# SEASONAL AND DIURNAL VARIATION OF WEIGHT IN FOUR PASSERIFORMES IN AUTUMN AND WINTER

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ABSTRACT - During four years of ringing activity, we collected data on seasonal (autumn and winter) and diurnal variations in body weight in four species of passerine birds (Robin *Erithacus rubecula* - Wren *Troglodytes troglodytes* - Dunnock *Prunella modularis* - Blackcap *Sylvia atricapilla*). Among the populations of the first three species, resident from October to March, we recorded a continuous increase in body weight, even when the environmental temperature was rising in Febraury and March. This pattern of weight variation is different from that observed in trans-Saharan migrating passerines, and in cold climates wintering birds. We also recorded a weight increase during the day, due in part to the storage of lipids utilized during the nightime rest.

KEY WORDS: Passeriformes / weight / fat / variation / wintering period

Many data on year-round variations in the body weight of birds are now available. Most of these data, however, refer to neartic passerines which migrate over long or mean distances (Odum 1960, Helms and Drury 1960, King 1963, King 1972, King and Mewaldt 1981) or to Paleartic passerines migrating over long distances (Gladwin 1963, Curry-Lindahl 1963, Ash 1969, Fry *et al.* 1970, Moreau and Dolp 1970, Pearson 1971, Pearson *et al.* 1979). Only seldom researches have been done on weight variations of European Passeriformes migrating over short distances and wintering in the Mediterranean area (Herrera 1981). Unlike trans-Saharan migrants, they do not perform long, continuous flights, so it is likely that they have a different way of storing up lipidic reserves (Pennycuick 1969, Wood 1982).

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We recorded the seasonal and diurnal variations in weight of the Robin *Erithacus rubecula*, the Wren *Troglodytes troglodytes*, the Dunnock *Prunella modularis* and the Blackcap *Sylvia atricapilla*, in order to determine the changes in body weight in species or populations wintering at mean latitudes.

## MATERIALS AND METHODS

The data were collected over four years of ringing activity during non-reproductive periods (October to March, 1976-1980) in an area of about four hectares near S. Piero a Grado, Pisa (Central Italy), 43° 40' N, 10° 18' E (for a detailed description see Benvenuti and Ioalé 1980). Captures were performed by mist-nets set up in fixed positions, and active in one or two days per week. The birds were weighed in the first few minutes after capture by means of a dynamometric scale (0.25 g approximation) and ringed (rings from the Istituto Nazionale di Biologia della Selvaggina). No estimate was performed of the amount of fat. Some of the birds were released on the capture site; the others were released at various distances, to investigate their homing behaviour. It may be presumed that any decrease of their weight due to the return flight had only a slight influence on the data, both because the dislocations were short and because the recapture times were quite long.

In non-displaced birds recaptured more than once on the same day, their weight was recorded only if they had been recaptured after at least four hours. In calculating seasonal variations, the weight of the birds recaptured less than seven days after the previous capture were not considered. Data on temperature were obtained from a weather station 10 km away from our study area.

## RESULTS

### Seasonal variations

Table I and Fig. 1 show the average weight and the trends of variation for the species studied. Even if the graphs for the four species follow different courses, increases in body weight were recorded for all of them from October to January, when body weight is at a maximum; then it remained constant in the Wren, it decreased markedly through February and March in the Robin, and it decreased slightly in the Dunnock and the Blackcap. Table II shows the weight in October and January.

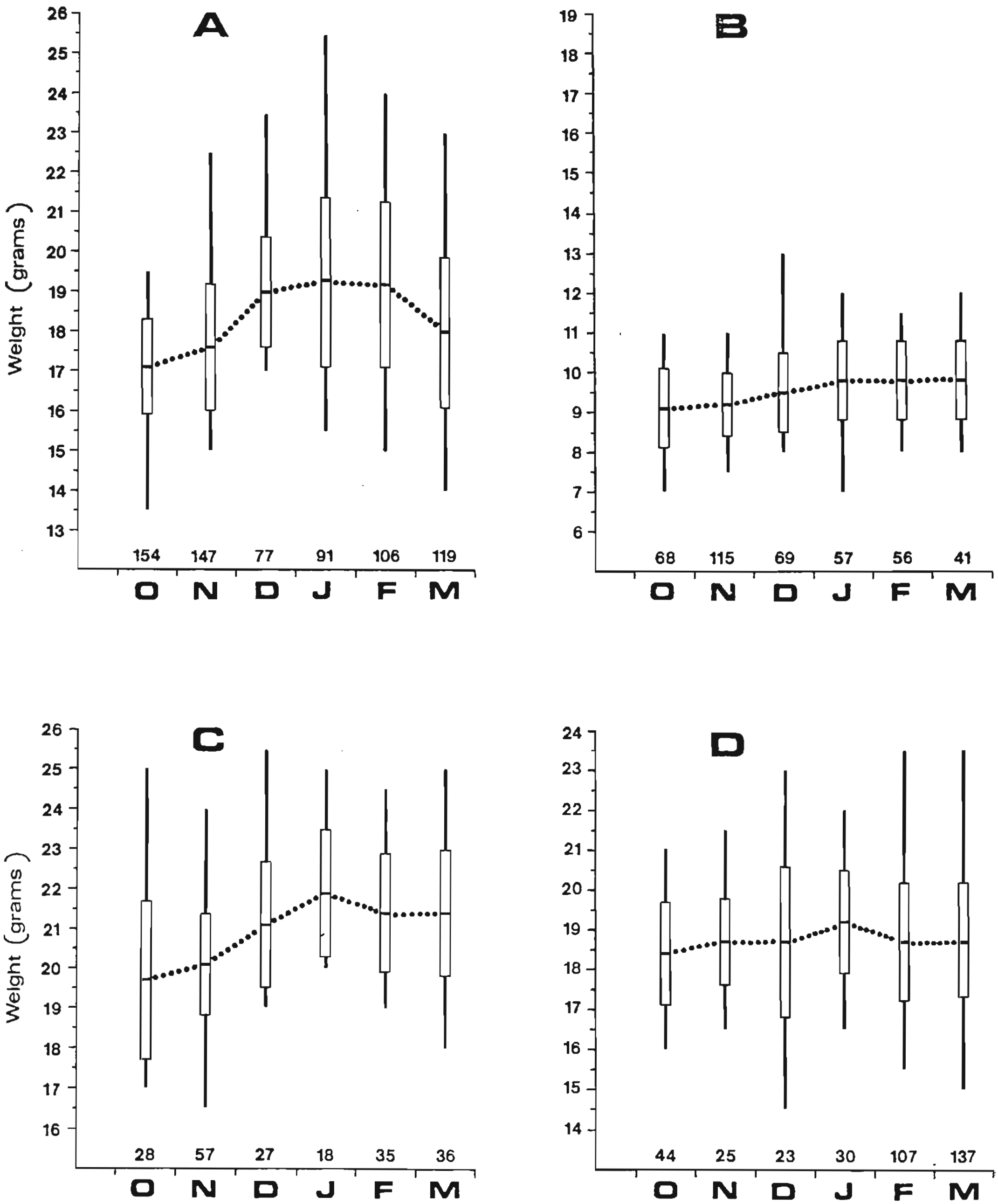


Figure 1 - Variation in body weight from October to March (A=Robin, B=Wren, C=Dunnock, D=Blackcap). The horizontal short lines show the average weight for each month, the vertical lines indicate the ranges and the rectangles the standard deviations. The number of records is shown at the bottom.

TABLE I - Average weight of the four species between October and March.

| | No. of birds ringed | No. of weights recorded | Mean weight | (±) S.d. |
|---|---|---|---|---|
| Robin | 487 | 694 | 18.2 | 1.9 |
| Wren | 161 | 407 | 9.4 | 0.9 |
| Dunnock | 117 | 201 | 20.8 | 1.6 |
| Blackcap | 219 | 364 | 18.8 | 1.5 |

TABLE II - Average weight of the four species in October and January.

| | Mean weight in October (in g) | Mean weight in January | Difference | Difference (%) |
|---|---|---|---|---|
| Robin | 17.0 | 19.2 | + 2.2 | + 12.9 |
| Wren | 9.1 | 9.8 | + 0.7 | + 7.7 |
| Dunnock | 19.6 | 21.8 | + 2.2 | + 11.2 |
| Blackcap | 18.3 | 19.1 | + 0.8 | + 4.4 |

Table III shows the composition of the population present in December and March in the study area. The Blackcap is not present in the table because already ringed birds of this species were very rarely recaptured; in any case, we found a considerable addition of new individuals during February and March, as in the other three species. In the Robin, we repeatedly recaptured a certain number of birds from October to March; Fig. 2 shows a continuous increase in their weight.

In Robin, Wren and Dunnock, the species repeatedly recaptured, we were able to record the variations in weight of birds captured in different months but at the same time of the day (this allowed the effect of circadian variation in body weight to be eliminated). The sign test on these data (+ means an increase in weight the following month, and - a decrease; Siegel, 1956) gives: Robin 18+/4- ($P = 0.002$); Wren 17+/4- ($P = 0.004$); Dunnock 10+/1- ($P = 0.006$). Clear tendency for weight to increase was found even in February and March in those birds we discovered to have stayed in the study area for at least two months: Robin 10+/2- ($P = 0.019$); Wren 9+/1- ($P = 0.011$).

TABLE III - Captures of already ringed and new birds, in December and March.

| | December | | | March | | |
|---|---|---|---|---|---|---|
| | Already ringed birds | New birds | New birds (%) | Already ringed birds | New birds | New birds (%) |
| Robin | 51 | 54 | 51.4 | 42 | 95 | 69.3 |
| Wren | 58 | 20 | 25.6 | 35 | 14 | 28.6 |
| Dunnock | 22 | 10 | 31.3 | 18 | 24 | 57.1 |

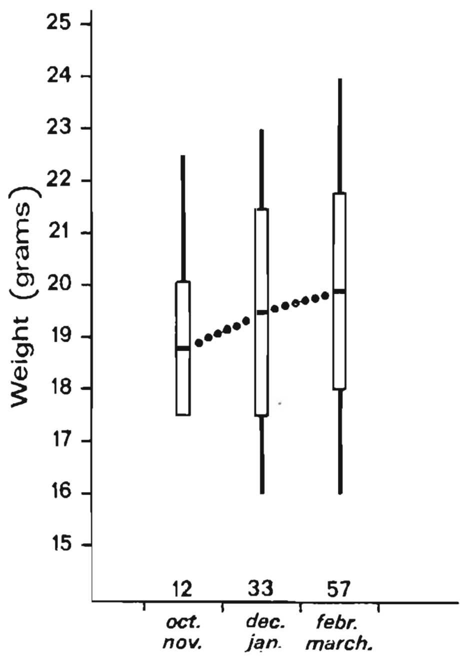


Figure 2 - Increase in body weight of the Robin in three periods of the trapping season, for birds recaptured after at least two months. Other explanations as in Fig. 1.

## Diurnal variations

Figure 3 shows the variations in body weight from morning to evening in the four species; the records were pooled every day in three periods of 3h and one of 4h. Table IV shows in detail the variation in weight for

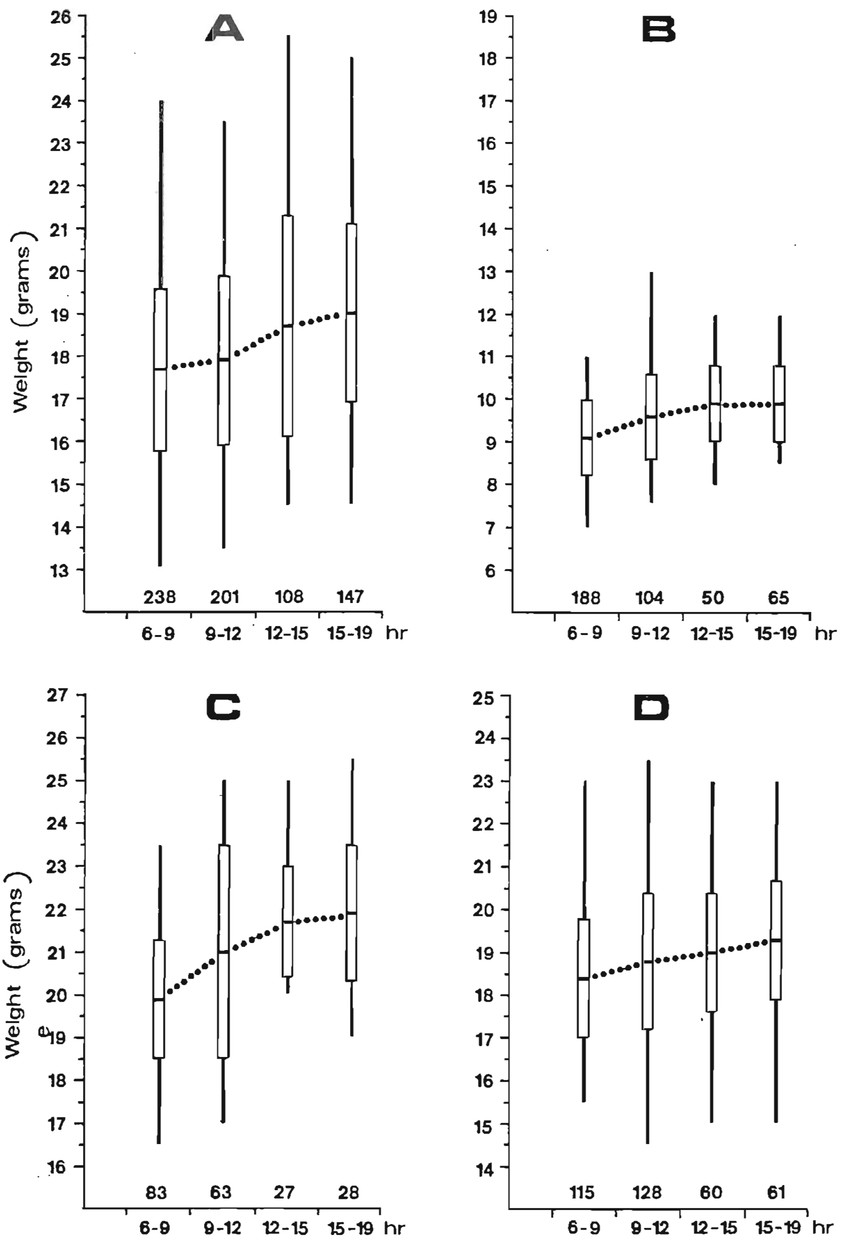


Figure 3 - Diurnal variation in body weight during autumn and winter (A = Robin, B = Wren, C = Dunnock, D = Blackcap).
Other explanations as in Fig. 1.

each of the four species from morning to evening. In the individuals recaptured more than once in the same day, the sign test on weight variation shows: Robin 13+/1- (P = 0.001); Wren 12+/2- (P = 0.006); Dunnock 7+/0- (P = 0.008); Blackcap 8+/1- (P = 0.02).

TABLE IV - Diurnal variation in body weight of the four species.

| | Mean weight (in g) 6.00 to 12.00 | Mean weight 12.00 to 19.00 | Difference | Difference (%) |
|---|---|---|---|---|
| Robin | 17.7 | 19.0 | + 1.3 | + 7.3 |
| Wren | 9.0 | 9.8 | + 0.8 | + 8.9 |
| Dunnock | 19.8 | 21.8 | + 2.0 | +10.1 |
| Blackcap | 18.3 | 19.2 | + 0.9 | + 4.9 |

## DISCUSSION

Major seasonal changes in weight of wild birds are due to fat storage (Odum and Perkinson 1951, King and Farner 1959); however in small trans-Saharian migrating passerines, almost 20% of the premigratory weight increase in early spring must be attributed to hypertrophy of the flight muscles (Fry *et al.*, 1970). Fat storage during the winter seems to be absent or very low in migrants wintering to the south of the Sahara (Ward 1963, 1964, Pearson 1971). Similarly, Pearson *et al.* (1970) found that weight was constant in water birds wintering in Kenya. Only on the very eve of departure or during the spring migration to the South of the Sahara, heavy weights were found (Pearson 1971); some species, like the Sedge Warbler *Acrocephalus schoenobaenus*, accumulate lipids very rapidly (Pearson *et al.* 1979).

On the other hand, other data indicate that fat storage during the wintering period is very common among birds wintering in cold climates (King and Farner 1966). The storage of subcutaneous fat is not only a precious reservoir of energy for birds heading for adverse food conditions, but also a very good thermal insulator. For example, Helms and Drury (1960) report that some North-American buntings reach their maximum body weight during the coldest winter period (2nd half of January - 1st half of February); then their weight goes down before the spring migration. An inverse correlation between environmental temperature and body weight has often been found in various species; this lead to the widespread belief that temperature is the main control factor. However, recent researches (see King 1972 for a review, Biebach 1977) suggest that this interpretation is not generally valid. In the species we studied, weight changes do not always reflect changes in ambient temperatures. In fact we think that the fall in weight observed throught Febraury and March is due to the fact that in this period most captutured birds are migrants, whereas in December and January almost the whole population is wintering. As a matter of fact, the percentage of birds never captured before increases considerably in February and March (Tab. III). Moreover, Fig. 2 shows that wintering Robins increase their average weight until the spring migration begins. The sign test, applied to the specimens of Robin, Wren and Dunnock which had certainly stayed in our area for at least two months, showed a general tendency for weight to increase even in February and March. This confirms that the decrease in average weight in this period is due to the arrival of migrating birds and not to true decrease in body weight of the wintering birds.

In conclusion, our data show that at least in the Robin, and probably also in the Wren and the Dunnock, the weight of the wintering individuals continues to rise in Febraury and March, when the average temperature is rising too.

About diurnal variation in body weight, Helms and Drury (1960) and Helms (1963) believe that in *Spizella arborea* and *Junco hyemalis*, and generally in small Passeriformes, the weight increase during the first two or three morning hours ($\sim$ 50% of the total increase) is mainly due to ingested food. After that time a constant quantity of food stays in the digestive tube, so that the increase in weight recorded during this part of the day should be mainly attributable to lipid storage. If so, about a half of the diurnal weight increase seems to be due to the food ingested and the other half to fat storage.

The diurnal increase in lipidic reserves is clearly an effective way of storing energy to be utilized during the nightime rest. This mechanism is very common among passerine birds wintering in high and mean latitudes (Steen 1958, Brooks 1968, Evans 1969, Helms and Smythe 1969, Barnett 1970); other species store great amounts of food in their crop in order to go through the night (e.g. *Lagopus lagopus* in Alaska, Irving *et al.* 1967). During the day we recorded an increase in body weight, which occurs at similar rates in the four species studied, and which is in agreement with the data on other Passeriformes (Nice 1938, Owen 1954, Helms e Drury 1960). Nevertheless, every species shows distinctive peculiarities. In the Robin, the increase is small in the first morning hours, great in the central day hours and then small again till full weight is reached at sunset. The Wren, on the other hand, reaches its maximum weight between 12 and 3 p.m.; its weight then stays unchanged till sunset. In the Dunnock, the increase is fast and continuous from sunshine till the early afternoon, but maximum weight is reached at sunset. Lastly, in the Blackcap, we found a small but constant increase throughout the daytime. These differences may be due to differences in food strategies and/or to the speed of lipid storage.

## RIASSUNTO


VARIAZIONI STAGIONALI E GIORNALIERE NEL PESO DI QUATTRO SPECIE DI PASSERIFORMES IN AUTUNNO E INVERNO

Durante quattro anni (1976-1980) di attività di inanellamento da Ottobre a Marzo, abbiamo raccolto dati sulle variazioni stagionali e giornaliere del peso corporeo in quattro specie di passeriformi (Pettirosso, Scricciolo, Passera scopaiola, Capinera) che svernano nella macchia e nel bosco mediterranei. La Fig. 1 mostra (A = Pettirosso, B = Scricciolo, C = Passera scopaiola, D = Capinera) la relazione fra il peso corporeo (in grammi) ed il periodo dell'anno da Ottobre a Marzo; vengono riportati il numero dei pesi registrati, il peso medio, la deviazione standard (rettangoli verticali) e l'intervallo di variazione (linee verticali) per ciascun mese. La Fig. 2 mostra la relazione fra peso corporeo e periodo dell'anno nei Pettirossi svernanti ricatturati due o più mesi dopo la prima cattura. La diminuzione del peso medio registrata in Febbraio e Marzo è dovuta probabilmente all'arrivo di uccelli migratori (Tabella 3; already ringed birds = uccelli già inanellati ricatturati in Dicembre e Marzo; new birds = uccelli catturati la prima volta in Dicembre e Marzo). Risulta quindi che gli uccelli che passano tutto l'inverno nell'area di studio aumentano di peso fino a Marzo, anche quando aumenta la temperatura ambientale. Le variazioni stagionali di peso sono diverse da quelle osservate in specie di Passeriformi migratori trans-Sahariani e di quelli svernanti in climi freddi.

In Fig. 3 è rappresentata la relazione, nelle quattro specie, fra peso corporeo e periodo del giorno (sulle ascisse sono riportati i quattro gruppi di ore in cui sono state divise le giornate di cattura). Tutte le specie mostrano un aumento di peso nel corso del giorno; circa la metà di questo aumento è probabilmente dovuta ad accumulo di lipidi per superare la notte.

RESUME

VARIATIONS SAISONNIERES ET JOURNALIERES DU POIDS DE QUATRE PASSEREAUX EN AUTUMNE ET HIVER

En quatre années (1976-1980) de baguage effectuée pendant la période d'hivernage (Octobre-Mars) on a recueilli des données sur les variations saisonnières et journalières du poids corporel de quatre petits passereaux (Rouge-gorge, Troglodyte, Accenteur mouchet et Fauvette à tête noire) qui sont communs dans la brousse et le bois méditerranéens pendant l'automne et l'hiver. La Fig. 1 montre (A = Rouge gorge, B = Troglodyte, C = Accenteur mouchet, D = Fauvette à tête noire) les variations du poids (en grammes) de Octobre à Mars; pour chaque mois on a donné le numero des poids enregistrés, la moyenne, la deviation standard (rectangle vertical) et l'intervalle de variation des poids (ligne verticale). La Fig. 2 montre la variation du poids corporel des Rouge-gorges hivérnants repris au moins deux mois après la première capture. La diminution du poids moyen enregistrée en Février et Mars est probablement due à l'arrivée des oiseaux migrateurs (Table 3, already ringed birds = oiseaux précédemment baguagés repris en Décembre et en Mars; New birds = oiseaux capturés pour la première fois en Décembre et en Mars). Il s'ensuivre donc que les oiseaux, hivernants dans l'emplacement d'étude, augmentent leur poids jusqu'à Mars, même lorsque la température du milieu augmente. Les variations saisonniéres du poid sont differentes de celles des passereaux migrateurs trans-Sahariens , et des oiseaux hivernants dans les climats froids.

La Fig. 3 montre la relation entre poids corporels des quatre espèces et la période de la journée (sur l'abscisse on a reportées les quatre tranches du jour dans lesquelles on a divisé les journées de prise). Toutes les espèces montrent une augmentation de poids dans le cours de la journée; probablement a peu près la moitié de cette augmentation est due à une accumulation de lipids à utiliser pendant la période de repos nocturne.

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