NUMBER OF EGGS LAID BY HERRING GULLS

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INTRODUCTION

BIRDS in general lay a more or less definite number of eggs in each clutch. Many passerines, for example, lay between three and five eggs, usually four. The variations which occur are frequently due to differences in age, metabolism, weather, or number of previous clutches. In spite of these factors, the size of a clutch in any given species varies within narrow limits. In some birds the number of eggs in the nest determines the cessation of laying. In others laying stops after a certain number has been laid no matter how many may be in the nest.

In this paper are reported the results of experiments on the Herring Gull, *Larus argentatus.* Eggs were added to or removed from the nests to find out the effect on the number of eggs laid. The effects of age, metabolism or other factors on the ability of birds to produce eggs will not be considered here. Before discussing the experimental data it is desirable to outline briefly the generally accepted hypothesis of the neuro-endocrine basis of the problem (cf. Witschi, 1935; Laven, 1940) and mention relevant data.

Certain birds will continue to lay when eggs are removed from the nest. The Flicker, *Colaptes auratus,* for example (Phillips, 1887), in one case laid 71 eggs when an egg was taken daily from the nest, Presumably such species will continue to lay until the nest contains a definite number of eggs. These species may be called indeterminate egg layers. An external stimulus, probably either optical or tactile, apparently acts through the hypophysis to stop the production of eggs by the ovary. Birds that nest in dark holes probably respond to a tactile stimulus on the breast. Incidental experiments have indicated that several species are indeterminate egg layers but as yet no comprehensive series of tests has conclusively proved that any species will lay until the nest contains a certain number of eggs.

In contrast to the indeterminate type are those birds that lay a definite number of eggs no matter how many eggs are in the nest. These species may be called determinate egg layers. The hypophyseal-ovarian mechanism is apparently fixed to produce and ovulate a definite number of eggs even though eggs are added to or removed from the nest. The addition of eggs does not restrain the female from laying; the removal of eggs does not induce the female to con-

tinue laying. Probably most species are determinate, but adequate evidence is largely lacking.

The problem under consideration is one example of the interrelationships between the nervous and the endocrine systems. It is clear that in indeterminate egg layers a nervous stimulus (visual or tactile) is transformed, probably at the hypophysis, into an endocrine stimulus. Determinate layers do not respond to such external stimuli. A consideration of the probable function of courtship as a stimulation of ovulation suggests the notion that spontaneous ovulators are determinate egg layers and that non-spontaneous ovulators are indeterminate layers.

For the present it is sufficient to outline briefly the problems and indicate the scope of future work. Experiments incidental to other research have indicated the type of egg layer in several species (Watson, 1909; Craig, 1913; Nice, 1937; Laven, 1940). The work on the Herring Gull here described is to be followed by comprehensive experiments on other species as opportunity permits. The synthesis and comparison await the accumulation of adequate data for many species.

The experiments were made on Penikese Island, off the south coast of Massachusetts. A large part of the island contains a tern colony. One small point has a gull colony of about 400 nests. The work was done during the week of May 16–22, 1940. Mr. Donald R. Griffin arranged for accommodation on the island and assisted in the observations while continuing his own special research.

EXPERIMENTAL DATA

The technique consisted of changing the number of eggs in nests to find out if the bird would continue to lay. Each nest was num-

TABLE 1

EGGS ADDED TO NESTS

Eggs laid	*Number added*							
	1	*2*	*3*	*1*	*2*	*3*	*1*	*2*
3	2	4	1	0	0	0	0	0
2	3	4	5	6	11	4	0	0
1	2	4	3	5	1	0	7	8
0	1	0	0	1	2	0	1	3
Number in nest		0			1			2

bered and visited daily in the early morning. The number of eggs was recorded and then eggs were added or removed according to the history of the nest. A total of 171 nests was observed. Twelve of these were deserted or otherwise rendered unsuitable for experiments. Thus the contents of 159 nests were manipulated in this research. Since the birds were in the midst of laying, nests containing 0, 1, 2, or 3 eggs were easily found. The adults were not marked for individual identification.

TABLE 2

DATA FOR NESTS

Nest number	*Eggs in nest*	*Eggs added*	*Eggs laid (May)*						*Total in nest*
			17	*18*	*19*	*20*	*21*	*22*	
144	0	1	1	0	1	0	1	0	4
134	1	1	1	0	1	0	0	0	4
111	2	1	1	0	0	0	0	0	4
154	0	2	0	1	0	1	0	1	5
85	1	2	1	0	1	0	0	0	5
185	2	2	0	1	0	0	0	0	5
89	0	3	1	0	0	1	0	0	5
138	1	3	0	1	0	1	0	0	6

Table 1 gives the results of adding eggs to the nests. The abscissa indicates the number of eggs in the nest at the time the experiments began. The ordinate indicates the number of eggs laid after eggs were added. The figures at the top of the table show how many eggs were added. In all cases the eggs were added all at one time. Thus, for example, note the experiments in which two eggs were added to nests which already contained one egg. In eleven of these cases two more eggs were laid by the birds. Thus these nests contained five eggs at the end of the experiment. Typical results are listed in Table 2. These data establish the important fact that the birds were not restrained from laying when the nest contained three eggs. The critical cases are those in which two or three eggs were added and then more were laid. While possibly more than a day would be required to shut off the ovary, nevertheless continued laying is proof that the ovary cannot be restrained by the addition of eggs to the nest. The data in Table 1 also show that in no case did the bird lay more than three eggs, no matter what the number in the nest may have been. Those nests in which the bird laid less than three eggs may be explained by the factors of desertion, robbery, or termination of observations before the clutch was complete.

TABLE 3

EGGS REMOVED FROM NESTS

Eggs laid	*Number removed*					
	1	*1*	*2*	*1*	*2*	*3*
3	3	0	0	0	0	0
2	6	0	0	0	0	0
1	3	13	4	0	0	0
0	1	2	6	14	17	12
	1	2		3		

Number in nest

TABLE 4

DATA FOR NESTS

Nest number	*Eggs in nest*	*Eggs removed*	*Eggs laid and removed (May)*						*Total in nest*
			17	*18*	*19*	*20*	*21*	*22*	
118	1	1	1	0	1	0	0	0	0
83	2	1	0	1	1	0	0	0	1
90	3	1	0	0	0	0	0	0	2
87	2	2	0	1	0	0	0	0	0
84	3	2	0	0	0	0	0	0	1
93	3	3	0	0	0	0	0	0	0

Table 3 gives the results of removing eggs from the nests. Each egg laid after the beginning of the experiment was removed so that the nests had the same number of eggs each day. The table is the same as Table 1 except that the numbers at the top refer to the number of eggs removed on the first day of the experiment. Table 4 shows some typical nest histories. These data establish the fact that in no case was the bird induced to lay more than three eggs by taking eggs from nests which contained more than one egg at the start. In three cases, after only one egg was laid, a nest contained three more eggs. These cases may be explained in several ways. The bird may have stolen eggs from nearby nests; the original bird may have deserted and another taken over the nest; a new clutch may have been started by the original bird. Possibly the ovary is so regulated that it can make up for the loss of an egg in the beginning of the laying period. These cases represent exceptions to the rule that the Herring Gull lays three eggs no matter how the number in the nest may be manipulated, if the above explanations do not apply.

In the other experiments the bird was not induced to continue laying by the removal of eggs. It seems more consistent to explain these three cases by some abnormality.

Evidence from other sources indicates that the Herring Gull is a determinate egg layer, depositing three eggs in a clutch. Both sexes incubate and have three distinct brood patches on the breast, one for each egg. Gross (1940) counted the eggs in 10,966 nests and found only two containing four eggs. Many of these nests had less than three eggs, probably due to incomplete clutches or predators. Goethe (1937) states, without giving the data, that if strange eggs are added to the nest, the female will continue to lay even though there are five or six eggs in the nest. Salmonson (1939), experimenting with Herring Gulls, removed the eggs as soon as laid. As many as sixteen eggs were removed from one nest during May and June. In most cases several successive clutches are included. In a few cases it is possible that the same female laid four eggs in one clutch. The author was not concerned with the problem of how many eggs are laid in a clutch but with the egg production in a season. He did not add eggs to nests. Gulls in general seem to have no perception of number. They commonly roll stones or sticks into the nest from nearby. Kirkmann (1937) found that *Larus ridibundus* would roll as many as seven eggs into its nest. These data support the conclusion from experiments that the Herring Gull is a determinate egg layer.

SUMMARY

During the laying period eggs were added to or removed from the nests of Herring Gulls (*Larus argentatus*) to ascertain the effect on the number laid in a clutch. The number of eggs was manipulated in 159 nests. The birds were not induced to lay more than three eggs by the removal of eggs nor restrained from laying three eggs by the addition of eggs.

The Herring Gull therefore is a determinate egg layer, whose hypophyseal-ovarian mechanism is fixed to produce three eggs in a clutch. This type of egg layer is contrasted with an indeterminate egg layer. Such species continue to lay until the nest contains a certain number of eggs, thus responding to an external stimulus (visual or tactile).

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