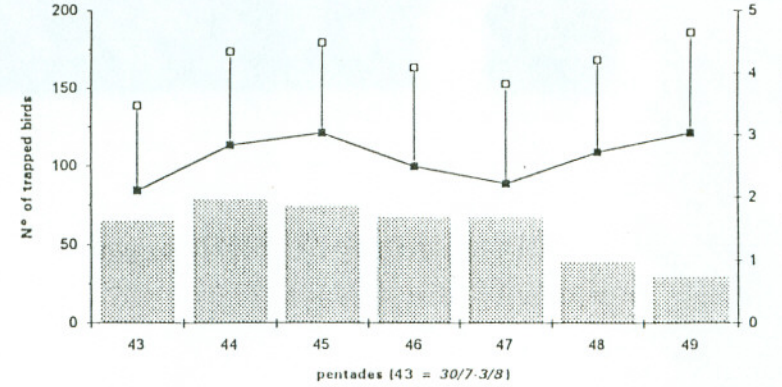

Figure 5d. Cona 1988-89-90 Adult Sedge Warblers

amounts of fat carried by adults might support the hypothesis of a better feeding efficiency and/or higher levels of fat accumulation at departure from the breeding grounds. When comparing the physical conditions of migrants resting in our stations with those of other European sites, a particularly low percentage of captures is represented by birds over the threshold of 13g, suggested by Bibby & Green (1981) to define 'clearly fat' individuals (Campotto: ad. = 8.5%, juv. = 2.6%; Cona: ad. = 15.8%, juv. = 8.2%).

Retraps of ringed birds

An extremely low local retrapping rate has been experienced in both sites. When taking into account the minimum stopover duration of three days as suggested also by Bibby & Green (1981) to evaluate possible variations in body mass, percentage values as low as 0.11% and 1.75% are recorded for Campotto and Cona respectively. Important fattening areas in Southern England and Southern Portugal show much higher percentages of retraps (between 2% and 30%, Bibby & Green 1981).

Controls of ringed birds

A clear Scandinavian origin of birds resting in both stations is shown by the list of direct controls collected during our three years of activity (Table 6). The hypothesis of a prevalent N-S migratory direction followed by birds moving across Central Europe had already been tested and confirmed in Val Campotto on the basis of field experiments based on Emlen funnels (Spina & Bezzi 1990).

Table 6. Origin of foreign recoveries

Origin of recovery	*Val Campotto*	*Palude di Cona*
Sweden	7	6
Finland	2	2
Estonia	1	-
Latvia	-	1
Holland	1	-
Denmark	1	-
Morocco	-	1

DISCUSSION

The two selected study sites represent a typical example of continental wetlands of Northern Italy, with large relict reed-beds which in summer are characterized by an almost complete absence of reed aphids (Spina & Bezzi 1990, Panzarin & Cester, *unpubl.*). Although large numbers of Sedge Warblers mainly of Northern European origin use our reed-beds as staging areas during their autumn migration, these habitats do not seem to play an important role as fattening areas when compared to other key sites along the Western European route. Only minor daily increases in body mass have been recorded, while most migrating birds seem to stopover for very short periods, as indicated by both the extremely low retrapping rate and the daily trapping patterns observed in both stations. Adult birds are larger than juveniles and seem to be in more advanced stages of fat accumulation, although both adults and first year birds show body mass and fat score values well below those proposed from other areas for birds ready to take off on prolonged flights. Similar apparently critical conditions had been reported from one of our sites on the basis of an analysis referred to a single year (Spina & Bezzi 1990); our larger sample confirms that further effort is still needed in order to clarify the strategies adopted by Sedge Warblers migrating through Central Europe. Despite being already relatively close to the northern limit of a major ecological barrier represented by the central Mediterranean, these birds show moderate to low amounts of fat, and yet our northern Italian wetlands, although regularly used by staging Sedge Warblers, do not act as fattening areas. Improved ringing activities along the southernmost Italian coasts and in North Africa might provide crucial information on the physical conditions of birds ready to cross the Mediterranean and the Sahara respectively.

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