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PARTRIDGE MARKINGS IN DENMARK

BY

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INTRODUCTION

In a previous paper (1957) I have presented the results obtained on the basis of 8,225 partridges *(Perdix perdix)* released during the years 1950/51–1954/55. Rings as well as wing tags were used. The birds, all reared, were released at different ages—from appr. 3 weeks of age to fully grown—and in different seasons, although largely during two periods, July–August, and November.

A supplementary material, consisting of 4,978 partridges released during the three years 1955/56–1957/58, is now available, hence the total number of markings reaches 13,203. The birds from this latter period were released under similar circumstances as previously, except that only rings were used. These as well as the wing tags were of the current types, carrying the address of the Game Biology Station and a serial number; all recoveries are recorded in the ringing files run by the Station, but since the individual records only contain data of purely local interest a list of recoveries seems out of place here. The complete data may be consulted in the Game Biology Station.

PARTRIDGE MARKINGS, 1950–1958

Recovery percentage.

Table 1 summarizes the distribution of all 13,203 markings between the years 1950–51 and 1957–58, and the 397 recoveries obtained on or before 31 March 1962. The distribution of recoveries on age-groups, extending from 1 April to 31 March, is also shown. The first of these age-groups coincides with the year of release.

The recoveries available on completion of the previous paper, and a single addition, are shown above the stippled ladder of the table while all data available on 31 March 1962 are set out above the ladder in continuous line. It is evident that the oldest markings have had the possibility of yielding recoveries during appr. 12 years while those from the last year have only had this chance during 5 years. Since, however, no releases have resulted in recoveries during the last two years, and many of them not for several years, further recoveries cannot reasonably be expected. The general picture is, therefore, not likely to change.

This did not hold true when the first analysis was made, hence a previously suggested method (*Paludan* 1951, 107) was used to calculate the further expected recoveries. According to these calculations another two recoveries were to be expected in the third and one in the fourth age-group, i.e. a total of three recoveries. Subsequent to the completion six marks have actually been recovered, but for two of them so few details were known that they could not be referred to age-group, and an attempt to obtain more detailed information met with no success. A third mark was returned with several years' delay, but it pertained to the second age-group. Among the remaining three recoveries two belonged to the third age-group, as expected, whereas the last came from the sixth age-group, not the fourth as was expected.

The recoveries obtained during the six years since the first analysis of the data was completed have, therefore, hardly affected the original calculations. As an example it is mentioned that while originally the mean annual mortality among adult birds was calculated as 83.9 $\pm$ 3.8 per cent, the same material after a further six years shows a mortality of 82.3 $\pm$ 3.9 per cent.

The recoveries resulting from the original material amounted to 2.8 per cent of the birds released. For the additional three years the percentage was 3.3. Since under otherwise identical circumstances (age at release, season of release) rings yield 50 per cent more recoveries than do wing tags, and since all birds released during the last three years were ringed the higher percentage may be due to this factor alone although others, such as age at release, may have contributed. For the entire material the percentage was 3.0.

Admittedly, the percentage recovery is low, in particular when compared to a percentage of 9.9 or 6.0 obtained from, respectively, adult and young pheasants released (*Paludan* 1959), or 16.7 per cent of released mallards (*Fog* 1958). The low percentage of recoveries from Danish partridges is, however, not unique since a Swedish material of 9,941 partridges, released in 1945–58, resulted in 204 recoveries up to the end of 1958, or 2.1 per cent (*Höglund* 1960) while in Italy the release of 10,697 birds gave 273 recoveries, or 2.6 per cent. I am unable to estimate the expected number of further recoveries in the two cases mentioned, but it will, certainly, not be sufficiently high to bring the percentage recovery up to the figure of 3.0, as obtained in the present material.

The poor recovery has prompted several comments from sportsmen, e.g. it has been suggested that only very few persons return the tags and rings they come across. Unfortunately, it is true that the sportsmen are not quite as cooperative as they ought to be. On the other hand, it is not reasonable to assume them to be less reluctant to return rings from pheasants and ducks, species for which the recovery percentage is from two to five times higher. A

Table 1. Survey of age distribution of 13,203 ringed partridges and the resulting 397 recoveries.

Birds released		Recoveries (until 31.iii. 62)												
Year (1. iv. – 31. iii.)	Nos.	Nos.	% of released	Distribution on age-groups (1. iv.–31. iii.)												
				1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1950–51...	753	24	3.2	17	7	0	0	0	0	0	0	0	0	0	0
1951–52...	2.067	58	2.8	43	12	1	1	0	1	0	0	0	0	0	
1952–53...	2.392	63	2.6	42	18	2	1	0	0	0	0	0	0		
1953–54...	1.483	42	2.8	25	13	4	0	0	0	0	0	0			
1954–55...	1.530	47	3.1	28	17	2	0	0	0	0	0				
1955–56...	1.777	57	3.2	41	13	3	0	0	0	0					
1956–57...	1.512	38	2.5	24	10	3	1	0	0						
1957–58...	1.689	68	4 0	35	31	2	0	0							
Total.....	13.203	397	3.0	255	121	17	3	0	1	0	0	0	0	0	0

real difference between these species and the partridge seems, therefore, certain, and the only likely explanation seems to be unrecorded mortality immediately after release and/or that the adult mortality not due to shooting must be considerably greater in the partridge than in the two other species.

It has also been claimed that since only a small fraction of the rings recovered by sportsmen is forwarded to the Station the estimation of annual mortality etc. must be so inaccurate as to be virtually of no value. This line of thought has already been refuted in the original publication, but it seems in place again to emphasize that the calculations are based not on the absolute number of recoveries, but only on the relative decrease of numbers from one age-group to the next, hence only a genuine change in attitude among the sportsmen, involving a change in reporting rate, would affect the calculations. There is, however, no evidence of such a changed attitude towards reporting rings back to the Station.

In order to get some idea of the extent to which recoveries are reported to us, and also to analyse some of the circumstances pertaining to the method, it was decided to set up a control experiment. It is commented upon in greater detail on p. 49, suffice it here to mention that 349 partridges were released on the island Fur on 29 Nov. 1956; however, in spite of activation of the local sportsmen's association and the farmers of the island we only succeeded in recovering 18 rings, or 5.2 per cent of the total release. Only one ring could not be retrieved although we knew, through hearsay, that the bird had been shot.

Admittedly, this concerted effort led to a recovery of 75 per cent more rings than in the country wide experiment, but in spite of maximum effort information on only a minute proportion of the released birds could be obtained. No less than 95 per cent escaped being reported.

An explanation of the relatively high recovery percentage in this material is found in the fact that birds found dead contributed no less than 15 of the 18 rings recovered, while birds actually shot only contributed 3 rings, or 0.9 per cent of the birds released, as opposed to 1.8 per cent in the material derived from the whole country (13,203 birds released).

This experiment does certainly not support the assumption that the generally low recovery percentage is caused by a large proportion of retrieved rings remaining—unreported—in the sportsmen's pockets.

It must be admitted that the poor recovery percentage and some other features to be mentioned in later sections disclose a rather pessimistic perspective as regards the possibility of obtaining a noticeable artificial increase of the breeding population through a release of birds. Since the sportsmen wish to close their eyes to this fact much criticism of the material has been forthcoming,

for example that the experiments were carried out during a "period of depression" which caused the poor results. In the first place the answer to this is that just the so called periods of depression indicate the time when supplementary birds might be desirable through release, a procedure which the sportsmen want to consider beneficial. During good years the natural surplus of birds is so large that a release of birds will certainly have no influence on the breeding population of the following year.

Another question is whether the results of ringing experiments are at all affected by the fact that most of the years were less favourable for the productivity of wild partridges. There is every reason for believing that the question of good or poor years is determined largely by the climatic conditions around hatching and during the period when the chicks are still downy and, therefore, less hardy (cf. e.g. *Blank & Ash* 1962). However, the reared chicks are not released until the plumage is fully developed, i.e. at a time when they can be supposed to be less affected by the climate. Furthermore, the climatic conditions, which might have been fatal to wild chicks, may have changed completely by the time of the release. In view of this fact good and poor years need not necessarily mean the same thing to wild and released chicks.

An attempt has been made to analyse the material as regards this question. Unfortunately, a fully satisfactory analysis cannot be made since in addition to climate other factors affect the recovery percentage, e.g., as already mentioned, age at release, time of release, releasing technique, use of rings or wing tags.

The relative success of different year classes of birds released is presumably best compared by only considering the birds that were shot (59.9 per cent of all recoveries). This proportion, as a percentage of the total number of birds released for each individual year-class, is shown in Table 2 which also gives the mean

Table 2.

Annual bag during years 1950/51–1957/58, and percentage recovery (as birds shot) from releases of same years.

	Years								Mean
	50/51	51/52	52/53	53/54	54/55	55/56	56/57	57/58	
Annual bag.....	389.900	340.600	294.900	285.900	211.700	197.000	193.000	259.600	271.575
Recoveries of birds shot.....	2.8	1.7	1.6	2.0	1.6	1.5	1.8	2.1	1.8

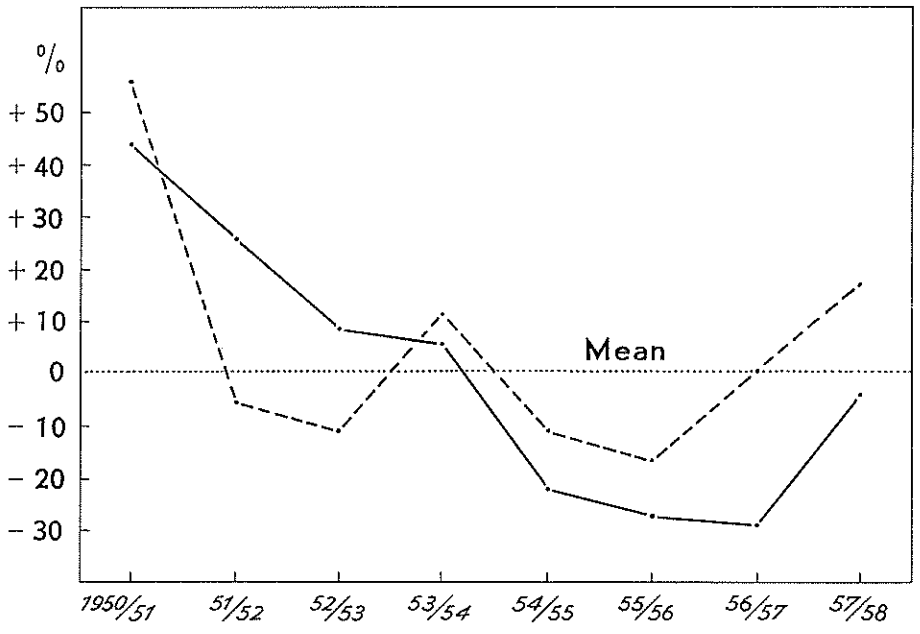

Fig. 1. Percentage departure of bag from mean of years 1950/51–1957/58 (continuous line) and recoveries of shot birds from releases in the same years, expressed as percentage deviations from the mean (stippled line).

percentage recovery due to shooting for the entire period. For comparison the all-country bag of partridges is also given for individual years. These figures were extracted from the game record which contains information supplied by the individual sportsmen when returning their licence card for annual renewal. The figures are not corrected for licence cards not returned.

In order to facilitate comparison of the two sets of figures they are shown graphically in Fig. 1 as the percentage deviation from the mean for the entire period. The first year, 1950/51, had by far the greatest bag (+ 43.6 compared to the mean), and also the birds released during this year resulted in the largest number of recoveries through shooting (+55.5 per cent). During the next two years the bag declines, though still above mean (+25.4 and +8.6 per cent). Also the percentage recovery drops in these two years, but much more so, to ÷5.6 and ÷11.1 per cent, respectively. For the remaining years the two curves show a certain measure of similarity, but the recovery is higher compared to the mean, than is the bag.

As can be expected, the two curves show no general agreement, although to a certain extent their excursions are in the same direction.

The year 1950/51 was an exceedingly favourable year, only little inferior to 1949/50 (401,500) which is the absolute peak since the bag record began in 1941. Thus, the ringing material covers almost the entire range from unfavourable to favourable years, and the variation found in the recovery during the whole period gives no support to the assumption that significantly better results could be obtained had the study been made at some other time, i.e., of course, without changing the circumstances of the experiment, such as age at release, time of release etc.

Mean annual mortality.

The first age-group in Table 1 is exposed to some hazards which do not operate in subsequent groups, e.g. chick mortality and the many causes of mortality which, collectively, may be termed release-mortality, attributed to lack of adaptation to the dangers of nature. Since these causes of mortality almost certainly will have a smaller chance of being reported than those operating in the older groups the first age group must be excluded from the calculation of mortality. It is also obvious that at the upper limit of the first age-group (31 March) the individual birds have been exposed to the risk of life for very different periods, depending on the time of release, and that the maximum is about 9 months.

It is, therefore, not possible to calculate the mean annual mortality from the moment of release, but only for the birds which were still alive on the first 1 April.

In the previous paper the mean annual mortality was found to be 83.9 $\pm$ 3.8 per cent (*Paludan* 1957, 24). It will be seen from Table 3 that the larger material now available, and the longer period during which recoveries could be obtained, lead to a figure of 84.0 $\pm$ 2.8 per cent, an agreement which is better than could be expected beforehand.

Table 4 shows the ideal life table, based on an initial population of 1000 and an annual survival factor of 0.16. According to this the expected distribution of the 142 recoveries is as indicated in Table 5; again the agreement between expected and observed values is obviously very good, a fact which is confirmed by the χ^2-test.

The mortality among partridges has apparently not been studied in other countries, but *Paleček & Toufar* (1957) and *Toschi* (1961) have published ringing results from Czechoslovakia and Italy, respectively. On this basis I have calculated the mortalities shown in Table 3. Among the birds released in Czechoslovakia the mortality was estimated to be 82.1 $\pm$3.8 per cent and in the material from Italy 82.1 $\pm$ 7.2 per cent. There is a surprisingly good agreement between these

Table 3.

Mean annual mortality rate based on distribution of recoveries on age-groups. Calculations for Czechoslovakia and Italy based on data published by Paleček & Toufar (1957), and Toschi (1962). x: age-group (0–5 corresponding to 1–6 in Table 1); d_x: nos. recovered in each age-group; $\hat{s}$ = annual survival factor; M = mean annual mortality rate.

Age-groups	Denmark No. released: 13.203		Czechoslovakia No. realeased: ?		Italy No. released: 10.697	
x	d_x	xd_x	d_x	xd_x	d_x	xd_x
0	255		289		250	
1	121	121	71	71	19	19
2	17	34	15	30	3	6
3	3	9	2	6	1	3
4	0	0	1	4		
5	1	5				
	N = 142	169	N = 89	111	N = 23	28
$\hat{s} = 1 - \frac{N}{\sum xd_x}$ = 0.1598			$\hat{s}$ = 0.1982		$\hat{s}$ = 0.1786	
S.D. = $0.8402\sqrt{\frac{0.1598}{142}}$ = 0.028			S.D. = 0.038		S.D. = 0.072	
M ± S.D. = 84.0 ± 2.8 %			M ± S.D. = 80.2 ± 3.8 %		M ± S.D. = 82.1 ± 7.2 %	

percentages and the one found in the Danish material, but it is unknown to what extent further recoveries could be expected in the two former cases.

The calculated mortalities mentioned so far concern only the fate of the released birds after the first 1 April. However, a person who releases birds is greatly interested in knowing what happens to them before that time. Only an indirect answer to this question can be obtained, namely by comparing the ringing results obtained from the different groups of released birds.

Since the main purpose of the release was to supplement the breeding population, and not to increase the first-year bag, the number of birds from the first

Table 4.

Calculated life table based on 1000 initial birds and an annual survival factor of 0.16.

Age-groups x	Nos. alive at beginning of each age-group l_x	Nos. dying in each age-group d_x	Σd_x
1	1000.00	840.00	840.00
2	160.00	134.40	974.40
3	25.60	21.50	995.90
4	4.10	3.44	999.34
5	0.66	0.55	999.89
6	0.11		

age-group killed during the shooting season (18 Sept.–1 Nov.) is of little interest, the main question being the number of recoveries from the second and later age-groups, this figure is an expression of the number of birds which have had lives sufficiently long to count as breeding birds.

A previous paper contained a comparison of the number of recoveries after 1 April for birds (add. + juvv.) released in July–August and in November, re-

Table 5.

Observed and expected distribution on age-groups of the 142 recoveries.

Age-group x	Nos. recovered in each age-group d_x	Expected d_x	Deviation of d_x from expected d_x	χ^2
1	121	119.28	+1.72	0.025
2	17	19.08		
3	3 } 21	3.05 } 22.70	—1.70	0.127
4	0	0.49		
5	1	0.08		
	142	141.98	+0.02	0.152
				0.95 > P > 0.1

Table 6.

Comparison between different categories of birds released during 1955/56–1957/58, and resulting recoveries; (total no. of recoveries as well as recoveries after first 1 April). Birds of groups A, B, and C were largely released in July, those of D in November although a small number as late as March.

Releasing time and age of birds	Nos. released	Recoveries			
		Total		After first April 1.	
		Nos.	%	Nos.	%
A. Summer, chicks	1.883	41	2.18	9	0.48
B. Summer, adults	471	18	3.82	4	0.85
C. Summer, age? but mostly chicks	992	28	2.82	7	0.71
Summer total	3.346	87	2.60	20	0.60
D. "Winter", adults and fullgrown chicks	1.632	76	4.66	43	2.60

spectively. It turned out that birds released in November would yield 4.6–5.1 times more recoveries than those released during the summer months. In other words, this means that the latter category had been reduced to about 20 per cent or less by November, or that no less than 5 birds must be released in summer to make up for 1 bird released in November.

By and large, this calculation is confirmed by the new data, for as shown in Table 6 a release of 3,346 birds in summer gave 20 recoveries after 1 April, or 0.60 per cent of those released, while 1,632 released in winter gave 43, or 2.6 per cent. This indicates 4.3 times more recoveries from birds released in winter than from those released in summer, or a reduction of the latter category to 23 per cent or less.

For this calculation all birds released in summer (A + B + C) have been pooled. The difference would become even more striking if the released chicks (A) are considered, after 1 April they only yielded slightly more than half the recoveries obtained from adults (B) released in the same period, 0.48 against 0.85 per cent, and only one fifth of the recoveries obtained from winter releases, 0.48 against 2.60 per cent.

A very optimistic estimate would, therefore, be as follows: 1000 chicks released in July–August have by November been reduced to 200, and in the following November to 32 individuals (annual mortality 84 per cent), which is 3.2 per cent of the birds released.

Longevity.

The percentage recovery from the large number of birds which succumb shortly after release is, undoubtedly, much lower than from the birds which are shot later in life. This implies that the mean age reached by the birds recovered cannot be taken to express the mean age reached by all birds released, the mean longevity must be considerably lower.

As a first guide it may be of some interest to calculate the mean longevity for the birds recovered. A mere glance at Table 1 convinces us that the longevity must be rather limited since the rate of recovery drops rapidly from one year to the next; already in the fourth year recovery is virtually absent, and only a single individual has managed to survive until the sixth year. Also a mean annual mortality among adults of 84 per cent indicates the chance of survival to be small.

In the previous paper a mean age of 5.1 months was calculated from 204 recoveries with sufficiently complete data to allow a calculation of age. Since that time another three recoveries of the ages 22, 22, and 62 months have been obtained; this necessitates a revision which brings the mean longevity up to 5.5 months. The supplementary material from the releases in 1955–58 gives exactly the same figure (Table 7).

While a mean longevity of 5½ months was found among birds recovered it must have been considerably lower among all birds released. This problem will be discussed later.

On the other hand, birds which have succeeded in surviving up to the first 1 April after their release have somewhat better prospects of survival. Of course, it is possible to calculate their mean expectation of further life from the known

Table 7.

Mean life-span of recovered partridges. First line containing data from the 1957 publication, second three recoveries obtained later, and third line the total.

Material	No. of recoveries	Total life-span from release (months)	Mean life-span (months)
Paludan 1957	204	1042	5.1
Correction	3	106	
Total 1950–54	207	1148	5.5
1955/58	163	857	5.5

Table 8.

Mean expectation of further life (y).

A: For birds alive at beginning of age-group 2.

Age-group x	Recoveries in each age-group d_x	Mean life-span for birds dying in the age-group z	zd_x	z^2	z^2d_x
2	121	0.5	60.5	0.25	30.25
3	17	1.5	25.5	2.25	38.25
4	3	2.5	7.5	6.25	18.75
5	0	3.5	0	12.25	
6	1	4.5	4.5	20.25	20.25
	N = 142		98.0		107.50

$$y = \frac{98}{142} = 0.69 \text{ years or } 8.3 \text{ months}$$

$$SAK = 107.5 - \frac{98^2}{142} = 39.87$$

$$S.E. = \pm \sqrt{\frac{39.87}{141 \times 142}} = 0.0446$$

$y \pm S.E. = 0.69 \pm 0.04$ years or 8.3 ± 0.5 months

B: For birds alive at beginning of age-group 3.

3	17	0.5	8.5	0.25	4.25
4	3	1.5	4.5	2.25	6.75
5	0	2.5	0.0	6.25	
6	1	3.5	3.5	12.25	12.25
	N = 21		16.5		23.25

$$y = \frac{16.5}{21} = 0.79 \text{ years or } 9.4 \text{ months}$$

$$SAK = 23.25 - \frac{16{,}5^2}{21} = 10.286$$

$$S.E. = \pm \sqrt{\frac{10.286}{20 \times 21}} = \pm 0.1565$$

$y \pm S.E. = 0.79 \pm 0.16$ years or 9.4 ± 1.7 months

data of individual birds, but, as shown in Table 8, it can also be calculated from the distribution of recoveries on age-groups.

It is seen that birds which have survived up to the beginning of the second age-group have a mean further life of 8.3 ± 0.5 months, and the few which survive up to the beginning of the third age-group can expect to live for another 9.4 ± 1.7 months. The data available for calculation of the latter figure are so few that it cannot be decided whether the two expectancies are genuinely different. The expectancy at beginning of age-group 3 might well be genuinely higher either because birds, initially not well adapted to natural conditions, go on improving themselves or because the birds which have managed to survive during the first years are individuals with better than average power to adapt themselves. In pheasants *Buss* (1946) found an indication of increasing chance of survival after the birds had reached the first winter, and *Farner* (1955) quotes other examples of this tendency.

In the great majority of bird species death occurs long before reaching old age. The difference between the mean natural longevity in a population and the potential longevity of its individuals is, therefore, considerable. Reliable data on the potential longevity of the Partridge are not available, and some experiments carried out in the Game Biology Station did not solve the problem; these experiments were also intended to shed light on the egg production of different age-groups; hence it was necessary to expose the 20 hens to the dangers of marriage during which six were so ill-treated that they died or had to be released. The high annual egg production, varying from 30–46, may also have had an unfavourable influence.

Among the 20 experimental birds 3 escaped and 1 was released. The remaining 16 reached a mean age of 48 months, a high age compared to a mean age of 5.5 months in the recovered, ringed birds and to the expected further life of 8.3 months in birds which have survived the first winter.

The oldest bird among the ringed birds recovered had been shot at 62 months of age while the oldest experimental bird reached 91 months' age.

In spite of the many dangers of penned life—hitting the fence, not being able to avoid attack by mate, intensified egg-laying, possibly insufficient food—conditions seem, on the whole less hazardous than in nature and the chance of reaching an age which approaches the potential longevity correspondingly greater.

Dispersal of marked birds.

In the previous publication I was somewhat reluctant to state distances between point of release and recovery, except when they were exactly known.

This is the reason why only 80 distances were quoted from among 230 recoveries. This cautious attitude is rather unsatisfactory, several recoveries are left out even when the maximum distance, an important piece of information, is known. As far as possible all recoveries are considered in the new material; a maximum recovery distance of, say, 3 km brings the bird into the group "2–3 km" although it might actually belong to the 1–2 km-group. Hence the distribution of the recoveries indicates maximum distances. The procedure enables one to base the calculations on 140 among 163 recoveries. The majority of the remaining 23 were released on islands too small to allow a normal pattern of dispersal and have, therefore, been disregarded here; or the data supplied were too incomplete to be used.

Table 9 shows the number and percentage distribution of recoveries in re-

Table 9.

Dispersal of recoveries from point of release.

Year & month of release and age		Distance between points of release and recovery (km).						Total	Mean distance (km)
		0–1	1–2	2–3	3–5	5–10	> 10		
1955/56–57/58									
A: chicks	Nos.	17	13	2	4		1	37	1.9
$^{1}/_{7}$–$^{31}/_{10}$	%	*45.9*	*35.1*	*5.4*	*10.8*		*2.7*	*99.9*	
B: adults	Nos.	5	6	4	1	1		17	2.4
$^{1}/_{7}$–$^{31}/_{10}$	%	*29.4*	*35.3*	*23.5*	*5.9*	*5.9*		*100.0*	
C: age? but mostly chicks	Nos.	14	4	3	4			25	1.8
$^{1}/_{7}$–$^{31}/_{10}$	%	*56.0*	*16.0*	*12.0*	*16.0*			*100.0*	
D: adults and full-grown.	Nos.	24	18	4	9	5	1	61	2.5
$^{1}/_{11}$–$^{31}/_{3}$	%	*39.3*	*29.5*	*6.6*	*14.8*	*8.2*	*1.6*	*100.0*	
Total.....	Nos.	60	41	13	18	6	2	140	2.2
	%	*42.9*	*29.3*	*9.3*	*12.9*	*4.3*	*1.4*	*100.1*	
1950/51–54/55	Nos.	46	25	3	2	3	1	80	
(*Paludan* 1957).....	%	*57.5*	*31.3*	*3.8*	*2.5*	*3.8*	*1.3*	*100.2*	
1950/51–57/58	Nos.	106	66	16	20	9	3	220	
Total.....	%	*48.2*	*30.0*	*7.3*	*9.1*	*4.1*	*1.4*	*100.1*	

Table 10.

Dispersal from point of release of recoveries obtained 6 months after release or later. A + C released as chicks, B + D as adults and fully grown juvenals. For A–D, see Table 6.

Released as		Distance in km						Total	Mean Distance (km)
		0-1	1-2	2-3	3-5	5-10	> 10		
A + C: chicks	Nos.	8	4	1	4			17	1.9
	%	*47*	*24*	*6*	*24*				
B + D: adults and full-grown juvenals.....	Nos.	9	10	4	3	3		29	2.7
	%	*31*	*34*	*14*	*10*	*10*			

lation to distance. Furthermore, the material from 1955/56–1957/58 is subdivided into four groups, A–D, of which A–C comprise the summer releases, and D releases made between 1 November and 31 March. Finally, the data already published have been included. The combined data show that 48.2 per cent were recovered within 1 km from the point of release, no less than 48.2 + 30.0 = 78.2 per cent within a maximum of 2 km, and only 5.5 per cent more than 5 km from the point of release, among the latter group 3 were recovered more than 10 km away, namely from 15, 16, and 17 km distance.

The 140 recoveries in the new material had a mean distance of recovery of 2.2 km; it must, however, be borne in mind that in many cases only the maximum distance was known, and that the true mean distance may be somewhat lower.

In group A, comprising birds released as chicks, and in C, where the exact age of individual birds is unknown, although the majority were known to be chicks, 45.9 and 56.0 per cent, respectively, were recovered within 1 km whereas the corresponding figures for B and D, adults and fullgrown juvenals, are 29.4 and 39.3 per cent. The corresponding mean distances are 1.9 and 1.8 against 2.4 and 2.5 km.

One might reasonably assume that this difference in the dispersal of chicks and adults is solely due to the fact that many chicks succumb on or near the point of release. It might also be explained through chicks being more stationary. In an attempt to settle the question all recoveries 6 months or longer after the release are set out in Table 10. Also here it appears that within 1 km the recovery from group A + C (mostly chicks) is greater than from group B + D (adults), 47 and 31 per cent respectively. For distances within 2 km the difference

Table 11.

Scatter of recoveries round point of release. Danish, Czech, and Italian data compared. The Danish data presented in last row corresponding to section D in Table 9 (full-grown birds released during interval $^{1}/_{11}$–$^{31}/_{3}$).

Material		Distance between points of release and recovery (km)							Total	Mean distance (km)
		0–2	2–5	5–10	10–20	20–40	40–100	100-150		
Danish	Nos.	172	36	9	3				220	
1950/58	%	78.2	16.4	4.1	1.4				100.1	1.9
Czech	Nos.	277	73	16	6	3	3		378	
(*Paleček & Toufar* 1957)	%	73.3	19.3	4.2	1.6	0.8	0.8		100.0	2.8
Italian	Nos.	125	50	75	17	4	1	1	273	
(*Toschi* 1962) ...	%	45.8	18.3	27.5	6.2	1.5	0.4	0.4	100.1	5.2
Danish	Nos.	42	13	5	1				61	
(D)	%	68.8	21.4	8.2	1.6				100.0	2.3

is smaller, 71 and 65 per cent. However, the mean distance, 1.9 km among the chicks, and 2.7 km among the adults, indicates a genuine difference.

Although the chicks seem genuinely more stationary the difference between chicks and fullgrown birds is small. In both groups the great majority were recovered from within 2 km, and only three birds from places more than 10 km away.

The dispersal from the point of release is also analysed in the Czech and Italian papers mentioned above. Table 11 shows the results, along with those obtained in the present study.

Although the data from all three sources have the feature in common that the bulk of recoveries were from within 5 km certain differences are distinct. The distribution of recoveries in Czech partridges shows surprisingly good agreement with the Danish material, 92.6 per cent recoveries within 5 km compared to 94.6 per cent in Denmark. However, the proportion of Czech partridges from outside this radius indicates a tendency to move even farther away; while the maximum distance in Denmark was 17 km no less than three of the Czech recoveries came from more than 40 km distance, *viz.* 46, 61, and 76 km. Although only few birds were involved in these long-distance movements they affect the

mean distance quite appreciably, 2.8 km in Czechoslovakia against 1.9 in Denmark. The calculations are based on the mean distance for each class (5–10 km being taken to mean 7.5 km a.s.o.) and not as individual distances, a procedure which has been followed in Tables 9 and 10.

The Italian material differs considerably from the two others, only 64.1 per cent were recovered from less than 5 km distance, and the mean distance was 5.2 km. The maximum distance between the points of release and recovery was no less than 139 km.

It is difficult to explain why the Italian partridges have moved about so much more than Danish and Czech birds. The origin of the birds seems not to matter; half of the recoveries were birds of Italian origin while the other half consisted of birds imported from Czechoslovakia, Germany, Hungary, the Netherlands, and Denmark, and no significant difference could be demonstrated in the movements of the two groups. Age at and time of release might also be suggested as an explanation. The great majority were released between December and March, hence the birds must have been adults and/or fullgrown yearlings. They must, therefore, have been quite similar to the Danish group D in Table 11 below; but also from this group do they differ considerably in dispersal. It is tempting to suggest some environmental factor as a likely explanation, e.g. a less favourable habitat or, though less probable, very intensive shooting (96.7 per cent of the recoveries were birds shot).

Some idea of the speed involved in dispersal is obtained from Table 12. Among other features it shows that birds recovered after 12–18 months had moved 2.1 km on an average against 2.2 km covered by individuals which had been recovered within the first two months of release. The number of later recoveries is so small that no value can be attached to the calculated mean distance. Furthermore, it can be mentioned that the two birds which were recovered from the greatest distances, 15 and 16 km, were recovered after 5 and 1½ months, re-

Table 12.

Relation between distance covered and time between release and recovery (months).

	Time in months between release & recovery						
	0–2	2–6	6–12	12–18	18–24	24–36	36–48
Nos. recovered	67	25	22	17	4	1	1
Sum of km	147	52	61	35	7	5	2
Mean distance (km.)	2.2	2.1	2.8	2.1	1.8	5	2

spectively. The former was released as adult or fullgrown juvenile in November, the latter as 4-week chick in August. The greatest distance occurring in the previously published material was 17 km, a bird not recovered until 23 months after release.

The general impression is that the main dispersal takes place within a short period immediately after release, at least late recoveries do not seem to come from greater distances than the early ones.

Causes of mortality

Unfortunately, the importance of different causes of mortality in a partridge population cannot be studied on the basis of ringing results since the probability of recovery is widely different in different cases. It must, therefore, be pointed out that the percentages quoted in Table 13 only reflect the frequency of causes of mortality among the birds recovered. Consequently, the main value of the survey is to record the causes of mortality disclosed through the ringing experiment.

It is hardly misleading to assume that the birds killed through shooting, and theoretically having a 100 per cent chance of being recovered, are over-repre-

Table 13.

Causes of death for 399 Danish recoveries and their percentage distribution. Same for a Czech (Paleček & Toufar, 1957), and an Italian material (Toschi, 1962).

Information on recoveries given by sender	Denmark		Czechoslovakia (378 recov.)	Italy (273 recov.)
	Nos.	%	%	%
Shot (or trapped (Czechoslovakia))	239	59.9	64.6	96.7
Found dead	78	19.5	19.6	1.8
Found dying	4	1.0		
Killed by farm implement, horses or cattle	11	2.8	1.6	0.4
Traffic	5	1.3		
Hitting wires and overhead lines	20	5.0	5.0	
Dogs and cats	11	2.8		
Predators	14	3.5	9.3	
Only mark recovered	3	0.8		
Incomplete information	13	3.3		
Caught and released	1	0.3		1.1
Total	399	100.2	100.1	100.0

sented in the material while all other causes of mortality—perhaps excepting traffic casualties—are under-represented.

The two last columns of the table show the distribution of mortality causes among 378 Czech and 273 Italian recoveries. Also in this respect there is surprisingly good agreement between Czech and Danish data, thus in either case overhead lines and wire fences are important contributors to mortality. In the Italian material the distribution of causes is entirely different, shooting being responsible for as much as 96.7 per cent. An inquiry into the reasons for this difference must be pure guesswork; the shooting pressure may be considerably higher than in Denmark; an alternative explanation may be that non-sportsmen have not been sufficiently encouraged to take part in the experiment through returning rings from birds found dead or dying.

SPECIAL RELEASES ON SMALL ISLANDS

Release on Fur, 1956.

The first analysis of the ringing experiments (1957) led to at least two results considered highly important for an evaluation of the intrinsic value of releases with regard to increasing the breeding population, the main purpose of the release of partridges. In the first place the recovery percentage was found to be very low and the mortality exceedingly high; this demonstrates the rapid turnover of a partridge population and that, consequently, the birds released count little in nature, at least in places which already have a population, which is the case on practically all places of release in Denmark.

However, in order to check these conclusions through a more rigorously controlled experiment a release was made on the island Fur in Limfjorden (Fig. 2). The total area of the island is 2220 ha and the northern part undulating country with alternating heathland, small plantations and arable land. The southern part is quite flat, cultivated, and with several small farms. Fur Sound, 10 m deep, separates the island from the mainland (Salling) to the south; the width of the Sound, where narrowest, is only 600 m. Presumably, this is sufficient to prevent the partridges from crossing unless for some reason they are forced off the island.

During the years 1919–48 practically all shooting on the island was hired out to a single shooting party, and from its records it appears that the annual bag varied between 33 and 318 partridges, with an average of 152, i.e. 6.8 partridges per 100 ha, a little less than the mean bag for the entire country (appr. 7.0 partridges during the years 1941–54). The picture conveyed by the figures is

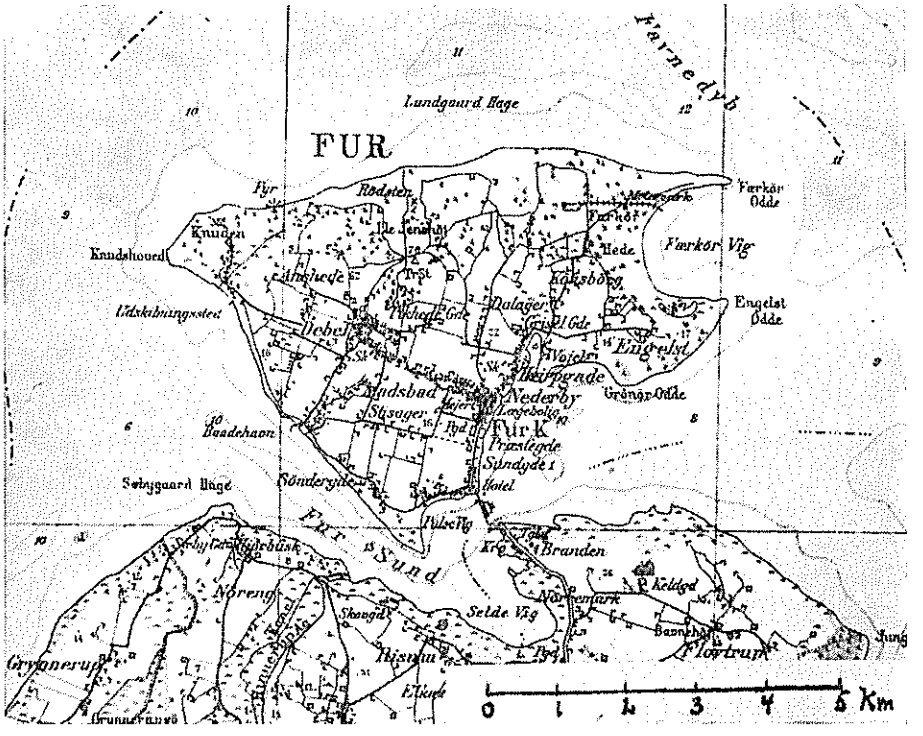

Fig. 2. Fur (After Geodætisk Institut).

presumably not quite true since the suitability of the area for partridges would seem to be above mean.

At 18 points, fairly evenly scattered throughout the island, 349 partridges were released on 29 November 1956:

	♂♂	♀♀
full-grown juveniles	148	175
adults	12	14
	160	189; grand total 349.

The release would correspond to 1 pair per 12 ha, or more birds than the highest bag during the period 1919–48, and more than three times the autumn bag of 1956 according to information supplied by the sportsmen of the island. The release must therefore be considered a rather massive one.

During the release operation and the subsequent contact with the sportsmen Mr. *Thomas Vester*, Fur, gave us his valuable assistance, we owe him much gratitude for his cooperation in retrieving rings and information on bags.

Before the first shooting season (1957) 14 birds were recovered dead. During the season 4 ringed birds were shot, but, as already mentioned, we only succeeded in retrieving three of them. Finally, one was found dead in December 1959. Up to 1962 they were the only (14 + 3 + 1 = 18) recoveries obtained, all of them from the island itself. The percentage recovery has already been discussed (p. 32).

Through personal visits to all the sportsmen of the island and to all holders of shooting rights living outside the island the total bag in 1957 could be estimated to 102 partridges, among which four were ringed.

Unfortunately, the age distribution of the 102 partridges is unknown, and it could not be determined since shooting takes place throughout the season and by a fairly large number of sportsmen acting independently. In a material consisting of 429 partridges from South Jutland and from the same shooting season, the yearlings contributed 81.6 per cent. Assuming the productivity of the Fur population to be the same. one would expect 83 young birds and 19 adults among the 102 birds killed.

Fig. 3. Scenery from Fur (After Fur-Jagten 1919–48).

Now, three of the adults were certainly marked, and a fourth was likely to be so. This implies that 20 per cent of the adults shot were contributed by birds released; if, furthermore, they are assumed to have had the same productivity as the wild birds also 20 per cent of the total bag, or appr. 20 birds, would be attributable to the birds released. According to this calculation the release of 349 birds has increased the bag by at most 20 birds during the first shooting season.

Their possible influence during subsequent years is hardly worth mentioning since the rapid turnover (annual mortality 84 per cent) quickly eliminates an artificial increase. The mere fact that only 4 birds out of 349 showed up in the bag taken only 8 months after the release is a sufficiently clear indication of this elimination. Much the same is apparent from the feature that no ringed birds have been shot during all subsequent years, but only one found dead.

It should furthermore, be pointed out that the actual bag increase during the first season need not necessarily be the 20 per cent (optimistically) calculated above. Firstly, the reproductive capacity of the birds released need not be as high as in the initial population; secondly, the release of this number of birds may have had competitive effect on the original population and caused a greater winter reduction than without competition from the released population.

The total bag in 1957 does not indicate an excess yield of 20 per cent due to the release. Through personal visits to farmers and holders of shooting rights information was obtained for more than 90 per cent of the area of the island. Here a total of 102 partridges were shot. Unfortunately, similar information on the bag of the previous year (1956) could not be had, but from an area which in 1957 yielded 73 (among the 102 birds) 69 were taken in 1956.

Thus, the indicated improvement would amount to less than 6 per cent instead of 20 per cent as calculated above. The effect of the release, might, however, also have been that of concealing a general decline in 1957 due to an unfavourable breeding season. This is, however, not supported by available evidence, the opposite seems more likely since according to the official bag record the county of Viborg (of which Fur forms part) showed a bag increase of almost 17 per cent from 1956 to 1957 (15,896 partridges bagged in 1956 against 18,551 in 1957).

In spite of the massive release no unquestionable increase of the bag could be demonstrated in the following year, at least it is certain that the effect was incommensurably small compared to the number of birds released.

Release on Illumø, 1958

Partridges are rarely found dead, although we know that many succumb in nature. It was, therefore, rather striking that no less than 14 were reported dead

from Fur before the first shooting season and the majority of them during the months immediately after the release. On the other hand this was in good agreement with the release mortality, known from the large ringing experiments to affect chicks as well as adult birds.

The birds released were fully grown farm birds with no obvious signs of disease or otherwise reduced vitality. However, the sportsmen and farmers of the island explained that the birds behaved in a way entirely different from wild birds. They were less shy, and they would often come quite close to the farms visiting gardens and manure heaps. Of course, this was particularly striking because so many birds had been released.

It is natural to explain this through the fact that the birds had spent their previous lives in a partridge farm. Thus they had got used to man and to surroundings reminiscent of farms and their environment. They may possibly also have had difficulties in finding the natural food in the fields, a further incentive to approach the neighbouring farms. However that may be, the altered behaviour would expose the birds to considerable risk (dogs, cats, etc.).

In order to study the behaviour of reared birds 44 partridges were released on Illumø in 1958.

The island is in the bay of Helnæs off the southwestern coast of Fyn. It is long and narrow, 4 by ½ km (Fig. 4). The shortest distance to the mainland, farther west, is appr. 1 km (Helnæs). In a northeasterly direction are the two islands Horsehoved and Vigø, to the east separated from the mainland by an appr. 1 km wide sound. Thus, the possibilities of an exchange of partridges between Illumø and the mainland are small, unless special factors are operating. The area of the island amounts to appr. 100 ha, 55 of arable land, the rest largely salt meadow and a couple of small wood lots; in several places the coastal slope is covered by scrub (Fig. 5).

Foxes and birds of prey do not occur on the island, but there are cats, crows, and an abundance of Herring Gulls.

Formerly, the island had a population of partridges, but as in several other small islands the population had not been able to maintain itself. When, in 1957, the Game Biology Station acquired the shooting rights, with a view to studies on hare biology, partridges could not be found in spite of very intensive beating.

The birds released, 22 ♂ ♂ and 22 ♀ ♀, carried rings and plastic back markers as used by Blank & Ash (1956). The markers were used to facilitate direct observation of the movements of individual birds and to avoid double counting in census work. They proved to have another important function, *viz.* to facilitate detection of carcasses. In several cases the greyish white or red markers were

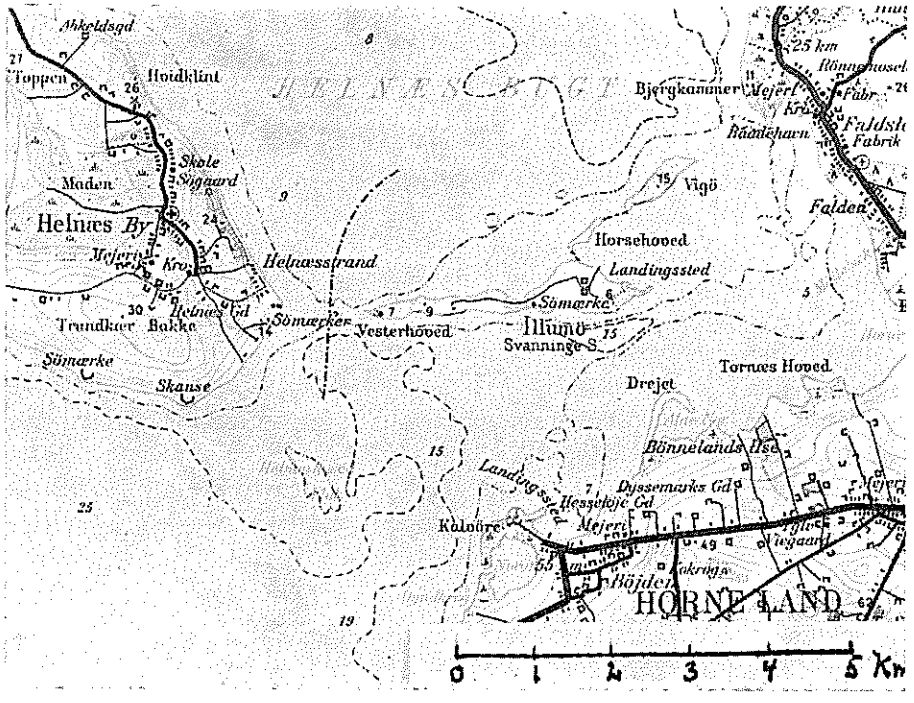

Fig. 4. Illumø (After Geodætisk Institut).

spotted while otherwise the carcass would never have been seen, e.g. when the shoulder girdle with a few attached remiges lay hidden among scrub, even in the open the markers were a great help, since they could often be spotted at considerable distance.

Due to unfavourable weather the release had to be postponed until 15 April. The next two days, and again on 5–7 and 19–20 April, were spent watching the behaviour and dispersal of the birds.

The partridges were not at all shy, and the distances at which they took flight were not at all comparable with the behaviour of wildliving birds. Often they would run about among the scrub a few metres in front of me, or they would crouch in the open until I was only a few metres distant. In one case a bird flew off before I had succeeded in reading the number on the marker. I followed it, therefore, to where it landed, but did not spot it until my foot happened to touch it and it flew off.

On another occasion I followed a bird which had settled near a stone wall. I searched long for it in vain until I spotted it in a small crevice left by a stone

that had fallen out of the wall. Unfortunately, the marker had fallen forwards, and the number could not be read. Just for fun, I tried to turn the marker with my stick and, much to my surprise, the operation was successful. Not until then did it take flight, and its ability to fly was obviously unimpaired.

A good many birds were found dead in places which indicated collision with barbed wire, stone walls, trees etc. On one occasion a collision was directly observed—even under rather unusual circumstances. It happened on 19 May, i.e. about one month after release. I was standing in a house searching a field for partridges through the binoculars when, suddenly, a bird flew past at top speed followed closely by a crow. The partridge shot into a scrub area on a slope while the crow stopped the pursuit and flew away. I felt certain that the partridge had killed itself but close search did not uncover it. On the following morning a dead and partially devoured partridge was found on the beach just below the copse, and it can hardly be doubted that it was the very bird I had watched on the previous day. I have never heard about crows pursuing partridges in flight, so it is perhaps not quite accidental that the victim was a released reared bird.

Before the end of May, i.e. within 1½ month, the remains of 16 dead partridges had been found, this amounts to 36 per cent of the release, and there is reason for believing that even more had succumbed, although the remains did not come to hand. During 19–20 May six survivors could be demonstrated, among which

Fig. 5. Scenery from Illumo; Helnæs in the background.

one was killed on 19 May, as described above. It cannot be doubted that the reduction which had taken place by that time would at least amount to a good deal more than one third.

The main part of the experiment was now finished, but for the sake of completeness the subsequent events are briefly mentioned. Early in September a covey of five partridges was seen, 3 with markers and 2 almost fullgrown chicks. During the days 18–24 October I visited the island for other purposes. In spite of extensive walking during this stay, only one covey of 6 partridges was seen. A similar number was seen during hare trapping on 27 November. On 12 February 1959 hare trapping took place again and, as usual, the entire island was covered by a closely spaced chain of beaters; only one partridge was seen on this occasion, and it even disappeared across the sea off the western end of the island. It could not be decided whether it reached Helnæs opposite. During repeated hare trapping five days later no partridges were seen.

Release on Illumø, 1959.

There is no doubt that the observations made on Fur concerning the abnormal behaviour of the released partridges are confirmed by the release experiment on Illumø in 1958, the heavy mortality immediately after the release is also confirmed.

There is, presumably, no way of preventing the changed behaviour of the birds; it will undoubtedly differ from that of wild birds irrespective of the circumstances of the release. However, the great release mortality may be caused by unsuitability of the area and, perhaps also by the large and conspicuous markers. Against the first possibility speaks the fact that the island has previously supported a fairly good partridge population, and as to the influence of markers direct observation of the birds gave no evidence of their being hampered by them; experience from other countries point in the same direction.

In order to analyse these problems in greater detail it was decided, in 1959, to make a simultaneous release of reared and captured wild birds, all marked as in 1958.

Through the kind cooperation of *General S. E. Johnstad-Møller* we obtained a permission to capture the required partridges in the areas belonging to the Danish Army on the island Amager. Through the very energetic work of Mr. *N. Mardahl Jensen*, Warden of the area, this tricky operation was carried through. The Game Biology Station is very grateful to the Game Department of the Army for the invaluable help thus received.

The captured birds (12 ♂ ♂ and 12 ♀ ♀, among which 21 came from Amager,

Table 14.

Experiment on Illumø, 1959. Observations on reared and wild birds.

	Back markers read on 20. iii. (No. of indiv.)	Found dead before end of August	Shot during Sept.–Oct.
Reared birds.....	6	8	2
Wild bred birds.....	0	4 (+1)	7

and 3 from Kalø) were released on Illumø on 6, 8, and 16 March 1959, immediately after they had been received. Simultaneously the same number of reared birds were released.

On 20 March I spent the whole day in an attempt to read the numbers of the markers through binoculars. Six different numbers were read with certainty, all carried by reared birds.

During the period up to the end of August carcasses or markers with entire straps from 12 birds were found, thus they had all died. Eight of them were reared birds, and four wild. Furthermore, one marker was found which might have been lost; it belonged to a captured bird (Table 14). The observations from 1959 can only be compared between them, not with those from 1958, since more time was spent on the observations in 1958.

Two recoveries came from outside the island. One, a reared female, was found dead on the northeastern coast of Helnæs, a couple of km from the western tip of the island, on 14 March; the other, a wild male, was found dead on the beach of Årø, about 24 km NW of Illumø, on 10 March. They had both been released on 6 March, hence the escape had taken place shortly after, perhaps immediately after. The distance covered by the last mentioned individual before it dropped into the sea cannot be decided since the current may have carried it far away.

The fact that only numbers belonging to reared birds were read confirmed the observation of previous years, namely that the reared birds were far less shy than the wild ones. The fact that the first months after the release yielded twice as many casualties among reared than among originally wild birds also point in the direction that the reared birds are less successful when left to themselves under natural conditions.

Now that we know for certain that partridges will attempt to cross the sea, with or without success, one might imagine that the more sturdy wild birds

would have escaped immediately. This might explain why none of them were read, and why so few were found dead on the island. It is, however, not the real explanation for during the subsequent shooting season we attempted to determine what might be left of the original release. Although the effort was concentrated on birds carrying markers only 9 were shot, 7 being wild birds and 2 reared. This shows that in spite of markers the wild birds showed a better survival up to September than did the reared birds, and the hypothesis that the wild birds had left the island to a greater extent proved untenable.

It is beyond doubt that the experiment reflects a noticeable difference in behaviour and survival between reared and wild birds. The observations cover the first six months after release, but they give no information on whether the survivors after this period—through experience or selection—are as successful as wild birds. On the other hand this question is of little practical interest since the few which survive the first period experience an annual mortality of about 84 per cent and are left with the prospect of a rather limited life-span.

Be it due to the earlier time of release, to the captured birds, or to more favourable weather conditions the breeding results in 1959 were considerably better than in the previous year. At least 3 and perhaps 4 coveys of chicks were present, 2 of them consisting of 15-18 chicks.

During two shooting days, 21 September and 30 October, 27 and 6 partridges were shot, respectively. Among these 33 birds 9 were adults, as already mentioned. The weights of these 9 birds were quite normal, the food situation seems, therefore, satisfactory at least at this time of the year.

During the shooting on 21 September 50–65 birds were seen, among which 27 were shot. During the first autumn hare trapping on 24 September only 8 partridges were seen. This was, however, only part of the population since about 25 were seen during the next trapping, on 6 October. Fifteen of these rose as one covey near the western end of the island, crossed the sound in moderate northwesterly wind and reached Helnæs opposite where they were seen by a fisherman. Thus the capture of hares interfered with the study of partridge populations due to the activity of beaters. Fortunately no capturing of hares took place between the release and 21 September when the first shooting took place, and the experiment proper was discontinued.

If the above observation is correct partridges may cross a 1 km stretch of sea. Pheasants, on the other hand, seem unable to do that; during the capture of hares pheasants were often seen to attempt crossing but on all occasions they disappeared en route; on some occasions dead pheasants have been washed ashore on Helnæs shortly after capturing operations on Illumø.

The three release experiments on Fur and Illumø are, admittedly, all small

contributions, but since they are in mutual agreement and give support to the large ringing experiment they are valuable. It seems permissible to conclude that adult, reared birds are considerably less shy than wild birds, and that they experience a much heavier mortality, at least during the months immediately after release.

SUMMARY

1. Data concerning 13,203 marked partridges (young birds and adults) from the years 1950/51–1957/58 are available.
2. 397 individuals, or 3.0 per cent of the total release were recovered.
3. An attempt, on the island Fur, to increase the percentage recovery of shot birds through activation of the people was unsuccessful.
4. The mean annual mortality among adult birds is estimated to 84.0 ± 2.8 per cent.
5. Only one fifth of chicks released in summer were still alive by November.
6. The mean longevity for birds recovered was 5 ½ months counted from the time of release.
7. Birds which survived up to the first 1 April had a calculated mean expectation of further life of 8.3 ± 0.5 months.
8. Appr. ¾ of the recoveries came from within a distance of 2 km from the point of release, only 3 from more than 10 km away, the maximum being 17 km.
9. 60 per cent of the recoveries were birds that had been shot.
10. A massive release in November on the island Fur hardly increased the bag during the following shooting season.
11. A release experiment during which fullgrown birds were released on the island Illumo demonstrated a suppressed flight reaction and great mortality in reared birds.
12. Simultaneous release in the following year on Illumo of reared and trapped wild birds demonstrated considerably greater chance of survival in wild birds.

LITERATURE

Blank, T. H. and J. S. Ash. 1956. Marker for game birds. – Jour. Wildl. Mgmt. 20: 328–330.

— 1962. Fluctuation in a partridge population. The exploitation of natural animal populations.— A symposium of the British Ecological Society: 118–133.

Buss, Irven O. (1946). Wisconsin pheasant populations. – Wisconsin Conservation Department's Publications 326, A–46, 184 pp.

Farner, Donald S. 1955. Birdbanding in the study of population dynamic. – Recent studies in avian biology: 397–449.

Fog, Jørgen. 1958. Mærkning af opdrættede gråænder 1950–55. (Summary: Hand-reared mallards (Anas platyrhynchos) marked during 1950–55). – Danske Vildtundersøgelser 8: 32 pp.

Höglund, Nils H. 1960. Svenske Jägareförbundets viltmärkningar 1957 och 1958. – Viltrevy 1: 352–397.

Marcussen, K. E. M. 1953. Fur-jagten 1919–1948. 13 pp.

Paleček, J. and J. Toufar. 1957. Stěhovāní vypouštěných koroptví (Resumé: Das Wandern der freigelassenen Rebhühner (Perdix perdix L.)). – Zoologicke Listy 6 (20): 133–138.

Paludan, Knud. 1951. Contributions to the breeding biology of Larus argentatus and Larus fuscus. Copenhagen. 128 pp.

— 1957. Ringmærkning af agerhøns 1950–54. (Summary: Partridges ringed during 1950–54.) – Danske Vildtundersøgelser 7: 27 pp.

— 1959. Results of pheasant markings in Denmark 1949–55. – Danish Rev. Game Biol. 4 (1): 1–23.

Toschi, Augusto. 1962. Preliminary results of the release of Partridges (Perdix perdix) in Italy. – Trans. V. Int. Union Game Biol.: 261–268.