

## Moult strategies of White Wagtail *Motacilla alba* and Yellow Wagtail *M. flava* in central Sweden

JAN SONDELL

---

### Abstract

The wing moult of the White Wagtail *Motacilla a. alba* and the Yellow Wagtail *M. f. flava* has been recorded since 1973 at Kvismaren, central Sweden. Based on data from 558 White and 78 Yellow Wagtails in active moult the wing moult duration of the former was estimated at 55-65 days and of the latter at 35-40 days. The moult sequence was the same in both species. The only significant difference was the speed of the moult. The reason for this difference in moult strategy is probably the difference in migration destination of the two species. The Yellow Wagtail arrives later than the White Wagtail, stays a shorter time in central

Sweden and starts the migration towards tropical Africa just before finishing the moult in the middle of August. Swedish White Wagtails winter in the east Mediterranean, arrive almost a month earlier and leave a month later. It is difficult to compare the present results with data from other part of Europe as there are plenty of misrepresentations published some decades ago and quoted in later works. Therefore, methods of moult data evaluation are also briefly discussed.

*Jan Sondell, Klövervägen 11, S-178 35 Ekerö, Sweden.*

---

Received 1 June 1993, Accepted 15 November 1993, Edited by Å. Lindström

### Introduction

Moult studies have been carried out at Kvismare Bird Observatory (59.10 N/15.25 E) since 1973. About 5 000 registrations of adult birds in moult have been collected in the area in 1973-1992. Many interesting questions can be illuminated based on these moult descriptions. In this paper I compare the moult period and moult speed of the White Wagtail *Motacilla a. alba* and the Yellow Wagtail *M. f. flava* and discuss possible differences in moult strategies.

### Methods and material

At Kvismaren the moult status is registered on a special form which shows a schematic wing and tail of a passerine (Sondell 1977). During examination, the lengths of growing feathers of the left wing (primaries, secondaries and tertials) and of the whole tail are marked on the form. Full length feathers are denoted old or new. The form is later evaluated and the length of each new and growing feather is

estimated in tenths of a fully developed one. A missing feather is given a length of zero. These estimates are then summarized separately for each of the three wing feather categories and the tail. The tail feather sum is divided by two to correspond to one wing. The number of "wing" feathers is the sum of primaries and secondaries.

The Kvismaren registration system can roughly be compared to the B.T.O. scoring system (cf. Ginn & Melville 1983) but has a higher resolution, and the image notation should reduce the risk of making errors.

The material analysed here consists of data on 558 White and 78 Yellow Wagtails in active wing moult collected in the years 1973-1992. Some of the birds were trapped twice during moult, making it possible to calculate moult speed of individual birds.

The main aim of this evaluation is to estimate the mean moult duration for the individual birds. Therefore *Time* is used as the dependent variable (*Y*)

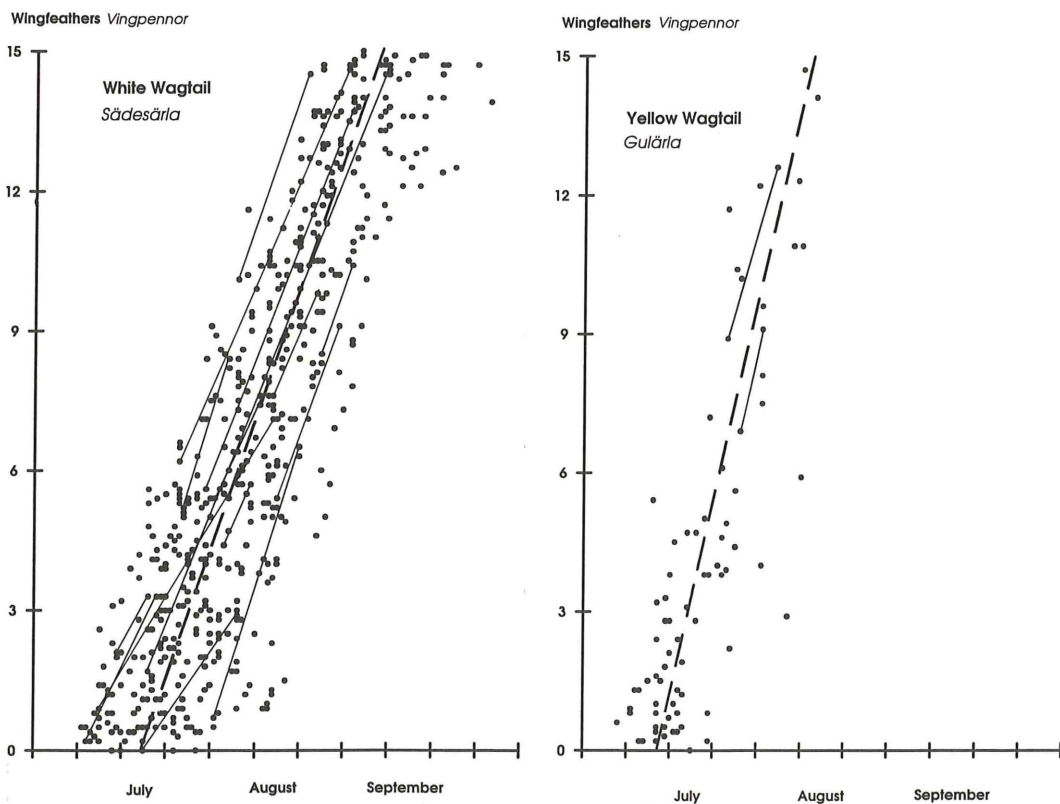


Fig. 1. Stage of moult (new primaries and secondaries summarized in tenths) over time for White Wagtail and Yellow Wagtail. The retraps after a week or more are connected with lines and the regression (wing on time) is shown as a line of short dashes. The time axis is divided in 10-days periods with start on 20 June.

*Ruggningsstadium (nya hand- och armpennor summerade i tiondelar) över tiden för sädesärta och gulärta. Återfångster efter en vecka eller längre tid är sammanbundna med heldragna linjer. Den streckade linjen är regressionslinjen med datum som beroende variabel. Tidsaxeln är uppdelad i 10-dagarsintervall med start 20 juni.*

in the regression functions (but shown on the x-axis in Fig. 1) and *Wing* (number of new primaries and secondaries) as the independent variable (X) (y-axis in Fig. 1).

How the wagtails perform their moult can also be illustrated by showing how many useable flight feathers there are during the moult and how many feathers that are growing at the same time. Useable is defined as the sum of old and new feathers in the stage 0.5 (half-grown) or longer. When at least half-grown I assume that the wing feathers start to contribute to the flight capacity of the birds.

Breeding seasons are defined as cold if the mean temperature sum for April, May and June deviated more than  $-3^{\circ}\text{C}$  from the normal and as warm if the mean temperature sum deviated more than  $+3^{\circ}\text{C}$

from the normal. The temperature was measured by SMHI at Ekeby-Almby in 1973-1988 and at Örebro in 1989-1992. According to this definition the cold years were 1987 ( $-4.2^{\circ}\text{C}$ ) and 1991 ( $-6.7^{\circ}\text{C}$ ), and the warm years were 1988 ( $+6.6^{\circ}\text{C}$ ), 1989 ( $+3.4^{\circ}\text{C}$ ), 1990 ( $+5.2^{\circ}\text{C}$ ) and 1992 ( $+4.6^{\circ}\text{C}$ ).

## Results

### *Moult period and speed of moult*

Fig. 1 shows scattergrams of the stage of wing moult over time. The retraps are connected with lines. The first degree (linear) regression line for time on wing moult is also shown. In Table 1 different regression functions are presented to illustrate the moult period and the moult speed of the two wagtail species. The

Table 1. Moulting periods for the wing and primaries of White Wagtails and Yellow Wagtails in 1973-1992. Three different regressions were calculated: first degree (linear), second degree (quadratic) and third degree function.

*Ruggningsperioder för vinge och handpennor hos sädesärta och gulärta 1973-1992. Tre olika regressioner beräknades: första grads (linjär), andra grads (kvadratisk) och tredje grads funktion.*

Criterium	Start	Moult		Duration in days	Number of birds	Corr. coef, %
		<i>Ruggning</i>	End			
<i>Kriterium</i>	<i>Start</i>	<i>Slut</i>		<i>Längd i dagar</i>	<i>Antal fåglar</i>	<i>Korr koeff, %</i>
<b>White Wagtail Sädesärta</b>						
Wing (primaries and secondaries) <i>Vinge (hand- och armpennor)</i>						
All linear <i>Alla linjär</i>	14 July		7 Sept.	55.2	558	87
All second <i>Alla andragrad</i>	15 July		8 Sept.	55.3	558	87
All third <i>Alla tredjegrad</i>	14 July		9 Sept.	57.5	558	87
Linear <i>Linjära</i>						
Males <i>Hanar</i>	9 July		6 Sept.	59.4	128	88
Females <i>Honor</i>	17 July		2 Sept.	46.6	121	78
Cold years <i>Kalla år</i>	14 July		4 Sept.	52.1	62	83
Warm years <i>Varma år</i>	13 July		3 Sept.	52.0	49	85
Primaries only <i>Enbart handpennor</i>						
Linear <i>Linjär</i>	9 July		1 Sept.	52.7	558	85
Second <i>Andragrad</i>	17 July		27 Aug.	51.0	558	86
Third <i>Tredjegrad</i>	13 July		8 Sept.	57.0	558	87
<b>Yellow Wagtail Gulärta</b>						
Wing (primaries and secondaries, linear) <i>Vinge (hand- och armpennor, linjär)</i>						
All <i>Alla</i>	7 July		11 Aug.	35.1	78	81
Males <i>Hanar</i>	7 July		11 Aug.	34.7	35	74
Females <i>Honor</i>	8 July		13 Aug.	35.5	24	82
Primaries only <i>Enbart handpennor</i>						
Linear <i>Linjär</i>	5 July		6 Aug.	30.6	78	81
Second <i>Andragrad</i>	7 July		8 Aug.	31.8	78	81
Third <i>Tredjegrad</i>	7 July		10 Aug.	33.3	78	82

material is separated into males and females, and for the White Wagtail also into the cold and the warm breeding seasons.

The mean duration of the wing moult according to the linear regression is 55 days in the White Wagtail and only 35 days in the Yellow Wagtail. According to the same regression, the primary moult lasts 95% of the time of the wing moult in the White Wagtail and 87% of that time in the Yellow Wagtail. Similar figures are obtained for second and third degree regressions (Table 1).

In the White Wagtail, the wing moult of the female is faster than that of the male. It takes only 46 days for the females compared to 59 days for the males according to the linear regressions. The Yellow Wagtail data set is small but the difference between sexes is obviously much smaller. Temperature did

not have any influence on the start or speed of the moult of the White Wagtail in this study.

There were 30 White Wagtails retrapped after 1 to 55 days. The wing moult duration calculated from the retraps gives a figure of 65 days. There were only 3 Yellow Wagtails retrapped.

#### *Relationship between wing feather tracts*

Fig. 2 shows the moult stage of the secondaries, tertials and tail in relation to the primaries. The sequences are about the same in both species. The moult of the tertials and tail starts in stage 0-3 new primaries, and the moult of the secondaries starts in stage 3-5. The moult of the tertials is finished in stage 5-7 primaries, and that of the tail in stage 8-9 primaries. The secondaries are in stage 5-6 when all

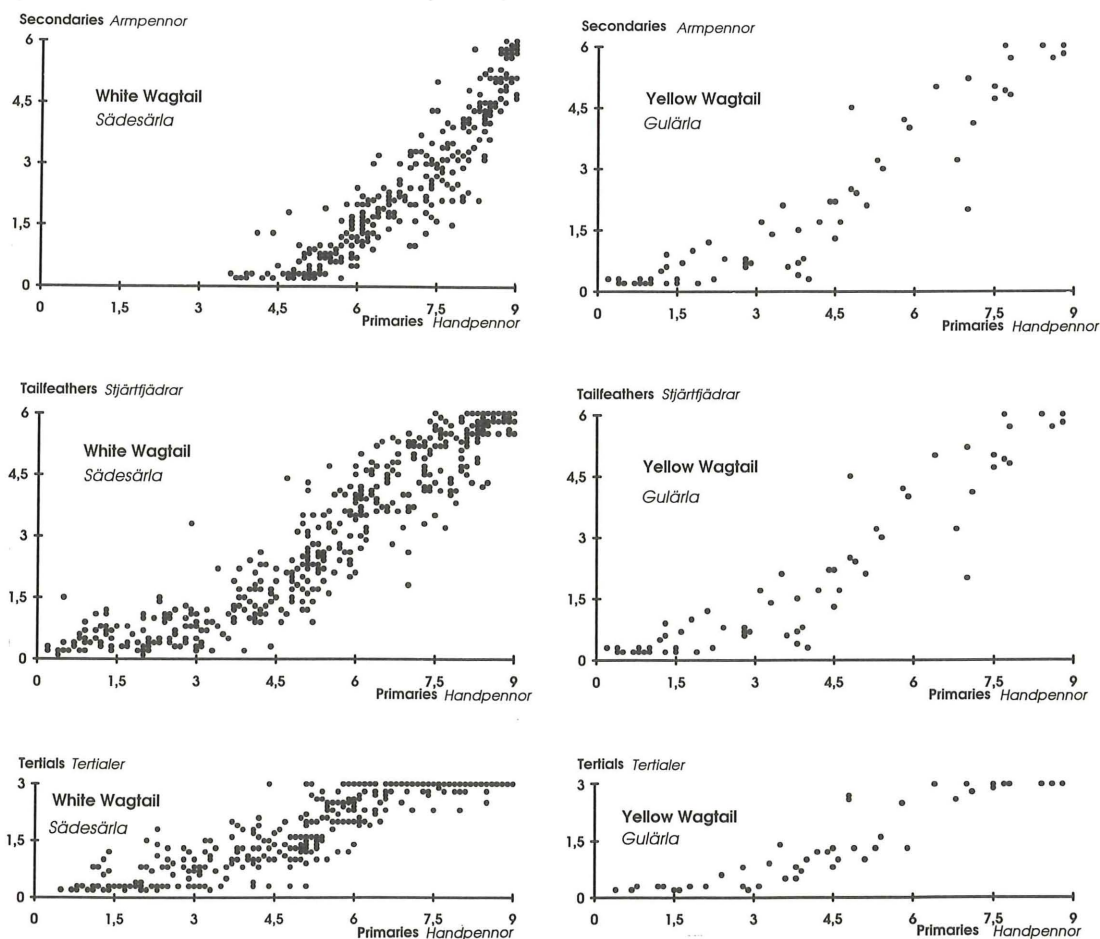


Figure 2. Moulting stage for secondaries, tertials and tail in relation to the primaries (new feathers summarized in tenths) for White Wagtail and Yellow Wagtail.

*Ruggningsstadium för armpennor, tertialer och stjärt i förhållande till handpennor (nya pennor summerade i tiondelar) för sädesärta och gulärta.*

primaries are full-grown. The moult of secondaries is speeded up after the tertials and tail are fully grown.

#### Available number of usable feathers during moult

The number of useable feathers is presented in Table 2. In both species a mean of about 12.4 (83%) of the 15 wing feathers (primaries and secondaries) are available. The lowest number is 10.8 (72%) for the Yellow Wagtail and 11.7 (78%) for the White Wagtail in the stage 9-10 new wing feathers. If also the tertials and the tail are added, a mean of 15.7-19.2 of

the nominal 24 feathers remains during the moult of the two species. The figures indicate a somewhat more reduced number of feathers in the Yellow Wagtail compared to the White Wagtail. The number of feathers in simultaneous moult is also a bit higher in the Yellow Wagtail than in the White Wagtail.

#### Sequence of moult

The moult of primaries starts with the innermost and ends with the outermost feather. The moult of the secondaries starts with the outermost and ends with the innermost. The tertials are shed as shown in



Table 2. Mean number of usable (at least half-grown) wing feathers and mean number of feathers in moult at the same time in the White Wagtail and Yellow Wagtail. P+S=primaries and secondaries, All=P+S+ tertials + rectrices, N=number.

*Medeltal användbara (minst halv vuxna) vingpennor och medeltal pennor i ruggning på samma gång hos sädesärta och gulärta. P+S=hand- och armpennor, ALL=P+S+ tertialer + stjärtpennor, N=antal.*

	Usable <i>Användbara</i>				In moult <i>I ruggning</i>			
	P + S		All		P + S		All	
	mean <i>medel</i>	lowest <i>lägst</i>	mean <i>medel</i>	lowest <i>lägst</i>	mean <i>medel</i>	highest <i>högst</i>	mean <i>medel</i>	highest <i>högst</i>
White Wagtail <i>Sädesärta</i> stand. dev. N=545	12.5 1.0	11.7 0.7	19.2 2.4	17.3 1.6	2.6 1.1	3.8 1.0	3.9 1.4	5.2 1.2
Yellow Wagtail <i>Gulärta</i> stand. dev. N=78	12.3 1.1	10.8 0.4	18.6 2.5	15.7 1.5	3.2 1.4	4.5 0.9	4.0 1.6	6.0 1.0

Table 3. The tertial to be shed first is normally number 8, and then the other two (7+9) are shed at about the same time in both species.

In Table 4 the moult pattern of the tail is shown. The tail feathers were normally shed symmetrically. The sequence was thus the same in each half of the tail. If two or three feathers were estimated to be shed at the same time, 0.5 or 0.33 was added to the order percentage in the table. The two species have the same general shedding pattern. The central pair of tail feathers is shed first followed by the outer pair (6) or pair number 2, almost at the same time (Table 4). It varies from individual to individual which pair of feathers should be dropped second. After that pair 4 and 5 or 5 and 4 are shed almost at the same time. Number 3 is the last pair to be shed.

## Discussion

### *Evaluation models and quality of data sets*

Moult evaluation is normally performed by regression techniques or by fitting a (straight) line to a plotted sample of observations. To obtain a good

estimation, the observations must be well distributed over the moult period. This could be difficult to achieve and therefore other evaluation methods have been suggested. Underhill & Zucchini (1988) presented a mathematical model based on the feather mass of each primary and Bensch & Grahn (1993) suggested a method based on the assumption that birds moulting with different speed have a corresponding variation in raggedness (amount of growing feathers).

The method of Underhill & Zucchini (1988) requires that the catching efficiency is not affected by the moult. This requirement is not fulfilled when using mist nets (Haukioja 1971a) as we do at Kvismaren. The method of Bensch & Grahn (1993) is yet only tested on Willow Warbler *Phylloscopus trochilus* in a subalpine area and needs calibration by many retraps. Therefore the regression technique is today the only easily available and realistic evaluation alternative for the moult of wagtails at Kvismaren.

When, as in this study, the aim is to estimate the mean moult duration for individual birds, a regression of time (date) on wing (Model 1) is appropriate.

Table 3. Moulting pattern of the tertials and the percentage of White Wagtails (N=216) and Yellow Wagtails (N=38) shedding the feathers in different orders.

*Ruggningsmönster för tertialer samt den andel sädesärlor (N=216) och gulärlor (N=38) som tappar pennorna i olika ordning.*

Tertial no. <i>Tertial nr</i>	First shed <i>Först tappad</i>					Last shed <i>Sist tappad</i>					
	7	8	9	7+8	8+9	7	8	9	7+8	7+9	8+9
White Wagtail, % <i>Sädesärta, %</i>	3	77	3	5	12	16	1	36	2	42	2
Yellow Wagtail, % <i>Gulärta, %</i>	11	82	3	–	5	16	–	18	–	63	3

Table 4. Moulting pattern for the tail. 1(90) and 6(50) means that feather number 1 is dropped first on 90% of the birds and feather 6 is dropped second on 50% of the birds etc. White wagtail: N=340, Yellow Wagtail: N=53.

*Ruggningsmönster för stjärt. 1(90) och 6(50) betyder att penna nummer 1 fälls först hos 90% av fåglarna och penna 6 fälls därefter hos 50% av fåglarna etc. Sädesärta: N=340, Gulärta: N=53.*

	Shedding order <i>Fällningsordning</i>					
	1	2	3	4	5	6
Most common order <i>Vanligaste ordning</i>						
White Wagtail <i>Sädesärta</i>	1(90)	6(50)	2(50)	4(51)	5(41)	3(81)
Yellow Wagtail <i>Gulärta</i>	1(90)	2(49)	6(49)	4(80)	5(55)	3(75)
Second most common order <i>Näst vanligaste ordning</i>						
White Wagtail <i>Sädesärta</i>	1(90)	2(40)	6(38)	5(43)	4(40)	3(81)
Yellow Wagtail <i>Gulärta</i>	1(90)	6(37)	2(32)	4(80)	5(55)	3(75)

In older literature results based on regressions are often presented with wing (or primary) score as dependent and time as independent variable. In that case the result will estimate the mean moult period for a population (Model 2). Obviously the latter model will generate a longer time value than the former (cf. Kasperek 1980, Ginn & Melville 1983).

Many authors have not been aware of this important difference as their calculations have generated reasonable results. Lack of material at the start and end of the moult will give a too short estimate of the period. Such lack of data occurs especially in nationwide materials, e.g. the "1970 moult enquiry in Finland" (Haukioja 1971b) and the "BTO Moult Enquiry" (discussed by Ginn & Melville 1983, p. 31). The specific problem is that the inadequate model and an incomplete data set tend to compensate each other to an unknown degree, still producing reasonable estimates. Nationwide data also suffer from the inclusion of different populations with possibly different moult timings. At localities where continual ringing is performed over the whole moult period, such as at Kvismaren, these problems are less prominent.

The White Wagtail material from Kvismaren is rather big but the Yellow Wagtail material is small. The representation over the normal moult period is fairly good for White Wagtail but no Yellow Wagtails were caught after 12 August. Very few Yellow Wagtails with almost completed moult have been caught at all (one with 14.7 new wing feathers on 9 August and one with 14.1 new wing feathers on 12 August). It is obvious that the Yellow Wagtails migrated southwards as soon as, or even before, they had finished their moult in mid August. This

conclusion is supported by migration figures from Ottenby at southern Öland and Falsterbo in SW Scania (Edelstam 1972, Ulfstrand et al. 1974). The migration starts before the middle of August at both localities.

#### *Moult period and moult pattern*

A first degree or linear model on primaries, or a straight line "fitted by eye" (Ginn & Melville 1983), is simple but not correct in theory since the rate of change of the primary moult score is slower at the start and particularly at the end of the moult, thus underestimating the duration of the moult. The slower growth of the primaries towards the end of the moult depends on the fact that the moult of tertials, tail and secondaries also is in progress at this stage. If only the primaries are used a second degree model may give a better fit, particularly towards the end of the moult period, and hence a better estimate of the end date of the moult period. In order to obtain better estimates of both the start and end of moult, a third degree function is the theoretically best one among the simple polynomials.

In Table 1 the results calculated by using the three different regression functions are presented. When the moult score of the wing (both primaries and secondaries) was used the estimates of starting and ending dates, and hence moult duration, were almost identical. Using only primaries, however, produced rather different estimates. For the primaries, it was only the third degree regression that gave almost the same date estimates as the whole wing. Consequently, for the wagtails, the best regression estimation of the wing moult duration is obtained using both primaries



and secondaries on time. A first degree (linear) model is in that case sufficient, which I have shown to be valid also for other passerines (Sondell 1977, Sondell & Schildt 1985).

It can be seen from Table 1 that although the date estimates by the three functions were rather different if only primary scores were used, the correlation coefficients were very similar. In fact, it is difficult to judge only from them which function that gives the best fit. This is because it is only for those points in the scattergram that represent the beginning and end of the moult that the different functions give different results, whereas for the vast majority of points representing the middle section of moult scores, the three functions give about the same fit. This sensitivity of different models when using only primaries is a further argument for always using the whole wing when estimating wing moult duration and timing.

The linear regression method gives a shorter wing moult duration (55 days) than the retraps (65 days) for the White Wagtail at Kvismaren. Such a result was not unexpected and accords with results from other species (Sondell 1977, 1987, Sondell & Schildt 1985). A combination of different factors is the probable explanation. The probability of retrapping a bird in slow moult compared to one in fast moult is of course greater. Furthermore, the regression function may somewhat underestimate the period since continuous ringing only lasts from about 25 June to 20 September. Catching and handling the birds may also delay the moult to some extent (Newton 1967 and own unpublished results) but this has not been the case for the White Wagtails at Kvismaren as no difference in moult speed was found between retraps after 1-5 (n=9) compared to 5-55 days (n=21).

In the White Wagtail males spend 27% more time in moult than females. The Yellow Wagtail data are not sufficient for such an analysis but the high speed of moult makes it unlikely that there will be any greater difference between the sexes. The mean starting date for the males of the White Wagtails is significantly (t-test, N=249,  $p < 0.001$ ) earlier than that for the females. An analysis of the moult of the Reed Bunting *Emberiza schoeniclus* and Willow Warbler at Kvismaren (Sondell 1993) showed that the female also in these species starts later than the male and has a faster moult. The same result has been obtained earlier for the Chaffinch *Fringilla coelebs* (Sondell & Schildt 1985). It is believed that in general more males than females remain unmated in a population. That could contribute to a longer moult time as such males are free to start the moult earlier

than the females of which most are occupied by breeding activities.

The Reed Bunting and Willow Warbler also start the moult significantly earlier in years with a warmer breeding and moult period but no such effect could be found for the White Wagtail. The first two species have only one clutch while the White Wagtail often has two clutches. In a year with a warm and early breeding period, the latter probably spends more time on breeding (see also below).

Both the White Wagtail and the Yellow Wagtail shed the different types of feathers very regularly and in the same sequence. The most significant difference between the species is the speed of the moult (Fig. 2, Table 2-4). The Yellow Wagtail finishes the moult after 35-40 days (the duration is probably a bit underestimated by the regression function) and the White Wagtail finishes it after 55-65 days. Thus the White Wagtail in general uses as much as 60% more time for the moult (Fig. 1).

In southern Scania the Yellow Wagtail starts its wing moult at the end of July (Lundwall & Persson 1984) and moults with about the same speed as at Kvismaren. The moult is finished at the beginning of September. The moult is about equally rapid in both areas of Sweden but is carried out three weeks later in Scania. In Finland the Yellow Wagtail moults its primaries in 40 days according to Lehikoinen & Niemelä (1977). The result is obviously based on Model 1 (time on wing) but no original data were presented. In Britain the Yellow Wagtail arrives in the end of April (Witherby et al. 1952), which is 10-15 days earlier than in central Sweden. The mean starting date for primary moult is 19 July and the finishing date is 31 August. The duration is 43-45 days (Hereward 1979, Model 1). The B.T.O. data suggest 45 days (Ginn & Melville 1983, fitted by eye).

The Yellow Wagtail generally rears two broods in England (Witherby et al. 1952) and possibly also in Scania (Lundwall & Persson 1984). In northwestern Europe there is obviously a variation in the start and duration of the moult for different populations of Yellow Wagtails. The species obviously adapts the breeding and moult periods to local conditions e.g. to temperature, daylength and food.

The large BTO material on primary moult of Pied Wagtails *Motacilla a. yarrelli* suggests a duration of 55 days, with no difference between sexes (Ginn & Melville 1983, fitted by eye). Unfortunately the main set of observations are hidden behind a grey area in their scattergrams. Therefore it is impossible to judge if their "fitting by eye" looks reasonable or

not. In Holland the primary moult of White Wagtails lasts for 68 days according to retraps (Jukema & Ripema 1984). For White Wagtails in Scotland, Galbraith (1977) concluded a primary moult period of 73 days (quoted without comments on the type of model by Ginn & Melville 1983), but using Model 2 (wing on time). Judged from his scattergram, the primary moult duration was about the same as in the B.T.O. data (55 days). In Finland, Haukioja (1971a) found a primary moult duration of 45-50 days based on an incomplete material and a Model 2 calculation.

It is very difficult to compare the Kvismaren White Wagtail moult duration to data from other parts of Europe because of the uncertainties in the older materials. There is obviously a need for a reevaluation of all older works in this field. In the future, original observations ought to be published without hiding zones. Probably the White/Pied Wagtail has about the same wing moult duration of 55-65 days in different areas in northwestern Europe as it has at Kvismaren. The figures from Holland indicate this.

#### *Moult strategies in relation to annual cycle*

The White Wagtail arrives in central Sweden in the middle of April and departs in the middle of September. The Yellow Wagtail arrives in the beginning of May and departs in the middle of August. The White Wagtail stays in Sweden for about 150 days but the Yellow Wagtail only for about 100 days. The White Wagtail winters in the east Mediterranean and the Yellow Wagtail in the savannah part of West Africa (SOF 1990). The stay on the breeding grounds at Kvismaren is occupied by the activities presented in Table 5. The Yellow Wagtail rears only one brood with time only for a replacement clutch if the first one is lost. The White Wagtail rears two broods or at least has time enough for a second one, though if it loses the first clutch there will probably be only a single brood that year.

Why is it necessary for the Yellow Wagtail to be in a hurry, compared to the White Wagtail, to leave the breeding grounds in early autumn? The migration route of the Yellow Wagtail is much longer and involves a passage of the Sahara. To be able to keep its time-table for the rest of the winter, the Yellow Wagtail probably has to leave in the middle of August. Perhaps the feeding conditions deteriorate in the Mediterranean area after the second half of September (when they pass Gibraltar; Finlayson 1992) so that they would not be able to build up sufficient fat deposits for the passage of the Sahara

Table 5. Estimates of time (days) for different annual activities of White Wagtails and Yellow Wagtails during their stay at Kvismaren, Central Sweden.

*Uppskattad tidsfördelning (dagar) på olika årliga aktiviteter för sädesärta och gulärta vid Kvismaren i mellersta Sverige.*

Activity Aktivitet	White Sädesärta	Yellow Gulärta
Mating, nest building etc. <i>Parning, bobyggnad etc.</i>	20	15
Breeding inc. replacement and second clutch <i>Häckning inkl. omläggningar och andrakullar</i>	60-65	45-50
Moult <i>Ruggning</i>	55-65	35-40
Days left before departure <i>Dagar över före höstflyttning</i>	5-10	0
Total <i>Totalt</i>	150	100

later on. The explanation for the early departure could of course also be deteriorating food resources in Sweden or an adaptation to an optimal arrival time in the wintering quarters south of the Sahara. Whatever the cause, the Yellow Wagtail has the strategy to speed up its moult as much as possible like many other passerines wintering in the tropics (Hasselquist et al. 1988) and to start migration before the last wing feathers are fullgrown.

A very similar difference in moult and migration strategies is found between the Ortolan Bunting *Emberiza hortulana* and the Yellowhammer *E. citrinella*, two species of the same genus breeding at Kvismaren. The Ortolan migrates to tropical Africa in August like the Yellow Wagtail, and the Yellowhammer winters in northern Europe. The moult of the Yellowhammer takes about 75 days (Sondell 1989). There are only a few Ortolans examined at Kvismaren, but the only two from August both had suspended their moult of secondaries, one after 2 and the other after 4 new feathers! Suspended moult of secondaries was also reported by Svensson (1984). Thus, suspended moult until later in the year may be a general strategy in the Ortolan and is another solution when the time for moult is limited or an early departure is favourable for some other reason.

Contribution No. 76 from Kvismare Bird Observatory.



## References

- Bensch, S. & Grahn, M. 1993. A new method for estimating individual speed of moult. *Condor* 95:305-315.
- Edelstam, C. 1972. The visible migration of birds at Ottenby, Sweden. *Vår Fågelvärld*, suppl. 7.
- Finlayson, C. 1992. *Birds of the Strait of Gibraltar*. Poyser, London.
- Galbraith, H. 1977. The Post-nuptial Moulting of a Migratory Population of Pied Wagtails. *Ringning & Migration* 1:184-186.
- Ginn, H. B. & Melville, D. S. 1983. *Moult in Birds*. BTO Guide 19. Tring.
- Hasselquist, D., Hedenström, A., Lindström, Å. & Bensch, S. 1988. The seasonally divided flight feather moult of the Barred Warbler *Sylvia nisoria* – a new moult pattern for European passerines. *Ornis Scand.* 19:280-286.
- Haukioja, E. 1971a. Flightlessness in moulting passerines in Northern Europe. *Ornis Fennica* 48:101-116.
- Haukioja, E. 1971b. Processing moult card data with reference to the Chaffinch *Fringilla coelebs*. *Ornis Fennica* 48:25-32.
- Hereward, A. 1979. The Autumn Moulting of the Yellow Wagtail. *Ringning & Migration* 2:113-117.
- Jukema, J. & Ripema, U. 1984. Leeftijdssamenstelling en rui van in kassen overnachtende Witte Kwikstaarten *Motacilla alba*. *Limosa* 57:91-96.
- Kasperek, M. 1980. Jahreszeitliche Aspekte der Mauser der Rohrammer. *Ökologie der Vögel* 2:1-36.
- Lehikoinen, E. & Niemelä, P. 1977. (Moult study on passerines.) *Lintumies* 2:33-44.
- Lundwall, U. & Persson, C. 1984. Ruggningsförloppet hos individ och population av törnsångare, lövsångare och gulärta i Skåne. *Fågelstudier* 2:52-58.
- Newton, I. 1967. Feather growth and moult in some captive finches. *Bird Study* 2:2-24.
- SOF. 1990. *Sveriges fåglar*. 2:a uppl., Stockholm.
- Sondell, J. 1977. Sävsparvens *Emberiza schoeniclus* ruggning i Kvismaren. *Vår Fågelvärld* 36:174-184.
- Sondell, J. 1987. Fyra trastarters ruggning i Kvismaren. *Vår Fågelvärld* 46:54-63.
- Sondell, J. 1989. Vädrets inverkan på fåglarnas häckning 1988. *Fåglar i Kvismaren* 4(2):24-27.
- Sondell, J. 1993. Vädrets inverkan på ruggningen hos lövsångare och sävsparv. *Fåglar i Kvismaren* 8(2):18-23.
- Sondell, J. & Schildt, E.-B. 1985. Bofinkens ruggning i Kvismaren. I *Verksamheten vid Kvismare fågelstation 1984*, pp. 2-8.
- Svensson, L. 1984. *Identification Guide to European Passerines*. Third Edition, Stockholm.
- Ulfstrand, S., Roos, G., Alerstam, T. & Österdahl, L. 1984. Visible bird migration at Falsterbo, Sweden. *Vår Fågelvärld*, suppl. 8.
- Underhill, L. G. & Zucchini, W. 1988. A model for avian primary moult. *Ibis* 130:358-372.
- Witherby, H. F. (ed.) 1952. *The Handbook of British Birds*. Vol. 1. Seventh Impression. London.

## Sammanfattning

*Ruggningsstrategier hos sädesärta och gulärta i mellersta Sverige*

### Metod och resultat

I Kvismaren har ruggningsstudier pågått i 20 år. Ungefär 5 000 registreringar av adulta fåglars ruggning har utförts och många intressanta frågor kan belysas med detta material. Man kan, som redovisas här, jämföra två närbesläktade fåglars ruggningsstrategier. Totalt har under åren 1973-1992 558 sädesärter och 78 gulärter i aktiv vingruggning undersökts. Metoden vid registrering och bearbetning har beskrivits tidigare (Sondell 1977).

Vid regressionsberäkningarna har tid (datum) använts som beroende (Y) och vingens ruggningsstadium som oberoende variabel. På så sätt kan ruggningsperioden beräknas som ett medeltal för individerna (modell 1). Kastas variablerna om får man istället ett värde för hur länge ruggningen pågår inom populationen (modell 2).

I Tabell 1 redovisas en jämförelse mellan olika regressionsmodeller (första, andra och tredje gradens ekvationer) och vidare jämförs resultaten när man använder antingen enbart handpennorna eller hela vingen.

I Tabell 1 redovisas materialet också uppdelat på vissa urvalskriterier. Enligt den linjära regressionsberäkningen ruggar sädesärlorna på 55 och gulärlorna på 35 dagar. Återfångsterna av sädesärter ger hela 65 dagars ruggningsperiod. Hanar av sädesärta ruggar på 59 och honor på 46 dagar (Tabell 1). Ingen skillnad i ruggningshastighet erhöles vid uppdelning på varma och kalla säsonger.

Ruggningens förlopp för de två arterna är mycket lika. I stadiet 1-2 bytta handpennor börjar ruggningen av tertialer och stjärten och i stadiet 4-5 handpennor börjar armpennorna bytas. Tertialerna är färdigruggade efter 5-7 handpennor, stjärten efter 8-9 och armpennorna är i stadium 5-6 när handpennorna är klara. Under ruggningen kan i genomsnitt 83% av vingpennornas yta användas (Tabell 2). Som lägst i stadiet 9-10 bytta vingpennor finns 72% tillgängliga för gulärten och 78% för sädesärlan. I genomsnitt ruggar sädesärlan 2,6 och gulärten 3,2 vingpennor samtidigt.

Handpennorna faller i normal ordning med den innersta handpennan först och den innersta armpennan sist. Av tertialerna faller den mellersta vanligen först och de två andra ungefär samtidigt därefter (Tabell 3). Av stjärtfjädrarna faller det mellersta (1) paret först, följt av de yttersta (6) eller det näst mellersta (2). Sist faller par nr 3 (Tabell 4).

## Diskussion

Huvudsyftet med utvärderingen har varit att beräkna ruggningstiden i medeltal för individer (modell 1). I äldre litteratur presenteras ofta resultat baserade på regressionser med vingens ruggningsstadium som beroende variabel (modell 2). Då erhålls ruggningsperiodens längd för populationen. Dessa resultat har ändå ofta varit rimliga beroende på att materialet också varit ofullständigt. Dessa två fel har sedan tagit ut varandra i okänd grad. Särskilt landsomfattande insamlingar av ruggdata från ringmärkare, som t.ex. i Finland och England, blir lätt lidande av att det fattas data under delar av ruggningsperioden. På lokaler där ringmärkning bedrivs dagligen under hela ruggningsperioden finns större förutsättningar att insamla ett fullständigt material.

Materialet från Kvismaren är tillräckligt stort för sädesärlna men ganska litet för gulärlna för att belysa ruggningsförloppet. Representationen över ruggningsperioden är relativt god, men för gulärlna finns inga fåglar fångade senare än 12 augusti och ingen med mer än 14,7 vingpennor bytta. Tydligt sträcker gulärlna söderut innan den ruggat helt färdigt. Detta bekräftas av uppgifter om sträckperioder från Ottenby och Falsterbo.

Jämförelsen i Tabell 1 visar att de olika regressionsmodellerna ger olika resultat om man använder enbart handpennorna för att beskriva vingruggningen. Om man däremot använder hela vingen spelar regressionsmodellen ingen roll och man kan då använda den enkla linjära anpassningen.

Regressionsmetoden ger kortare ruggningsperiod än återfångsterna för sädesärlna. Detta kan ha flera skäl. Dels är det större möjlighet att återfånga långsamt ruggande individer. Ringmärkningen bedrivs också mindre intensivt före 25 juni och efter 20 september. Representationen är alltså lite sämre i början och slutet av ruggningsperioden.

Hanan av sädesärlna utnyttjar i genomsnitt 27% längre tid än honan för ruggningen. I materialet ingår troligen en del icke parade hanar som startar tidigt och sedan inte har så bråttom. Liknande skillnader mellan könen har tidigare noterats bl.a. för sävsparv, lövsångare och bofink. De två förstnämnda arterna har också startat tidigare varma vårar med tidig häckningsstart. En sådan anpassning har inte kunnat konstateras hos sädesärlna, möjligen därför att arten lägger två kullar.

Båda ärlearternas ruggning är mycket regelbunden och förloppen är mycket lika. Den största skillnaden är ruggningsperiodens längd, 35-40 dagar för

gulärlna och 55-65 dagar för sädesärlna. Den senare arten behöver alltså 60% längre tid för sin ruggning.

I södra Skåne börjar gulärlna sin vingruggning först i slutet av juli och ruggar sedan lika fort som i Kvismaren. I Finland tar handpennruggningen 40 dagar och börjar ungefär vid samma tid som i Kvismaren. I England ruggas handpennorna på ca 45 dagar och ruggningen börjar omkring 19 juli. I England och möjligen i Skåne har gulärlna två kullar. Tydligt har olika populationer av gulärlna i Nordvästeuropa anpassat häckningsperioden till lokala förutsättningar när det gäller t.ex. temperatur, daglängd och föda.

Utifrån ett stort material av engelsk sädesärlna (Ginn & Melville 1983) bedöms handpennruggningen ta ca 55 dagar, ingen skillnad kan spåras mellan könen. Det mesta av originalmaterialet är i redovisningen dolt av en gråzon så det är omöjligt att avgöra hur det är fördelat. Övriga europeiska uppgifter har varierande kvalitet. Många härleds som nämnts ovan enligt modell 2. Tyvärr blandar Ginn & Melville uppgifter enligt olika modeller utan att det framgår vilket som är vad.

Troligen varierar sädesärlnans ruggningstid inte så mycket i Nordvästeuropa. Det mesta talar för en vingruggning på 55-65 dagar som i denna undersökning.

Gulärlna stannar i Sverige ca 100 dagar och sädesärlna 150 dagar (Tabell 5). Gulärlna hinner bara med en kull i Kvismaren medan sädesärlna har tid för två. Varför har gulärlna så bråttom? Gulärlna flyttar till savannområdet i Västafrika och har alltså både en längre och besvärligare sträckväg än sädesärlna, som bara ska till östra Medelhavsområdet. Troligen är det så att gulärlna för att hålla sin tidtabell behöver komma iväg från mellersta Sverige i mitten av augusti. Gulärlnans strategi är därför att rugga så snabbt som möjligt och påbörja flyttningen innan de sista nya fjädrarna är helt utväxta, medan sädesärlnan inte gör sig någon större brådska.

Vid Kvismaren häckar också gulspärv och ortolansparv. Gulspärven övervintrar i Nordeuropa medan ortolanan likt gulärlna flyttar till tropiska Afrika. Gulspärven ruggar på ca 75 dagar. Av ortolanan är bara några få ruggningsundersökta. De två som fångats i augusti hade båda avbrutit ruggningen efter 2 respektive 4 bytta armpennor! Detta antyder att ortolanan inte byter alla fjädrar i Kvismaren utan sparar några till senare under året, ett annat sätt alltså att snabbt bli klar inför flyttningen.

Meddelande nr 76 från Kvismare fågelstation.