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Spring weights and fat deposition of palaearctic passerine migrants in Senegal

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This paper compares the patterns of weight and fat-class of Palaearctic passerine migrants trapped at two sites in Senegal in spring 1986. Despite considerable variations in some species (Reed Warbler *Acrocephalus scirpaceus* and Subalpine Warbler *Sylvia cantillans*) the great majority of the birds trapped had weights well above the breeding and wintering levels and showed clear evidence of premigratory fattening. In the Yellow Wagtail *Motacilla flava* and Chiffchaff *Phylloscopus collybita* some individuals weighed more than twice as much as others. Mean values of fat-classes of first captures and retraps differed significantly. Species could be divided into two different groups: (a) those (Sand Martin *Riparia riparia*, Yellow Wagtail and Pied Wagtail *M. alba*) with small variation in fat classes (12%-23%), and (b) those (Chiffchaff, Subalpine Warbler, Reed Warbler and Redstart *Phoenicurus phoenicurus*) showing a high variation in fat-class (39%-55%). Birds of the first group had a significantly higher mean fat-class than those of the second group. The possible reasons are discussed.

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INTRODUCTION

Since the pioneering work of Morel & Roux (1966, 1973) on Palaearctic passerine migrants in Senegal, there has been little research on this subject. The Senegal should be a fattening area for migrants in spring before they cross the desert in one long hop, or in shorter hops and fattening in oases (Bairlein 1985, Biebach *et al.* 1986).

This paper presents weights and fat-classes of 11 migrant passerine species obtained during a four week study in Senegal in March/April 1986, immediately prior to migration to the Palaearctic. This is a rather severe period in Senegal when the last marshes dry up in temperatures in excess of 42°C.

METHODS AND STUDY SITES

Senegal belongs to the semi-arid Sahel zone, an *Acacia/Commiphora* grassland and bush savanna, immediately south of the Sahara. This thorn-belt marks the northernmost limit of the movement of the Inter-tropical Convergence Zone (ITCZ), where rain falls in only two or three months of the year (annual mean 300-500 mm, Hubert *et al.* 1973). In Senegal the vegetation zones are very compressed, so that one passes from the Sahel in the north to the Sudan in the middle and the Guinea-zone in the south even though the country extends over only 450 km from north to south (Figure 1).

Data were collected during the course of 30 ringing sessions using mist nets from 16 March to 6 April 1986. Nets were checked at least every 15 minutes. Birds were transported to our camp where species, sex (if possible), biometric measurements, weights (to the nearest 0.1 g) and fat-class were recorded. The amounts of visible fat were scored according to Busse & Kania (1970) and Petterson & Hasselquist (1985) (0 = no visible fat to 6 = whole belly covered with a thick layer of fat). Fat deposits were estimated visually on the birds' bellies and in their tracheal pits. The measurement techniques adopted were according to Svensson (1984).

Usually (except a few wagtails caught in the very late evening) birds were weighed and released within 2-3 hours of capture. This might account for losses of body weight through capture stress. Two ringers assisted in recording data. In order to minimize effects of between-observer variation, regular calibrations were made.

Except for Tree Pipit *Anthus trivialis* and Redstart, almost all birds were caught in the Senegal valley (Figure 1). All weights are morning weights, except for the Wagtails which were weighed in the evening. Moult was recorded according to the scale in Kasparek (1981) and Bub (1985): 0 = old feather; 1 = feather missing or feather germ; 2 = "pencil" stage (germ burst); 3 = feather about half grown; 4 = feather nearly grown; 5 = fully grown new feather. Abbreviations: S = secondary; T = tail-feather.

In order to compare weights with observations of other authors mean weights of species are regarded as 100%. Data from literature (mean weights) are compared with my own data and expressed as a relative percentage. The study was conducted at the following sites, shown in Figure 1.

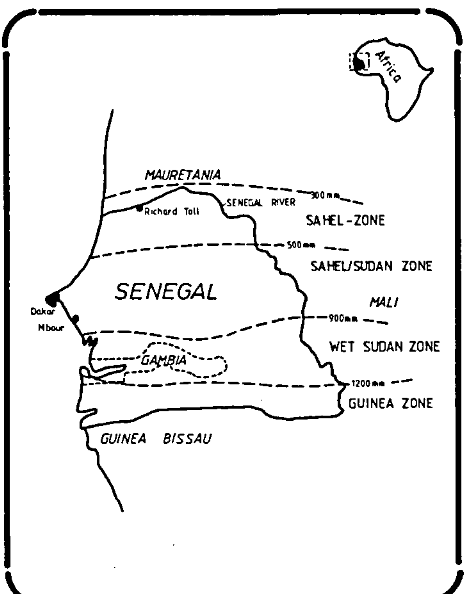

FIGURE 1. Map of Senegal and the surrounding countries with the two stopover sites (Richard Toll, Mbour) where passerine migrants were trapped. The vegetation zones are indicated by lines of equal rainfall.

Richard Toll (16°25'N 15°42'W)

This area belongs to the bush savanna ecosystem of the lower Senegal valley near the Mauretanian border. Due to man's recent activities (overgrazing, clearance of woodland and scrub) the area is almost completely denuded of higher trees. Sixteen trapping sessions (07.00-10.00 hrs) took place along an old course of the Senegal river 5 km W of Richard Toll. Vegetation consisted of scattered shrubs (mainly non spiny bushes such as *Tamarix senegalensis* and *Salvadora persica*) along the waterline. Nine trapping sessions at wagtail roosts (1900-2100 hrs) were undertaken in sugar cane *Sacharum officinale*.

Mbour (14°25'N 16°50'E)

This area belongs to the transition zone between Sahel and Sudan, situated at the coast and 60 km SE of Dakar. Trapping took place in the garden of the Station Geophysique (ORSTOM) with plenty of dense shrub and single trees. The garden area is situated immediately at the shoreline. Five trapping sessions were made between 2-6 April.

RESULTS

Body-weights and fat-classes of species of which a sufficient number were trapped are given in Table 1.

TABLE 1. Body weights and fat classes of palaearctic passerine migrants trapped in Senegal in March-April 1986.

Species	*Mean weight (g) ±S.D. (range in brackets)*	*Fat-class, score, 0-6 (range in brackets)*	*Number of birds*
Sand Martin	13.9±0.9 (12.6 -14.8)	5±0.6 (4 - 6)	6
Swallow	15.5 (12.4 - 18.2)	1 (0 - 3)	5
Tree Pipit	24.6 (17.8 - 27.5)	5.1 (0 - 6)	7
Yellow W'tail	18.8±3.0 (13.1 - 27.5)	4.9±1.1 (2 - 6)	122
Pied Wagtail	24.4±2.9 (20.2 - 28.6)	5.2±1.2 (3 - 6)	6
Sedge W'bler	11.4 (8.6 - 13.7)	4 (1 - 5)	4
Reed Warbler	10.1±1.7 (8.1 - 16)	2.9±1.6 (0 - 6)	50
Orp'n Warbler	17.1 (16.5 - 18.4)	1.4 (1 - 2)	5
Sub'ne W'bler	10.3±1.7 (7.8 - 13.2)	3.8±2.1 (0 - 6)	19
Chiffchaff	8.2±1.5 (5.6 - 12.6)	4.2±1.6 (0 - 6)	36
Redstart	15.4±2.7 (11.9 - 20.9)	3.4±1.7 (1 - 6)	13

Sand Martin *Riparia riparia*

Senegambia is probably the main wintering area for this species after the Lake Chad region (Glutz 1986). Return passage culminates in March/April with thousands of birds passing even as late as 15 May. In the 1960s there were gigantic roosts along the shore of Lac Guier which is 15 km SW of Richard Toll (Morel & Roux 1966, Moreau 1972). Today, the situation has changed markedly. There are no more extensive reed beds along the northern shore of Lac Guier, but east of it vast sugar cane fields of up to 40,000 ha are to be found. We recorded a maximum of 30,000 birds. The mean weight of the 6 birds which were trapped was 19% (2.6 g) and 26% (3.0 g) higher compared with spring birds found in Southern Morocco and Lybia (Ash 1969, Erard & Larigauderie 1972). No primary moult was recorded. Two birds showed moult of body plumage.

Swallow *Hirundo rustica*

There is almost no wintering of this species and northward passage is not evident before February/March (Morel & Roux 1966). The species was commonly seen feeding in desert areas even during the hottest hours of the day.

Mean weight of the 5 birds trapped was within the known range of spring migrants at the northern edge of the Sahara (Ash 1969, Erard & Larigauderie 1972). No moult was observed.

Tree Pipit *Anthus trivialis*

There is evidently a small winter population in Senegal with many passage birds appearing in February/March (Morel & Roux 1966, Moreau 1972). Except for single records in gardens of Richard Toll we recorded up to 10 individuals per day in the Mbour garden. One bird ringed between 1 and 6 April was observed until 26 April indicating a longer stay for feeding (Rouchouse pers. comm.).

Mean weight of the birds trapped was 26% (6.4 g) and 17% (4.4 g) higher than spring birds at the northern edge of the Sahara (Ash 1969, Erard & Larigauderie 1972), but 16% (3.9 g) lower than Nigerian spring birds (Smith 1966). Except one bird without any fat at all, birds trapped had very high subcutaneous fat deposits. No moult was observed.

Yellow Wagtail *Motacilla flava*

Senegal holds a large winter population with big roosts in the Senegal valley (Morel & Roux 1966). The species was the most abundant palaearctic migrant and was widespread in open fields, especially near water. A number of small and large roosts (up to 2000 individuals) were found in the sugar cane plantations SW of Richard Toll. The species was often associated with millions of weaver birds Ploceidae while roosting. Different subspecies were determined according to the coloured illustrations in Bub 1981. The proportions were ($n = 148$) : *M. flava flava* (89%); *M. flava iberiae* (8.5%); *M. flava flavissima* (2.5%). The male/female ratio was 1 : 1.2. Males and females differed highly significantly in weight (*U*-Test; $z = 5.6$); fat score ($z = 4.4$, see Figure 2); and wing-length ($z = 6.8$, Table 2). Males were, on average, 14.7% heavier than females.

TABLE 2. Weight, fat-class and wing length of male and female Yellow Wagtails. Mean values, standard deviations and ranges (in brackets) are given.

	Mean Weight (g)	*Fat-class* (0-6)	*Wing-length* (mm)	*n*
Male	20.4±2.9 (15.2–27.5)	5.4±0.9 (3.0–6.0)	81.5±2.7 (70–86)	56
Female	17.5±2.4 (13.1–24.1)	4.5±1.1 (2.0–6.0)	78.2±2.1 (73–86)	66

One hundred and two (84%) of the birds showed clear evidence of premigratory fattening by the fat-class 4-6. There were no birds without any fat (fat-class 0-1). 16% of the birds trapped showed moult of the head plumage.

Adult mean weight was 13% (2.5 g) and 14% (2.8 g) higher than Nigerian winter birds (Wood 1978, Smith & Ebutt 1965) and 22% (4.2 g) higher than Southern Moroccan spring birds (Ash 1969).

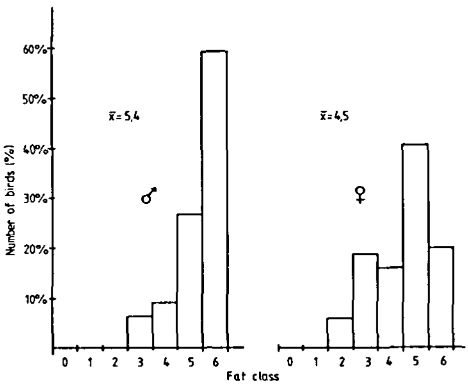

FIGURE 2. Frequency distribution of fat classes of male and female Yellow Wagtails.

Pied Wagtail *Motacilla alba*

In Senegal there is a resident winter population; there is evidence that it is derived from Iceland (Morel & Roux 1966). Within the Yellow Wagtail roost numbers of Pied Wagtails were often found. The ratio between Pied and Yellow Wagtails was 1:20-1:50. All but one of the 6 birds trapped had remarkably high weights and fat-classes.

Sedge Warbler *Acrocephalus schoenobaenus*

There is at most only a small winter population in Senegal. Return passage is noted in March/April with small numbers until the beginning of May (Morel & Roux 1966). In contrast to the Reed Warbler this species was only locally common and confined almost exclusively to water edges.

The mean weight of the 4 birds trapped is within the range of the normal winter weights in east Africa (Pearson 1971, Pearson *et al.* 1979, Loske & Lederer 1988), but 17% (1.9 g) higher than spring birds after the Sahara crossing (Ash 1969).

Reed Warbler *Acrocephalus scirpaceus*

The Senegal valley is, at most, a wintering area of minor importance for Reed Warblers. Spring passage occurs in March with small numbers passing until early June (Morel & Roux 1966). The species was independent of reed-beds and most common in dense Tamarisk scrub near water. One bird was even trapped in dense sugar cane.

Although 10% of the birds were "heavy" (>13 g, Bibby & Green 1981), only 18 birds (36%) showed clear evidence of fattening, whilst 12 individuals (24%) had almost no fat. Mean weight in the Senegal valley is between 3% (0.2 g) and 17% (1.7 g) lower than available spring data from Lake Chad and Uganda (Dowsett & Fry 1971, Fry *et al.* 1972, Pearson 1971). After Subalpine Warbler, this species showed the highest variability in fat-class. Retrap data indicated weight loss for three out of the four birds (Figure 3). Four individuals (8%) showed active moult as follows:

(1) Left T1–5:5; T6:2
Right T1–4:5; T5:3; T6:2

(2) T1:2; T2:3; T3:4; T4–6:0 simultaneously

(3) Left T1–5:5; T6:2
Right T1–6:5
Body moult to 50%

(4) Left wing : S1–3:5; S4–5:3; S6:1; S7–9:0
Right wing : S1–3:5; S4–6:3; S7–9:0

Orphean Warbler *Sylvia hortensis*

In Senegal some birds stay in the northern parts, but most move a little further south. Spring passage takes place from March to early May (Morel & Roux 1966, Moreau 1972). All birds seen and trapped were confined to areas dominated by *Salvadora persica*, a tall shrub. There was almost no evidence of premigratory fattening and no bird exceeded fat-class 2. February birds from the Niger area were much heavier ranging from 20.3 g – 22.8 g (Jones pers. comm.) No moult was observed.

Subalpine Warbler *Sylvia cantillans*

In Senegal and Mauritania the species is common in winter wherever there are bushes and trees. Spring passage is noted from February onwards to early May (Morel Roux 1966, Gee 1984). Concentrations were mainly confined to areas with *Tamarix senegalensis* and *Acacia nilotica.* At our trapping site with *Tamarix* bushes the species was outnumbered only by Reed Warbler and Chiffchaff.

As in the Reed Warbler there was a high variation in weight and fat-class with four birds (21%) without almost any fat and twelve individuals (63%) with distinct fat deposits. Two birds (10.5%) showed active moult:

(1) S1–4: 5; S5:2; S6–9:0 simultaneously;
tail left : T1:0; T2–3:4; T4–5: 0; T6:3;
tail right : T1–6:0;
body moult to 70%

(2) Body moult to 20%

Chiffchaff *Phylloscopus collybita*

Outside the Mediterranean, Senegambia is probably the main winter quarters of chiffchaffs in West Africa. Spring passage seems to be short with the majority of the birds passing through in March and very few staying until April and early May (Morel & Roux 1966, Moreau 1972). The species was widespread in damp spots mainly frequenting places with *Tamarix senegalensis* and *Acacia nilotica* near water. According to Schonfeld (1978) at least 6 (46%) males belonged to the eastern race *abietinus.*

Twenty six birds (72%) showed clear evidence of premigratory fattening, while 4 (11%) had almost no signs of fat. Some weights reported are as high as any recorded elsewhere. Mean weight was 23% (1.9 g) higher than in Southern Moroccan birds (Ash 1969). No moult was observed.

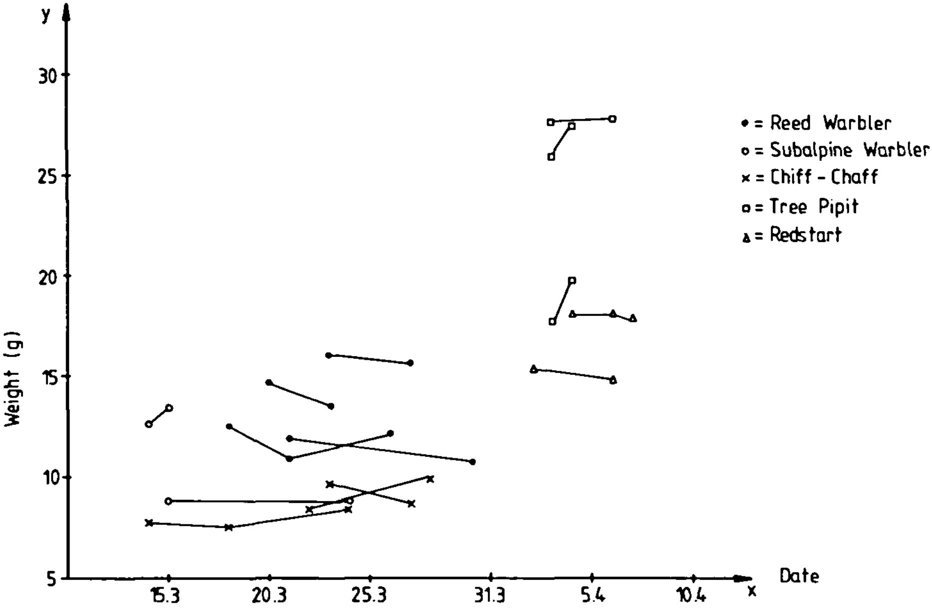

FIGURE 3. Weight changes of five passerine migrants retrapped in Senegal ($n=14$).

Redstart *Phoenicurus phoenicurus*

There is a large winter population in Senegal and spring passage is noted until early May (Morel & Roux 1966). The species was widespread wherever higher vegetation occurred and most numerous in riverine *Acacia* woodland. Passage was very marked at the coast where about 100-150 individuals were counted on 1 April around the Mbour station, giving a density of 3.3 – 5 birds/ha. Interspecific competition (with Tree Pipits) was commonly observed.

Males clearly predominated and I estimated the male/female ratio to be 2–3:1. This agrees well with authors from Africa (Smith 1966, Ash 1969, Haas 1974). According to Blondel's (1967) wing-lengths some of the birds seem to derive from eastern Europe.

Four birds (31%) had considerable fat deposits and one bird had almost no fat. Mean weight is 4% (0.6 g) and 15% (2.3 g) higher than Lake Chad and southern Moroccan spring birds respectively (Dowsett & Fry 1971, Ash 1969), but slightly lower (2% 0.3 g) than Central Nigerian spring birds (Smith 1966). No moult was observed.

DISCUSSION

The distribution and migration patterns of most Palaearctic migrant species which occur in Senegal are still very imperfectly understood. In all, the main exodus for the species investigated occurs in March/April (Morel & Roux 1966). The scarcity of ringing recoveries makes it impossible to predict the precise Palaearctic breeding areas of the birds trapped during this investigation, but present indications suggest that they mainly derive from the western Palaearctic (but see Chiffchaff and Redstart).

It is well established that Palaearctic passerine migrants show a dramatic increase in body weight prior to migration, both in autumn and spring. The premigratory weight gain is almost entirely due to the deposition of fat, which is the main source of energy during long-distance flights of migrating birds (Berthold 1975, Bairlein 1985).

Despite the considerable variation in some species, especially Reed Warbler and Subalpine Warbler, the great majority of birds trapped in Senegal had weights well above the breeding and wintering levels and showed evidence of premigratory fattening. Senegal therefore must serve at some time of the year as an important fattening area where migrants replenish their fat reserves before crossing the desert belt. In some species, notably the Yellow Wagtail and the Chiffchaff, some individuals weighed more than twice as much as others. In the species for which comparative data are available (Reed Warbler and Tree Pipit), mean Senegal weights are 11% – 26% higher than those birds trapped in other places having crossed the Sahara in spring.

TABLE 3. Correlation between wing-length and weight in migrant passerines trapped in Senegal in March-April 1986.

Species	*Number of birds*	*Spearman's correlation coefficient,* r_s	*P*
Yellow Wagtail	122	0.38	***
Reed Warbler	50	0.36	*
Subalpine Warbler	19	0.30	n.s.
Chiffchaff	36	0.12	n.s.
Redstart	13	0.08	n.s.

Intraspecific weight differences may result from variation in body size (associated with differences in wing-length). In the present study positive correlations were obtained for the five species with sufficient data (Table 3), out of which two were significant. Fat-classes therefore should give better measures of migratory habits, independent of body size.

Retrap data are needed for the study of fat deposition. However the number of retraps were too low for an analysis of fat deposition, even when all species were pooled. Seven birds with weight gains are offset by another seven individuals with weight losses (Figure 3). Only the Tree Pipit showed definite weight gains, while both gains and losses were obvious in the other species.

Ringing provided an indication of the ability of certain individuals to recognise the stopover site. Nine of the fourteen retraps (Reed Warbler, Subalpine Warbler, Chiffchaff) were made near Richard Toll. The birds were ringed and released in the camp, 6 km from the trapping site. Two of the nine birds were even retrapped twice (Figure 3). Such behaviour would be expected to be associated with an abundant food suppy, which seemed to be the case at the ringing site. Everywhere in the Tamarisk bushes we found small insects, with almost all migrants feeding in the cooler morning hours.

Bairlein (1985) has divided passerines grounded at Saharan oases in autumn into two groups of different patterns of fat deposition. In this investigation the picture is not conclusive. Birds trapped with high fat deposits were recaught more often and the proportion of birds with weight gains was more clearly in high initial fat-classes. On the other hand stopover was longer in birds with lower initial fat-classes (Table 4). Besides, mean values of fat-classes of the first captures ($\bar{x}=3.85\pm1.85$ g; $n=124$) and retraps ($\bar{x}=4.76\pm$ 1.4 g; $n=17$) differed significantly (U-Test; $z=2.5$, $P<0.05$).

TABLE 4. Percentage of retrapped birds, mean minimum length of stopover (days) and percentage of birds with weight gain for different fat classes. Due to the small sample size, lower fat - classes are omitted.

initial fat class	*percentage retrapped (retraps in brackets)*	*mean minimum stopover (days)*	*percentage of birds with weight gain*
3 - 4	7.4 (4)	7	25%
5 - 6	18.7 (9)	3.2	55%

Two different groups of species were recognised.

(1) those with small variation in fat-classes (12-23%) Sand Martin, Yellow Wagtail, Pied Wagtail.

(2) those showing a high variation in fat-classes (39-55%): Chiffchaff, Subalpine Warbler, Reed Warbler and Redstart.

Birds of the first group had a significantly higher mean fat class ($x=4.9$, $n=134$) than those of the second group ($x=3.5$, $n=117$; U-Test; $z=6.5$ $P<0.01$). The observed differences might reflect lack of synchrony in fattening-up in some species. This may be due to the arrival of lighter birds and mixing of different populations with different migration patterns. However, there was some evidence that the turnover rates of individuals were not excessive. However, these differences could suggest that some species are fattening disproportionately and possibly — for the population as a whole — to a lesser extent than others. As almost nothing is known about the origins of the Senegal birds, it is uncertain whether the species of the second group with high fat-variations and lower mean fat-classes are fattening disproportionately because of a closer expected end of migration. According to Biebach *et al.* (1986) it might well be that individuals of some bird species crossing the Sahara have the choice between intermittant migration or non-stop migration, depending on environmental conditions.

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