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# Wing moult of the Bearded Reedling (*Panurus biarmicus*) in Northern Italy

By Alberto Massi and Fernando Spina

Abstract. (1996): Massi, A., & F. Spina. Wing moult of the Bearded Reedling (*Panurus biarmicus*) in Northern Italy. Vogelwarte 38: 180–187.

Between 1985–1992 a total of 3,153 Bearded Reedling (*Panurus biarmicus*) moult cards have been collected in Val Campotto (Ferrara, Northern Italy). Aim of the study was to analyse the duration and dynamics of wing moult, also with respect to age and sex classes. A regular replacement of primaries has been observed, without any marked change in speed during its progression. Primaries are shed starting from P1, ending with P10 (descendant moult); secondaries moult from S1 to S6 (ascendent moult), and the sequence of tertiary moult is T2, T3 and finally T1. The onset of moult for secondaries, tertials and rectrices takes place once P4 has been shed. A total of 186 retraps of moulting birds have been used to calculate the duration of moult, which resulted in an average estimate of 66.8 ± 10.9 days, being longer than that recorded for more northern populations. The mean starting date of primary moult is July 22th, ranging from May 31st to August 14th. No variations in moult duration and sequence have been detected when taking into account the different age and sex classes.

Key words: Bearded Reedling (*Panurus biarmicus*), moult, Italy.

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## 1. Introduction

The Bearded Reedling (*Panurus biarmicus*) is one of the European Passerines with a complete summer moult both in adults and juveniles (Melville, in Cramp & Perrins, 1993). The fairly low predation rate on juveniles allows them to survive a period of limited flight ability (Pearson 1975). Furthermore, the highly sedentary habits of this species, which seldom performs limited dispersal movements, allows all broods to renew body- and flight-feathers. The prolonged breeding season with usually 2–4 broods (Cramp & Perrins 1993) can also affect the dynamics of moult: the renewal of flight feathers, at least in northern populations, is relatively fast, if compared to that of other similarly sedentary, but single-brooded species (Jenni & Winkler 1994).

The duration of primary moult averages between 45–60 days in central and west Europe (Germany: Steiner 1971; Great Britain: Pearson 1975; Netherlands: Buker et al. 1975); a similar moult schedule is reported in adults and juveniles. In the latters, birds hatched later in the season have a slightly faster wing moult than those from earlier broods, due to an increased number of simultaneously moulting primaries (Pearson 1975).

Aim of this paper is to describe the sequence and dynamics of wing moult in an Italian population. Data were collected in Val Campotto (Ferrara, Northern Italy) during ringing activities carried on within the EURING Acroproject (Koskimies & Saurola 1985).

## 2. Study area

Val Campotto – Vallesanta Natural Reserve (44.35N, 11.51E) is a 1800 ha freshwater wetland of international importance under the RAMSAR CONVENTION. Detailed habitat descriptions are reported in Piccoli (1976) and Santucci (1978). The trapping site is a pure reed bed of *Phragmites australis* in which a 300 m board walk transect has been built to set the nets (Spina & Bezzi 1990).

## 3. Materials and methods

Ringing activity has been based on continuous and standardized mist-netting following the methods described by Berthold & Schlenker (1975). The study has been carried out in 1985–1990 and 1992, during the following sampling periods: 1–20 August (1985), 30 July – 30 October (1986), 30 July – 2 September (1987, 1988, 1989, 1992), 30 July – 30 September (1990). The presence of many freshly-fledged Reed- and Great-Reed Warblers (*Acrocephalus scirpaceus*, *A. arundinaceus*) in our ringing site till the end of July did not allow an earlier start of our activities, although Bearded Reedlings can already start moulting in mid-July (Pearson 1975; Cramp & Perrins 1993).

Each bird has been aged (until P10 was shed), sexed and measured. Moult stage was recorded with reference to Ginn & Melville (1983), and each feather numbered accordingly (old feather = 0, new feather = 5). Since P10 is fairly large in the Bearded Reedling, and markedly so in juveniles, this feather has been included in the calculation of the primary score. For body moult, the code used in the M.R.I. program (0 to 3, Berthold & Schlenker 1973) has been adopted, which allowed to consider the intensity of body and wing moult.

For all statistical tests the SPSS-PC package has been used. Siegel (1956) was followed for non-parametrical analyses; other statistical methods have been taken from Sokal & Rohlf (1981).

We wish to thank the Consorzio della Bonifica Renana, owner of the area and the C.I.S.O. Ornithological Station for providing permission and accomodation facilities. We are grateful to all the ringers who joined the project for their friendly support. Lukas Jenni kindly revised a first draft of the manuscript.

## 4. Results and discussion

### 4.1. Seasonal progression of moult

A total of 3,153 moult cards have been filled in the 7 years (Tab. 1). At the beginning of August more than 50% of the birds trapped are already moulting (Fig. 1); the percentage of birds which still have to start moulting decreases in the second half of August. Yet, a small proportion of birds in such conditions is recorded till mid-September, when it is made exclusively of young birds from latest broods.

Table 1: Overall totals and number of moult cards collected (3 = 1st year, 4 = adults, 2 = age unknown; M = male, F = female). – Anzahl erfaßter Mauserkarten (3 = Vögel im 1. Lebensjahr, 4 = adulte Vögel, 2 = Alter unbekannt, M = Männchen, F = Weibchen).

| | 3M | 4M | 2M | 3F | 4F | 2F | Total |
|---|---|---|---|---|---|---|---|
| Ringings | 456 | 78 | 655 | 387 | 73 | 637 | 2286 |
| Retraps | 194 | 245 | 83 | 147 | 181 | 99 | 949 |
| Total | 650 | 323 | 738 | 534 | 254 | 736 | 3235 |
| Moult Cards Ringing | 415 | 76 | 653 | 358 | 69 | 635 | 2206 |
| Moult Cards Retraps | 194 | 227 | 99 | 148 | 171 | 108 | 947 |
| Total | 69 | 303 | 752 | 506 | 240 | 743 | 3153 |

A very small proportion of birds has already completed their moult by mid-August. The percentage of fully moulted individuals quickly increases, reaching the 50% level of catches by mid-September. By the end of this month, almost all birds have moulted.

### 4.2. Moult description and dynamics

The first feather to be shed was P1 (= innermost primary) in all 11 cases with primary score = 1. In all 17 cases with primary score = 2, P2 has also dropped. Likeways, P3 starts moulting soon after P2: in 35 out of 47 cases with P3= 1 (74%), P2 scored 1 or 2; in the remaining 12 cases it was at stage 3. All other primaries are then renewed sequentially. The last primary to be shed is P10; out of 17 cases with P9= 1, P10 was still old in 16 cases (94%). When looking at the 80 cases with P10=

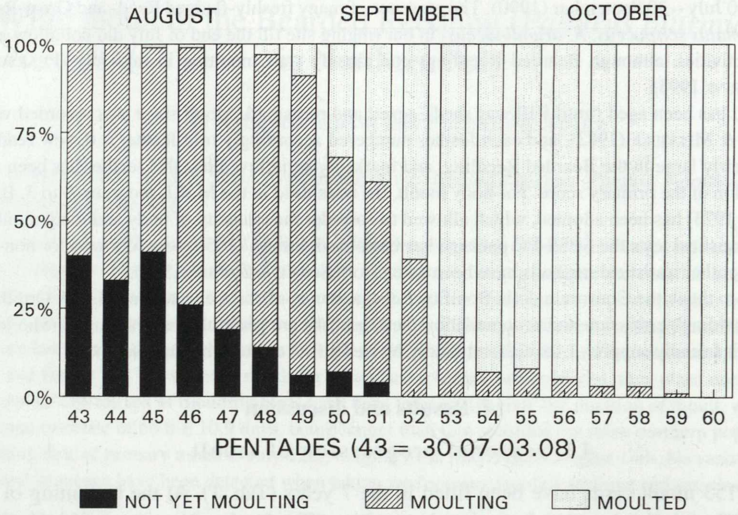

Fig. 1: Seasonal progression of primary moult. - Jahreszeitlicher Fortgang der Handschwingenmauser.

1, none had P9= 0. On the contrary, in 74 cases (93%), P9 scored 3 or 4, suggesting a gap between the replacement of P9 and P10. The last primary to be fully renewed is P9, which is much longer than P10; in all 44 cases with primary score = 49, the only feather still growing was P9.

The first secondary to be dropped was S1 (= outermost secondary) in all 41 cases with secondary score = 1. Secondaries always start moulting when some primaries have already been dropped. In particular, S1 is generally renewed together with P4 or P5; when S1 scored 1, P4 also scored 1 in 15 of 46 cases (33%), while P5 was in stage 1 in 18 cases (39%) and still old in 22 cases (48%). This tendency seems to be confirmed by P3 and P6 moult scores: in 45 cases (98%) P3 scored at least 3, and in 43 cases (93%) P6 was still old. The other secondaries are moulted sequentially, P6 being the last one to be renewed.

The onset of tertiary moult is generally closely related to that of secondaries: when tertiary score was 1, secondaries still had to start moulting in 15 of 28 cases (54%), had a score = 1 in 10 cases (36%), while only in 3 cases (10%) the score ranged between 2 to 6. Conversely, when secondaries had a score = 1, the score of tertials was 0 in 10 of 41 cases (24%), 1 in other 10 cases (24%) and 2 to 6 in 21 cases (52%). Neither secondaries nor tertials had a score greater than 6 when the other group had just started moulting. A fairly strong similarity in the timing of the onset of secondary and tertiary moult can therefore be assumed; tertials begin to moult slightly earlier than secondaries, even if not significantly (Chi-square test, n=25, p=0.317). T2 was replaced first in 25 of 28 cases (89%) with tertiary score = 1, T1 only in 1 case (4%), and T3 in 2 cases (7%). The last tertial to be fully renewed was T1 in 51 of 56 cases with tertiary score = 14 (91%), T2 in 1 case (1%) and T3 in 4 cases (7%). The moult of tertials is completed when primary moult is more than halfway progressed, showing no particular relationship with primaries (tertiary score = 14: n=56, mean primary score = 41.23, s.d.= 4.98, range 28–50).

In the 35 cases with only one remex still in growth, this was S6 in 33 cases (94%) and P9 in 2 cases (6%).

To further describe the development of the moult of remiges, the total primary score has been used in Fig. 2 as a reference to show the relationship between the moult stage of primaries and the shedding of each of the wing feathers.

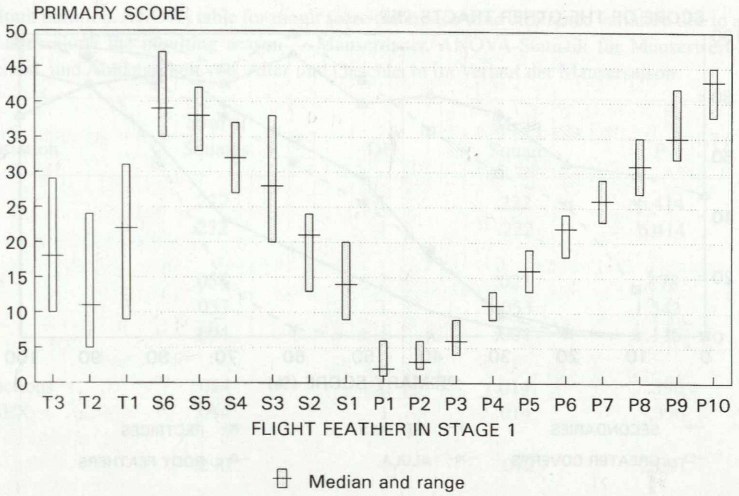

Fig. 2: Onset of moult (score 1, old feather missing or new feather completely in pin) for each flight feather with reference to the stage of primary moult expressed as median and range of primary score. P= primaries, S= secondaries, T= tertials. - Mauserbeginn („Mauserwert 1", bedeutet fehlende Feder oder Federkeim) von Handschwingen (P), Armschwingen (S) und Schirmfedern (T) bezogen auf das Stadium der Handschwingenmauser (angegeben ist jeweils Medianwert und Schwankungsbreite des Handschwingen-Mauserwertes).

As already mentioned (see above), a fairly constant progression can be observed in the sequence of moult of both primaries and secondaries. Such a 'linearity' in the progression of the renewal of primaries has been proposed in several models aimed to calculate the duration of moult (Underhill & Zucchini 1988, Underhill, Zucchini & Summers 1990). Yet, some species can also show patterns of primary moult sequence which are far from being so regular (Spina & Massi 1992), and can be interpreted as a strategy which strongly favours a more compressed and fast moult, leaving the birds time enough to fatten up and get ready for migration.

Our Bearded Reedlings can on the contrary be regarded as a typical example of a fully sedentary population (the whole sample of ringed birds produced 1 single recovery at a distance of 11 kms), in which selection rather favours a longer moult with a regular shedding of feathers, so decreasing the risks connected to a high degree of wing raggedness, and therefore a limited flight ability.

The dynamics of the renewal of the different feather tracts with respect to the percentage of primary score is shown in Fig. 3. Body and greater coverts are already moulting when primaries start, and they are generally fully renewed when 60% of primaries are replaced; tertials and rectrices start to moult when primary replacement is well developed, but then their renewal gets faster, ending up accordingly to primaries. Secondaries start when primary moult is already well in progress, and their moult is still delayed when primaries get fully renewed; alula is the last component of the wing to start moulting, and is characterized by a very fast pattern.

The replacement of alula takes place when primary moult is well advanced (alula score less then 3: n = 12, mean primary score = 33.33, s.d. 4.50, range 25–38). Afterwards it proceeds very fast, mainly due to the small dimensions of these feathers (alula score = 14: n = 10, mean primary score 41.57, s.d. 3.10, range 39–47).

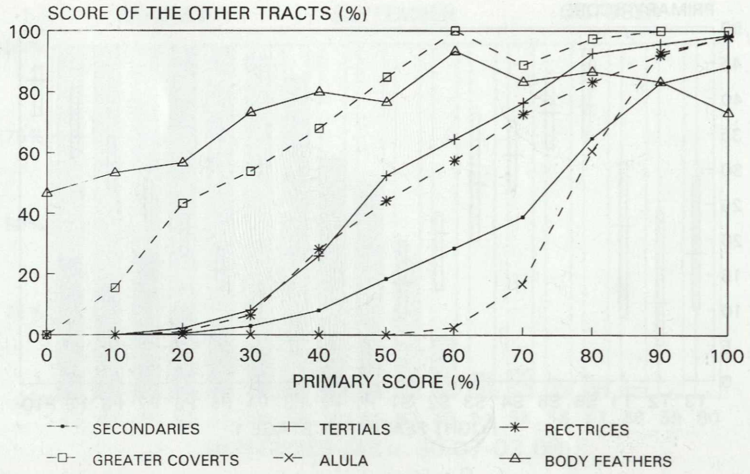

Fig. 3: Moult progression for each feather tract with reference to primary score. - Mauserfortgang in den einzelnen Gefiederpartien bezogen auf den Handschwingenmauserwert.

Rectrices are shed together with P4 in 14 of 17 cases with tail score = 1 (83%), and with P5 in 3 cases (17%); all tail-feathers are generally replaced simultaneously. These data are therefore in accordance with those previously reported (PEARSON 1975, BUKER et al. 1975). As for tertials, no correlations came out between the end of tail moult and primary score (tail score greater than 55: n = 18, mean primary score 43.7, s.d. = 4.55, range = 32–50).

### 4.3. Moult duration

186 Bearded Reedlings (3M = 79, 3F = 68, 4M = 29, 4F = 10) with two moult cards recorded in the same season were used to evaluate the duration of moult in this species and the influence of different sources of variation, such as sex and age. From this sample we have obtained two highly related variables (Pearson's r = .93): moult score difference (Δ-score) and time difference (Δ-date).

In order to have a general overview of the moult pattern of the population, and since the inter-annual variability is most likely to originate mainly from factors which have not been taken into account in this study (e.g. environmental conditions, food availability, productivity, number of clutches, etc.), we decided to lump together the different years of sampling, which were not homogeneous as for sex/age compositions, sampling dates and periods, etc. The inter-annual variability, in this case, would be part of the unexplained variation.

Differences among sex and age classes have been investigated on the whole sample, by means of an ANOVA analysis. When testing for differences among the four sex and age classes, the ratio between Δ-score and Δ-date was used as the dependent variable, in order to minimize the effect due to their strong correlation. After having tested the four groups for homogeneity of variance (Bartlett-Box test, $p = 0.7$), an ANOVA was performed, with age and sex as the factors and retrap date as the covariate, the latter being used to detect differences of moult speed along the season. The results are shown in Tab. 2, confirming that the level of significance was not reached for sex and age classes. The covariate effect could be caused by the moderate but significant negative correlation observed between Δ-score/Δ-date and retrapping date (n = 186, Pearson's $r = -0.18$, $p < 0.01$), a relationship which might be due to the fact that while proceeding towards the end of the moult period, the bulk of the sample is obviously made of birds with progressively higher moult scores.

Table 2: Moult duration. ANOVA table for moult score difference/time difference variation due to age and sex classes along the moulting season. – Mauserdauer. ANOVA-Statistik für Mauserwert-/Zeitunterschied und Abhängigkeit von Alter und Geschlecht im Verlauf der Mausersaison.

| Source of Variation | Sum of Squares | DF | Mean Square | F | Signif of F |
|---|---|---|---|---|---|
| Covariates | .222 | 1 | .222 | 6.414 | .012 |
| DAT2 | .222 | 1 | .222 | 6.414 | .012 |
| Main Effects | .054 | 2 | .027 | .778 | .461 |
| AGE | .053 | 1 | .053 | 1.543 | .216 |
| SEX | .004 | 1 | .004 | .116 | .734 |
| 2-way Interactions | .014 | 1 | .014 | .396 | .530 |
| AGE SEX | .014 | 1 | .014 | .396 | .530 |
| Explained | .290 | 4 | .072 | 2.091 | .084 |
| Residual | 6.272 | 181 | .035 | | |
| Total | 6.562 | 185 | .035 | | |

When looking (Tab. 3) at the mean values of Δ-score / Δ-date in 5 sub-samples with both trapping and retrapping moult scores included in a single category (cat. 1 = score 1–10, 2 = 11–20, 3 = 21–30, 4 = 31–40, 5 = 41–50), a slight tendency to the decrease of moult speed can be noted from cat. 1 to cat. 5 (n = 39, Person's r = -0.13, not significant). The birds with high scores have also a generally late retrapping date; this cumulative effect could determine the significance due to the retrapping date in the ANOVA analysis.

Table 3: Moult duration. Means of moult score difference/time difference in 5 primary score categories. – Mauserdauer. Mittel Mauserwert-/Zeitunterschied für 5 Handschwingen-Mauserwert-Kategorien.

| | 1–10 | 11–20 | 21–30 | 31–40 | 41–50 |
|---|---|---|---|---|---|
| Mean | 0.80 | 0.72 | 0.74 | 0.65 | 0.68 |
| N | 6 | 11 | 9 | 7 | 6 |

On the basis of these assumptions, the regression between Δ-score and Δ-date has been calculated on the whole sample, and the resulting equation is:

$Y_{\Delta\text{-score}} = .730\ X_{\Delta\text{-date}} + 0.288$ $(n = 186, R^2 = .90, p = 0.000)$.

By calculating the 95% confidence limits for Y = 49, a Δ-date estimation of 66.8 ± 10.9 days is obtained. This estimate seems to be confirmed by direct observations made on 3 data available with Δ-score > 40 (Δ-score = 46, Δ-date = 62; Δ-score = 44, Δ-date = 62; Δ-score = 43, Δ-date = 61).

When comparing these results with those referred to Northern European populations (PEARSON 1975, BUKER et al. 1975), it can be noticed that Italian Bearded Reedlings perform a slower moult, a strategy likely to be related to the longer period of favourable environmental conditions they can generally rely on, often lasting well into October.

Table 4: Mean date (day.month) of moult onset in the whole sample and for each age and sex class. The differences are not significant (Mann-Whitney U-test). – Mittlerer Mauserbeginn (Tag. Monat), aufgeschlüsselt nach Geschlecht und Alter (keine signifikanten Unterschiede).

| | N | Mean | Range |
|---|---|---|---|
| 3M | 415 | 23.7 | 31.5 – 14.9 |
| 3F | 358 | 20.7 | 1.6 – 11.9 |
| 4M | 76 | 19.7 | 9.6 – 28.8 |
| 4F | 69 | 19.7 | 9.6 – 21.8 |
| 2M | 653 | 23.7 | 15.6 – 20.8 |
| 2F | 635 | 22.7 | 1.6 – 20.8 |
| Total | 2206 | 22.7 | 31.5 – 14.9 |

Linearity in the progression of moult has been postulated by some authors (see above). In some cases, however, forced by ecological factors frequently related to migration strategies and/or flight efficiency, the speed and sequence of wing moult may vary during its development (Spina & Massi 1992). In this study, the correspondence of our data to a linear model has been tested by calculating the amount of explained and residual variability; the results show that in this case a linear model adequately describes the relationship between moult progression and time ($\Sigma y^2$ (explained) = 14215; $\Sigma d^2yx$ (residual) = 282; p = 0.000).

The predictive equation has finally been applied to the whole sample; in order to have one value for each bird, only the first moult card has been used in the case of birds retrapped later in the season. The mean starting date obtained (day.month) was 22.7, ranging from 31.5 to 14.9. No statistical differences were found among sex-age groups (Tab. 4). The wide range of variation may be explained on the basis of the prolonged breeding season of the species. Early single brood breeders and their offspring may moult already in June or July, while adults performing a second or replacement clutch with their youngs can only start their wing moult by August-September.

## 5. Closing remarks

In several european species climatic conditions are proved to determine shorter moult periods in northern populations with respect to southern ones (Jenni & Winkler 1994); the results of our study seem to confirm such a strategy also in the Bearded Reedling. The difference in duration with respect to the British, German and Dutch populations could be an adaptation to local average climatic conditions, which remain favourable well after the end of the breeding season, allowing Italian Bearded Reedlings to minimize the daily cost of feather replacement by means of a longer moulting period (Berthold et al. 1990; Jenni & Winkler 1994); accordingly, no difference in moult duration was detected when taking into account early and late broods.

Probably for the same reason, in the case of Northern Italian Bearded Reedling populations selection seems not to have acted in favour of a concentration of the energetic costs of moult in a particular phase of the wing feather replacement; the progression of their moult can in fact be appropriately described by a linear model, which has proved not to be the case for species of long-distance migrants breeding in the same area (e.g.: *Motacilla flava*, Spina & Massi 1992).

## Zusammenfassung

Von 1985–1992 konnten in Val Campotto (Ferrara, Nord-Italien) insgesamt 3153 Mauserkarten mit Mauserdaten von Bartmeisen (*Panurus biarmicus*) erfaßt werden. Ziel der vorliegenden Arbeit ist es, Mauserdauer und Mausermuster von Hand- und Armschwingen sowie der Schirmfedern zu analysieren, auch bezogen auf Alter und Geschlecht der Vögel. Die Handschwingenmauser verläuft regelmäßig ohne auffällige Wechsel in der Geschwindigkeit im Verlauf der Mauser. Die Handschwingenmauser beginnt bei der innersten Handschwinge (P1) und schreitet dann zur äußersten (P10) fort; die Armschwingen werden von außen (S1) nach innen (S6) vermausert und die Schirmfedern fallen in der Reihenfolge T2, T3 und T1. Die Mauser von Armschwingen, Schirmfedern und Steuerfedern beginnt erst nach Ausfall der 4. Handschwinge. 186 Wiederfänge mausernder Bartmeisen gaben Hinweise auf die Mauserdauer (66,8 ± 10,9 Tage), die länger ist als bei weiter nördlich lebenden Populationen. Der Beginn der Handschwingenmauser fällt im Mittel auf den 22. Juli (31. Mai –14. August). Zwischen den Geschlechtern und verschiedenen Altersklassen gab es in der Dauer und Sequenz der Mauser keinen Unterschied.

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