Contributions to the Biology of the Ruff (*Philomachus pugnax* (L.)) II.[1]

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(Med et Dansk Resume: Bidrag til Brushanens (*Philomachus pugnax* (L.) Biologi II.)

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Introduction.

The present treatise is based on the work carried out in the bird sanctuary Tipperne on a peninsula in the big lagoon Ringkøbing Fjord (about 55° 53' n. lat., 8° 13' e. long.). The fjord and the sanctuary have been thoroughly described in "Ringkøbing Fjords Naturhistorie i Brakvandsperioden 1915—1931" (1936). As to the demarcation of the sanctuary the southern boundary is no natural one, being drawn by a ruler; on the other sides the sanctuary is surrounded by the fjord.

Since 1929 maps have every year been worked out showing the nests in the sanctuary, and biological observations on the birds have been written in a diary. Of the many ornithologists

[1]) Contributions to the Biology of the Ruff I, published in Dansk Ornith. Foren. Tidsskr. **38**, 1944, p. 26.

engaged in this work, the following may be mentioned: J. CHRISTIANSEN, A. NISSEN PEDERSEN, L. JENSEN, N. H. JENSEN, K. SKOTTE MØLLER, P. VALENTIN JENSEN, J. BOËTIUS, J. ANDERSEN, T. ANDERSEN, F. ECKARDT, H. MADSEN and E. MADSEN. The author has taken part in this work since 1940.

As reeves' nests are always well hidden, some nests may have been overlooked. The maps used as basis for the mapping of the nests were improved during the years; some improvement came in 1933, but since 1941 an exact map (1 : 4000) has been used. Since 1944 ruffs were caught every year by snares on the "hills", and in 1946 and 1947 females were trapped on the nests for ringing.

I wish to thank the members of the sanctuary commitee of the Danish Council for Protection of Nature, professor dr. phil. R. SPÄRCK, dr. phil. Å. VEDEL TÅNING and chief forester O. FABRICIUS for all they have done to facilitate my work. I also thank Mrs. A. VOLSØE for having read the MS.

Topography of nests and "hills".

Location of the nests.

During the 19 years of investigation on the sanctuary the reeves' nests have shown great changes in location and number. Table 1 shows the distribution of the nests on the 20 sections of the sanctuary in each of the years 1929—1947 (cf. fig. 1). Apart from the pronounced differences from year to year, the table indicates that some sections are distinctly favoured as breeding places; this is clearly shown in the last column, indicating the number per sq. km of nests in 9 big sections, the area of which has been determined by the weighing method (shown in the preceding column). The sections with the highest density of nests are 11 and 12. This is, no doubt, due to the fact that in 17 of the 19 years there was a "hill" in one of these two sections (see p. 130) and the fact that in most years the grass has not been mowed in section 11 and has, therefore, provided good cover for the nests.

Also the roadside (verge and ditch) has been favoured as a breeding place, the grass being generally not mowed there. This is shown in part 2 of table 1, which indicates (1) the number of nests at the roadside, and (2) this number in per-

centage of the total. Reckoning with a breadth of the roadside of 2 m on each side, its area is calculated at 0.017 sq. km, which gives 21 % of the nests on 0.3 % of the area or 236 nests per sq. km. Thus the roadside exerts a considerable at-

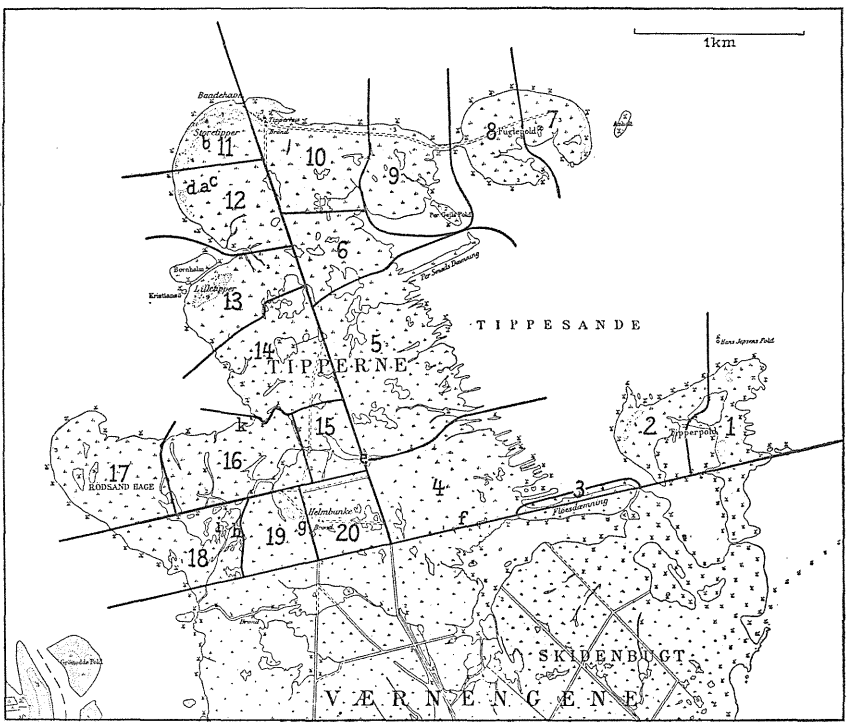

Fig. 1. Map shoving the division of the bird sanctuary Tipperne into 20 sections, and the approximate situation of the "hills" (the letters *a-k*).

Kortet viser Inddelingen af Tipperne i 20 Sektioner, og den omtrentlige Beliggenhed af Skoggerpladserne.

traction to the nestbuilding reeves. The high density of nests at the roadside compared with the rest of the territory may, however, partly be due to the fact that nests are seldom overlooked on the former, because one will find them while moving on the road for other purposes, and they are easily located from a bicycle, when the reeve flies up, but this fact cannot account for the whole of the evidence.

Table 1. Number of Reeves' Nests in
Antal Reder af Brushane

	Section (*Sektion*) / Year: (*Aar*)	1929	1930	1931	1932	1933	1934	1935	1936	1937
part 1	1	—	—	—	—	—	—	—	—	—
	2	—	2	2	—	2	—	—	—	—
	3	—	—	—	—	1	—	—	1	—
	4	1	2	2	8	5	8	3	3	3
	5	—	—	1	1	4	5	2	1	—
	6	—	—	—	—	1	—	1	—	—
	7	1	1	1	—	—	—	—	—	—
	8	—	—	1	—	—	—	—	2	2
	9	—	—	—	—	—	—	—	1	—
	10	—	1	1	1	—	—	1	2	1
	11	4	5	—	—	1	2	3	1	—
	12	2	1	1	—	2	3	1	2	1
	13	5	2	—	—	1	3	2	1	1
	14	—	—	—	—	—	3	—	2	—
	15	—	—	4	1	4	3	3	—	—
	16	—	—	2	1	—	2	—	—	—
	17	1	—	—	1	—	1	1	—	1
	18	—	—	—	—	—	—	—	2	—
	19	1	—	1	3	—	3	2	1	1
	20	—	—	—	—	2	8	5	3	—
	Total	15	14	16	16	23	41	24	22	10
part 2	Nests at the roadside[1]: Number	4	0	0	2	7	4	2	5	1
	%	27	0	0	13	31	10	8	22	10
part 3	"Repeats"[2]	6	3	5	5	11	14	5	2	
	Expected "repeats"[3]	1.3	1.4	1.6	2.3	6.0	6.2	3.3	1.4	
	Difference (significant "repeats"[4])	5	2	3	3	5	8	2	1	
	%[5]	36	13	19	13	12	33	9	10	

[1]) *Antal Reder ved Vejkanten.* — [2]) Number of nests placed within 100 m of some nests *af foregaaende Aars Reder.* — [3]) Calculated according to the formula $\frac{a_1 a_2}{A}$; see the text *sikre "Gengangere".* — [5]) Significant "repeats" in percentage of the total number

the Bird Sanctuary Tipperne.
paa Reservatet Tipperne.

1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	total	Area (sq. km) (*Areal km²*)	Numb. of nests per sq. km (*Antal Reder pr. km²*)
—	1	—	1	—	1	—	—	—	1	4		
—	1	1	—	2	1	1	1	—	2	15	0.391	3.0
—	—	—	—	—	—	1	—	—	—	3		
—	1	1	1	1	2	5	—	—	1	47		
—	—	1	—	1	3	3	1	2	2	27	1.315	3.2
—	—	1	—	—	1	1	—	1	—	6		
—	—	—	—	—	—	—	—	—	—	3	0.297	2.0
—	—	1	—	—	—	—	1	1	—	8		
—	—	—	—	—	—	1	—	—	—	2	0.533	2.6
1	1	1	1	4	—	2	1	2	4	24		
1	1	—	3	1	2	2	4	6	11	47	0.411	11.0
—	—	1	—	1	2	4	4	4	10	39		
—	1	1	—	—	2	2	—	—	2	23		
—	—	—	1	—	1	2	—	1	2	12	0.736	4.1
—	—	—	—	1	1	4	—	—	1	22		
—	1	1	—	2	1	3	—	1	2	16	0.667	2.3
3	—	—	1	1	—	1	—	1	1	13		
1	—	1	—	—	7	—	2	—	—	13	0.412	3.7
1	—	—	—	—	—	—	—	2	1	16		
2	—	1	2	—	1	2	—	—	—	26	0.194	7.1
9	7	11	10	14	25	34	14	21	40	366	4.957	3.9
3	0	4	3	3	8	15	1	6	8	76	0.017	236
33	0	36	30	21	32	44	7	29	20	21	0.3	
1	1	0	1	3	6	5	4	7	13	92		
0.6	0.4	0.5	0.7	0.9	2.2	5.4	3.0	1.9	5.3	44.4		
0	1	(÷1)	0	2	4	0	1	5	8	50		
0	14	—	0	14	16	0	7	24	20	14		

of the preceding year. "*Gengangere*": *Antal Reder, som laa indenfor 100 m fra en eller anden* p. 135. *Forventede "Gengangere"; beregnet efter Formlen* $\frac{a_1\, a_2}{A}$; *se Teksten p. 135.* — [4]) *Forskel;* of nests (part 1). *Sikre "Gengangere" i Procent af det totale Antal Reder (Part 1).*

The high density in section 20 (7.1 nests per sq. km) may be due to nests at the roadside, the section being small and surrounded by the road on the three sides.

Location of the "hills".

The maps and diaries of the 19 years show that the "hills" have been of highly different importance, some being in use for many years in succession, others only for a single year. Within the boundaries of the sanctuary the most used "hill" is in section 12. In 1929 and 1930 the "hill" in this section was on exactly the same spot (as far as can be judged from the somewhat inexact maps); it was in the neighbourhood of point *a* fig. 1. In 1931 there was no "hill" in the section (there was no "hill" at all in the northern part of the sanctuary; see fig. 2). In 1932 there were two "hills" about 50 m apart in the neighbouring section 11. In 1933 the "hill" was again in section 12 (point *a*, fig. 1), and it may have been there also in 1934, since this year there were three "hills", their location, unfortunately, being unknown. In any case it was on the same spot in 1935 and 1936, and likewise in 1937, but this year display was often observed in the neighbourhood on all sides of the "hill". In 1938—1945 the "hill" was likewise on the same spot (point *a*, fig. 1), but in 1945 we often visited the "hill" in order to catch the ruffs, and that may be the reason why some of them moved to another "hill (point *b*, fig. 1) at a distance of 250 m in section 11, and this "hill" was in use besides the old one in the following two years. In 1947, however, two ruffs and a reeve were killed by a sparrow-hawk while caught in my snares on "hill" *a*. This resulted in "hill" *a* being left, the ruffs moving to two other "hills" (point *c* and *d*, fig. 1) at a distance of 60 and 90 m respectively from the old one.

The number of ruffs observed on the "hill" in section 12 (and 11) was generally about 10, but every year since 1940 a maximum of 20 was occasionally counted.

The other "hills" in the sanctuary have only been in use for a single or a few years, and in 12 of the 19 years no "hill" was observed outside sections 11 and 12. The other "hills" observed were in the following places:

In 1929 5 ruffs and 10 reeves were (May 13.) reported haunting in section 13 immediately to the south of a hilly place, where 4 nests were found, but no definite "hill" is mentioned in the diary or shown on the map. In 1931 the map shows only one "hill" in the sanctuary, *viz.* on the road where

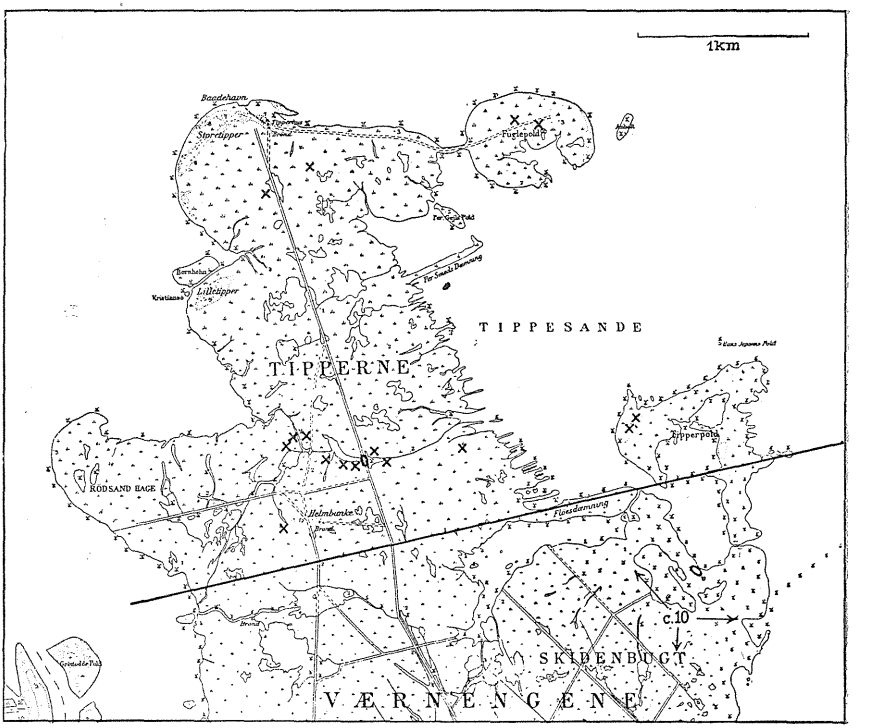

Fig. 2. Map showing the situation of "hill" and nests in Tipperne 1931.
Kort over Beliggenheden af Skoggerplads og Reder paa Tipperne i 1931.

sections 4, 5 and 15 meet (point *e*, fig. 1, see also fig. 2). In the diary, however, is noted (May 30.) that some ruffs were haunting steadily at point *g*.

In 1932 the map shows only one "hill" outside sections 11 and 12, namely on point *f*, but the diary says that flocks of about 10 ruffs and reeves were seen daily, also along the road, and on point *g*. In 1933 a definite "hill" is recorded on point *g*. In 1934 three "hills" are mentioned in the diary, but unfortun-

ately their location is not recorded; one may have been on the road. In the years 1935—1941 and 1943—1945 no "hills" besides the northern one were recorded from the sanctuary, but in 1942 a "hill" with 4 males is recorded on point *k*, and in 1946 one on point *i*. Finally, in 1947, scattered display was observed on and around point *h*.

Outside the sanctuary "hills" have not been regularly recorded, but in most of the years it is known that one or two "hills" have been used by 10—20 males about 0.5 km to the south of the border. One of them was on the road, and the number of ruffs were therefore often counted; in the last two years there were seldom more than 4 males.

Correlation between location of nests and "hills".

It is generally supposed that reeves' nests are more or less in the neighbourhood of the „hills", but a closer investigation of this question has hitherto never been attempted. An attempt is therefore made in table 2, showing the number of nests within a radius of 100—1000 m from the northern "hill". The investigation was confined to the northern "hill" in order to avoid disturbance of the result by unknown factors from outside the border of the sanctuary. The four columns to the right in the table indicate: (1) The total number of nests within reach of each radius during the 17 years, (2) the increase of this number by 100 m increase of the radius, *i. e.* the number of nests in the circle-shaped area resulting as the difference between a circle with the radius in question and one with a radius of 100 m less. (3) The next column indicates the above circle-shaped areas (in sq. km), *i. e.* the area of each circle minus the area of the preceding one with a radius of 100 m less. These areas had to be calculated by the weighing method, as most circles included parts of the fjord. (4) The last column indicates the number of nests per sq. km. This is also shown in the diagram fig. 3. The ordinate signifies the increase in number of nests per sq. km within a circle by every increase of 100 m of its radius (mean value for 17 years); the abscissa represents the length of the radius. The graph indicates that the number of nests shows a growing decrease by increasing distance from the "hill", until it has reached

the mean value for the whole area of the sanctuary, at which size the number of nests is almost constant by increasing distance.

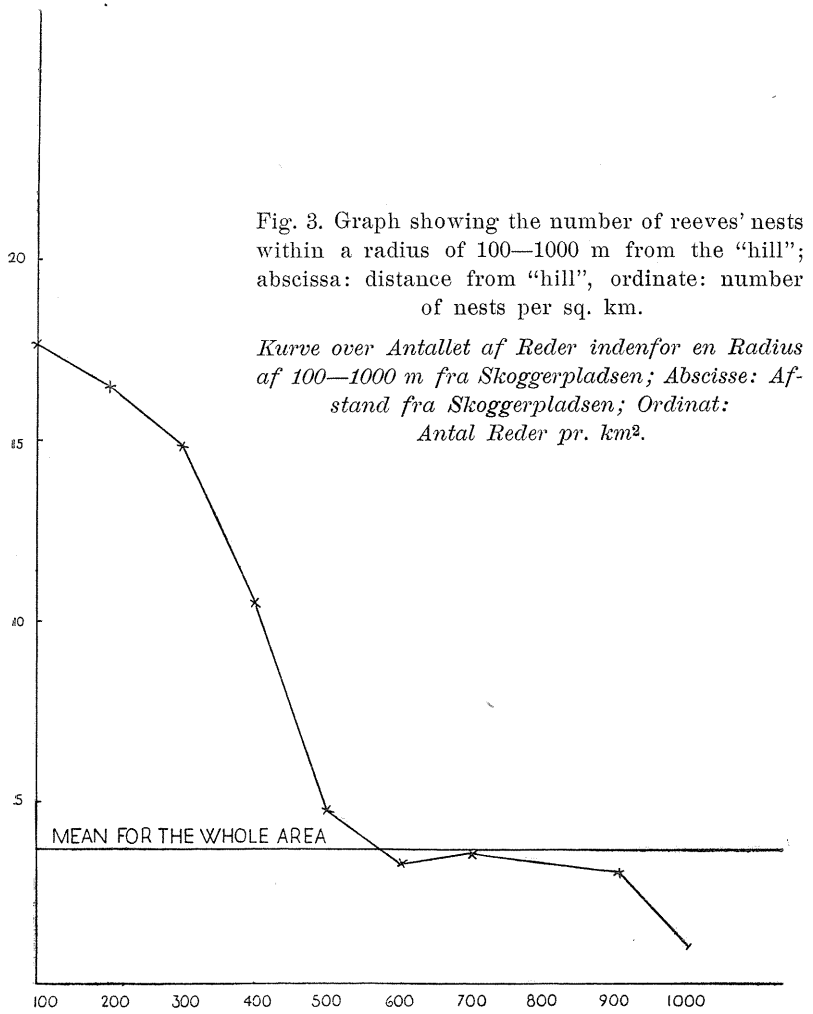

Fig. 3. Graph showing the number of reeves' nests within a radius of 100—1000 m from the "hill"; abscissa: distance from "hill", ordinate: number of nests per sq. km.

Kurve over Antallet af Reder indenfor en Radius af 100—1000 m fra Skoggerpladsen; Abscisse: Afstand fra Skoggerpladsen; Ordinat: Antal Reder pr. km².

The shortest distance which I have observed between a nest and the "hill" is about 20 m. The maximum distance observed during the investigations on Tipperne is shown on the map fig. 2: the distance between the nest in section 7 (see fig. 1) and the only "hill" in the sanctuary (at point *e*) is 2 km, and

Table 2.

Number of reeves' nests within a radius of 100—1000 m from the northern "hill" on Tipperne 1929—1947 (except the years 1931, when the northern "hill" was not used, and 1934, when the location of the "hill" was not known).

(Antal Brushønereder indenfor en Radius af 100—1000 m fra den nordlige Skoggerplads paa Tipperne 1929—1947 (med Undtagelse af 1931, da denne Skoggerplads ikke var i Brug, og 1934, da Skoggerpladsernes Beliggenhed er ukendt)).

Within a radius of (m) (*Indenfor en Radius af (m)*) / Year (*Aar*)	1929	1930	1932	1933	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	(1) Total	Increasement (*Tilvækst*) (2) Number per 17 years *Antal i 17 Aar*	(3) Approximate area (sq. km) *Omtrentligt Areal*	(4) Number per sq. km per year *Antal pr. km² pr. Aar*
100	1	3	0	1	0	0	0	0	0	0	0	0	0	0	2	0	2	9	9	0.030	17.6
200	2	4	0	3	2	0	1	0	0	0	1	1	2	3	3	2	10	34	25	0.089	16.5
300	4	6	0	3	4	2	1	1	1	0	1	1	2	3	4	9	17	59	25	0.099	14.9
400	5	6	1	3	4	2	1	1	1	1	1	2	4	6	8	10	23	79	20	0.112	10.5
500	6	6	1	3	4	3	1	1	1	1	3	4	4	7	8	11	26	90	11	0.135	4.8
600	6	6	1	3	5	4	2	1	2	3	3	5	4	7	9	11	27	99	9	0.158	3.3
700	8	7	1	3	5	4	2	1	3	3	4	6	5	9	9	11	27	108	9	0.149	3.6
800	10	9	1	4	7	4	2	1	3	3	4	6	5	10	9	12	27	117	9	0.158	3.3
900	11	9	1	5	8	5	3	1	3	4	4	6	7	10	9	13	27	126	9	0.172	3.1
1000	11	9	1	5	8	6	3	2	3	4	4	6	7	11	9	13	27	129	3	0.179	1.0
Total for the sanctuary (*Total f. Reservatet*)	15	14	16	23	24	22	10	9	7	11	10	14	25	34	14	21	40	309		4.957	3.7

the distance from the nest to the southern border is the same, so that some unknown "hill" outside the border should be more distant.

Correlation between location of the nests in two successive years.

It is known that many birds (*Passeres, Accipitres, Ciconia*) return to the same nest year after year or build a new nest in the neighbourhood of the old one. The *Charadriidae* never use the same nest for another breeding, but it is known from ringing experiments (p. 136) that they may return to the neighbourhood of previous nests, and in the following an attempt is made to judge to what extent they have done so during the years of observation on Tipperne. In part 3 of table 1 (p. 128) the first horizontal column shows the number of nests which were placed at a distance of 100 m or less from some nests of the preceding year. It is obvious, however, that a number of nests will by mere chance fall within that distance of some nests of the preceding year, and this number depends on the total number of nests in each of the two years, and an estimate of it may be obtained in the following way: Imagine a piece of crossruled paper with a total of A squares. If a_2 points are placed at random on the paper, the chance of a certain square getting a point is $\frac{a_2}{A}$, and the chance of certain a_1 spuares getting a point is a_1 times as big: $y = \frac{a_1 a_2}{A}$. In spite of our case concerning not squares, but circles (with a radius of 100 m) the formula may be used for estimation, a_2 being the number of nests of the year in question, a_1 the number of the preceding year, A being the area of the sanctuary (4.957 sq. km) divided by the area of a circle with a radius of 100 m ($\pi \cdot 0.01$ sq. km; thus $A = 158$), and y is the number of nests that must be expected to fall within a distance of 100 m of the nests of the preceding year, if all nests were placed at random.

The expected numbers of nests (y) are indicated in the second horizontal column of part 3 in table 1. The third horizontal column shows the difference between the found and the expected numbers varying between 0 ($\div$ 1) and 8 with a mean of between 2 and 3 nests. This difference expresses

in which degree the nests were moved on the map from one year to the next. It will be noticed that the figure is small, and the moving pronounced in years with a small number of nests and therefore probably bad conditions for reeves breeding in the sanctuary; and it is big, and the moving less pronounced, in years with many nests and probably good conditions for breeding. The most obvious exception is in 1944 with 34 nests, and the expected number of "repeats" exceeding the empirical number. This is, however, explained by the fact that 1944 had a very wet sommer, whereas 1943 was normal in this respect; many reeves were therefore forced to move because their nesting-places of 1943 were flooded in 1944. This was the case *e. g.* with 7 nests on section 18 in 1943 (cf. part 1 of table 1).

It should also be possible to estimate the relative number of nests in a certain year belonging to birds breeding (or reared) in the sanctuary in the preceding year. As shown below (p. 138) these birds often place their nests at an average distance less than 100 m from their nest of the preceding year (respectively the nest in which they were reared), and their number therefore has some relation to the figures in part 3 of table 1. It may be estimated that the number of nests belonging to birds breeding (or being reared) the preceding year is between 14 % and 25 % (50 and 92 in percent of 366) in average of 18 years. (As all the nests are not placed at random, the expectation according to random distribution may be too big, and the figure 14 % accordingly too small). The percentage of returners in 1947 (cf. p. 138) may accordingly be estimated at 20—33 % (8—13 in percent of 40).

Homing of ringed, breeding birds.

Females.

In 1946 and 1947 adult females were caught on the nest by a trap[1]) or a catcher. The result is indicated in table 3. In 1946 11 females were caught and ringed. Of the 26 females caught in 1947, 4 had already been ringed in 1946 (3 as adults and 1 as a nestling), 2 had been ringed earlier in 1947 and 20 had not been caught before. Further data concerning the

[1]) The method has been described by HAVERSCHMIDT (1946), who also lists the literature. My trap is only slightly different from those used by him.

Table 3.

Number of females caught on the nests. The sections refer to fig. 1. For the birds ringed and recaptured in 1947 the figures in brackets indicate the section in which they were ringed. The birds recaptured one year after ringing were all recaptured in the section in which they were ringed.

(*Antal Hunner fanget paa Reden. Sektionerne refererer til Fig. 1. Tallene i Parentes ved Fugle, der er mærket og genfanget i 1947, angiver den Sektion, hvor de blev mærket. De Fugle, der blev genfanget Aaret efter Mærkningen, blev alle genfanget paa den Sektion, hvor de var mærket.*)

Section (*Sektion*)	1946	1947			
	Ringed (*Mærket*)	Ringed (*Mærket*)	Recaptured, ringed 1946 (*Genfanget, mærket 1946*)	Recaptured, ringed 1947 (*Genfanget, mærket 1947*)	Total captured (*Fanget ialt*)
4.....	—	—	—	1 (20)	1
5.....	2	—	—	—	—
10.....	1	1	—	—	1
11.....	3	8	3*)	1 (10)	12
12.....	2	7	1	—	8
13.....	—	1	—	—	1
14.....	—	1	—	—	1
16.....	1	—	—	—	—
17.....	1	—	—	—	—
19.....	1	1	—	—	1
20.....	—	1	—	—	1
total	11	20	4*)	2	26

*) Including one ringed as a nestling (*medregnet 1 mærket som Redeunge*).

recaptured females are given in table 4. The table shows that all recaptured females have moved their nests less than 150 m, no matter whether they have migrated in the meantime or not, and a female ringed as a nestling placed her nest a little more than 100 m from the nest in which she was reared.

On the basis of the number of ringed and recaptured birds it is possible to estimate the percentage of birds returning to the sanctuary after a season of migration: If all females had been ringed in 1946, the percentage of returners should be equal to the percentage among the caught birds of birds ringed as adults: $\frac{3 \cdot 100}{24}$; if, however, not all, but $\frac{11}{21}$ of the females were

Table 4.

Recaptured reeves (*Genfangede ♀♀ af Brushane*).

no. *(Nr.)*	Date of ringing *(Dato for Mærkning)*	Date of recapture *(Dato for Genfangst)*	Distance moved (in m) *(Flyttet i m)*	Distance from mother's nest (in m) *(Afstand fra Moderens Rede (i m))*
730796	May 17. 1946	May 30. 1947	60	
730799	May 21. 1946	May 21. 1947	130	
730865	June 11. 1946	June 2. 1947	120	
730814	May 29. 1946	June 2. 1947		115
730893	May 10. 1947	June 14. 1947	110	
730894	May 19. 1947	June 17. 1947	45	

ringed in 1946 (21 nests in all, se table 1), the percentage of returners should therefore be: $\frac{3 \cdot 100 \cdot 21}{24 \cdot 11} = 24\ \%$. This agrees well with the result obtained on another basis (20—33 %, see p. 138).

Males.

Since 1944 some adult males have been ringed every year on Tipperne, the birds being caught by snares on the "hills". The results concerning homing appears from table 5. Two males ringed on "hill" *i* are not included in the table, which deals with the northern "hills" on sections 11 and 12. The table shows that some of the ruffs returned to the same locality at least three years in succession: 8 were recaptured one year and 4 two years after having been ringed. From analogy with the females (see p. 137) it is possible, on the basis of these figures, to estimate the percentage of returners, that is the percentage of the whole stock of a certain year that has been present also the year before. This is attempted at the foot of table 5 on the assumption that every year the stock has been at least 20 males (every year on some date or other 20 males are counted at a time on the northern "hills"). As the results are not very significant owing to the small numbers, a calculation based on the whole evidence is attempted in table 6: The number of ringed returners is seen to be 12, but as only half of the stock was ringed the first year, 12 out of the 32

Table 5.

Number of males ringed and recaptured on the northern "hills".
(Antal Hanner mærket og genfanget paa de nordlige Skoggerpladser).

Ringed *(Mærket)* / Captured *(Fanget)*	1944	1945	1946	1947
1944	4	2	2	0
1945	—	8	2	2
1946	—	—	12	4
1947	—	—	—	12
Total captured *(Ialt fanget)*	4	10	16	18
Minimum total number of males present on the northern "hills". *(Minimale totale Antal Hanner tilstede paa de nordl. Skoggerpladser)*	20	20	20	20
Calculated returners (%) *(Beregnede tilbagevendte (%))*	—	100	50	42

Table 6.

Calculation of male returners. *(Beregning af tilbagevendte Hanner)* 1944—1947.

Pair of years *(Aar-Par)*	Number first year *(Antal første Aar)*		Captured second year *(Fanget andet Aar)*		
	Total stock *(Totale Bestand)* (minimum)	Ringed *(Mærket)*	Previously ringed *(Allerede mærket)*	Not previously ringed *(Ikke tidligere mærket)*	Total
1944—1945	20	4	2	8	10
1945—1946	20	10	4	12	16
1946—1947	20	16	6	12	18
Total.....	60	30	12	32	44

not ringed are also returners. Thus the percentage of returners is 55 % (24 out of 44).

Comparing males and females we find that the percentage of returners in 1947 is much bigger among the males (42 %, see table 5) than among the females (24 %, p. 138). This is

obviously due to the fact that the number of females has increased from 21 in 1946 to 40 in 1947 (see table 1), while the number of males on the northern "hills" has been estimated at 20 in both years; in fact, it is my impression from 8 years of observations that the total number of males on the northern "hills" has remained almost constant, while the number of females (= nests) has been subject to considerable fluctuations. This seems to indicate that the males are more conservative concerning their "hill" than are the females concerning their nesting localities, and this may very well be the case, because females are likely to make greater demands on the nesting place than the males do on the "hill".

Other observations.

Colours of breeding plumage of males.

The colours of the ruff and ear tufts of all males caught on the "hills" for ringing (see p. 138) were described.

As was to be expected no changes of the colours were observed in the 12 birds which had been described at least a year before recapture. That the ruffs "assumes a similarly coloured habit" every year was already shown by BLÜMEL (1869), who kept one in captivity for four years.

There is, therefore, reason to believe that the colours are genetically fixed, and it is useful to describe statistically the 39 males belonging with certainty to the same population, as such a description may be used to check racial identity with

Table 7.

Number of males with white and other colours caught on Tipperne. (*Antal hvide og anderledes farvede Hanner fanget paa Tipperne*).

Ruff (*Krave*) \ Ear tufts (*Øretoppe*)	White (*Hvide*)	Other colours (*Andre Farver*)	Total
White (*Hvid*).....	7	8	15
Other colours (*Andre Farver*)....	3	21	24
Total	10	29	39

Table 8.

Number of males with white and other colours in the Danish collection of the Zoological Museum, Copenhagen. (*Antal hvide og anderledes farvede Hanner i den Danske Samling i Zoologisk Museum).*

Ruff (*Krave*) \ Ear tufts (*Øretoppe*)	White (Hvide)	Other colours (*Andre Farver*)	Total
White (*Hvid*)	16	21	37
Other colours (*Andre Farver*)....	5	122	127
Total	21	143	164

or difference from any remote population. For such a description the proportion of white to other colours may be convenient as indicated in table 7. The table shows that the colours of ruff and ear tufts do not vary independently, the number of males with white ruff combined with otherwise coloured ear tufts and *vice versa* being too small (a χ^2 test shows that the probability of independence is 0.01—0.02).

In order to check this result on a greater number of birds 164 Danish skins were examined in the Zoological Museum in Copenhagen. The result is given in table 8, which shows the same as table 7.[1])

This correlation between the colours of the two parts of the plumage cannot, however, be expected to show racial variation, as it is due to the same genes partly controlling both of them, and we may therefore expect this correlation in all populations of ruffs. Geografical variation may, on the other hand, be expected in the proportion of white ruffed males. This is indicated in table 9, which shows a great, but not significant, difference between the two samples. As, however, part of the skins in the Copenhagen collection originates from the neighbourhood of Tipperne (and some of them are only labelled "West Jutland"), there may be a real difference between remote populations.

[1]) The deviation from the figures expected on the assumption of independence of the colours of the plumage is highly significant, χ^2 being 41 for one degree of freedom.

Table 9.

Proportion of males with white ruffs (irrespective of the colour of the ear tufts) in males caught in Tipperne, and in the Danish collection in the Zoological Museum, Copenhagen.

(Procentisk Antal hvidkravede blandt Brushaner fanget paa Tipperne og i Zoologisk Museums danske Samling.)

Colour of ruff (*Kravens Farve*)	Tipperne	Zool. Mus.
White (*Hvid*)	38 %	23 %
Other colours (*Andre Farver*)	62 %	77 %
Specimens examined (*Antal undersøgt*)	39	164

Table 10.

Number of males caught on the "hills" in 1947.

(*Antal Hanner fanget paa Skoggerpladserne i 1947*).

Hour (*Time*)	Number af males caught (*Antal Hanner fanget*)	Number of snares per hour (*Antal Doner pr. Time*)	Number of males per hour per 100 snares (*Antal Hanner pr. Time pr. 100 Doner*)
4—5	3	13	23
5—6	3	19	16
6—7	0	19	0
7—8	1	33	3
8—9	0	30	0
10—11	1	52	1.9
11—12	2	113	1.8
12—13	0	117	0
13—14	4	214	1.9
14—15	0	192	0
15—16	3	211	1.4
16—17	5	211	2.4
17—18	6	233	2.5
18—19	6	265	2.3
19—20	1	243	0.4
20—21	1	110	0.9
21—22	0	6	0

Diurnal variation in activity on the "hill".

SELOUS (1906 and 1907) showed that the display on the "hill" was at its highest in the early hours of the morning

and that display took also place in the afternoon. A numerical estimate of the diurnal variation of this activity can be obtained from the data concerning the catch by snares of ruffs on the "hills". This is shown in table 10. The time is Middle European Time, an thus about 30 minutes ahead of Local Time. The table indicates that the ruffs are much more active in the morning than in the afternoon.

Table 11.

Length and breadth of eggs (*Ægmaal*) (mm); Tipperne 1947.

Clutch no. (*Kuld Nr.*)	Date (*Dato*)	Egg no. 1		Egg no. 2		Egg no. 3		Egg no. 4	
		Length (*Længde*)	Breadth (*Bredde*)	Length (*Længde*)	Breadth (*Bredde*)	Length (*Længde*)	Breadth (*Bredde*)	Length (*Længde*)	Breadth (*Bredde*)
1.	23. 5.	40.60	30.00	40.85	31.05	41.40	31.20	42.15	31.45
2.	7. 6.	40.70	30.20	41.05	31.25	41.70	30.75	42.30	31.30
3.	23. 5.	42.40	32.00	43.30	31.25	43.55	31.55	45.15	31.50
4.	23. 5.	42.70	30.20	42.80	29.70	44.65	29.75	45.20	30.40
5.	23. 5.	44.95	31.90	45.05	32.40	45.20	32.65	45.40	32.40
6.	23. 5.	43.00	31.05	44.70	31.40	44.85	30.85	45.25	31.35
7.	24. 5.	43.80	30.45	43.90	31.05	44.80	31.40		
8.	24. 5.	43.85	31.95	44.30	32.15	44.60	32.65	45.70	32.15
9.	24. 5.	40.25	30.60	41.20	31.80	41.70	31.20	42.50	30.70
10.	24. 5.	43.50	30.60	44.30	30.75	44.35	30.80	45.65	30.65
11.	24. 5.	44.30	31.75	44.60	31.30	45.20	31.60	45.95	31.05
12.	24. 5.	44.50	31.75	44.80	32.25	44.90	32.05	47.30	31.55
13.	26. 5.	40.50	29.75	40.50	30.30	42.80	28.65	43.15	30.45
14.	16. 6.	42.65	31.05						
15.	2. 6.	42.45	31.00	44.60	31.50	45.25	30.90	46.25	30.90
16.	31. 5.	41.75	30.20	42.60	30.50	43.00	30.15	43.70	30.50
17.	2. 6.	44.45	30.25	44.80	30.20	45.00	30.40	46.90	30.30
18.	7. 6.	40.95	30.50	42.30	30.70	43.05	30.60	43.25	30.20
19.	11. 6.	42.95	32.00	44.45	32.00	44.55	31.25	46.80	31.70
20.	12. 6.	45.80	32.00	45.80	32.40	45.85	31.95	46.00	31.90
21.	15. 6.	46.15	31.95	46.65	31.55	47.15	30.90	47.65	31.35
22.	15. 6.	43.50	31.00	43.75	30.55	43.80	31.40	44.20	31.90
23.	15. 6.	43.60	30.50	44.35	30.40	44.70	30.60	45.80	30.35
24.	21. 6.	42.20	31.30	42.90	31.60	43.70	31.95	43.75	31.55
25.	22. 6.	42.50	31.65	43.35	31.60	44.10	31.50	45.10	31.50
26.	21. 6.	45.70	31.15	47.05	30.45	48.25	31.05		
27.	22. 6.	44.05	32.65	45.15	32.05	45.25	32.10		
28.	25. 6.	43.95	31.30	44.50	30.90	45.60	31.05		

Size of the eggs.

Table 11 gives the sizes of 105 eggs from 28 clutches; greatest length and breadth were measured by a sliding calliper with vernier (to 0.05 mm). Fig. 4 and 5 show the distribution of the 105 eggs according to length and breadth respectively. The length varies from 40.25 to 48.25 mm and the breadth from 28.65 to 32.65 mm. The highest frequency is reached at a length of 44—45 mm and a breadth of 31.0—31.5 mm. Fig. 6 and 7 show the distribution of the differences between the greatest and smallest length and breadth (respectively) of the four eggs in 23 clutches of four. A comparison of these two diagrams with fig. 4 and 5 clearly shows that the variation within a clutch is much smaller than among eggs from different clutches. The maximum difference in length in 105 eggs (fig. 4) is 8.0 mm compared with 3.8 mm within a clutch (fig. 6), and the maximal difference in breadth in 105 eggs (fig. 5) is 4.0 mm compared with 1.8 mm within a clutch. This means that the size of the eggs depends on some quality of the individual female, and this is confirmed by comparison of the two clutches 1. and 2. (table 11) belonging to the same female, which was caught twice on two different nests.

Interval between two broods.

In two cases females were caught on two nests in 1947. As the first nest was left in both cases, when the bird was caught, it is possible to calculate the interval between the two broods, incubation period and rate of egg-laying being known (ANDERSEN 1944).

(1) The first nest of female no. 730893 was found to contain 2 eggs on May 4., and incubation began on 4 eggs on May 6. The bird was caught on May 10. and left the nest. Her second nest containing 4 eggs was found on June 8., she was caught on breaking eggs on June 14. and her 3 young hatched on June 16. The last egg in the second nest was consequently laid May 27. and the first May 24. Thus, in this case, the female left her first clutch on the fifth day of incubation and required an interval of 14 days before laying a new clutch.

(2) The first nest of female no. 730894 contained 4 eggs, when it was found May 18. The next day the female was

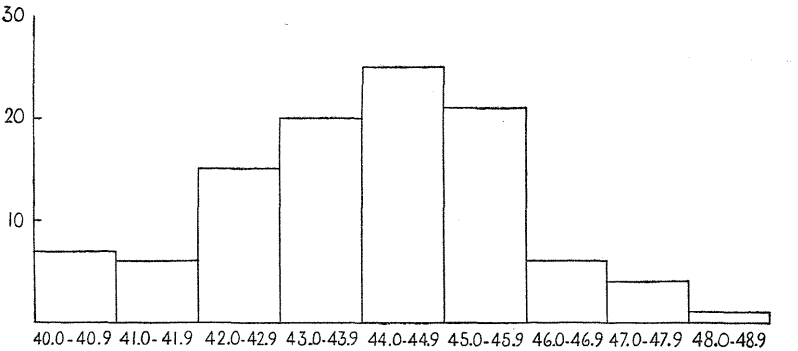

Fig. 4. Distribution according to length (mm) of 105 eggs of Reeves in Tipperne. Standard deviation (σ): $\pm$ 1.8 mm. (*Fordeling efter Længde (mm) af 105 Æg af Brushane paa Tipperne.*

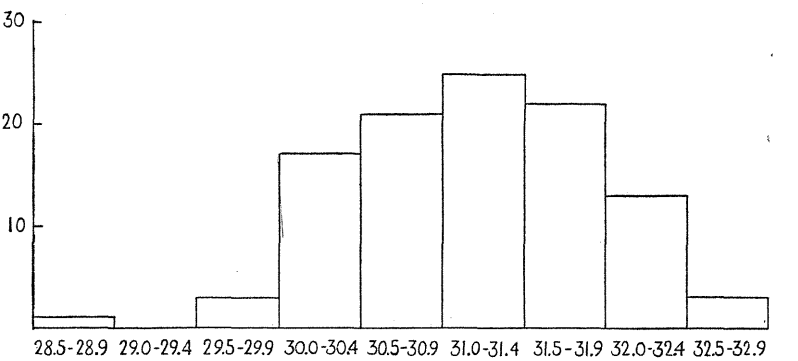

Fig. 5. Distribution according to breadth (mm) of 105 eggs. Standard deviation (σ): $\pm$ 0.77 mm. (*Fordeling efter Bredde (mm) af 105 Æg*).

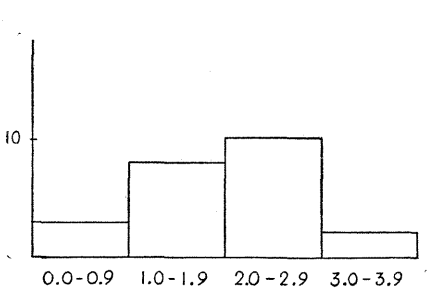

Fig. 6.

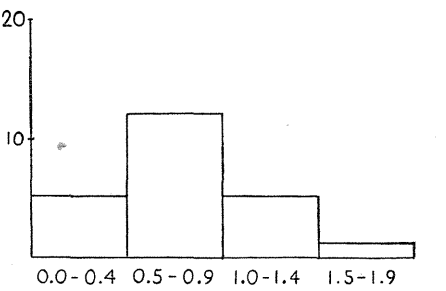

Fig. 7.

Fig. 6. Distribution of the differences between greatest and smallest length of eggs in 23 clutches of four (mm). Standard deviation (σ): $\pm$ 0.85 mm. (*Fordelingsdiagram over Differencen mellem største og mindste Æglængde indenfor 23 Fire-Kuld (mm)*).

Fig. 7. Distribution of the differences between greatest and smallest breadth of eggs in 23 clutches of four(mm). Standard deviation(σ): $\pm$0.396 mm. (*Fordelingsdiagram over Differencen mellem største og mindste Ægbredde indenfor 23 Fire-Kuld (mm)*).

caught and consequently left the nest. Her second nest was found June 2. containing 4 eggs. On June 16. three eggs were breaking, and the next day the female was caught and again left. As the eggs start breaking on the 17. day (ANDERSEN 1944, p. 27), the last egg was laid on May 30. and the first on May 27., which is 8 days after the first clutch was left. In this case the first clutch has, no doubt, been incubated for a shorter time than in the case of no. 730893, and the resorbation of the big eggs in the ovaries was consequently not so advanced, when incubation was interrupted.

Possible identification of the sex of nestlings.

The difference in size of ruff and reeve is rather great, and when ringing the adults it is obvious that different sizes of rings must be used; the ruff requires a ring no. 6 (inside diameter: 5.4 mm) and the reeve a ring no. 7 (inside diameter: 4.4 mm). The ring no. 7 is rather tight for a male. When ringing newly hatched young it is, however, impossible to use no. 6 exclusively, because about half of them would loose a ring of this size. All young are therefore given ring no. 6 at first, and if it can be drawn off the legg again, the young is given ring no. 7; otherwise it keeps the ring no. 6.

Now, among other waders it is a fact that the ring that fits the adult, is the largest size that the newly hatched young does not lose. It is therefore probable that by the procedure described above the ruffs get no. 6 and the reeves no. 7, and this is not contradicted by the case of a female ringed as a nestling and caught the following year[1]) (see p. 138), in fact she wore a ring no. 7. It is also supported by the number of young fitting the two sizes: 14 no. 7 and 12 no. 6 in 1945, 6 no. 7 and 12 no. 6 in 1946 and 23 no. 7 and 23 no. 6 in 1947, giving 43 no. 7 and 47 no. 6 as total, which is not too far from 50 %.

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[1]) Perhaps this is the first record of a one year old reeve found breeding. The size of her eggs (clutch no. 10, table 11) in no way deviates from the general picture. Her four young hatched on June 4. 1947; this is rather early for 1947, but not exceptionally early.

DANSK RESUME

Bidrag til Brushanens (*Philomachus pugnax* (L.)) Biologi II.

Undersøgelsen omhandler Brushøns paa Tipperne ved Ringkøbing Fjord. Den bygger paa Redekort og Dagbøger fra 1929—47, samt for de seneste Aar paa Resultater af Ringmærkning af voksne Fugle. Redekortene viser, at Hunnerne helst lægger Reden paa Steder, hvor Græsset ikke bliver slaaet (Vejrabatter, Omraade 11; se Tabel 1 og Fig. 1). Der gives en Beskrivelse af Skoggerpladsernes Beliggenhed gennem Aarene; nogle er meget konstante, medens andre kun er i Brug et enkelt Aar. Redernes Tæthed i forskellig Afstand fra Skoggerpladsen beskrives i Tabel 2 og med Kurven Fig. 3 og illustreres med Kortet Fig. 2.

Paa Grundlag af en Undersøgelse af hvormange Reder, der ligger indenfor 100 m fra en af foregaaende Aars Reder, skønnes, at af Ynglefuglene et bestemt Aar havde gennemsnitlig 14—25 % ynglet paa Omraadet Aaret før. For 1947 er de tilsvarende Tal 20—33 %.

Dette stemmer godt med Beregninger udført paa Grundlag af Mærkningsforsøg med voksne Hunner, der gav 24 %. Iøvrigt viser disse Forsøg, at Hunnerne anbringer Reden omkring 100 m (45—130 m) fra det Sted, hvor de rugede sidst, uanset om der gaar et Aar eller kun 8—14 Dage mellem de to Kuld (Tabel 4), og en Hun mærket som Unge i 1946 rugede i 1947 115 m fra Moderens Rede. (Vistnok er det her første Gang vist, at Brushønen ruger som 1-aarig).

Den Procent af tilstedeværende Hanner, der ogsaa var tilstede Aaret før, er aabenbart større end det tilsvarende Tal for Hunner, i 1947 saaledes 42 % (Tabel 5), sammenlignet med Hunnernes 24 %; i Gennemsnit for Aarene 1945—1947 er Tallet 44 %.

Som man kunde forvente, fandtes Yngledragtens Farver at være konstant hos 12 Hanner, der blev fanget mindst et Aar efter Mærkning og Beskrivelse. Iøvrigt kunde det vises paa Grundlag af Beskrivelser af 39 Hanner fra Tipperne, at Kravens og Øretoppenes Farve ikke er uafhængig af hinanden, idet hvid Krave kombineret med anderledes farvede Øretoppe, og omvendt, optræder sjældnere, end man i saa Fald maatte

forvente (Tabel 7); det samme gælder 164 Hanner i Zoologisk Museums danske Samling (Tabel 8). En Sammenligning af Tallene fra de to Tabeller sandsynliggør, at Procenten af hvidkravede er underkastet geografisk Variation (Tabel 9).

Døgnvariationen i Hannernes Aktivitet paa Skoggerpladsen beskrives numerisk (Tabel 10).

Maal af 105 Æg fra 28 Kuld præsenteres i Tabel 11, og det paavises, at Variationen indenfor de enkelte 4-Kuld (Fig. 6 og 7) er meget mindre end indenfor det samlede Antal Kuld (Fig. 4 og 5).

Tidsrummet mellem de Tidspunkter, paa hvilke et Kuld forlades og et nyt lægges, bestemtes til 14 Dage i et Tilfælde, da første Kuld blev forladt paa 5te Rugedag. I et andet Tilfælde, da første Kuld blev forladt tidligst paa 2den Rugedag, var det tilsvarende Tidsrum 8 Dage.

Tilsidst nævnes Muligheden af Kønsbestemmelse af Redeungerne, idet de, der kan bære en større Ring, skulde være Hanner, de øvrige Hunner.

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