BEAUFORTIA

SERIES OF MISCELLANEOUS PUBLICATIONS
INSTITUTE OF TAXONOMIC ZOOLOGY (ZOOLOGICAL MUSEUM)
UNIVERSITY OF AMSTERDAM

No. 306 Volume 23 May 15, 1975

Post-juvenile moult of the Bearded Tit, *Panurus biarmicus* (Linnaeus, 1758), in Zuidelijk Flevoland, the Netherlands (Aves, Timaliinae).

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ABSTRACT

The post-juvenile moult of the Bearded Tit, *Panurus biarmicus*, has been described quantitatively on the basis of mass trappings of the explosively increased population in Zuidelijk Flevoland, the Netherlands.

The strongly scheduled moult takes place from the end of July till the beginning of October, a period during which practically all wing feathers are being replaced in 56 days. Body feathers are moulted at the same time as the wing feathers but this process is completed later.

The post-juvenile moult causes a considerable reduction in flying capacity. Tentativily the timing of this moult is related to other activities of this species in summer and autumn.

INTRODUCTION

In the summer and autumn of 1973 during extensive mist-netting in Zuidelijk Flevoland observations have been made on the progress of moult of the Bearded Tit, *Panurus biarmicus*.

The polder uncovered in 1968. Owing to the development of extensive reed vegetation, stimulated by the sowing of reedseed, an unusually large Bearded Tit population came into being in the IJsselmeerpolders. The reedbeds alternate with pools surrounded by zones of *Senecio congestus* and cattails *Typha latifolia* and *T. angustifolia* and are in many places mixed with willows *Salix* spp. It is hard to estimate the number of Bearded Tits, but on the basis of retrap percentages and local estimates we found that in late summer many tens to perhaps some hundreds of thousands populated this area. Thanks to this explosive development the species appeared in numerous

Received: January 7, 1975

places in and around the Netherlands. Since this unique situation is likely to be of a temporary nature, we thought it useful to give a summary of all data collected on moulting. Before long we shall not be able anymore to take samples of this size in a single population during one season. From July 12th through November 3rd 1973 the moult of 686 Bearded Tits could be noted.

The Bearded Tit, like larks (Alaudidae), the Long-tailed Tit *Aegithalos caudatus*, the Penduline Tit *Remiz pendulinus*, the Corn Bunting *Emberiza calandra*, sparrows (Ploceidae) and starlings (Sturnidae) belongs to a small group of birds in Europe, the young of which have a complete moult, including the remiges, before the winter sets in (Svensson, 1970). Since the Bearded Tit's first winter plumage is identical to the adult's they are already indistinguishable half-way through the post-juvenile moult. The ratio between juveniles and adults was extremely high during the research period due to the enormous reproduction and to the fact that the largest mortality does not occur until winter (Spitzer, 1972): less than one percent of the individuals which could be aged, appeared to be adults. This means that the following data relate almost exclusively to first-year birds.

The data have been subjected to a twofold process. First, the observations made on various feather groups are being related to the sequence of the primary moult, which results in a characteristic pattern of the species. Then the progress in moult with the season is being described. The results are being compared with the literature on the Bearded Tit.

Methods

The way moult is being described almost entirely coordinates with the method set forth in "Moult Enquiry" of the British Trust for Ornithology, as described by Snow (1967). Moulting feathers are given a score from 1 to 4 according to their stage of growth. Old feathers are marked by the score 0 and new feathers by the score 5. By adding all scores of a feather group we arrive at the moult score of this specific group. Primaries, secondaries, tertials and tail feathers have been described in this manner.

The amount of "raggedness" of the wings as applied by Haukioja (1971) may be inferred from the remiges' stage of growth. A fully grown, old or new feather has been recorded using code 0 and a growing feather code 4 (feather absent or in pin) through 1 (almost fully grown). The primary and secondary codes are being added up. The code of the outermost, small primary is not taken into consideration because it has almost no effect on raggedness. So raggedness might theoretically vary between 0 (all feathers fully grown) and 60 (all feathers absent).

The bird's small feathers have been classified in four groups, namely: wing coverts and bastard-wing, underparts, upperparts and head feathers. This is not a very detailed classification, but we did regard a more detailed research on living birds unacceptable. As to these four feather groups we only examined whether the birds were moulting or not (presence of blood-quills) and incase of non-moulting birds, whether the feathers were old or new.

Results

The moult sequence is being described in detail for primaries, secondaries, tertials and tail. The progress of moult of all feather groups is being compared with that of the primaries. An analysis of the data, subdivided into males and females, showed that both sexes gave identical results, so they have been combined.

Primaries. On moulting, the innermost primary is being shed first and the outermost last (descendantly). Five feathers may be moulting simultaneously. The entire moult takes about 56 days, as will be shown later.

Secondaries (fig. 1). The outermost secondary is moulted first at a primary score of approximately 15 (P = *c.* 15). The entire process takes place in the direction of the body (ascendantly) and finishes at the same time or just before the primaries, moulting at a constant rate in relation with these. Many bird species have replaced all secondaries just before the primary moult is completed (Snow, 1967), although there are exceptions to this rule such as the Chaffinch *Fringilla coelebs* (see Haukioja, 1971), the Great Tit *Parus major* and the Blue Tit *Parus caeruleus* (see Flegg & Cox, 1969) but also the Tree Sparrow *Passer montanus* (see Bibby, 1970), a bird that like the Bearded Tit passes through a complete post-juvenile moult. The secondary moult of these species continues much longer than the primary moult.

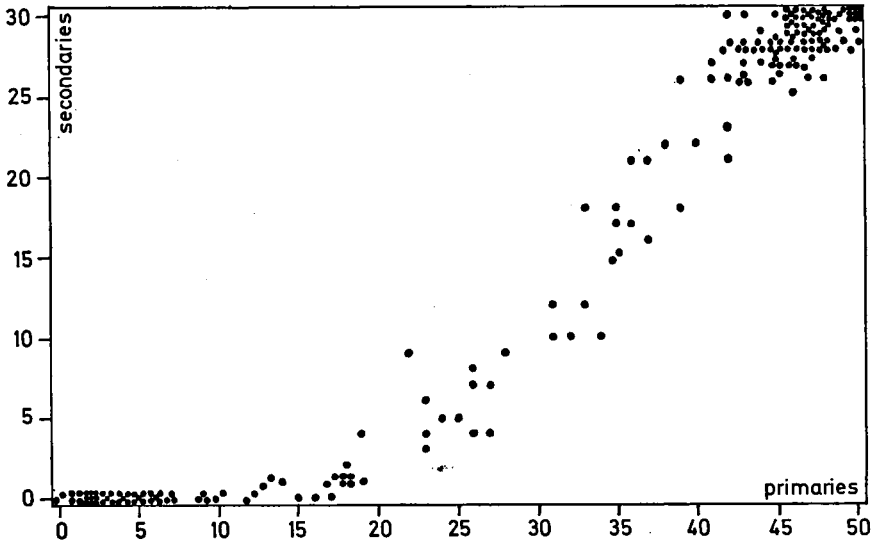

Fig. 1. Secondary scores against primary scores.

Tertials (fig. 2). The moulting pattern of the tertials is not as fixed as that of the other remiges. As a rule, it takes place descendantly, now and then however, irregularly; for example, the middle feather is being shed first. With

respect to the primaries the tertials are being shed with much more variation than the secondaries. The moult takes place at a fairly constant rate.

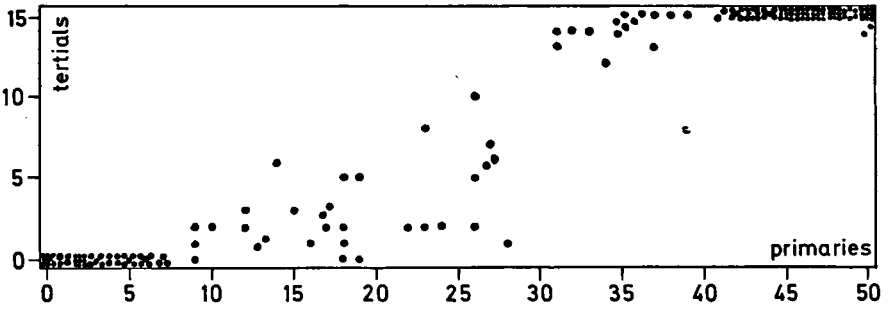

FIG. 2. Tertial scores against primary scores.

Tail (fig. 3). The tail is usually moulted from the middle outwards (centrifugally), but often all tail-feathers are being dropped at the same time. Tail-feathers start moulting in advance of the secondaries at P= *c.* 11, and the moult is also completed somewhat earlier. In addition, the start is more variable in relation to the primaries, but the rate of growth is again fairly constant.

Moult scores of the tail indicate simultaneous feather loss as scores with all feathers in the same stage (6, 12, 18 and 24) are more frequently found than could be expected if replacement of feathers should always be gradual (table I).

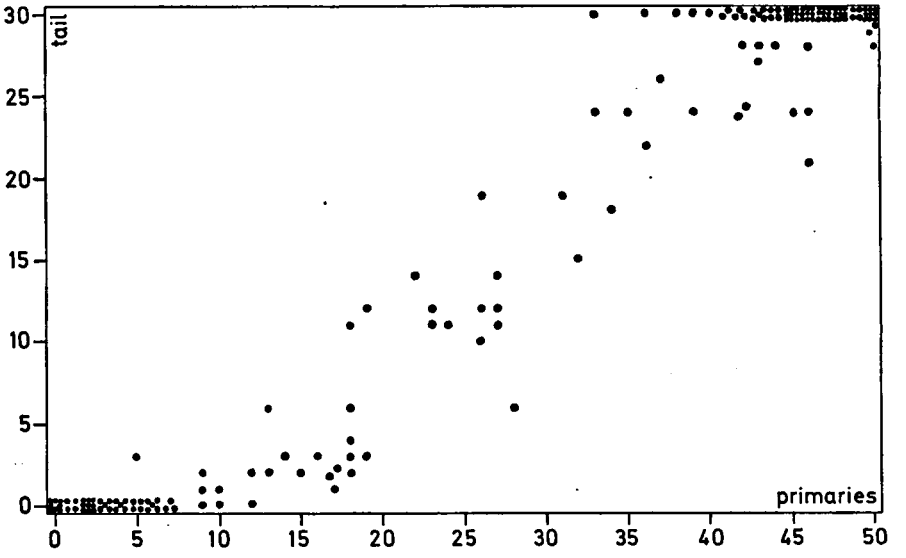

FIG. 3. Tail-feather scores against primary scores.

TABLE I. Observed (1) and expected (2) frequencies in scores of tail moult. (For further explanation see text).

	(1)	(2)
Scores with all feathers equally grown	15	7.2
All other scores	37	44.8
$\chi^2 = 9.8$ (df = 1) significant at 1% level.		

Wing coverts and bastard-wing. Moult of these feathers starts at the same time or somewhat later than the primaries. The moult is completed between P = 40 and P = 50. So coverts and flight feathers are moulted largely synchronously.

Underparts (fig. 4). Feathers of the underparts start to moult just before or virtually at the same time as the primaries and the moult continues after the completion of primary moult. Two individuals with P = 0 showed moult on underparts. 152 birds were still moulting their underparts while the primaries were fully grown.

Upperparts (fig. 4). Most Bearded Tits start to shed their upperpart feathers before or at the same time as the primaries. The moult of the rhomboidally shaped feather group at the back ("Spinalflur", Steiner, 1971), starts first. The upperpart moult exceeds the primary moult period. At P = 0 eight individuals were already moulting their upperpart feathers and 169 still did so at P = 50.

Head feathers (fig. 4). Head feathers start much later than the other feather groups, i.e. on the whole at P = *c.* 20. The head feathers are all renewed just before or after the end of primary moult. 119 birds with P = 50 were still moulting their head feathers.

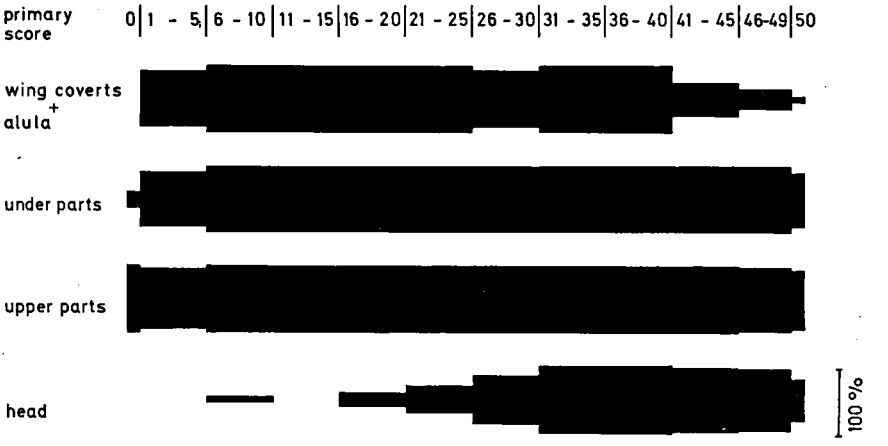

FIG. 4. Percentage of birds with moulting wing coverts + alula, underparts, upperparts and head feathers at different stages of primary moult as mentioned above.

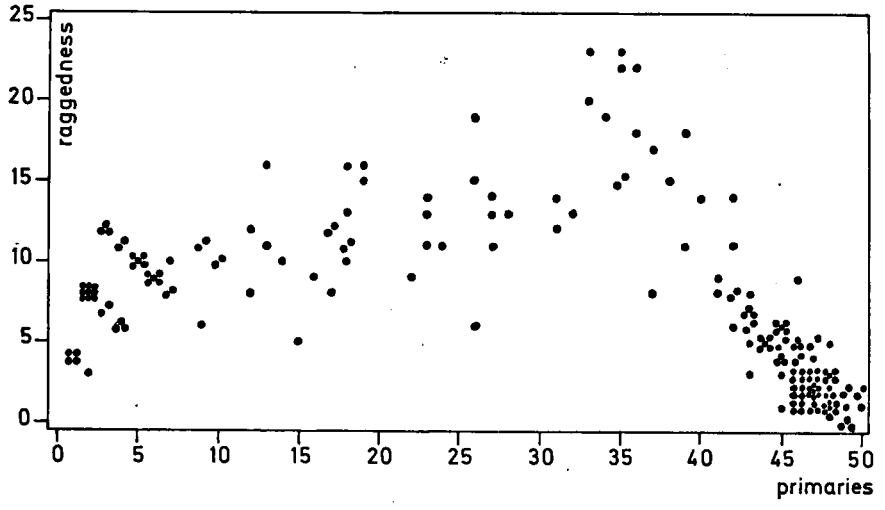

FIG. 5. Raggedness against primary score.

To sum up, we arrive at the following general picture of the moult: this process starts on the upperparts, then the underparts and the primaries begin followed by the wing coverts. Tail feathers begin at P = *c.* 11, the tertials and secondaries at P = *c.* 15. Finally, the first head feathers are being shed at P = *c.* 20. The moult of the tertials is completed first, then the moult of the wing coverts and of the tail feathers. Shortly afterwards secondaries and primaries are fully grown. Then moult of the head is completed, followed by that of the underparts. Moult of the upperparts continues longest.

PROGRESS OF MOULT IN TIME (FIGS. 6, 7 AND 8)

The progress of moult in time is usually gauged with reference to the primary moult (Snow, 1967). The primary score develops slightly sigmoidal in time but can be usually regarded as linear. This also goes for Bearded Tits. It enables us to assess the average moult rate on the basis of moult score increase of trapped birds and especially of retraps. In all, only 32 moulting birds have been caught twice. 21 of these did not show primary moult at one time or the other. From the other 11 retraps (fig. 6) the duration of moult has been calculated at 56.2 days. Figure 7, however, shows that moult takes only 48.0 days. The regression equation of primary score against date in fig. 7 is computed from the mean dates for each primary score. This method is recommended by Haukioja (1971) if scatter in the start of moult is great.

The difference of well over eight days in the duration of primary moult may have been caused by the fact that birds in the early and late stages of moult are caught more frequently than birds in intermediate stages (see Moult and flying capacity). This leads to an underestimation of the duration of moult. Figure 7 also shows that not all Bearded Tits start moulting at the

same time. The first birds start on July 20th, the last on approx. August 30th. Figure 8 shows a survey of the moult of all feather groups.

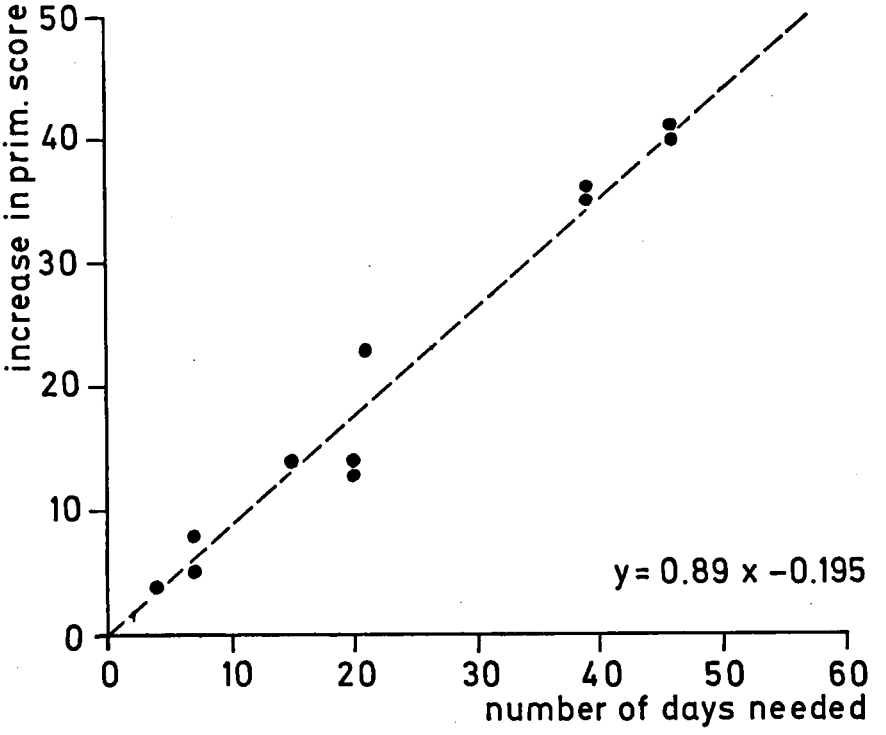

FIG. 6. Increase of primary score in time (from retraps).

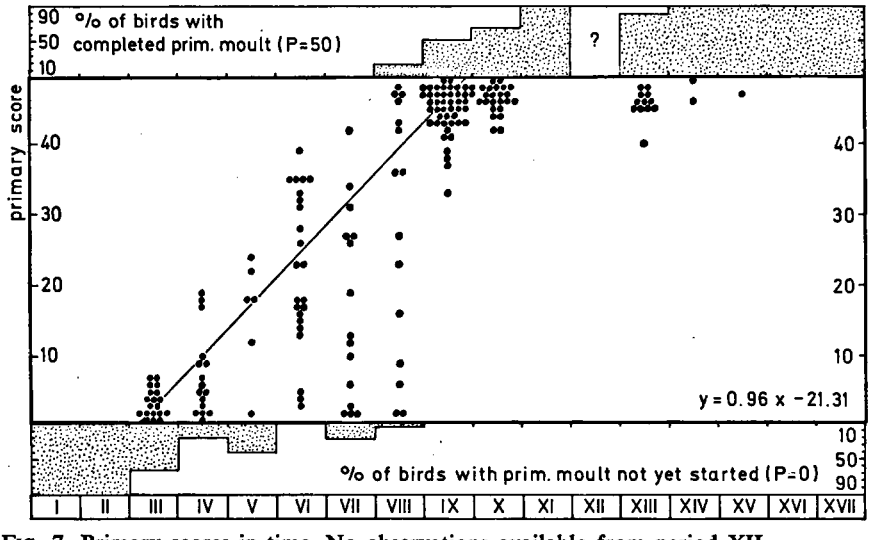

FIG. 7. Primary scores in time. No observations available from period XII.

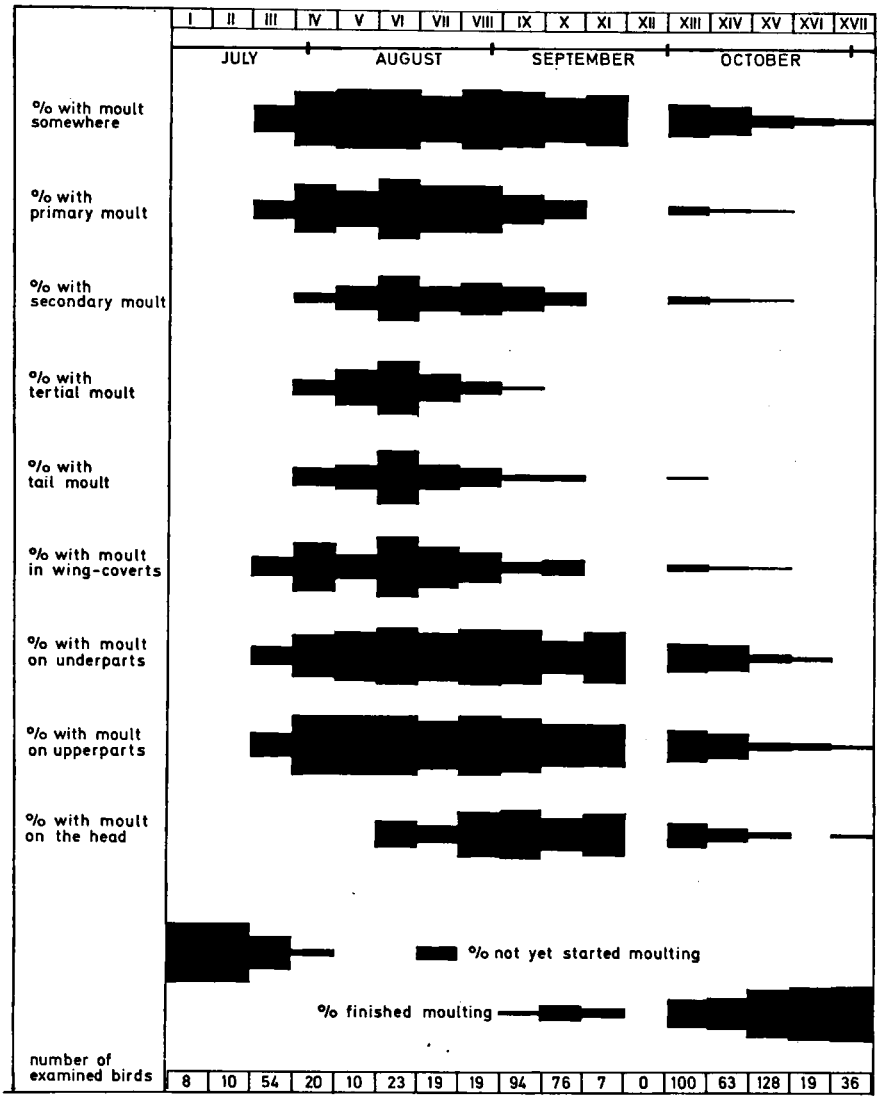

FIG. 8. Percentages of birds with moult for the different feather groups successively.

MOULT AND FLYING CAPACITY

In figures 9 and 10 both raggedness and trapping results in time are being compared. In case of poor flying capacity (so, considerable raggedness) the Bearded Tits are hard to catch. In period VI an unexpectedly high number of birds was caught because a group of primary moulting birds were quite accidentally driven into the mistnet.

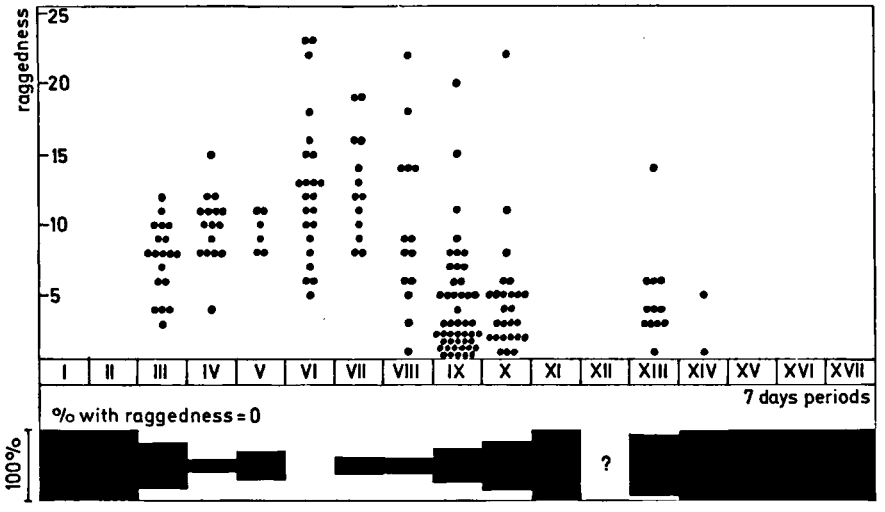

FIG. 9. Raggedness in time. No observations available from period XII.

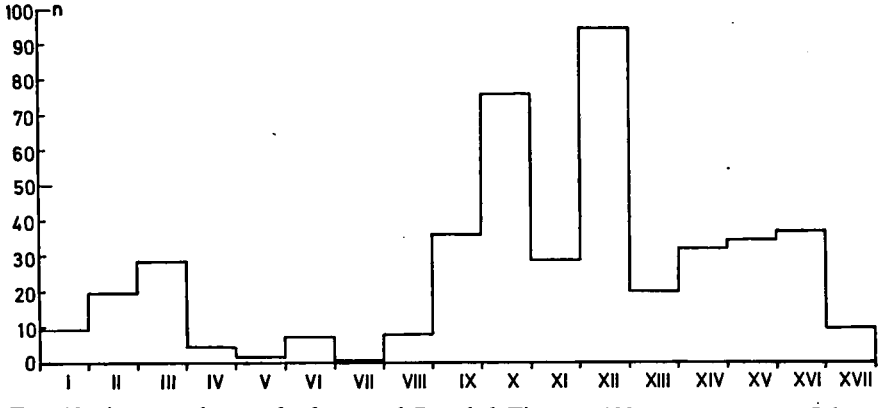

FIG. 10. Average day total of trapped Bearded Tits per 100 metres net per 5 hours at the fixed mistnet-station in Zuidelijk Flevoland.

DISCUSSION

Despite selective trapping of non-moulting birds the various feather groups still show a regular development in relation to each other. The moult as a whole is therefore strongly scheduled. Body feathers show greatest variation, possibly related to their being not involved in maintaining flight. The wing coverts exactly follow the flight feathers, so that the wing is in fact ragged only for a short while, but this raggedness is such that there can hardly be any question of flying. The Bearded Tits are very inactive at this stage. They may be reducing physiological stress by spreading the body moult.

Apparently there is no time to be lost in moulting the wings in view of the need for rapid restoration of an optimal flying capacity. Just after the moult

the flying and calling activities greatly increase. The Bearded Tits with completely new plumage carry out curious social flights, which mark the annual dispersion period ("Höhenflüge", Spitzer 1972 and 1974). The structure of the stomach wall changes during the dispersion period, which relates to a radical change in food from insects to reed seeds (Spitzer, 1972).

The enormous reproduction is assured by the number of clutches layed each year. Regularly pairs succeed in raising three broods, sometimes even four (Eyckman et al., 1937). According to Spitzer (1972) there is a possibility that under favourable conditions even the young of the first brood attempt to breed in their year of birth.

At least two consecutive broods may be recognised both in the moult process in time (fig. 7) and in the variation of trappings (fig. 10). This assumption is backed by the reappearance of birds with P = 0 in period VII. Bibby (1970) too found that there is variation in the moult score of the Tree Sparrow, which he related to various fledging periods.

Acknowledgements

We wish to thank the "Rijksdienst voor de IJsselmeerpolders" (Lelystad) for permission to trap and ring passerine birds in the polder Zuidelijk Flevoland. The translation of the original text into English was performed by Miss Drs. M. Raaymakers to whom we extend our sincere thanks. Dr. J. Wattel (Institute of Taxonomic Zoology) commented on an earlier draft of this paper and suggested various improvements, for which we are very grateful.

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