Oological Studies in Gulls

I. Egg-producing Power of Larus argentatus Pont.

By Finn Salomonsen.

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Many authors have in recent years contributed to our knowledge of the oology of the Herring-Gull (*Larus argentatus* Pont.), *e. g.* H. W. Culemann (1928), R. M. Lockley (1932) and F. Gœthe (1937), and all the life-habits of this species are now well-known. At any rate our knowledge about the oology of the Herring-Gull is sufficient to form the basis for the following investigation of the egg-producing power in this gull. The egg-producing power in birds is known for a number of species but no serious attempts have been made to study it in detail and no real experiments have been carried out in the field. In the literature the following statements have been made concerning the egg-producing power in birds:

H. Alderson (1897, p. 511) removed the eggs of a Wryneck (*Iynx torquilla* L.), each egg regularly being removed as soon as laid; the 17th July the total number reached 62, this bird thus being a very prolific layer. In another experiment 43 eggs were taken, being removed in batches of four and five. In two earlier experiments quoted by Alderson the number of eggs amounted to 42 and 22. B. Riviere (1897, p. 575) doubts the possibility of a non-stop laying of 62 eggs in the wryneck, one egg every day. Having made similar experiments he has always found that "the bird continued laying up to its normal number, and that there was then an interval of five days between the two sets of eggs which it laid.... I may mention that a good number of the birds experimented on deserted the nests." Like Alderson also K. Warga (1925, p. 290) daily took an egg from a wryneck which did not stop laying until 33 eggs were removed.

From a Kingfisher (*Alcedo ispida* L.) 20 eggs were removed, *i. e.* at first 7, then 6, 4 and 3 (Jahresbericht 1884, p. 31). R. F. Miller (1910, p. 183) robbed the eggs of a Florida Gallinule (*Gallinula chloropus cachinnans* Bangs) three times, taking 9, 9 and 18 eggs respectively, i. e. a total of 36 eggs. The egg-production in a Dipper (*Cinclus cinclus* (L.)) from which the eggs were successively removed was by O. Grabham (1897,

p. 575) found to be 32 eggs, and A. BANKES (1897, p. 575) found the production in a Redshank (*Tringa totanus* (L.)) to be 18 eggs.

A. KREYMBORG (1911, p. 86) states that Magpies (*Pica pica* (L.)) continue their laying up to a number of 18—21 eggs, if the eggs are removed every 2nd or 3rd day. E. PUHLMANN (1914, p. 512) removed the eggs as soon as laid in some Sparrows and found the laying being continued in the House-Sparrow (*Passer domesticus* (L.)) until 10 eggs were laid, in the Tree-Sparrow (*P. montanus* (L.)) until 12, exceptionally 16, eggs were laid. Further, F. GRŒBBELS (1937, p. 243) mentions the following instances of egg-producing powers in birds: *Burhinus oedicnemus* (L.) 8 eggs; *Accipiter nisus* (L.) 12; *Picus viridis* L. 17 & 19; *Iynx torquilla* L. 18; *Colaptes auratus* (L.) 33 & 71; *Upupa epops* L. 23; *Corvus corax* L. 16; *Passer domesticus* (L.) 49.

This review shows that only few and occasional studies have been made concerning the egg-producing power in birds. As regards the Herring-Gull only three brief statements may be quoted on this subject. O. LEEGE (1905, p. 14) says about the colonies on the island of Borkum, off the German North sea coast: "Vor Jahren nahmen die Pächter der Kolonien ihnen die ersten Gelege fort, ohne den Bestand zu schädigen, und steigerten die Legekraft bis auf 12 Eier". Recently F. GŒTHE (1937, p. 65) says: "Von 7 Kontrollpaaren habe ich bei 4 Paaren ein drittes Gelege mit 1—2 Eiern festgestellt, so dass ein Vogel nicht mehr als höchstens 8 Eier geliefert hat." G. STEINBACHER (1931, p. 350) states that the maximum number of eggs is 6—9.

To study the egg-production in the Herring-Gull and various biological phenomena associated with this problem, rather extensive investigations have been carried out in the spring of 1938 on the islet Græsholm near Christiansø off the east-coast of Bornholm. Græsholm forms a scientific bird-sanctuary to which all entrance is prohibited, so the experiments could be carried out without disturbance from accidental visitors. On Græsholm a mixed colony of Herring-Gull and Lesser Black-backed Gull is nesting, numbering about 1000 pairs. A small part of this colony, situated at the SW corner of the island and consisting only of Herring-Gulls was used in the experiments.

Methods.

The egg-laying of the Herring-Gulls on Græsholm was watched from the very beginning. As soon as an egg was laid it was removed and the empty nest was designated with a special label with a number. Some difficulties arose as the gulls removed the labels, although they were placed under a stone apparently quite hidden from the gulls. It was therefore necessary to use small wooden sticks, which were hammered down into the soil or in a crevice in the cliffs and bore the number of the nest in question. These sticks could not be removed by the gulls and they soon became accustomed to them. In order to disturb the great number of sea-birds breeding on the protected island as little as possible, the Herring-Gulls were visited only every 2nd day, some few times only every 3rd day when bad weather prevented the landing on the island. However, as the Herring-Gulls lay their eggs with an interval of 2—3 days (cf. below) it was sufficient to visit the birds every 2nd day. In order not to make the birds suspicious a number of nests situated in the experimental field were left undisturbed and in these the clutch became full, the young hatched and reared as normally.

When the first egg was taken in a nest the bird in most cases laid a new egg in the same nest. This egg, again, was immediately removed, but some birds continued laying, notwithstanding the robbing of their eggs, and the new eggs were then removed as soon as they were laid. In other cases the empty nest was deserted by the gulls and a new nest placed in the close vicinity of the old. According to H. W. CULEMANN (1928, p. 616) the Herring-Gulls have a strong territory-sense even when the nests are placed $1^1/_2$—2 m from each-other in the colony, and the intrusion by a stranger excites always a hostile response. In the Black-headed Gull (*Larus ridibundus* L.) also a territory-feeling is present, but the territories appear to overlap slightly (F. B. KIRKMAN 1937, p. 37). On account of this strong sense of territory in the gulls it is possible to conclude, that a pair will stick to the same restricted locality even if the nest has been robbed, an if a new egg is found in such a nest it must belong to the original pair whose eggs have been removed. If the birds prefer to build a new nest

after the egg or eggs have been removed they will place the nest within their own territory. F. GŒTHE (1937, p. 64), who studied the social life of the Herring-Gull, found in 4 cases that new eggs were laid in the old nest from which the original clutch was robbed, but in 11 cases that the nest was deserted and a new nest placed 0.70 to 3.50 m. from the old nest, *i. e.* not far away. Owing to the great concentration of breeding pairs in the colony on Græsholm it was in most cases impossible to say to which pair a new nest belonged. Consequently every nest in which an egg was found was supplied with its own number notwithstanding the fact, that the same pair during the entire breeding-season steadily builds new nests when the old ones are continually robbed of eggs.

Altogether 855 eggs were removed, and 340 nests were examined. The material is too large to be enumerated here, but an example is shown in table I, *viz.* the egg-production in the nests in which the first egg was found on the 2nd May.

Table I.

Egg-Production in Nests in which 1st Egg was found 2nd May.

No. of Nest	May														June							
	2	4	6	9	11	13	15	17	19	22	24	26	28	30	1	3	5	7	9	11	13	15
68	o																					
69	o		o																			
70	o			o																		
71	o		o	o		o																
72	o		o																			
73	o			o																		
74	o																					
75	o	o	o	o																		
76	o	o		o	o				o	o	o		o		o		o			o		o
77	o																					
78	o		o																			
79	o	o	o	o				o	o	o												
80	o	o				o		o	o	o	o		o	o		o						
81	o	o																				
82	o	o																				

Of the 15 nests shown above 3 were deserted after the first egg had been removed, 7 after the 2nd egg and 2 after the 4th egg had been removed. In three nests the egg-production was continued until 7, 10 and 12 eggs, respectively, had been removed.

During my work on Græsholm I received most valuable help from Messrs JANUS KJØLLER and ESKILD KOCH; I am much indebted to both. Some of the results of this investigation may be of interest in connection with recent experiments on the removal of eggs for the purpose of diminishing the number of Gulls.

Results.

Time for Egg-Laying; Number of Eggs: In table II (A) is shown the number of eggs laid (and collected). The variation from day to day is illustrated in the diagram, fig. 1. No eggs were found until 20th April and the majority of birds did not commence laying until 24th April. The number of eggs removed at every visit (every 2nd day) was almost constant in the period 24th April—19th May, i. e. about 30, but on 22nd May the egg-number was considerably augmented suddenly, reaching 62 this day. On the following days also the number was extraordinarily large, being 55, 42 and 41 during the next three visits (24th, 26th and 28th May). Then the number decreased to the common level. The 1st June only 21 eggs were collected, but then the number increased again, reaching 38 the 7th June, thus not reaching nearly the amount of 22nd May. From the 9th June the egg-number steadily declined, reaching as low as 10 the 17th June, but then increasing a little the following days, to 14 and 11 the 19th and 21st June. From now on the egg-producing power of the gulls appeared to be practically finished, the 23rd and 25th June only 4 eggs were laid, the 27th and 30th June none and the 1st, 3rd and 5th July, only 1. After this latter date the egg-production definitely ceased.

The experiment shows that the artificially prolonged time for egg-laying covered almost two months, starting 24th April, before which date only a few precocious birds had commenced egg-laying, and finishing 21st June, after which date only a few late or very persevering egg-layers continued the egg-production.

Influence of Weather on Egg-Production: The conditions under which the artifically augmented egg-production took place were identical during the whole breeding-season, every egg in all nests in the entire experimental area being

Table II.

Various Data regarding the Egg-Production.

A: Total number of eggs laid in the experimental nests.
B: Average interval (in days) between laying of eggs in the same experimental nest.
C: Average number of eggs in all nests in which 1st egg was found on date in question.
D: Percentage of nests deserted after 1st egg was removed.

Date	A	B	C	D
18. 4	0			
20. 4	4		1.8	50
22. 4	11	2.0	3.2	22
24. 4	27	1.8	3.8	44
26. 4	22	2.0	1.8	46
28. 4	23	3.0	3.1	18
30. 4	29	2.5	3.3	33
2. 5	33	2.6	3.6	20
4. 5	27	2.3	2.8	25
6. 5	31	3.4	2.8	22
9. 5	35	3.8	1.9	46
11. 5	30	2.5	3.7	27
13. 5	31	4.3	1.7	61
15. 5	23	3.7	1.9	55
17. 5	25	3.6	3.6	50
19. 5	26	3.8	2.3	33
22. 5	62	4.4	2.9	27
24. 5	55	2.4	2.4	50
26. 5	42	2.8	1.6	58
28. 5	41	2.9	2.8	30
30. 5	26	2.5	1.8	50
1. 6	21	4.3	1.8	67
3. 6	27	4.0	1.6	73
5. 6	34	3.4	1.7	61
7. 6	38	2.9	1.8	63
9. 6	28	2.9	1.5	69
11. 6	22	4.0	2.1	44
13. 6	18	4.4	2.3	0
15. 6	18	3.6	1.3	67
17. 6	10	3.7	2.3	0
19. 6	14	3.8	1.8	25
21. 6	11	2.8	1.0	(100)
23. 6	4	2.7	2.0	(0)
25. 6	4	3.5		
27. 6	0			
30. 6	0			
1. 7	1			
3. 7	1	4.7		
5. 7	1			
7. 7	0			
9. 7	0			
11. 7	0			
13. 7	0			

carefully removed as soon as laid. Hence the curve showing the egg-production might be expected to proceed very regularly, *viz.* having a gradually ascending part succeeded by a gradually descending part when the egg-production was decreasing. However, the egg-production does not take place so regularly, and three times it increases suddenly to much more than the normal level, *viz.* the 22th—28th May, the 3rd—7th

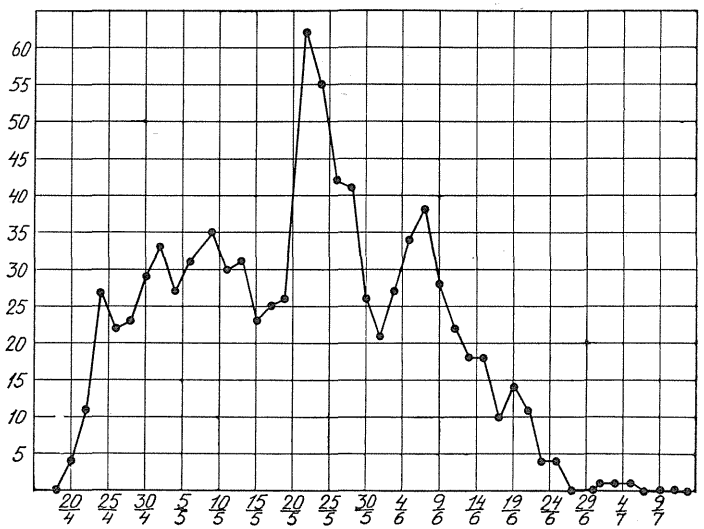

Fig. 1. Egg-production in the experimental area.
Abscissa: Date. Ordinate: Number of eggs found at each inspection.

June and perhaps also the 19th—21st June (cf. fig. 1). In my opinion the irregularity is due to interference from the weather, *i. e.* the egg-production may be influenced by climatic factors. It is most natural to think that temperature and light are able to influence the egg-laying, and for this reason I have calculated the daily mean-temperature at Christansø. The material was with great kindness placed at my disposal by the "Meteorologisk Institut" in Copenhagen.

The daily mean-temperature for the entire breeding-season is figured on the diagram fig. 2. The accordance with the curve for the egg-production can be seen at a glance. An increase in the temperature is always followed by an augmentation of

the egg-production which takes place 10—12 days after the increase of temperature. This appear to show that the "gestation-period" in this species is 10—12 days. This corresponds with the fact, demonstrated by F. GŒTHE and quoted below (p. 129), *viz.* that Herring-Gulls if the clutch is removed or destroyed lay a new clutch 12—14 days later.

Table III.

Daily Mean-Temperatures (in °C) of Christiansø.
April—July 1938.

	April	May	June	July
1.	6.1	6.1	11.1	14.6
2.	5.5	7.4	12.2	13.7
3.	3.4	7.2	10.3	13.6
4.	2.6	7.8	12.6	15,9
5.	4.3	7.8	14.1	14.7
6.	5.4	5.5	11.6	15.7
7.	5.8	6.9	13.8	16.1
8.	5.1	5.5	16.3	18.1
9.	3.0	6.5	16.5	17.1
10.	3.9	7.2	14.2	15.0
11.	6.6	7.0	13.5	16.0
12.	6.2	9.5	12.7	17.6
13.	7.0	11.8	12.8	16.4
14.	6.8	12.9	13.3	17.1
15.	6.9	15.0	11.1	18.5
16.	9.2	15.2	12.4	19.4
17.	3.3	12.9	13.0	18.5
18.	3.4	10.8	12.9	16.6
19.	3.9	9.1	14.2	15.7
20.	4.1	7.8	13.1	16.8
21.	5.1	7.5	12.3	15.1
22.	3.7	8.8	14.1	16.9
23.	3·5	9.8	12.1	16.5
24.	3.9	10.1	12.1	18.6
25.	5.3	10.0	13.4	17.8
26.	6.9	10.3	13.4	19.6
27.	6.8	12.5	13.1	19.6
28.	8.2	12.4	13.7	19.6
29.	8.0	10.4	13.6	19.5
30.	7.0	9.3	15.1	20.5
31.		10.3		21.2

We may follow the correspondance between temperature and laying in detail: From the 9th to the 16th April the temperature steadily increases, from 3.0° to 9.2° and then it suddenly falls to 3—4°, at which level it remains until a new increase begins the 25th April. It is possible that the temperature-increase 9th—16th April has stimulated the birds to begin the egg-laying 20th—24th April. However, much more

interest is attached to the next large temperature-increase. From 25th April to 11th May the temperature has oscillated between 5° and 8°, but the 12th—16th May it suddenly rises, reaching 15.2° the 16th May, after which date it falls again, reaching 7.5° the 21st May. In my opinion there is no doubt that the large increase in temperature 12th—16th May is the cause of the augmented egg-production 10 days later, 22nd—

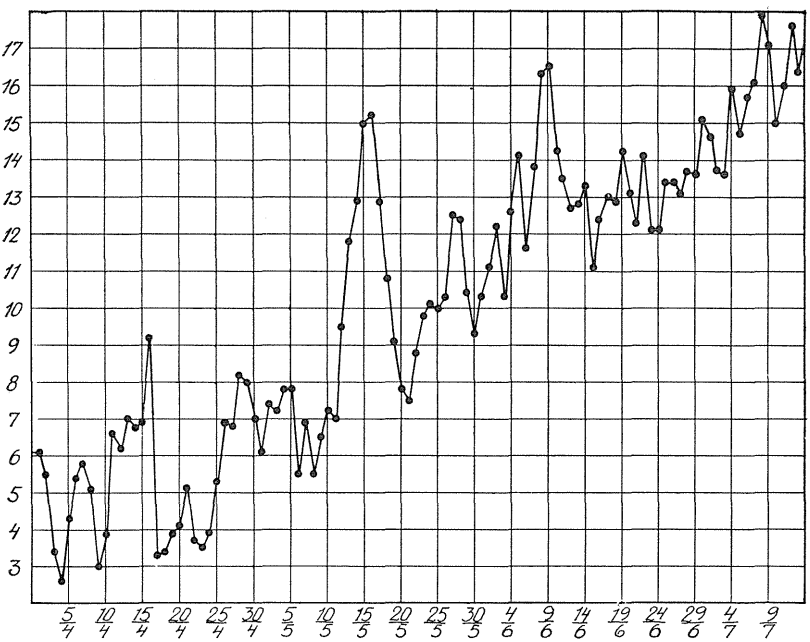

Fig. 2. Daily Mean-Temperature (in °C.) of Christiansø, April—July 1938.

28th May. The correlation between temperature and egg-laying is continued. A new temperature-oscillation in the days 22nd —27th May brings the temperature up to more than 12°, *i. e.* a smaller increase than in mid-May. The new rising of the temperature results in an augmented egg-production 3rd—7th June, *i. e.* 10 days later, but the augmentation is not so large as that about 22nd May. From about 10th June the egg-production rapidly decreases, but it appears that a new, large increase in temperature has been able to stop the fall in the egg-production for some days. In the period 7th—10th June

the temperature increases, reaching for two days more than 16°, a height which is not reached again until a month later. This extraordinary rise is probably responsible for the small increase in the egg-production 19th—21st June (10 days later), in a period when the egg-laying appeared to be rapidly decreasing.

The distinct correlation between temperature and egg-production shows that an increase in temperature is in some way able to encourage the egg-laying, either by accelerating the development of the egg or by stimulating the birds physiologically or psychologically to begin or to continue the egg-production.

Recent experiments have shown that not only the temperature but the light also controls the sexual periodicity in birds and mammals (cf. W. ROWAN 1938, p. 374; T. H. BISSONNETTE 1936, p. 171). This may also be the case with the gulls in question, but according to my notes on the weather at Christiansø in the spring 1938 there does not appear to exist any correlation between rise in temperature and increase in light (hours with sunshine). So no doubt also temperature, besides light, may be of importance regarding the egg-production.

Rate of Egg-Production: During the normal laying the 2nd egg of the Herring-Gull is laid constantly 2 days after the 1st, and the 3rd egg 2—3 days (on an average 2.5 days) after the 2nd (R. M. LOCKLEY 1932, p. 312). The results obtained by me with some control-nests, from which the eggs were not removed, confirm this, as shown in table IV.

Table IV.

Egg-Production and Incubation-Period in Control-Nests.

No. of Nest	Dates of Laying			Dates of Hatching			Incubation-Period		
	1st egg	2nd egg	3rd egg	1st egg	2nd egg	3rd egg	1st egg	2nd egg	3rd egg
a	28. 4	30. 4	2. 5	25. 5	26. 5	28. 5	27	26	26
b	28. 4	30. 4	2. 5	25. 5	26. 5	28. 5	27	26	26
c	28. 4	2. 5	4. 5	26. 5	28. 5	30. 5	28	26	26

The eggs in the 3 control-nests mentioned in table IV were laid at intervals of 2 days, in one single case 4 days. The incubation-period is 26 days as regards the 2nd and 3rd egg,

whereas for the 1st egg it is 27—28 days. This shows that the incubation does not always begin with the laying of the first egg but may be delayed 1—2 days. This has already been demonstrated by F. GŒTHE (1937, p. 51), and R. M. LOCKLEY (1932, p. 310) also admits that there is some individual variation on this point.

In the case of the experimental nests the rate of egg-production is somewhat smaller. It may be seen in table I that the eggs are not always laid 2—3 days after the predecessor, but sometimes at intervals of 4 and 6, exeptionally 8 or even 10 days. However, the average interval between two eggs laid in the same experimental nest does not differ essentially from the normal interval of 2—3 days. The average interval is shown in table II (B). It is usually about 3 days, sometimes slightly less, approaching 2 days (once 1.8 days), sometimes somewhat larger, but never reaching 5 days. The average-interval appears to be the same during the whole breeding-season, perhaps with a slight tendency to grow a little larger during the latter part of the breeding-time (June), but this tendency is not very pronounced. Altogether 509 eggs have been used in the calculation.[1] The total sum of intervals between these eggs and their predecessors is 1646 days, which gives an average interval for the whole period of 3.234 days.

Egg-producing Power of the Individual Bird: It is not easy to find the egg-production of the individual bird as the nests are so often deserted when the eggs are removed. However, in a few cases a large number of eggs were collected in the same nest, i. e. belonging to the same female. In 3 cases 12 eggs, in 3 cases 13, in one 14 and in one case even 16 eggs were collected in the same nest. The 16 eggs were laid in the period 17th May—25th June. No doubt the latter bird has not started the egg-production so late but has previously laid some eggs in other nests, now deserted. If starting the egg-production on 24th April (cf. p. 117) this very prolific bird must have laid about 25 eggs altogether. Probably

[1] Naturally the 1st egg in all 340 nests examined could not be used in this calculation. The total number of eggs removed was 855, but 509 + 340 is only 849. This apparent difference is due to the fact that in 6 nests 2 eggs were found when examined the first time.

the number is much smaller in most birds. The average period of egg-production was 24th April—21st June (p. 117). The average interval between two eggs laid by the same bird was said to be 3.2 days. If the birds steadily continued the egg-production at this rate in the period in question they would be able to lay 18 eggs, but this number is also too high. In the period in question 829 eggs have been laid. This means that only 46 pairs have been examined in the experimental area (829 : 18 = 46). However, some days eggs were found in more than 46 nests; for example, on 22nd May 62 eggs were collected from 57 nests (in 5 nests were 2 eggs). The number of pairs which served as experimental birds lies between 60 and 70. With an estimate of 65 pairs every femal has laid 13 eggs on an average. This is probably not far from the true number. As we know that certain specimens have laid at least 16 eggs, there must be a considerable variation in the egg-production of the individual bird.

Adherence to Nest: A special interest is attached to the question, to what degree will the birds keep to the original nest when the eggs are continuously removed. F. B. KIRKMANN (1937, p. 164) in some interesting experiments with the Black-Headed Gull has shown that the birds usually keep to the eggs when these are placed $1^1/_2$ feet outside the nest; 60 per cent built new lining round the eggs and began brooding, 15 per cent rolled eggs back to old site or lining and 25 per cent ignored the eggs. What happens, however, when the eggs are entirely removed? It should *a priori* be expected that the empty nest would be deserted by the birds. F. GŒTHE, as quoted above, has shown that of 15 nests in which the eggs were removed or destroyed, 11 were deserted by the gulls whereas 4 were used again. My results show that a large individual variation exists on this point. In table V is shown the distribution of nests according to number of eggs laid in each nest before its desertion, the dates on left giving the day when the 1st egg was laid in the nests in question. It appears from table V that a very large number of nests were deserted after the first egg was removed (140 out of 340 nests examined), a fairly large number of nests (83) were deserted after the 2nd, a somewhat smaller number (63) after the 3rd, and only in

Table V.

Distribution of Nests according to Number of Eggs removed from each Nest before this was deserted by the Gulls. Dates on left give the Day when the 1st Egg was laid in the Nests in Question.

Number of eggs: / Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
20. 4	2	1	1													
22. 4	2	1	3		2	1										
24. 4	8	3	1	2			1			1			2			
26. 4	6	5	1	1												
28. 4	2	3	3	2					1							
30. 4	4	1	4	1			1					1				
2. 5	3	7		2			1			1		1				
4. 5	3	3	4		1				1							
6. 5	2	3	2	1			1									
9. 5	6	4	2			1										
11. 5	4	4	3		1			2						1		
13. 5	8	2	2	1												
15. 5	5	2	1		1											
17. 5	4	2				1										1
19. 5	2	1	2	1												
22. 5	10	8	11	4		2						1	1			
24. 5	7	2	4		1	2										
26. 5	7	3	2													
28. 5	4	4	2		1		2									
30. 5	2	1	1													
1. 6	6		2	1												
3. 6	7	2	1	1												
5. 6	10	5	2		1											
7. 6	10	4		1	1											
9. 6	9	1	3													
11. 6	3	3	3													
13. 6		2	1													
15. 6	2	1														
17. 6		2	1													
19. 6	1	2	1													
21. 6	1															
23. 6		1														
Total:	140	83	63	18	9	7	6	2	2	2	0	3	3	1	0	1

54 cases have the birds stuck to their old nest after the 3rd egg has been taken. Of these 54 nests 18 were left after the 4th egg had been taken, 9 after the 5th, 7 after the 6th and 6 after the 7th egg had been removed. But a few birds still keep to the same nest although 8—13 or even 14 or 16 eggs are taken away. The average number of eggs laid in the nests is shown in table II (C). This number differs slightly during the breeding-time, being slightly lower (1.5—2.5) in the nests

in which the egg-production commences in June than in those in which it commences in May (often almost up to 4), as was also to be expected. The average egg-production for all nests examined is 2.52 egg.

The number of nests deserted when the first egg has been taken constitutes every day during the whole nesting-season about 40 per cent of all nests examined. This percentage is shown in table II (D). From this it appears that the percentage of nests deserted after the first egg has been removed slightly increases during the breeding-season, constituting 20—50 until mid-May and 30— 70 from mid-May to mid-June. However, this difference is not very pronounced.

Difference between "Cliff-Nests" and "Grass-Nests": As regards adherence to the nest the population examined consisted of two different biological types. The nests were placed partly on the bare cliffs or boulders facing the sea ("cliff-nests"), partly on the grass-covered field behind the cliffs ("grass-nests"). The difference between cliff- and grass-nests is to be seen from fig. 3. The birds nesting in the cliff-nests had to fetch the nest-material a distance away as no plants grow on the nude cliffs, whereas the birds nesting in the grass-field find ample nesting-material right up to the nest. Besides, the grass-nesting birds may easily scrape a site for the nest in the soft turf whereas the site on the cliffs has to be chosen more critically and carefully. Accordingly, for the cliff-nesting birds it is a much more difficult process to build a new nest and consequently the cliff-nesting birds adhere to their nests to a much greater degree than the grass-nesting birds. The difference between the two groups regarding adherence to nest is shown in table VI below.

Table VI.

Frequency Distribution of "Cliff-Nests" and "Grass-Nests" according to Number of Eggs laid before Desertion of Nest.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
"Cliff-Nests"	12	9	12	5	3	4	2	2	2	2		2	3	1		1
"Grass-Nests"	128	74	51	13	6	3	4					1				

The difference is very convincing. All nests, except one, with more than 7 eggs are cliff-nests. The number of nests deserted after 1—3 eggs have been removed is much larger in the group of grass-nests than in the group of cliff-nests. The average number of eggs in the cliff-nests is 4.8, in the

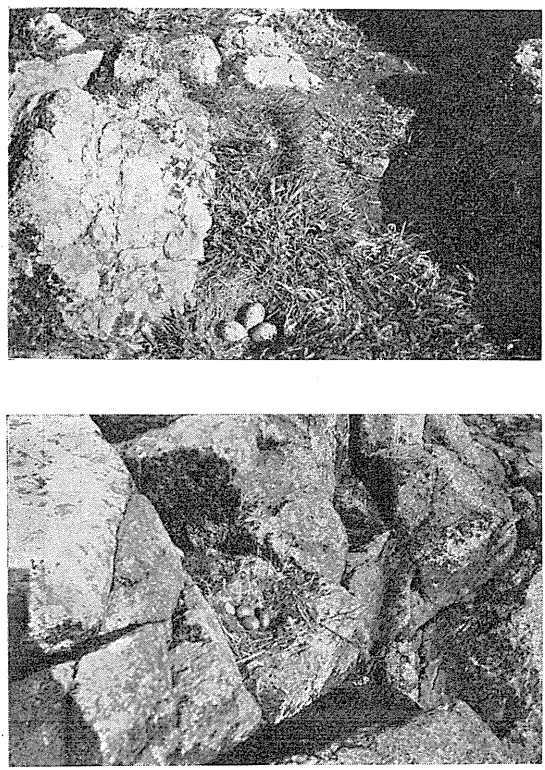

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Fig. 3. Difference between "Grass-nest" (top), placed in the grass-covered field and "cliff-nest" (base) placed on the bare cliffs.

grass-nests 2.0, which shows the distinct difference too. The percentage distribution of the two groups of nests as regards egg-number is shown in the diagram fig. 4. In the cliff-nesting birds a very strong adherence to the nests is present. About 50 per cent of all nests are still used when more than 3 eggs have been removed; in the grass-nesting birds the correspond-

ing figure is only 9 per cent. In the grass-nesting birds the adherence to nest decreases very rapidly when the number of eggs successively removed is augmented. When x is the number of eggs removed, and y the number of nests left after the removal of x eggs the adherence of the Herring-Gull to its nest when the eggs are continuously removed as soon as

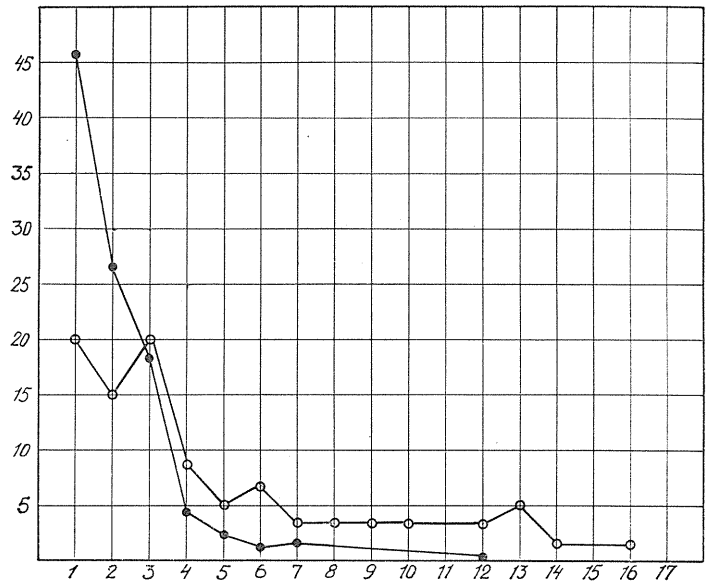

Fig. 4. Percentage distribution of cliff-nests and grass-nests as regards egg-number. Ordinate: percentage of nests. Abscissa: Number of eggs laid before desertion of nest. Open marks (o) designate cliff-nests, solid marks (•) grass-nests.

they are laid and where ample nesting material is present may be expressed as $yx^2 = C$, where C is a constant. In fig. 5 is shown the real and the theoretical curves for adherence to nest in the grass-nesting birds.

The difference between the behaviour of the grass-nesting and cliff-nesting birds shows how difficult it is to conclude anything from a single experiment, the conditions may differ from place to place, from biotop to biotop.

The Nest-Making Instinct: According to F. GŒTHE'S valuable work on the biology of the Herring-Gull the sight of

the empty nest from which the clutch has been removed very soon, often in the course of 5—10 minutes, induces a nesting-rsaction ("Nisttriebäusserung") in the gulls, which shows that a new sexual cycle is now commencing. Not until 12—14 days later is the new clutch laid. When the eggs are successively removed as soon as laid, as in our experiments, the rate of

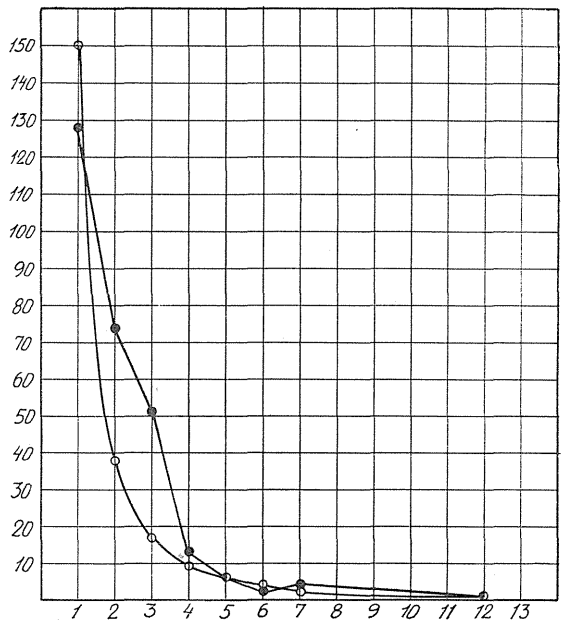

Fig. 5. Real and theoretical curves of the adherence to nest in the grass-nesting birds. Abscissa (x): Number of eggs removed. Ordinate (y): Number of nests left after the removal of x eggs. Solid marks (●) designate the status of the grass-nesting birds in the experiment, open marks (o) the theoretical curve $yx^2 = C$, when C is chosen as 150.

the egg-laying is somewhat higher. As shown above (p. 123), the average rate is 3.2 days between two eggs, and sometimes 10—16 eggs were laid in the same nest without the rate diminishing. Further, when the nest is deserted and a new nest built, the rate of egg-production is the same. This may be seen in a few cliff-nests which were very isolated and in which it could distinctly be seen how the old nest-material was removed by the gulls to form the new nest. This is shown in table VII.

Table VII.

Egg-Production in a Series of Nests used by the same Pair.

Pair	No. of Nest	May					June										
		22	24	26	28	30	1	3	5	7	9	11	13	15	17	19	21	23
I	196	1		1	1	1												
	265							1		1	1		1					
II	285								1	1	1							
	319											1	0					
	331														1	1	1	
III	266							1										
	281								1									
	300									1								
	320											1		1				
	320A															0	0	0

Pair I, having laid 4 eggs in nest 196, removed the nest, building a new one (265) about 1 m from the old place and began laying already 4 days after the last egg had been laid in the old nest. Altogether 4 eggs were laid in this nest.

Pair II laid 3 eggs in 285, removed the nest about 1 m, and built no. 319, in which already 2 days after the laying of the last egg in 285 a new egg was laid. Two days later 319 was still present but contained no new egg. Two days later this nest too was removed about 1 m., and rebuilt as no. 331 and two days later the egg-production was already commenced in this nest, in which a total of 3 eggs were laid.

Pair III laid 1 egg in 266, removed the nest about 1 m. and built it up as no. 281. Two days after the last egg was laid in 266 an egg was found in 281. Two days later also this nest was removed and rebuilt about 2 m. away (no. 300) already now containing an egg. A third time the nest was removed, being rebuilt about 2 m. away (no. 320) on the site of the former no. 281, and an egg was laid 4 days after the last egg was laid in no. 300. Four days later another egg was placed in no. 320 and then also this nest was removed by these persevering birds. They rebuilt it on the site of the former 266, about 1 m. away, the nest being finished 4 days later, but did not contain any eggs, the egg-producing power of this pair now being lost.

The nest-making instinct is present during the whole breeding-season and by removal of the eggs the laying of a new egg is always preceded by investments of new plants or straws

in the lining of the nest or other amendments of the nest. According to F. GŒTHE (1937, p. 47) the nesting-material is collected 1—2 days before the egg-laying. However, when the eggs are taken, new nesting-material will almost immediately be carried to the nest if this is not deserted by the birds. Fresh green herbs are then found in the lining as a sign that the birds intend to continue the egg-laying in this nest. Often 6—8 days will pass before the next egg is laid in the nest, and sometimes in the last part of the breeding-season when the egg-producing power is lost there will come no eggs at all. An instance of this behaviour is to be seen in table VII. Pair III has built a new nest (320 A) although the egg-producing power is entirely lost. It appeared to be a common phenomenon that the nest-making instinct continued although the egg-producing power had finished. The 27th June no eggs were found at all, but 38 nests in which eggs were removed at earlier visits were still supplied by the birds with new herbs and feathers. In the early days of July a single pair continued the egg-laying, producing 3 eggs in a nest (no. 194), but right to 11th July 26 nests were rebuilt or amended by the birds, *i. e.* even when all these birds had lost their egg-producing power the nest-making instinct still continued.

When the moult commenced in mid-June the feathers shed by the Gulls were used to a great degree by the still nest-making gulls. This was also noticed by F. GŒTHE (1937, p. 48). The first white feathers used as nest-material were found 19th June.

Summary:

This paper deals with some experiments carried out on the Islet Græsholm off Christiansø East of Bornholm in the spring of 1938, to study the egg-producing power in the Herring-Gull (*Larus argentatus* Pont.). In all nests in the experimental area the eggs were removed successively as soon as laid and the nest designated with a special numbered label. An example of the egg-production in a number of nests is shown in table I, p. 116. The following results were obtained:

1. The artificially prolonged time for egg-laying covered almost two months.

2. Temperature seems in some way able to influence the egg-production. An increase in temperature is always followed by an augmentation of the egg-production, which takes place 10—12 days after the increase of the temperature. This appears to show that the "gestation-period" of this species is 10—12 days.

3. The rate of egg-production, *i. e.* the interval between two eggs laid in the same experimental nest, varies between 2 and 4 days. The average interval is 3.234 days and appears to be almost the same during the whole breeding-period, perhaps being a little larger during the latter part of the breeding-time.

4. The egg-producing power of the individual birds varies very much. In some nests 10—16 eggs were collected and the average number of eggs laid by a female is estimated to be 13.

5. The average number of eggs laid in a nest before it is deserted by the gulls is 2.52. The daily average differs slightly during the breeding-time, being slightly smaller in the latter part of the breeding-season. A very large number of nests (140 out of 340) are deserted after the 1st egg has been removed, a fairly large number are deserted after the 2nd and 3rd egg, but several are not deserted until 4—7 eggs have been removed, and a few even not until 8—16 eggs have been taken. The number of nests deserted after the 1st egg has been removed increases slightly during the breeding-time.

6. The nests were placed partly on the bare cliffs („cliff-nests") partly on the grass-covered field ("grass-nests"). It is a much more difficult process for the cliff-nesting birds to build a new nest (lack of nest-material, difficulties in scraping site) than for the grass-nesting birds and consequently they adhere to the old nest to a much larger extent than the grass-nesting birds. All "grass-nests" (except one) are deserted before 8 eggs are removed (average egg-number 2.0), whereas the "cliff-nests" are often used although 8—16 eggs have been removed (average egg-number 4.8). The adherence to the nest in the grass-nesting birds may be expressed as $yx^2 = C$, where x is the number of eggs removed from a nest, y the number of nests deserted after x eggs have been removed, and C a constant.

7. The nest-making instinct is present during the whole breeding-season and by the removal of the eggs the laying of a new egg is always preceded by investments of new plants or straws in the lining. Even when the egg-producing power is finished the nest-making instinct continues for some time. When a nest is deserted it takes only 2—4 days to build a new nest and lay the 1st egg in it. After the beginning of the moult in mid-June the feathers shed by the gulls were used as nest-material.

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