Weight-changes at Hesselø in Nightmigrating Passerines due to Time of Day, Season and Environmental Factors

(Med et dansk resumé: Vægtændringer på Hesselø af nattrækkende spurvefugle som funktion af tid på dagen, årstid og ydre faktorer.)

By
FINN DALBERG PETERSEN

Medd. fra Naturfredningsrådets Reservatudvalg, no. 86

INTRODUCTION

Since 1963 large-scale birdbanding has regularly been carried out at Hesselø. The number of banded birds is about 40000 (LARSEN 1965, RABØL 1967, 1969a, 1969b, TØNDER 1971, TØNDER and RABØL 1972, MØLLER and PETERSEN in print). In addition to the banding activity different studies were carried out, e. g., orientation experiments (RABØL and PETERSEN 1971, TØNDER and RABØL 1972, PETERSEN and RABØL (1972), and calculations of the length of resting time in nightmigrating birds (RABØL and PETERSEN in print).

The purpose of this paper is to show how the weight of migrant birds resting on Hesselø is changing during the day, how this change depends on different environmental factors, and to compare the length of the resting time with the change in weight.

MATERIAL AND METHODS

In the spring of 1963 LARSEN (1965) weighed 115 Redstarts *(Phoenicurus phoenicurus)* and 244 Robins *(Erithacus rubecula)*. J. RABØL weighed 73 male Redstarts in the spring of 1966, and O. TØNDER 161 Lesser Whitethroats *(Sylvia curruca)* and 60 Reed Warbler *(Acrocephalus scirpaceus)* in the spring of 1970. Finally H. U. SKOTTE MØLLER and F. DALBERG PETERSEN weighed 233 Redstarts and 1040 Robins in the spring of 1971. Especially the 1971 material will be treated in this paper.

The birds were trapped in mistnets which were inspected every 1$^1/_2$ hours. Immediately after the bird was taken from the net, it was put into a plastic-bag, and weighed on a Pesola 30-gms. springbalance. This balance is calibrated to gms, but is sensitive enough to allow measurements on 0.1 gms. The birds were not weighed when they were recaptured.

On the other hand, the recaptures were used to calculate how large a proportion of the birds was resting more than one day. A more detailed analysis of the calculations is given by RABØL and PETERSEN (in print). A short description of the method follows:

The recaptures of birds on the same day as they are banded (day$_0$) are called G_0, recaptures on the day after the banding (day$_1$) are called G_1, etc. The number of recaptures on day$_0$ cannot directly be used and compared with G_1. G_0 becomes too low because the number of previously banded birds is 0 at the start of the trapping on day$_0$. In the course of day$_0$ the number of banded birds then increases to r. If G_0 is to be comparable to G_1 the number of banded birds might be r in the whole trapping period on day$_0$. G_0 is only about half of the theoretical value, which can be designated G_{oc}. For Robin 1971 the correction factor (G_{oc}/G_o) was 1.96. The proportion between G_1 and G_{oc} shows which fraction of the birds which has not left the island from day$_0$ to day$_1$. So we have $K = \frac{G_1}{G_{oc}}$, where the recaptures are summed for several days in the different periods.

The material is mainly presented as estimation equations. I have used the lineary and non lineary equations: $Y = a + b X$, and $Y = a + b \log X$, respectively (CROXTON 1953, chapter 6 and 7). Which of the equations was used depended on the coefficient of correlation, r. If r is significantly different from 0 (i.e., $p < 0.05$), that equation which produces the largest r is used. If r is not significantly different from 0 for any of the equations, and if the material is to be compared with other similar material, the same estimation equation as in this material is used.

Time in hours *Timer*	N	g/N	S. D.
1	27	15,98	1,01
2	97	16,29	1,30
3	145	16,46	1,06
4	114	16,69	1,22
5	115	16,56	1,22
6	85	17,00	1,19
7	117	16,82	1,17
8	69	17,03	1,21
9	62	16,95	0,97
10	76	16,93	1,21
11	80	17,07	1,13
12	36	16,79	1,16
13	17	16,93	0,85
Total *I alt*	1040	16,72	1,19

Table 1. Robin *(Erithacus rubecula)* Spring 1971. The number N, the meanweights and the standard deviations is shown for each hour and for the whole material.

Tabel 1. Rødhals. Foråret 1971. Antallet N, gennemsnitsvægten og standardafvigelsen er vist for hver time og for det samlede materiale.

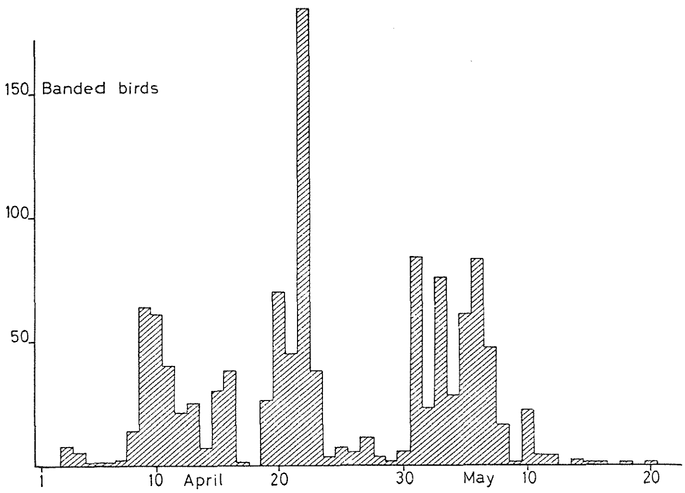


Fig. 1. The daily number of banded Robins *(Erithacus rubecula)* in the spring 1971.

Fig. 1. Antallet af ringmærkede Rødhals pr. dag i foråret 1971.

Table 2. The results of the spring weighings at Hesselø 1970–71. This table shows the estimation equations, the number of weighings, the correllation coefficient r, and the statistical probability for coincidence, p for each species and for each group.

Tabel 2. Resultaterne af vejningerne på Hesselø 1970–71. Tabellen viser regressionsligninger for forskellige arter i forskellige perioder.

Species *Art*	Period *Periode*	Equation *Ligning*	N	r	p
Robin	1971	Y = 16.03 + 0.96 log X	1040	0.21	< 0.001
(Erithacus rubecula)	4/4–20/4	Y = 16.92 + 0.12 log X	372	0.002	> 0.90
	21/4–30/4	Y = 15.97 + 0.61 log X	259	0.16	< 0.01
	24/4–30/4	Y = 13.92 + 2.64 log X	27	0.52	< 0.02
	1/5–10/5	Y = 15.85 + 1.20 log X	410	0.30	< 0.001
	Cloud: 7–8/8	Y = 15.73 + 0.72 log X	107	0.21	< 0.05
	Cloud: 0–1/8	Y = 15.90 + 1.33 log X	303	0.31	< 0.001
	Large days	Y = 15.89 + 1.16 log X	328	0.40	< 0.001
	Small days	Y = 15.67 + 1.35 log X	82	0.34	< 0.01
Redstart	female 1971	Y = 14.40 + 0.18 X	90	0.52	< 0.001
(Phoenicurus phoenicurus)	male 1971	Y = 15.43 + 0.08 X	143	0.22	< 0.01
Reed Warbler *(Acrocephalus scirpaceus)*	1970	Y = 11.21 + 0.86 log X	60	0.27	< 0.05
Lesser Whitethroat *(Sylvia curruca)*	1970	Y = 11.27 + 0.24 log X	161	0.094	> 0.25

RESULTS

Robin, spring 1971

a) *The whole material*

In Fig 2 and Tables 1 and 2 are shown the mean-weights and the standard deviations for every hour during the day.

Fig 2 shows the curve: Y = 16.03 + 0.96 log X, which is the estimation equation for the whole material. The increase in weight is about one gm in ten hours.

The weights of the birds are decreasing throughout the spring, as shown in the estimation equation: Y = 17.10 — 0.019 D, where D is the number of days after April 3. (N = 1040, r = —0.36, $p < 0.001$). The earliest birds are presumably males, as shown for other species, where it is possible to determine the sex, e. g., Redstarts, Blackcaps *(Sylvia atricapilla)*, Pied Flycatcher *(Ficedula hypoleuca)* and Willow Warbler *(Phylloscopus trochilus)* (Rabøl 1967, 1969b, Møller and Petersen in print). As the males are larger than the females (Whitherby et al. 1940, Dementjef et al. 1954, Scott 1965), the birds early in the season will on an average be larger and heavier than birds later in the spring. Scott (1965) has shown that the mean-weight of Robins increases by increasing size (wing-length).

b) *Comparison between emigration and increase in weight during the day*

The material is divided in three periods: I) 4/4–20/4, II) 21/4–30/ and III) 1/5–10/5. The results are shown in Figs 3, 4 and 5, and in table 2. The increase in weights througout the day is least in the first and highest in the third of these periods. The slopes of the corresponding estimation equations are tested against each other (Hald 1948). The slope from III is significantly higher than the slope from I ($p < 0.005$), while the slope from III is not significantly higher than the

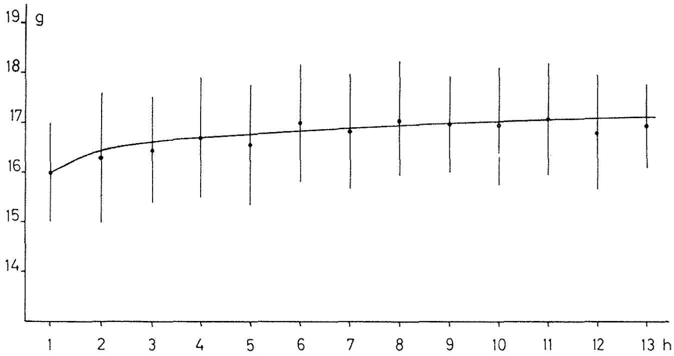


Fig. 2. Robin *(Erithacus rubecula)* all weighings spring 1971. The dots show the meanweights of the birds for every hour, and the bars the standard deviations. The curve of the estimation equation Y = 16.03 + 0.96 log X, is shown. The abscissa shows the number of hours after sunrise. The ordinate shows the weight in gms.

Fig. 2. Rødhals forår 1971. Alle vejninger. Gennemsnitsvægte og standard afvigelser for hver time. Abscissen viser tiden i timer, ordinaten vægten i g. Den første time er den time, inden for hvilken solen står op. Den indlagte kurve har formlen Y = 16.03 + 0.96 log X, og er den kurve, der bedst beskriver vægtfordelingen som funktion af tiden.

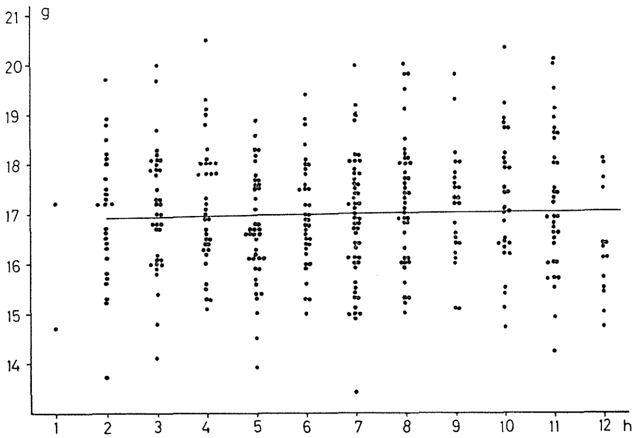


Fig. 3. Robin *(Erithacus rubecula)* 4/4–20/4 1971. The abscissa shows the time, and the ordinate the weight, as in fig. 2. The dots is the weights of single birds. The curve shows the estimation equation Y = 16.92 + 0.12 log X. The ratio of birds resting from day_0 to day_1 in this period is K = = 0,51.

Fig. 3. Rødhals 4/4–20/4 1971. Hver prik viser vægten for én fugl. Ellers som i fig. 2. Regressionslinien er Y = 16.92 + 0.12 log X.

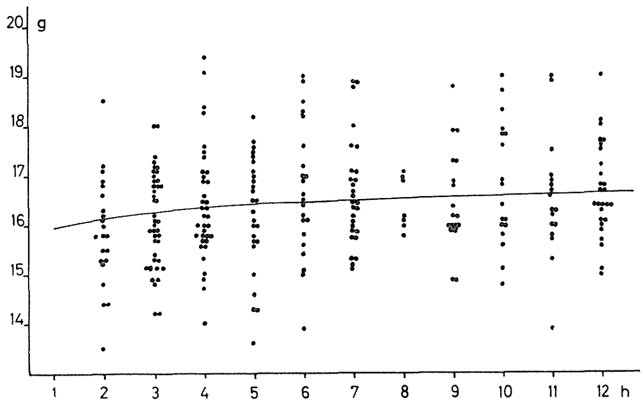


Fig. 4. Robin *(Erithacus rubecula)* 21/4–30/4 1971. Same text as in Fig. 3, but the estimation equation is now Y = 15.97 + 0.61 log X, and K = 0.28.

Fig. 4. Rødhals 21/4-30/4 1971. Som Fig. 3. Regressionsligningen er Y = 15,97 + 0,61 log X.

Fig. 5. Robin *(Erithacus rubecula)* 1/5–10/5 1971. Same text as in Fig. 3, but the estimation is Y = 15.85 + 1.20 log X. K = 0.09.

Fig. 5. Rødhals 1/5–10/5 1971. Tekst som i Fig. 3. Regressionsligningen er Y = 15.85 + 1.20 log X.

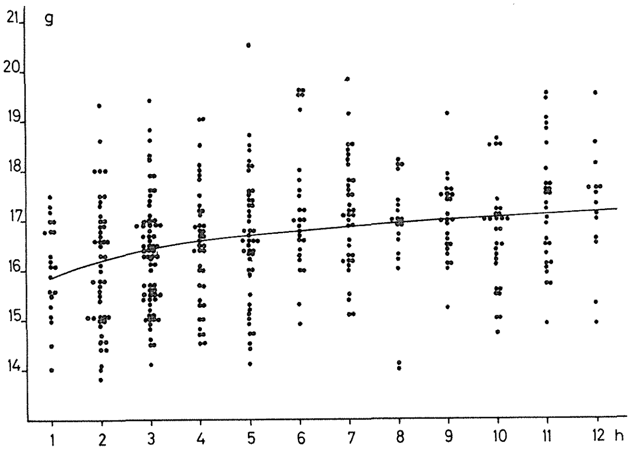


Fig. 6. Robin *(Erithacus rubecula)* 1/5–10/5. Days with a cloudiness of 0–1/8. Same text as in Fig 3, but the estimation equation is Y = 15.90 + 1.35 log X. K = 0.08.

Fig. 6. Rødhals 1/5–10/5. Dage med skydække på 0–1/8. Tekst som i Fig 3. Regressionsligningen er Y = 15.90 + 1.35 log. X.

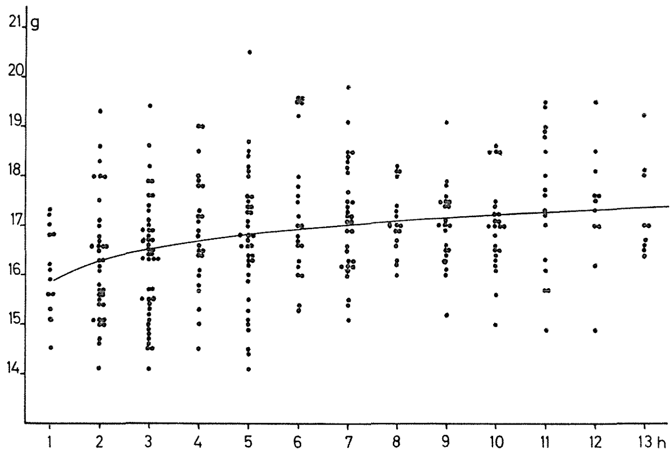
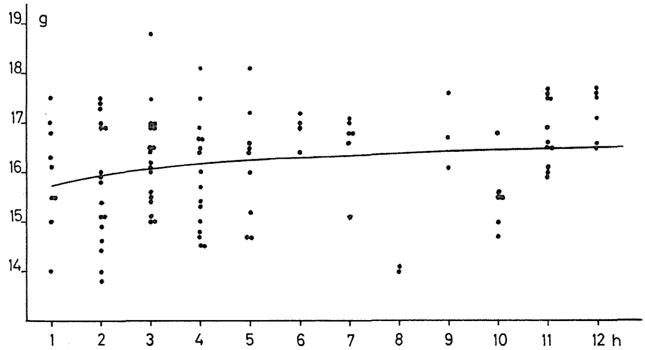


Fig. 7. Robin *(Erithacus rubecula)* 1/5–10/5. Days with a cloudiness of 7–8/8. Same text as in Fig 3, but the estimation equation is Y = 15.73 + 0.72 log X. K = 0.10.

Fig. 7. Rødhals 1/5–10/5. Dage med skydække på 7–8/8. Tekst som i Fig 3. Regressionsligningen er Y = 15.73 + 0.72 log X.



slope from II ($p = 0.06$). Also the slope from II is not significantly higher than the slope from I ($0.10 < p < 0.20$).

I have calculated the ration of $G_1 : G_{oc}$ for the same three periods.

$$\text{I) } K = \frac{13}{25} = 0.51, \quad \text{II) } K = \frac{7}{25} = 0.28,$$

$$\text{III) } K = \frac{5}{55} = 0.09.$$

By using the observed G_0 instead of the calculated G_{oc} a X^2-test was applied in order to test the differences between the ratios. The difference between I and III is significant ($p < 0.005$), but the differences between the other periods are not (I : II, $p > 0.30$, and II : III, $0.05 < p < 0.10$).

The conclusion should be that the larger increase in weight, the shorter the resting time at the island.

c) *The influence of environmental factors*

The material for the period 1/5–10/5 was divided in days with cloudiness 0–1/8, and 7–8/8, respectively. The results are shown in Table 2 and Figs 6 and 7. The increase is largest on clear days, but the difference between the slopes is not significant ($0.10 < p < 0.20$).

The days in the two groups are distributed between each others, and theoretically the weights at sunrise should thus be the same in the two groups (in table 2 the start-weights 15.73 and 15.90 gms in fact match this consideration). Differences in the final weights in the two groups should, however, express a different change in weight.

Therefore, the arithmetic mean for birds weighed after the sixth hour is calculated. On days with cloudiness 0–1/8, 151 birds were weighed (mean 17.19 gms), and on cloudy days 38 birds were weighed (mean 16.45 gms). The difference is significant ($T = 3.943$ $p < 0.001$). The birds were not trapped later on clear days than on overcast days. So the test applied should be reasonable. Perhaps a Mann-Whitney U-test (SIEGEL 1956) is more correctly applied. This test yields a $p < 0.01$.

The period of 1/5–10/5 was also divided in two groups according to the number of trapped birds (table 2): Large days (> 50 Robins banded) and small days (< 50 Robins banded). The increase in weight througout the days was a little higher on small days, but the difference was not significant ($p > 0.70$).

Probably, the cloudiness does not influence the birds directly, but it influences the microclima. The insulation is increased on cloudless days, and then the temperature at the surface of the earth. This increases the activity of the insects, and thus produces »more« food.

Of the 1040 weighed Robins 42 were recaptured during the following days. At the banding-time the mean weight of these 42 recaptures was 16.10 gms (s. d. = 1.36 gms). The mean weight of the 1040 Robins was 16.72 gms (s. d. = 1.19 gms). The difference between the two groups is highly significant ($p < 0.001$). The average K from the 3 periods mentioned above is 0.27, indicating that about 30 % of the 1040 Robins are resting more than one day and one night at the island. The birds resting for more than one day and night (e. g., the 42 recaptures) are thus presumably birds which have not yet built up a sufficient amount of fat for leaving the island.

The period 21/4–30/4 should be specially mentioned. On the 22/4 there was a large immigration, and 185 Robins were banded. About 2000 Robins were resting on the island. In the course of the following night it blew up, and it blew hard for the next four days, and no significant immigration occurred. On 27/4 the weather was calm, but in the meantime the temperature dropped and was now much below normal. There was nearly no immigration in the whole period. It was not until the 1/5 that there was again a large immigration (fig 1). Fig 4 and table 2 shows the results of the weighings in the period

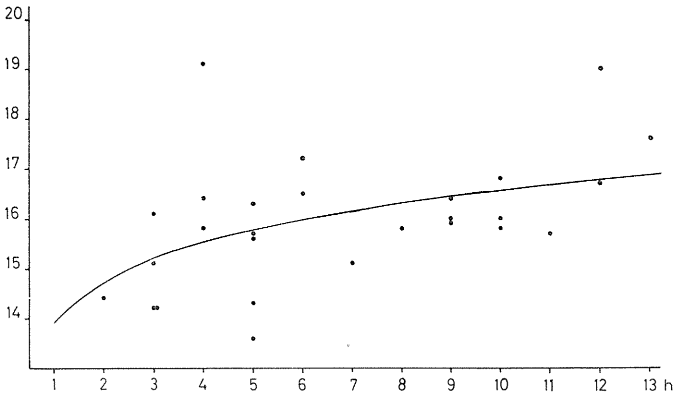


Fig. 8. Robin *(Erithacus rubecula)* 24/4–30/4. Same text as in Fig 3, but the estimation equation is Y = 13.92 + 2.64 log X. K = 0.83.

Fig. 8. Rødhals 24/4–30/4 1971. Tekst som i Fig 3. Regressionsligningen er Y = 13.92 + 2.64 log X.

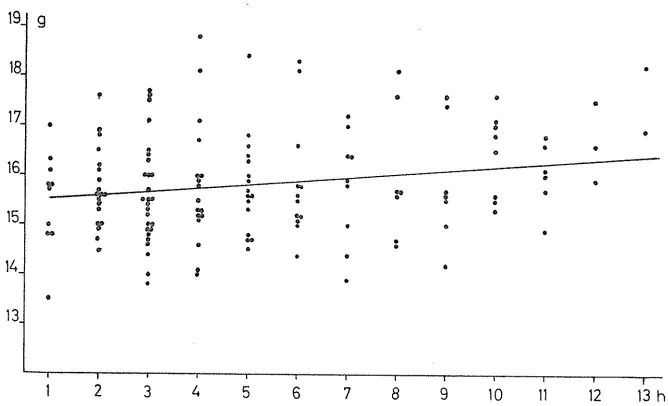


Fig. 9. Redstart *(Phoenicurus phoenicurus)* Males, spring 1971. Text as in Fig 3, but the estimation equation is Y = 15.43 + 0.08 X.

Fig. 9. Rødstjert han foråret 1971. Tekst som i Fig 3. Regressionsligningen er Y = 15.43 + 0.08 X.

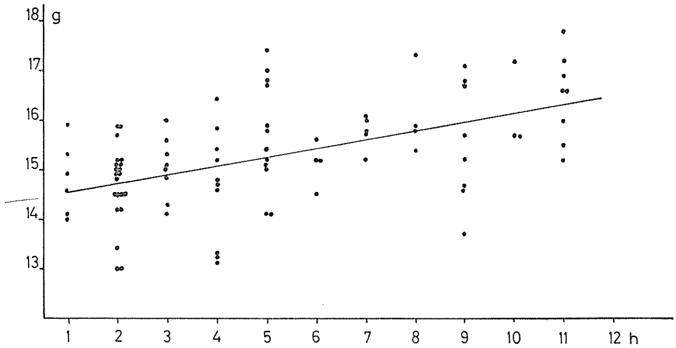


Fig. 10. Redstart *(Phoenicurus phoenicurus)* Females, spring 1971. Text as in Fig 3, but the estimation equation is Y = 14.40 + 0.18 X.

Fig. 10. Rødstjert hun foråret 1971. Tekst som i Fig. 3. Regressionsligningen er Y = 14.40 + 0.18 X.

21/4–30/4 (the figure is dominated by 21/4 and 22/4). Nearly all the birds which were on the island on 23/4 are remainders of immigrants from the 22/4. On this day the change in weight is rather confusing. At first the weights seem to decrease and later to increase (the net increase is about 0.6 gms in 10 hours, but r is not significant). Perhaps the confusing result is caused by the rather small material (N = 31).

The results of weighings in the period 24/4–30/4 are shown in fig 8 and table 2.

K is calculated for the periods 20/4–22/4 and 23/4–30/4. In the first period $K = {}^{3}/_{25} = 0.12$ and in the other $K = {}^{5}/_{6} = 0.83$. A Fisher-test (Siegel 1956) was applied on the observed values: ${}^{8}/_{13}$ and ${}^{5}/_{3}$ ($p = 0.043$). That means that the birds rest for a longer time in the windy and cold period.

Other species

a) Redstart *(Phoenicurus phoenicurus)*
In Fig 9 and 10 are shown the weights of male and female Redstarts, respectively. The estimation equations are shown in table 2. Note that there are used lineary equations which yield the best descriptions. Furthermore, the table shows that the males are heavier than the females, and the females increase in weight faster than the males. However, the difference in slope is not significant ($p > 0.20$).

In 1966 Rabøl weighed 73 male Redstarts, and the estimation equations was $Y = 14.60 + 0.08 X$. Why the Redstart males were heavier in 1971 than in 1966 is not known.

b) Lesser Whitethroat *(Sylvia curruca)*
In 1970 161 Lesser Whitethroats were weighed (Table 2). r is not significant different from 0 ($p > 0.25$).

c) Reed Warbler *(Acrocephalus scirpaceus)*
In 1970 60 Reed Warblers were weighed (Table 2). r is significantly different from 0 ($p < 0.05$).

DISCUSSION

Cause of errors

The birds which were weighed have on the average been in the nets for ${}^{3}/_{4}$ hours. During the stay in the nets the weight is decreasing. The size of that decrease is not known, but could be considerable, as shown by some experiments carried out by K. Hansen on the island Hjelm in the spring of 1971 (pers. comm.). K. Hansen weighed some Robins, and put them into a net, and after ${}^{1}/_{2}$–1 hour the birds were weighed again. Some of the weight-losses were found to be 0.5–1 gm, i. e., much more than was to be expected by metabolism and natural evaporation alone. So we have to consider that the largest part of the loss in weight is due to defecation and loss of water in a unphysiological large amount, as a reaction of fear. During banding the birds very often liberate excrements, which are absolutely liquid and most certainly contain material and water, which should have been absorbed in the intestine – if not for the trapping of the bird. If the birds in this way liberate part of the intestinal content we must conclude that the birds loose more weight later in the day than in the morning, where the intestinal content may be rather small.

Even if we have tried to make the time the birds averagely spend in the nets as constant as possible, we cannot consider that the curves show the weight-changes, or are in parellel to what really happens to the free living birds. On the contrary we must consider a larger slope and thus a larger increase in weight than the curves show.

Comparison with other investigations

In 1963 Larsen (1965) weighed 244 Robins and 115 Redstarts. She weighed the birds on a pair of scales which were placed in the field near the nets. After the trapping the birds were put into a bag and later weighed. Another difference from the 1971 procedure was that nearly all of the birds were trapped after 9 in the morning.

For the Robins a meanweight of 16.7 gms was found. This corresponds to the 16.72 gms of 1971. For female and male Redstarts 15.1 gms and (70 birds) and 15.4 gms (45 birds) respectively, were found. No s. d. was calculated. Correspondingly, the mean of female 1971 was 15.29 gms (s. d. = 1.05 gms, N = 90) and for males 15.84 gms (s. d. = 1.06 gms, N = 143). The differences between 1963 and 1971 are rather small and hardly significant.

When meanweights from different localities or investigations are compared, great care is necessary. The weight of a single bird is not a constant value, as for instance measurements of wing or tarse. It is on the contrary very variable, and depends on the time of the day, season, and some environmental factors.

Never-the-less the results from Hesselø are to be compared with the results from a material collected in the autumn at Falsterbo (SCOTT 1965). I presume that the birds at Falsterbo are from the same population as the birds at Hesselø. For the 266 1st year birds the meanweight was 15.81 gms and the s. d. 0.87 gms. This mean is somewhat lesser than the mean of the Hesselø birds. This could simply be due to the fact that the birds in spring are heavier than in autumn. But the explanation could also be that the birds trapped on the Falsterbo peninsula are birds which have not yet found a place to rest, and therefore have not been able to eat very much, and not increased in weight after the flight during the night. Unfortunately SCOTT gives only little information about the distribution during the day of the weighed birds. Probably most of them were weighed very early in the day and it would have been better to compare the meanweight at Falsterbo with the weight in the morning at Hesselø. – Table 2 shows the following starting-weights for the three periods: 16.92 gms, 15.97 gms, and 15.85 gms. The latter two are nearly equal to the meanweight at Falsterbo. Thus it could not be concluded from these materials that the Robins are heavier in spring than in autumn.

Resting-time and weight-change

It was shown how an increase in weight during the day and the resting-time were correlated. The problem is now whether the amount of food or the change in weight has any direct influence on the length of time the birds are resting? Or is the resting-time and the emigration controlled by some innate schedule in such a way that the resting-time is adapted to the average possibilities of getting enough food?

Furthermore, the weights were shown to ascend faster on days with a clear sky than on days with an overcast sky. If the resting-time was directly determined by the possibility of getting enough food, one should expect a larger emigration on the night after a clear day. I. a. $K = \frac{G_1}{G_{oc}}$ should be lesser for clear than overcast days. In the period 1/5–10/5 K was $^3/_{39}$ = 0.08 and $^1/_{10}$ = 0.10 for clear and overcast days, respectively. Unfortunately, the material is very limited, but there seems to be no differences in the rate of emigration. So, the conclusion of these observations could tentatively be that there is some innate rhythm which determines the rate of emigration, and which is adapted to the speed in which the birds normally are able to build up their fatreserves.

On the other hand, is was demonstrated that the Robins, which were recaptured one or more days later, at the time of banding weighed lesser than the birds which were not recaptured. This indicate that the lightest birds rest for a longer time.

In the period 21–30/4 there was a large difference from day to day in the rate of emigration that probably depended on different weather conditions (or perhaps on different degrees of crowding?), but there was surely not a corresponding difference in the increase in weight. On the cold and windy days of the period the birds stayed for a rather long time.

Contrary, RABØL and PETERSEN (in print) have shown, how the extreme conditions primo may 1969, with lack of food (and certainly no increase in weight) and a high degree of crowding, produced a large rate of emigration; even considerable day emigration by several nightmigrating species was seen.

Certainly the relationship between weight (or weight-change) and resting-time is not a simple one.

ACKNOWLEDGEMENTS

The investigations were supported by Naturfredningsrådet. The owner of Hesselø, F. L. Smidth & Co. kindly gave permission to the investigations. O. TØNDER is thanked for permission to use his material, and H. U. SKOTTE MØLLER for participation in the investigations. Special thanks to J. RABØL for help by the planning and preparation of the investigations, and for criticizing the manuscript.

SUMMARY

1. In the springs of 1963, 1966 and 1971 several passerine species, especially Robins, were weighed at Hesselø.

2. All species investigated showed an increase in weight during the day. If the weight (Y) was expressed as a function of hours after sunrise (X) most distributions were better fitted by $Y = a + b \log X$ than $Y = a + b X$, where a and b are constants.

3. For the Robins the increase in weight is calculated for 3 different periods and compared with the rate of emigration. It is shown that the rate of emigration is largest when the increase in weight is largest, and vice versa.

4. The increase in weight is larger when the sky is clear than when the sky is covered by clouds. The number of birds present on the island had apparently no influence on the change in weight.

5. The meanweight of the Robins which leave the island is larger than the meanweight of the birds, which do not leave.

6. It is concluded that both innate and environmental factors influence the degree of emigration.

DANSK RESUMÉ

Vægtændringer på Hesselø af nattrækkende småfugle som funktion af tid på dagen, årstid og ydre faktorer.

Siden 1963 er der blevet ringmærket ca. 40.000 fugle på Hesselø. I 1963, 1966, 1970 og 1971 blev vejet en del Rødhalse, Rødstjerter, Rørsangere og Gærdesangere.

I foråret 1971 blev der således vejet 1040 Rødhals. Det viste sig, at vægtændringen i løbet af dagen er proportional med logaritmen til tiden ($Y = a + b \log X$, hvor Y er vægten og X er tiden i timer efter solopgang, a er vægten i første time, og b er vægtændringen i de første 10 timer). For hele foråret var vægtstigningen 0,96 g i de første 10 timer af dagen.

Materialet blev delt i perioderne I) 4/4–20/4, II) 21/4–30/4 og III) 1/5–10/5, og der fandtes følgende 10-timers vægtstigninger: 0,12 g, 0,61 g og 1,20 g.

Ved hjælp af genfangster kan man beregne, hvor stor en del af fuglene, der ikke er trukket

bort i løbet af den første nat (K). I de tre perioder er K: I) 0,51, II) 0,28 og III) 0,09. Dvs. i de perioder, hvor fuglene stiger mest i vægt, trækker de også hurtigst bort.

Fuglene stiger mere i vægt på dage med skyfrit vejr, end de gør, når det er overskyet (b = 1,33 og 0,72 i III. periode). Der var ikke forskel på K, hvilket tyder på, at borttrækket ikke bestemmes direkte af vægtstigningen.

Borttrækshastigheden kan dog påvirkes af de enkelte fugles vægt. Det blev således påvist, at de fugle, der trækker bort, vejer mere end de, der ikke gør det (gennemsnitsvægten for alle 1040 Rødhalse er 16,72 g, og for de fugle, der er genfanget 1 eller flere dage senere, 16,10 g ved første-fangsten).

Borttrækshastigheden vil desuden kunne påvirkes af vejret. Således kan koldt og blæsende vejr bevirke, at kun få fugle trækker bort (24/4–30/4 1971), eller koldt vejr i forbindelse med mange fugle og fødemangel kan bevirke et meget kraftigt borttræk (primo maj 1969).

REFERENCES

Croxton, F. E., 1953: Elementary Statistics, New York.

Dementjef, G. P. & N. A. Gladkow, 1954: Birds of the Soviet Union, (Translation of 1968) Jerusalem.

Hald, A. 1948: Statistiske metoder. København.

Larsen, A. 1965: Fuglelivet på Hesselø med særligt henblik på trækfuglene. – Typewriten report.

Møller, H. U. Skotte and Petersen, F. Dalberg (in print): Hesselø 1971. – Feltornithologen.

Petersen, F. D., and J. Rabøl, 1972: Comparison of the Overcasts and Starry Sky Orientation of Nightmigrating Passerines. – Dansk Ornith. Foren. Tidsskr. 66: 113–122.

Rabøl, J. 1967: Trækobservationer på Hesselø 1964–66. – Flaro og Fauna 73: 113–126.

Rabøl, J., 1969a: Sjældnere fugle på Hesselø, især 1964–67. – Dansk Ornith. Foren. Tidsskr. 63 :115–127.

Rabøl, J. 1969b: Hesselø, Forår 1969. – Feltornithologen 11: 182–187.

Rabøl, J. and Petersen, F. Dalberg 1971: Experiments on the orientation of nightmigrating passerines in Denmark. Comparison of the reactions at 6 different sites. – Dansk Ornith. Foren. Tidsskr. 65: 20–26.

Rabøl, J. and Petersen, F. Dalberg (in print): Lengths of resting time in various nightmigrating passerines at Hesselø. – Ornis Scand.

Scott, R. E. 1965: Weights and measurements of migrant passerines, September 1962. – Vår Fågelvärld 24: 156–171.

Siegel, S. 1956: Nonparametric statistics for the behavioral Sciences, New York.

Tønder, O. 1970: Hesselø. – Feltornithologtn 12: 210–211.

Tønder, O. and Rabøl, J. 1972: Hesselø forår 1970. – Feltornithologen 13; 6–8.

Witherby, H. F., Jourdain, F. C. R., Ticehurst, N. F. and Tucker, B. W. 1940: The Handbook of British Birds, London.

MS received June 14th 1972

Author's address: Zoological Laboratory, Universitetsparken 15, 2100 København Ø.