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Weight variations of adult Marsh Warblers *(Acrocephalus palustris)* during the breeding cycle

By Françoise Dowsett-Lemaire and Pierre Collette

Weight studies of adult birds during the breeding cycle are very few (RICKLEFS 1974), and merely point out an increase in ♀ weight just before and during egg-laying (e. g. NICE 1937) and a decrease in the weight of both sexes when feeding the young (e. g. NEWTON 1966). More recently, WINKEL & WINKEL (1976) examined weight variations of adult Pied Flycatchers *(Muscicapa hypoleuca)* during part of the breeding cycle; they were dealing with a larger sample than in previous weight studies, but their data were restricted to the brooding and nestling stages. Here, in parallel to a population study of individually marked Marsh Warblers *(Acrocephalus palustris)* by F. D.-L., we are able to examine weight variations in greater detail since the stage of breeding of each bird caught was known exactly from its arrival to its departure. The interpretation of some of the results remains tentative, however, since at certain stages our sample is rather limited.

1. Material and methods

The study area is situated near Liège, eastern Belgium, and consists of a few hectares of dry filled-in land covered with a dense herbaceous growth dominated by *Urtica dioica,* and with some scattered small trees, clumps of *Rubus* and *Polygonum cuspidatum.* The breeding population of Marsh Warblers varied annually between 35 and 62 pairs in the period of study — 1974 to 1977. All birds caught were colour-ringed, weighed and measured. F. D.-L. was helped by P. C. for most ringing sessions in 1974 and 1975, and by J. ROSSI in 1976 and 1977.

Weights were measured with a 30 g spring balance to the nearest 0.1 g. Birds were caught either in the early morning, from 5.00 to 8 or 9.00 hrs (GMT + 1), or in the evening, from 18.00 to 20 or 21.00 hrs. 40 ♀♀ out of a total of 159, and 81 ♂♂ out of 256 were caught in the evening. Overnight losses of individual birds (n = 15) show an average difference of 1.0 g between evening and morning weights; throughout this paper, evening weights have been reduced by 1.0 g and are considered together with morning weights. The catching effort was maximum at the beginning of the cycle to mark the newly-arrived birds, and fewer ringing sessions were organised at later stages when more time was required for direct observation; thus the sample is not uniform in time. The catching success for ♂♂ is higher than that for ♀♀, especially at the beginning of the cycle when playback of the species's song was used to attract ♂♂ into the net; only some ♀♀ responded to playback.

Sexes were identified from differences in the feathering of the abdomen and shape of the abdomen and cloaca, these identifications being checked by direct observations of the birds' behaviour. ♀♀ develop a brood patch only from the start of laying and do not start refeathering it before the young of their single brood become independent. But even at the very beginning of the cycle, it is possible to distinguish sexes since ♀♀ present a fairly round abdomen and large, flattish cloaca, whereas ♂♂ show a protuberant cloaca and also a small protuberance on the lower abdomen accentuated by two blue veinlets. No identification made in this way was proved wrong by later observations, so that spring migrants were also sexed with this method. ♂♂ are also longer-winged on average than ♀♀: ♂ wings average 69.9 mm against 68.5 mm in ♀♀, the difference being highly significant (Student's $t = 9.4$, $P < 0.001$). However, the zone of overlap is quite large (Table 1), which would make this method of sexing rather unreliable. CATCHPOLE (1967) found a more narrow overlap between wing-lengths of ♂ and ♀ Reed and Sedge Warblers *(Acrocephalus scirpaceus* and *schoenobaenus)* in a British population. The wing was measured flattened against the ruler, as in method No. 2 described by SVENSSON (1975). Fat levels in the furculas were measured in a 5-degree scale: 0 (no fat), 1 (traces), 2 (half full), 3 (just full), 4 (furculas more than full and overflowing).

2. The breeding cycle

Some characteristics of the Marsh Warbler breeding cycle in connection with the observations discussed below are summarized briefly here. Fuller data will appear elsewhere (DOWSETT-LEMAIRE in prep.).

Marsh Warblers do not spend more time on the breeding grounds than is just necessary to raise their single brood. ♂♂ establish a territory as soon as they arrive, and most of them get mated a day or two later. The nest is built by the ♀ alone, and most ♀♀ take 4 days to do so,

Tab. 1 Range and distribution of wing-lengths (in mm) of adult Marsh Warblers *(Acrocephalus palustris);* n = 269 ♂♂, 169 ♀♀ — Häufigkeitsverteilung der Flügellängen adulter Sumpfrohrsänger.

	64	65	66	67	68	69	70	71	72	73	74
♂♂				8	52	56	60	56	27	4	6
♀♀	1	3	13	23	48	42	21	16	2		

starting on the day following their arrival. ♂♂ display actively for 2 or 3 days with a maximum intensity on the day prior to the laying of the first egg, when copulation seems to take place. Most ♀♀ start laying a day or two after the nest is completed, thus 6 or 7 days after their arrival on average. 9% of clutches consist of 3 eggs, and 46 and 45% of 4 and 5 eggs respectively. Incubation starts at the laying of the third egg in 3 and 4-egg clutches, and at the laying of the third of fourth egg in 5-egg clutches; it lasts from 12 to 13.5 days. Only ♀♀ brood at night, but ♂♂ brood as much as ♀♀ by day. On average, both sexes share the feeding of the nestlings equally. Feeding rates increase with the age of broods to reach a maximum of 22—23 feeds per hour from the age of 7 days. Most broods leave the nest at the age of 10 or 11 days. The brood is then divided between the parents who feed the same young until they reach independence at the age of 26 to 31 days. Practically all adults disappear as soon as their young are emancipated, and most of them are then in a state of active body moult. The peak of arrivals is recorded in the second half of May, and there is evidence that the „autumn" migration starts as early as in the second week of July.

3. Weight variations in females (Fig. 1)

♀ weights vary considerably during the breeding cycle, showing a high peak at the beginning of laying, and a smaller one at the end of incubation (Fig. 1).

On arrival, the range of weights is fairly large. There is a mixture of lean and fat individuals, as in the spring migrants, which only pass through the study area. Migrant birds are not overall fatter than local breeding birds: this is not surprising since, once they reach Belgium, Marsh Warblers are practically at the western limit of their range.

At the beginning of the nest-building stage, none of the birds caught 6 or 7 days before the start of laying showed any increase in the size of the abdomen (suggesting the preparation of a clutch), nor did, probably, the only ♀ caught 5 days before. But all 4 birds caught 4 days before the laying of the first egg presented a noticeable swelling of the abdomen, so that the average weight increase (13.9 g against 12.8 g at the beginning of nest-building) is probably significant. The rapid phase of ovarian growth is also known to take about 4 days in birds of comparable size like a tit *Parus* sp. (RICKLEFS 1974). In our Marsh Warbler population however, 2 ♀♀ are known to have prepared a clutch within 3 days: one started to lay a 5-egg clutch on 28 june (1977) 3 days after entering the territory and pairing up, and another started to relay a 3-egg clutch on 11 July (1975), 3 days after her previous clutch was destroyed. At that time of the season, food is of course abundant, and more so than in May when such a performance might not be possible. Intervals of 4 days between a ♀'s arrival (or clutch destruction) and the start of laying are known in at least five cases in this study.

Weights increase most noticeably in the last 2 days before the first egg. Theoretically, weights should not increase any further after the laying of the first egg, but our sample is very small, and 2 of the 3 ♀♀ caught weighed in fact just as much as some birds caught the day before (E-1). Weights then decrease sharply, but ♀♀ are still heavy at the beginning of incubation (I 1/3), soon after laying their last egg, probably because the ovaries and oviduct have not had time to deflate yet. In the middle of incubation (I 2/3), some ♀♀ fatten up considerably (on the 7th or 8th day), the 2 highest weights being 14.9 and 15.6 g with fat levels in the furculas of 3 and 4 respectively. ♀♀ are generally quite heavy at the end of incubation, 4 of the 7 birds caught having fat levels of 3 or 4.

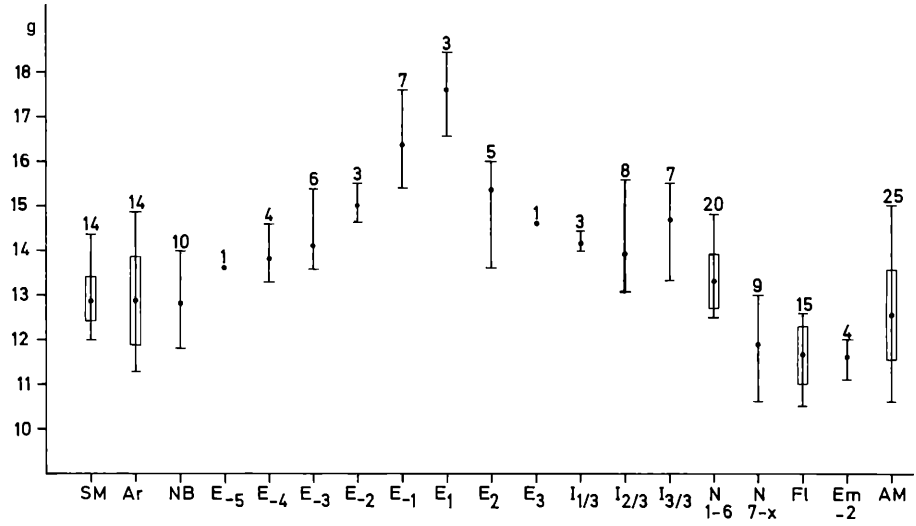

Fig. 1. Weight variations of ♀ Marsh Warblers *(Acrocephalus palustris)* during the breeding cycle. Weights on the day of arrival (Ar) are compared to those of spring migrants (SM). The other symbols read: NE = nest-building (beginning); E-5 . . . E-1 = from 5 to 1 day before the start of egg-laying; E1 . . . E3 = laying of the first . . . third egg; I 1/3 . . . I 3/3 = incubation period divided into 3 parts of 4 days each except I 3/3 (4 days or more); N 1—6 = the first 6 days of the nestling period; N 7—x = the second part of the nestling period; Fl = the fledgling period, except the last 2 days before emancipation (Em-2); AM = autumn migrants (July). Vertical lines show the range on each side of the mean (dot); standard deviations are indicated for samples of 14 birds or more; sample sizes are written above each measurement. — Abb. 1 — Gewichtsvariation weiblicher Sumpfrohrsänger *(Acrocephalus palustris)* während der Brutzeit. Gewicht von Frühjahrs- (SM) und Herbstdurchzüglern (AM) und von Brutvögeln am Tage der Ankunft (Ar), zu Beginn des Nestbaus (NB), 5 bis 1 Tag(e) vor Eiablage (E -5 bis E -1), am Tage der Eiablage des 1. bis 3. Eies (E1—E3), während des ersten, zweiten und dritten Drittels der Bebrütung (je 4 Tage — I 1/3, I 2/3, I 3/3), während der ersten 6 Nestlingstage (N1—6), während der zweiten Hälfte der Nestlingszeit (N 7—x), während der Ausfliegeperiode der Jungen (Fl), ausgenommen die letzten zwei Tage vor dem Selbständigwerden (Em—2).
Punkt: Mittelwert, vertikaler Strich: Spannweite, Rechtecke: Streuung.

These reserves are quickly used up during the feeding of the nestlings, particularly after the 7th day when the feeding effort is maximum (N 7-x). ♀♀ remain lean during the fledgling period, and the 4 birds caught in July a day or two before they left the breeding grounds were not fat either. Their weights are, however, within the range of weights of autumn migrants caught in July: it is in this category that we find the largest individual variations. There is no reason to suppose, however, that birds have to deposit much fat at this early stage, since they will find many suitable feeding places in their long journey across Europe before having to fly over the dry Near East and Red Sea area.

26 retraps of individual birds conform to the general pattern of Fig. 1. For instance, one ♀ weighing 13.2 g on arrival (with fat level of 3) reached 16.0 g the day before laying her first egg, and declined to 13.4 g at the beginning of the nestling stage. Another one lost 4.7 g between the end of incubation and the time her young were 22 days old (15.6—10.9 g). Two ♀♀ lost 4.1 and 5.9 g respectively between the day prior to the laying of the first egg (when they weighed 16.0 and 17.0 g respectively) and the last day of the fledgling period, just before leaving the area.

4. Weight variations in males (Fig. 2)

Overall, ♂ weights vary little during the breeding cycle, showing only a slight peak in the middle of the incubation period (Fig. 2).

As for ♀♀, weights of local breeding birds on arrival are comparable to those of spring passage migrants, and show large individual variations. Some fat individuals lose their overweight in the following days when they are still unmated (Ce) or pair up (Pa), so that the average weight in these categories has decreased slightly. From then on, weights remain unchanged until the beginning of incubation. They increase on average by 0.8 g (from 12.9 to 13.7 g) in the middle of incubation (I 2/3), to decrease again towards the end (I 3/3) by the same amount. It is not clear why weights should decrease in the last days of incubation; this might be an arterfact due to the small sample. Only 2 birds were caught twice during incubation: one weighed 12.6 g on the 8th day and 12.3 g on the 11th, decreasing afterwards to 11.1 g when his young were 12 days old. The other decreased from 13.9 g on the 5th day to 13.3 g on the 13th, and was down to 12.4 g when his nestlings were 8 days old. Three other ♂♂, however, show an increase of 0.6, 0.7 and 0.8 g respectively, from pairing to the end of incubation. From the end of incubation, mean weights decrease slightly until the fledgling period. One of the 3 ♂♂ caught in July the day before they left showed some fat (level 3) with an evening weight of 14.6 g. As for ♀♀, the weights of migrant ♂♂ show large individual variations.

79 retraps of individual birds confirm the general pattern of Fig. 2, showing that weights remain unchanged at the early stages of breeding (apart from a few individuals fat on arrival who lost up to 2.0 g in the following days), and that there is an increase sometimes during incubation, followed by a decrease. One bird lean on arrival (12.2 g) had gained 0.9 g on the 4th day of incubation (13.1 g) and was down to 11.8 g when his nestlings were 5 days old. Another ♂ gained 1.6 g from the pairing stage to the 8th day of incubation (12.9 to 14.5 g): this increase of 12% is the maximum recorded in the population. Three birds lost respectively 1.5 g (13.9—12.4), 1.4 g (14.4—13.0) and 1.5 g (12.6—11.1) from the 5th, 6th and 8th day of incubation to the late nestling stage or fledgling stage. On the other hand, the constancy of weight in the early stages of breeding is best illustrated by an individual who weighed 13.1 g on arrival, 12.8 g 2 days later, 12.9 g when he got mated (7 days after arrival) and 12.7 g when his ♀ laid her first egg. All these individual examples deal with morning weights only.

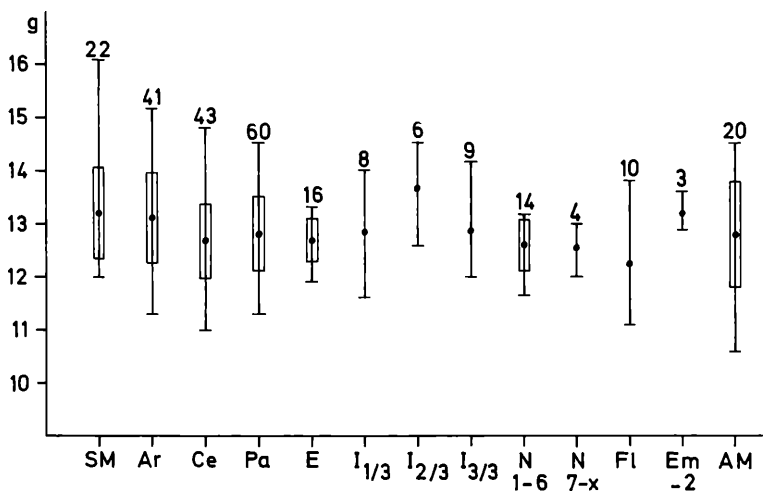

Fig. 2. Weight variations of ♂ Marsh Warblers *(Acrocephalus palustris)* during the breeding cycle. The symbols are the same as for Fig. 1 except: Ce = period of celibacy following arrival; Pa = from pair formation to courtship; E = period of egg-laying. — Abb. 2 — Gewichtsvariation männlicher Sumpfrohrsänger *(Acrocephalus palustris)* während der Brutzeit. Symbole wie in Abb. 1, außer: Gewicht Ce = unverpaarte ♂ nach der Ankunft, Pa = von der Paarbildung bis Balz, E = während der Eiablage.

5. Concluding remarks

In summary, ♀♀ increase their weight by 28 to 38% from the early nest-building stage (prior to the preparation of a clutch) to the beginning of laying (E-1, E1), that is from 12.8 g to 16.4—17.7 g on average (Fig. 1). Weights then decrease sharply (except for an increase at the end of incubation) down to 11.7 g on average at the fledgling stage. The largest mean weight variation observed is 6.0 g and occurs between the beginning of laying and the fledgling stage; similarly, one individual ♀ lost 5.9 g (17.0—11.1) between the day preceding the laying of her first egg and the last day on which she was feeding her fledglings.

On the other hand, ♂♂ increase their weight by 7—8% on average from the early stages of breeding (Ce, Pa in Fig. 2) to the middle of incubation, that is from 12.7—12.8 to 13.7 g. Weights then decrease to 12.3 g at the fledgling stage. Thus the largest mean weight variation is 1.4 g, between the middle of incubation (13.7 g) and the fledgling period (12.3 g). The mean variation in ♀ weights between the same two stages is 3.0 g (14.7—11.7), that is twice as great. ♂♂ brood by day as much as ♀♀, so that the reason why ♀♀ manage to put on more weight than their partners is not clear. During their non-brooding time, however, ♂♂ are more active than ♀♀: they frequently wander outside their territories or, in sunny weather, take part in group singing with their neighbours, whereas ♀♀ are more sedentary and usually quiet.

At the beginning of the cycle, there is no difference between the mean weights of ♂♂ and ♀♀: ♀♀ weigh 12.7 g (at the beginning of nest-building) while ♂ weights fluctuate between 12.7 and 12.8 g. At the brooding stage as a whole, ♀♀ weigh on average 14.3 g (from 13.0 to 15.6 g), being significantly heavier than ♂♂ ($t = 15.3$, $P < 0.001$) who average 13.1 g (from 11.6 to 14.5 g). Towards the end of the breeding cycle, at the fledgling stage, ♀♀ weigh on average 0.6 g less than ♂♂ (11.7 against 12.3 g), and this difference is nearly significant ($t = 1.9$, P very close to 0.05) although the sample is small (15 and 10 birds). Similarly, in the Pied Flycatcher, ♀♀ are also noticeably heavier than ♂♂ at the incubation stage; they then lose relatively much more weight when feeding nestlings so that the sexual differences in weight are very much reduced when the young are about to leave the nest (WINKEL & WINKEL 1976).

One would expect an overall difference in weight between the sexes of Marsh Warblers outside the period of intense sexual activity, since ♂♂ are significantly longer-winged than ♀♀ on average (see earlier). Moreover, there seems to be a relationship between wing-length and weight in ♂ birds (COLLETTE in prep.); the large weight fluctuations of ♀♀ do not allow such an analysis. The fact that ♀♀ are as heavy as ♂♂ at the very beginning of breeding is probably due to the general reactivation of their gonads which takes place some time before the rapid ovarian growth. At the fledgling stage, ♀♀ are on average 1.1 g lighter than at the beginning of breeding, whereas ♂♂ are only 0.4—0.5 g lighter.

Dr. B. LEISLER kindly translated the English summary into German and commented on the text.

6. Summary

Weight variations of breeding Marsh Warblers *(Acrocephalus palustris)* were investigated during a population study of individually marked birds in the Liège area (eastern Belgium), from 1974 to 1977. Data come from the weights of 159 ♀♀ and 256 ♂♂ whose stage in the breeding cycle was known exactly.

♀ weights vary greatly during the cycle, showing a high peak at the beginning of laying (when weights increase by 28—38%) and a smaller one at the end of incubation (Fig. 1). The rapid phase of ovarian growth probably takes 4 days in most cases, but there is evidence that 2 ♀♀ prepared their clutch in 3 days.

♂ weights vary little, showing only a slight peak in the middle of incubation when weights increase by 7—8% (Fig. 2). ♂♂ fatten up less than ♀♀ during the incubation, although both sexes share brooding equally by day. Weights of both sexes are lowest at the fledgling stage. A number of individual retraps confirm the general pattern of Figs 1 and 2.

7. Zusammenfassung

Gewichtsvariation adulter Sumpfrohrsänger *(Acrocephalus palustris)* während der Brutzeit.

Von 1974 bis 1977 wurde die Gewichtsvariation brütender Sumpfrohrsänger *(Acrocephalus palustris)* in einer farbberingten Population nahe Lüttich (Ostbelgien) untersucht. Das Material stammt von 159 ♀ und 256 ♂, deren Brutstatus genau bekannt war. Das Gewicht der ♀ variiert während der Brutperiode

stark. Es zeigt einen hohen Gipfel zu Beginn der Eiablage (Gewichtszunahme um 28 bis 38%) und einen kleineren am Ende der Bebrütung (Abb. 1). Das schnelle Wachstum des Ovars benötigt wahrscheinlich meist vier Tage. Bei zwei ♀ fanden sich Hinweise auf eine Eibildung innerhalb von drei Tagen. Das Gewicht der ♂ variiert wenig. Es zeigt nur eine geringe Zunahme (von 7 bis 8%) zu Mitte der Bebrütung (Abb. 2). Obwohl beide Geschlechter tagsüber zu gleichen Teilen brüten, nehmen die ♂ während der Bebrütung weniger zu als die ♀. Beide Geschlechter erreichen die geringsten Gewichtswerte nach dem Ausfliegen der Jungen. Eine Reihe von Wiederfängen bekräftigt die Allgemeingültigkeit der in Abb. 1 und 2 gezeigten Muster der Gewichtsentwicklung.

8. References

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Address of the authors: Dr F. Dowsett-Lemaire, University of Liège (Ethology), 22 Quai Van Beneden, B-4020 Liège, Belgium.
P. Collette, 257 rue de Jupille, B-4620 Fléron, Belgium.

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Zungenfleckung und Irisfarbe als Alterskennzeichen beim Teichrohrsänger *(Acrocephalus scirpaceus)*

Von Holger Kuschert

1. Einleitung

Um u. a. für populationsbiologische Fragen zusätzliche Informationen zu erhalten, ist die Bestimmung von Alter und Geschlecht der Fänglinge wünschenswert. Bei vielen Arten der Passeres gibt es brauchbare Kriterien (Svensson 1975). Speziell beim Teichrohrsänger werden die folgenden Merkmale benutzt: Altersbestimmung: abgeriebenes Kleingefieder der Adulten, neues Klein- und Großgefieder der Juvenilen (Svensson 1975, Williamson 1974). Geschlechtsbestimmung: mit Einschränkung Brutfleck der ♀ zur Brutzeit (Svensson 1975).

Da bei der Altersbestimmung die Gefiederqualität jedoch, besonders bei fehlenden Vergleichsmöglichkeiten, oft schwierig zu beurteilen ist, soll in dieser Arbeit geprüft werden, inwieweit sich die Irisfarbe und die Zungenfleckung zur Altersbestimmung des Teichrohrsängers eignen.

Herrn Dr. D. Moritz danke ich für die kritische Durchsicht des Manuskriptes.

2. Material und Methode

Die Teichrohrsänger wurden in Zusammenarbeit mit Herrn O. Ekelöf zwischen 1968 und 1977 jeweils von Mai bis Oktober in dem Schilfgürtel der unteren Treene bei Friedrichstadt (54.22N/9.05E) gefangen. Es wurden sowohl lokale Brutvögel als auch Durchzügler untersucht. Außerdem beringten wir die Nestlinge in einer ausgesuchten Probefläche. Bei jedem gefangenen bzw. wiedergefangenen Teichrohrsänger wurden neben anderen morphologischen Parametern die Irisfarbe und die Intensität der Zungen-