Weights of Reed Buntings (*Emberiza schoeniclus*) during Summer

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There are many studies dealing with the weights of birds (NICE 1937, 1938, BALDWIN & KENDEIGH 1938, RICHDALE 1947, NEWTON 1966 b etc.); among others, different weight components have been studied in detail by KING *et al.* (1965) and NEWTON (1968). Rather few data exist about the importance of bird weights during critical periods in bird life. This paper describes the weight changes of the Reed Bunting during summer and early autumn and, in addition, I discuss some survival aspects on the basis of weight data.

Material and methods

The present data were collected during the years 1966—1968 mainly on my Reed Bunting study area at Pori at the mouth of the Kokemäki River (61°32'N, 21°44'E) in western Finland. During those years I ringed in the area about 2000 Reed Buntings, which were generally weighed at least once. The catching (using mist-nets) period has extended over the whole time that there are Reed Buntings in the study area, that is from March-April to the beginning of October. Until the beginning of September the Reed Buntings at the mouth of the Kokemäki River are mainly local birds. The migration of juvenile females begins in the first half of September, that of juvenile males and adult females in the middle of September and that of adult males at the end of September (HAUKIOJA 1968 a).

The weight of Reed Buntings, as in birds generally, fluctuates during a day (about the Reed Bunting, see SCOTT 1961). That is why I have chosen for the material of this paper only birds weighed between 06.00 and 10.00 a. m. It is true that the weights increase as a rule during this time, but that probably does not significantly affect the final result.

In weighings I have used a spring balance sensitive to 0.1 g.

Criteria for sexing and ageing

It is generally easy to sex a Reed Bunting; adults can be sexed on the basis of black parts in the head feathers (SVENSSON 1964). The length of the wing is also a good criterion. Reed Buntings, classed as adults according to their rings and measured during an autumn after the postnuptial moult in order to eliminate the wear of feathers, have had following wing lengths:

	Mean	Range	n
Males	80.9±0.23 mm	78—84 mm	36
Females	75.1±0.28 mm	72—77 mm	22

The difference between sexes is statistically significant ($P < 0.001$). All wing measurements in this paper are from unflattened wings.

It is not possible to sex juvenile Reed Buntings on the basis of head colouration before they are about two months old. I have sexed younger juveniles, still in juvenile plumage, according to the length of their wings. The wing length of juvenile Reed Buntings, ringed as nestlings in my study area and captured during the first summer or autumn and which were then sexed according to their head colouration (during or after moult), has been:

	Mean	Range	n
Males	78.0±0.26 mm	74.5—81 mm	32
Females	73.3±0.17 mm	71—76 mm	53

The difference between sexes is statistically significant ($P < 0.001$). In the weight data of this paper I have regarded as females those individuals in juvenile plumage with a wing length of 75 mm or less, and as males those with 77 mm or more. If a juvenile with a

TABLE 1. The weights (in grams) of adult Reed Buntings from April to October. (*Vanhojen pajusirkkujen paino (g) huhti—lokakuussa.*)

Dates *Jakso*	♂♂ Weight *Paino*	♂♂ Standard deviation *Keskihajonta*	♂♂ n	♀♀ Weight *Paino*	♀♀ Standard deviation *Keskihajonta*	♀♀ n
1—10. 4.	19.9	0.8	5	—	—	0
11—20. 4.	19.9	0.9	14	18.1	—	1
21—30. 4.	19.1	0.6	14	17.6	1.0	5
1—10. 5.	20.1	1.0	22	18.5	1.7	21
11—20. 5.	19.9	1.1	11	19.2	1.4	12
21—30. 5.	20.2	1.0	20	19.8	1.3	23
31.5.— 9. 6.	20.1	0.9	19	18.7	1.4	10
10—19. 6.	19.8	0.6	12	19.6	1.7	15
20—29. 6.	20.1	0.9	17	18.4	1.3	9
30.6.— 9. 7.	20.1	1.1	21	18.6	1.2	15
10—19. 7.	20.5	0.9	3	18.3	0.7	4
20—29. 7.	20.1	0.6	2	17.6	1.4	6
30.7.— 8. 8.	19.9	—	1	—	—	0
9—18. 8.	20.8	0.9	5	—	—	0
19—28. 8.	—	—	0	17.8	—	1
29.8.— 7. 9.	20.0	1.1	20	18.2	1.1	10
8—17. 9.	19.8	1.0	13	18.2	0.6	9
18—27. 9.	19.9	1.2	33	17.6	0.7	21
28.9.— 7.10.	20.5	0.5	6	18.8	1.1	9

wing length of 76 mm has not been caught anew during or after the postjuvenal moult, it has not been included in the material of this paper. The error that is caused from this practice is probably negligible.

It is easy to recognize a Reed Bunting in juvenile plumage. Its feathers are not worn, the apterium of the belly is quite bare, etc. It is also easy to age a breeding or moulting adult on the basis of its worn plumage or the moult in remiges. After the postjuvenal moult a male in its first year is generally less bright than an adult male after the postnuptial moult. The differences in colouration (WITHERBY *et al.* 1958, CORNWALLIS & SMITH 1962) are not completely reliable, I think. I have aged the juveniles and adults during autumn by a method, which has its basis on the shape of the points of rectrices, mentioned by SVENSSON (1964). In juveniles and birds less than a year old the points of the rectrices are more or less pointed while those of adults are generally much more rounded. In the data of this paper most of birds less than a year old are aged according to their rings. The adult birds whose weights are presented here are usually aged on the basis of their rings, too, but some individuals, very obviously old (rounded points of the rectrices), are included.

The wing length data presented above reveals that the length of wing is in both sexes longer in the adults than in the juveniles (see STEWART 1963). The difference is statistically significant ($P < 0.001$) in both sexes. The measurements of the wings can only in extreme cases, however, be used as a more or less certain criterion in the ageing of the Reed Bunting.

Weights of adult birds

The summer weights of 238 male and 171 female Reed Buntings are shown in Table 1. The small number of weighings in July is caused by the movements of birds away from their best breeding habitats (meadows with low willow bushes) during the postnuptial moult; in general I have netted only in my main

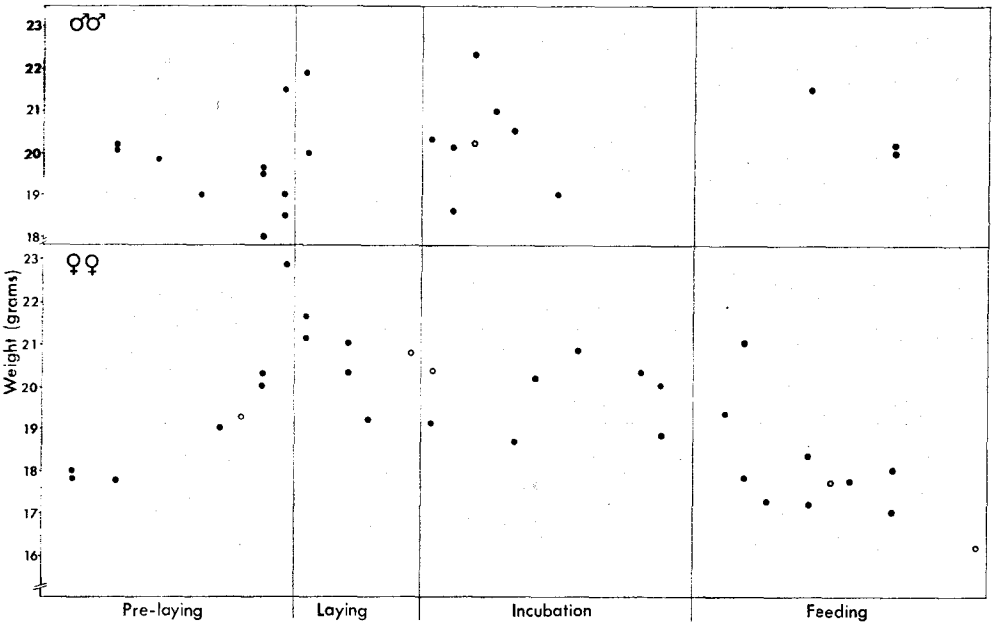

FIG. 1. The weights of Reed Buntings weighed at known phases of their breeding cycle. Black dots indicate first broods, open ones replacement or second broods. (*Tunnetuissa pesimäkierron vaiheissa punnittujen pajusirkkujen paino. Mustat ympyrät tarkoittavat ensimmäistä poikuetta, avoimet toista tai uusintapesyettä.*)

study area, the vegetation of which I have described elsewhere (HAUKIOJA 1968 b).

According to Table 1 there are no great changes in the weights of the Reed Bunting males during a summer. It is likely that the weights are higher during the moulting period, July—September, than during the breeding cycle, but on this point my data are too scanty. During the laying and incubation period, from the beginning of May to the latter half of July, the average weight of female Reed Buntings is about 18 g, which may be considered as a crude estimate of the "normal" pre- and postbreeding weight of females during summer. The heavy weights of females during the breeding cycle are due to the heavy weight of ovaries and developing eggs (e.g. NEWTON 1966 b). During the breeding cycle females are rather heavy in comparison with males; this is a general phenomenon in birds (NICE 1938).

Fig. 1 shows the weights of breeding Reed Buntings in known phases of their breeding cycle; all weights are from individually colour-ringed birds, whose nests were found. There are probably no big fluctuations in the weights of breeding males; the same was indicated by Table 1. The weight of females begins to increase probably about 4—5 days before the laying of the first egg. This interval is the same as between the destruction of a nest and the laying of the first egg in the replacement nest (HAUKIOJA 1968 a) and represents probably the time an egg demands to develop. During incubation there is no apparent change in the weights of females. NICE (1938) considers an increase in weight in the Song Sparrow (*Melospiza melodia*) possible during

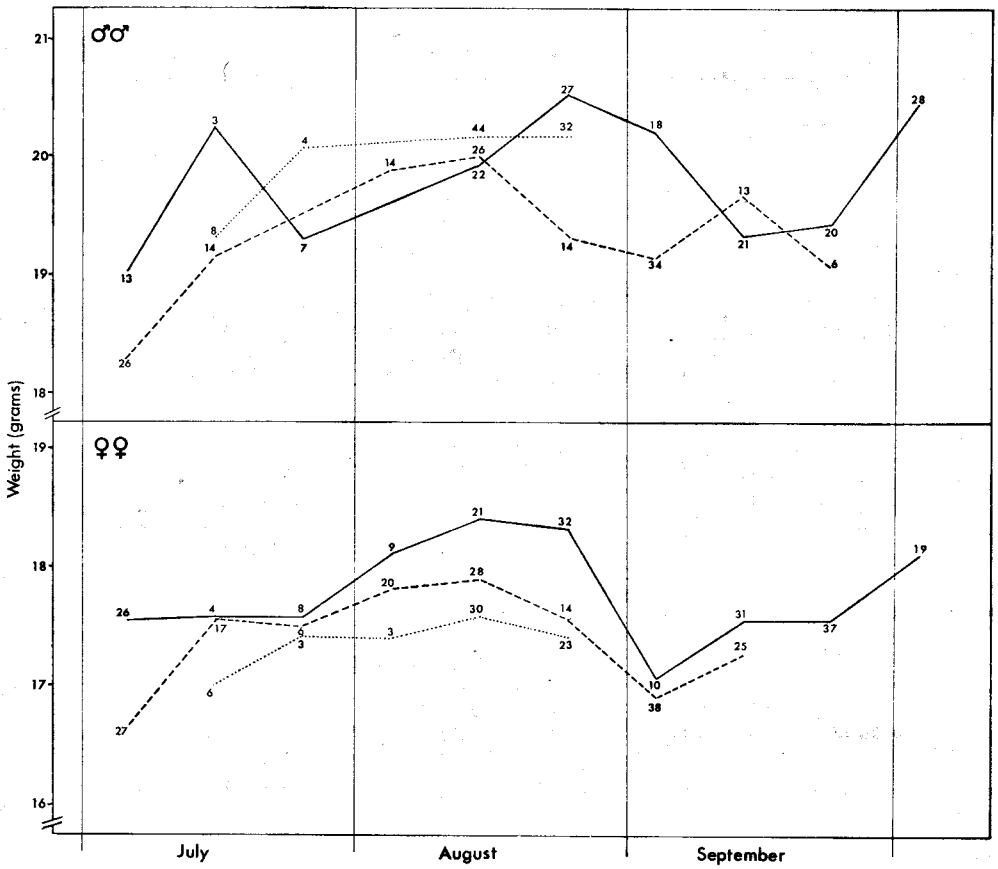

FIG. 2. The weights of juvenile Reed Buntings in ten-day periods during summer and autumn. The numbers indicate the size of the sample. Only averages based on three or more weighings are shown. The year 1966 (.....), 1967 (———) and 1968 (----). (*Nuorten pajusirkkujen keskipaino kesä- ja syyskaudella kymmenpäiväjaksoina. Luvut ilmaisevat, kuinka suureen aineistoon keskiarvo perustuu. Alle kolmesta yksilöstä laskettuja keskiarvoja ei ole merkitty. Vuosi 1966* (.....), *1967* (———) *ja 1968* (----).

incubation and RICHDALE (1947) has discovered a weight increase during this period in the Yellow-eyed Penguin (*Megadyptes antipodes*).

During the feeding period the average weight (18.1) of female Reed Buntings is lower than that (19.8) during the incubation period ($P < 0.01$). Especially females feeding a second brood have been rather light. On this point I have more data from other times of the day than between 06—10 a. m.

Weights of juveniles

The weights of juvenile Reed Buntings (437 ♀♀, 394 ♂♂) captured in my study area during the summers and autumns are given in Fig. 2. Those weighed in the latter half of September 1967 are from Turku, some 90 km south of the study area. The period of maximum juvenile weights, distinct especially for females, seems to be in the middle and second half of August, that is about

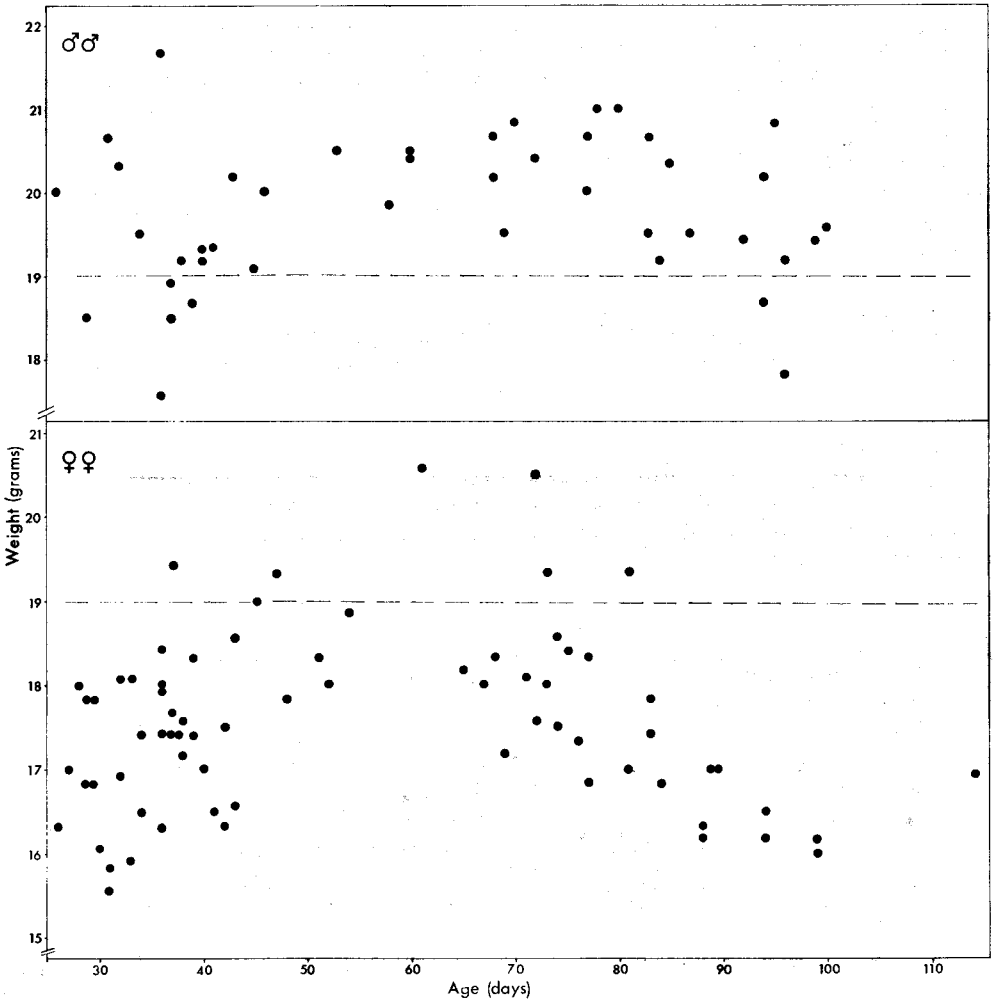

FIG. 3. The summer and autumn weights of juvenile Reed Buntings hatched before or on 15th June and ringed as nestlings in relation to their age. (*Viimeistään 15.6. kuoriutuneiden, pesäpoikasina rengastettujen nuorten pajusirkkujen paino suhteessa ikään.*)

ten weeks after hatching of most first broods. The young birds are then in their postjuvenal moult and an increase in weight during the moulting period has been observed, among others, in the Bullfinch (*Pyrrhula pyrrhula*) (NEWTON 1966 b, 1968).

During the late summers I have captured and weighed so many of the juveniles which I had ringed as nestlings that on the basis of their weights it is possible to get a rather good idea of weight changes during the first summer (Fig. 3). According to my observations the postjuvenal moult also in juveniles from first broods begins at an age of under 40 days and ends at an age of 80—95 days, so the time of heavy weights coincides with that of the postjuvenal moult. The weight peak during

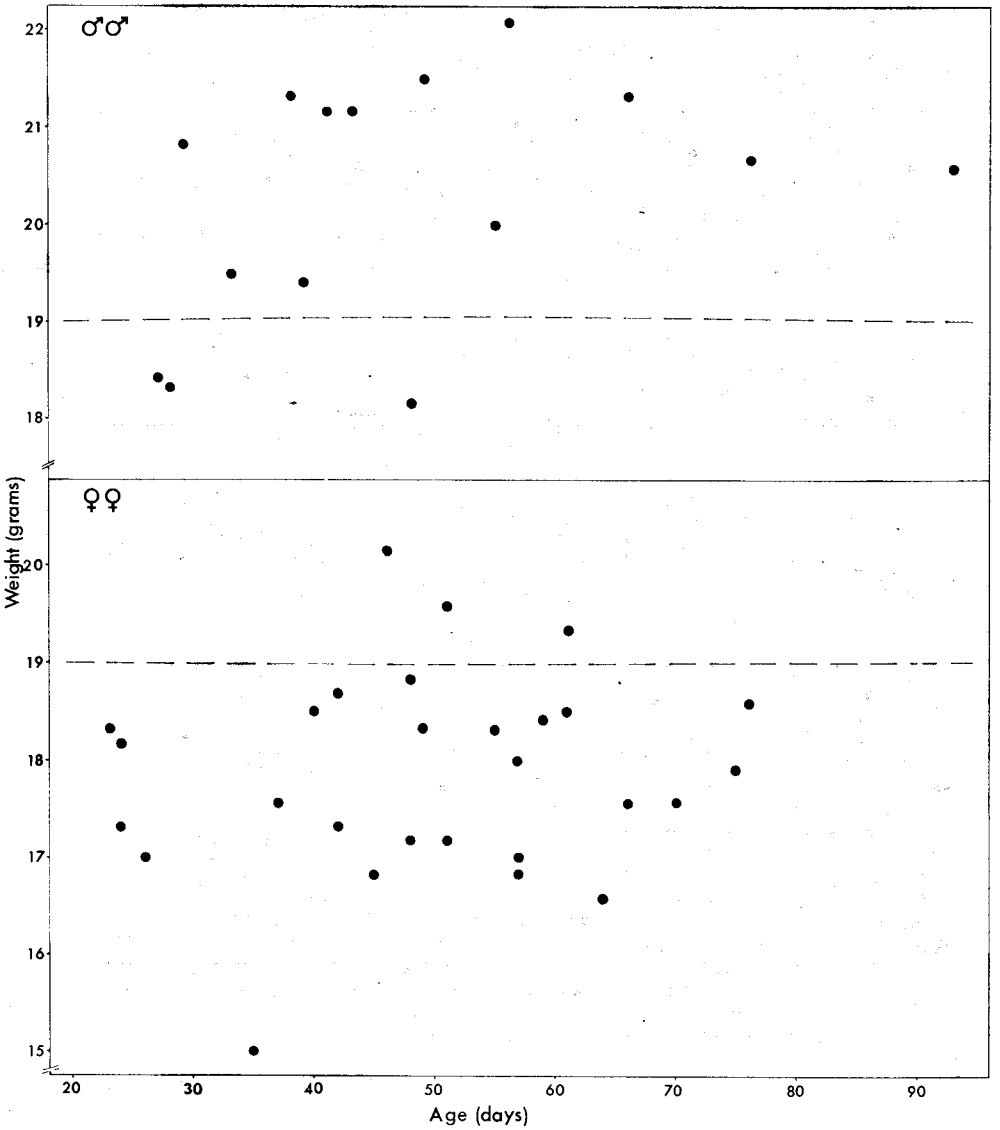

FIG. 4. The summer and autumn weights of juvenile Reed Buntings hatched on or after 16th June and ringed as nestlings in relation to their age. (*Aikaisintaan 16.6. kuoriutuneiden, pesäpoikasina rengastettujen nuorten pajusirkkujen paino suhteessa ikään.*)

moulting in Figs. 2 and 3 is less distinct in males than in females. This may depend on the fact that moulting seems to be about ten days faster in females than in males. So it is probable that the high weights during moult are necessary for (rapid) moulting and possibly moulting in males is slightly less severe than that of females.

Fig. 4 gives the corresponding weights of juveniles from late broods as Fig. 3 from early broods. The postjuvenal

moult of the juveniles from late broods is a little faster than that of those from early broods. Fig. 4 cannot, therefore, be directly compared with Fig. 3. However, it seems evident that there is a more irregular fluctuation in the weights of juveniles from late broods than in the weights given in Fig. 3. It seems that they, unlike juveniles from the first broods have the high weights of the moulting period and the period of premigratory fatdeposition followed closely upon each other as e.g. in the White-crowned Sparrow (*Zonotrichia leucophrys gambelii*) (KING *et al.* 1965).

The weight of juvenile and adult Reed Buntings after moulting but before premigratory fatdeposition seems to differ, but as my data are based only on those birds captured at this intermediate phase after earlier ringing, the data is too scanty.

Survival aspects

In papers dealing with the weights of birds there are generally no distinctly underweight individuals from the moulting or other periods. But what is an underweight individual like? For instance, I have never weighed a juvenile or adult Reed Bunting female which weighed less than 15.0 g, although there have been about twenty females with a weight of under 15.5 g among about 3000 Reed Buntings which I have weighed. The minimum weight margin seems, then, to be rather clearly drawn. But Fig. 3, which has been made on the basis of weighing juveniles of a known age, indicates that the weight of a juvenile in moult probably cannot fall to such a figure which at other phases might be interpreted as average. For instance, a juvenile female weighing 17 g attains its average weight at the ages of about 30 and 90 days but at the age of 60 days the same weight indicates an underweight individual (Fig. 3). So the word "underweight" may have very different meanings in terms of grams at various phases in a bird's life.

The fact that generally no underweight individuals are found has been interpreted as indicating that such birds perish very quickly (NEWTON 1966 b). I think that this is the correct explanation, and I have indirect evidence of the vulnerability of birds during the postjuvenal moulting period, which, in my opinion, is connected with difficulties maintaining a high metabolism and weight during the postjuvenal moult. (The metabolic rate of birds tends to increase during the moult (for *Emberiza*-species, see WALLGREN 1954) and according to this author individual variation during this phase is wider than during nonmoulting periods.)

On the 5th and 6th August 1967 there was a heavy storm in western Finland (on the 5th there were 41 mm. of rain in Pori, Kuukausikatsaus Suomen ilmastoon, elokuu 1967). After this storm the August numbers of young Reed Buntings in my study area were, according to an analysis of netting results, much smaller than in 1966 (HAUKIOJA 1968 a) and 1968 (new data), although the numbers in July in each year had been about the same. According to an inquiry of mine concerning the numbers of autumn Reed Buntings in 1966 and 1967 the area of the storm and the area in which there were reduced numbers of autumn Reed Buntings seem to coincide, so it is probable that this storm was the reason why many Reed Buntings perished (HAUKIOJA 1968 a).

In the year 1967 the bulk of nestlings in my study area hatched about 5th June, so that at the beginning of August they were at the height of their moult. The fact that the beginning of August was most severe for juveniles from the first brood is shown by Fig. 2, too. At the end of August, when juveniles from

first broods are about 80 days old (in 1966 and 1967 during the period 20—29th August and in 1968 10—19th August, Fig. 2), at the age when their weights seem to decrease, the average weight in 1967 was in both sexes higher (♂♂ 1967/1966+1968 $P < 0.025$, ♀♀ 1967/1966+1968 $P < 0.01$) than in the years 1966 and 1968, when weather conditions were not unduly severe. This high average weight probably means that in 1967 there were proportionally more late-moulting, heavy birds living than lighter, early-hatched birds compared with the years 1966 and 1968. Because the number of early broods as a proportion of all broods was about the same in every year, it is probable that moulting Reed Buntings at the time of the storm had a greater mortality rate than those not yet in full moult. It is worth mentioning that SONDELL (1967) has observed in the Sedge Warbler (*Acrocephalus schoenobaenus*) an average weight loss of 0.7 g in birds weighed after a day's rain, and it is probable that the birds which perhaps perished had suffered an even greater decrease in weight.

The more irregular weight fluctuation (Fig. 4) of the juveniles from late broods may be interpreted as an indication of the fact that the faster moult and the premigratory fatdeposition following closely upon each are a greater strain for the juveniles of late broods than for those of early broods (Fig. 3). The lowered survival rate of juveniles which have been hatched late and moult fast has been noted in the Bullfinch (NEWTON 1966a) and the Thee Sparrow (*Passer montanus*) (PINOWSKI 1968) and this probably plays an ultimate role in determining the end of breeding season on those species as well as on the Reed Bunting.

The time of becoming independent is generally regarded as the worst point for juvenile mortality in birds (LACK 1954, 1966). This is certainly important in the Reed Bunting, too, and I shall later analyse my Reed Bunting data in this respect. I think that the data presented here point to the importance of moulting period in bird's life, too, although as great losses as in 1967 probably are rare.

Summary

The data of this paper were collected during the years 1966—1968 at Pori in western Finland. About 2000 Reed Buntings were ringed and weighed but in order to eliminate weight changes during a day from the data, only those weighed between 6.00 and 10.00 a.m. have been included.

In general only the weights of those birds whose age is known according to their earlier ringing are used. The difference in length of wing between juveniles and adults of both sexes is statistically significant.

The weights of adult birds are presented in Table 1, and those weighed at known phases of their breeding cycle in Fig. 1.

The weights of juvenile Reed Buntings during their first summer and autumn are given in Figs. 2—4.

Juveniles from early broods, especially females, have a distinct weight peak during the postjuvenal moult. In the juveniles of the later broods, whose moult is fast, the high weights seem to last to the premigratory fatdeposition. The weight peaks of late-hatching juveniles seem to be rather obscure.

The paper deals with the effects of high weights and probable physiological strain on the survival of Reed Buntings. At the beginning of August 1967 one and half day's rain probably caused the deaths of many Reed Buntings over wide areas. Especially juveniles in moult suffered losses, but younger birds, not yet in full moult, survived better.

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Selostus: **Pajusirkun paino kesäkaudella.**

Kirjoituksen aineiston muodostavat Porissa vuosina 1966—1968 rengastetut ja punnitut n. 2000 pajusirkkua. Vuorokautisen painonvaihtelun eliminoimiseksi on aineistoon otettu mukaan vain klo 6.00—10.00 punnitut yksilöt.

Painomateriaaliin on otettu yleensä vain sellaisia yksilöitä, joiden ikä on tunnettu aikaisemman rengastuksen perusteella. Nuorten ja vanhojen lintujen siivenmitat eroavat tilastollisesti merkitsevässä määrin toisistaan molemmilla sukupuolilla.

Aikuisten lintujen paino kesäkaudella on esitetty taulukossa 1. Tunnetussa pesimäkierron vaiheessa punnittujen yksilöiden painot on esitetty kuvassa 1.

Nuorten lintujen keskipainoja ensimmäisen elinkesän aikana kuvaa kuva 2, ja kuvassa 3 on esitettynä tunnetunikäisistä, pesäpoikasina rengastetuista yksilöistä saadut painot. Kuvassa 4 on vastaavat painot myöhään kuoriutuneista poikueista.

Varhaisten poikueiden poikasilla, erityisesti naarailla, on selvä painohuippu sulkasatokaudella. Myöhäisillä poikueilla, joiden poikasilla on nopein sulkasato, näyttää sulkasatokautinen korkea paino jatkuvan suoraan muuttoaedeltävän rasvanmuodostuksen kautena. Painonvaihtelut ovat myöhään kuoriutuvilla poikasilla epäsäännöllisemmät kuin aikaisin kuoriutuvilla.

Kirjoituksessa käsitellään sulkasatokautisen painonnousun ja todennäköisen fysiologisen rasituksen vaikutusta lintujen elossasäilymiseen. Elokuun alussa 1967 sattunut kova myrsky yhtämittaisine sateineen tuhosi ilmeisesti laajalla alueella suuren osan silloin sulkasadossa olleista ensimmäisen poikueen poikasista. Nuoremmat sulkasatoaan alkamattomat linnut selvisivät ilmeisesti paremmin. Tähän viittaa se, että vuoden 1967 keskipainot nuorilla linnuilla olivat molemmilla sukupuolilla merkitsevässä määrin korkeammat kuin vuosina 1966 ja 1968 elokuun lopulla, jolloin keskipainot normaalisti laskevat ensimmäisen poikueen poikasten saatua sulkasatonsa päätökseen.

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