RESPONSES OF ADELIE PENGUINS TO COLORED EGGS

LEIGH H. FREDRICKSON AND MILTON W. WELLER

ADELIE Penguins (*Pygoscelis papua*) normally lay one or two greenish-white eggs. Males, less commonly females, occupy old nest depressions from which they display and attract former or new mates (Sladen, 1958). Nest sites usually are occupied for several weeks before the laying of the first egg and either sex may sit in the incubating position on the nest bowl. Both sexes incubate, but males start intensive incubation first when females leave to feed after laying (Penney, 1968). The incubation drive is very strong, and nest defense can be intense.

As part of a study involving measurement of variations in incubation behavior, and recording temperatures of incubating birds, by means of thermistors placed in artificial eggs, we wanted to determine: 1) the ability of penguins to recognize their own eggs, 2) the likelihood of ejection of unlike eggs, and 3) possible measures of incubation intensity. Field studies of incubation behavior of Adelie Penguins provide an insight into how a species can maintain itself in this adverse environment.

PROCEDURES

Weller experimented with 13 pairs of Adelie Penguins at Hallett Station, Antarctica, during early November in 1969, and Fredrickson studied 23 pairs between 31 October and 20 November 1970. Birds studied during 1969 were of unknown age except for one female which had been banded as a breeding adult in 1959. Four birds banded in 1969 returned to the colony and were retested in 1970. The sexes of all pairs were determined in 1970, but only seven of 13 pairs were sexed in 1969. Sexed birds were color-marked with paint for rapid determination of the individual on the nest.

Plastic, hollow "Easter eggs" were used because of their availability, bright colors, and the fact that ballast (sugar and salt were used) could be placed inside to duplicate the weight and balance of real eggs. Plastic eggs of two sizes were used: 45 × 63 mm in 1969, and 57 × 83 mm in 1970. One size was smaller and the other larger than real Adelie Penguin eggs (56 × 70 mm for 126 eggs at Hallett, J. Weinrich, unpubl. data).

In this study, eggs were introduced into the nest bowl. This method is inferior to the choice of two nests method used for Herring Gulls (*Larus argentatus*) by Tinbergen (1961:151), but the minimal nest spacing and aggressive behavior of colonial Adelie Penguins would not permit such experimentation.

PRE-LAYING STAGE

In 1969 Pair 1 in the pre-laying stage was exposed to white, blue, and yellow plastic eggs for 2 minutes each. Each egg presented was accepted and incubated in the nest with the exception of the blue egg which was found out of the nest. Normally, penguins do not retrieve even their own eggs (Penney,

TABLE 1

NUMBER OF COLORED PLASTIC AND BLOWN PENGUIN EGGS EJECTED FROM ADELIE PENGUIN NESTS PRIOR TO LAYING. HALLETT STATION, ANTARCTICA, 1970.

Days prior to laying	Number of eggs ejected					
	Colored plastic eggs			Blown eggs		
	By male	By female	By pair	By male	By pair	
1	2/9*	0/9	0/9	0/2	0/2	
2	2/3	0/3	0/3	0/3	0/3	
3	0/8	0/8	1/8	0/2	0/2	
4	0/12	0/12	0/12	0/2	0/2	
5	2/6	0/6	0/6	0/3	0/3	
6	1/4	1/4	0/4	1/3	1/3	
7	1/8	0/8	1/8	1/2	0/2	
8	5/9	1/9	0/9	1/3	0/3	
9	0/3	0/3	0/3	0/1	0/1	
10	1/1	0/1	0/1	0/0	0/0	
11	0/2	0/2	1/2	0/0	0/0	
13	0/2	0/2	2/2	0/1	1/1	
15	0/1	0/1	0/1	0/0	0/0	
Totals	14/68	2/68	5/68	3/22	2/22	26/90

* In 9 trials, 2 eggs were ejected by a male.

1968). A pink plastic egg then was left for 20 minutes, and this time subsequently was used for tests of all birds in the pre-laying stage. Three other pairs in the pre-laying stage were tested with eggs of these four colors and all accepted each egg and incubated for 20 minutes each. Eggs were presented in different sequences of color.

Then, two highly aggressive pairs were used, including one banded female estimated to be in excess of 13 years of age. In both cases, the female was standing over the egg but the male pecked at the egg viciously until it was ejected from the nest. In both nests, all four test eggs were pecked until ejected from the nest bowl at which time they were ignored. This striking difference in behavior suggests that physiological state and perhaps experience may influence acceptance of any egg in the nest bowl. In another experiment, a blown, weighted Adelie Penguin egg was viciously pecked by both members of another pair but was finally accepted and incubated for several days.

In 1970, birds were tested from 1 to 15 days before laying with blue, pink, yellow, and natural colored, blown and weighted Adelie Penguin eggs. Eggs were pecked until ejected from the nests in 26 of 90 tests (Table 1). Males accounted for 17 of the ejections compared to only two ejections

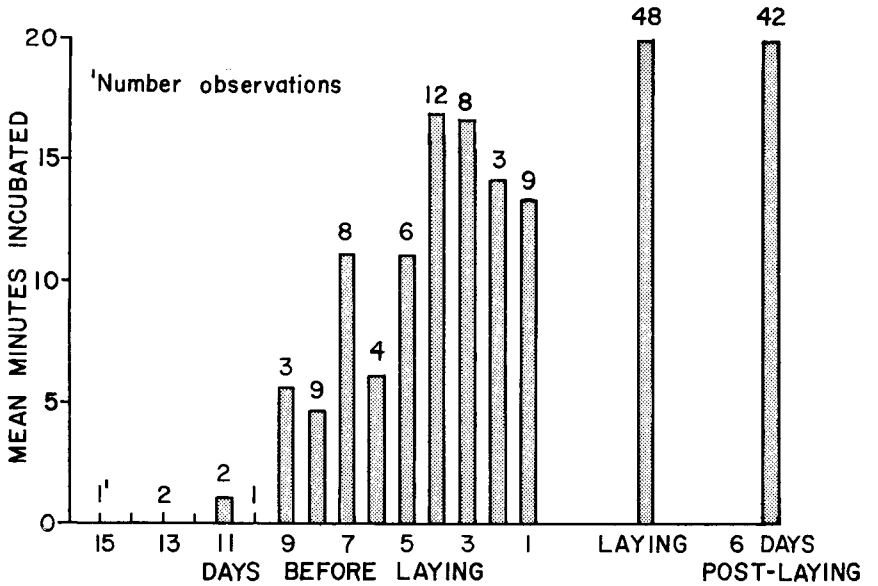

FIG. 1. Summary of responses to colored plastic eggs placed in nest bowls of Adelie Penguins prior to, during, and after laying. Hallett Station, Antarctica, 1970.

by females. In seven tests, both members of the pair actively ejected eggs. At no time did females eject blown, weighted Adelie eggs from the nest bowl. Females ejected colored plastic eggs at 6 and 8 days before laying, but one male ejected colored eggs the day before eggs appeared in the nest. In five of 22 tests, when blown and weighted Adelie Penguin eggs were ejected from nests, all rejections were 6 or more days before laying.

In six tests made from 15 to 7 days before laying the penguins either peered at the experimental eggs or ignored them, but the eggs were not incubated during the 20-minute test period. Four of these six tests were with colored eggs and two were with blown Adelie Penguin eggs.

Four penguins marked in 1969 were tested 12 times in 1970 during the pre-laying stage. These birds accounted for eight of 26 tests in which eggs were ejected from the nest. Six of these eight rejections were with colored plastic eggs. In three other tests from 15 to 6 days before laying, these birds failed to incubate eggs.

As laying nears, Adelie Penguins become increasingly broody (Fig. 1). Of nine tests 1 day before laying, all but one bird incubated at least 18 minutes. The mean incubation of 13.5 minutes shown in Figure 1 for a 20-minute test on the day before laying resulted from one particularly aggressive male, which ejected colored eggs during two tests the day before laying.

LAYING—INCUBATION STAGE

To test the responses of birds known to be broody in the laying or post-laying stage in 1969, three nests were selected with two, one, and one eggs, respectively. Pair 7 had two eggs and accepted a white plastic egg in place of one of its own eggs. Then a pink egg was presented to test both a smaller and strikingly different colored egg. It accepted the egg without hesitation and incubated for 10 hours, at which time the original egg was replaced.

The two pairs with one egg each were given a yellow or a blue egg in place of their own egg. In each case the egg was accepted as though it were its own, and incubation of the plastic egg continued for 10 hours at which time the original egg was replaced.

Briefer experiments of a similar nature were conducted on four pairs which had two, one, one, and two eggs, respectively. In nests of two eggs, one of the two was replaced by a plastic egg; real eggs were removed from nests of one egg. All of the birds readily accepted the pink, blue, and yellow substitutes even when in the nest bowl with a real egg. The behavior of several individuals suggested recognition of the colored eggs by their hesitancy and peering but the relative roles of color, sheen, size, and other factors in recognition cannot be clearly evaluated. However, in most cases responses other than incubation were masked by the external and internal stimuli that cause birds to incubate their eggs.

On 11 November 1969 Pairs 5 and 6, which had refused to accept plastic eggs, were tested again when they had two eggs. Each was given the one pink plastic egg for 20 minutes in place of one of its own. The male of Pair 5 was alone and was less aggressive but more broody than previously. This male examined the one pink and one normal egg for 3 minutes and then incubated for the 20-minute test period.

Pair 6, however, did not change in their response to the foreign eggs. The female accepted the egg by standing over it but the male pecked it out of the nest; thereafter, its second egg was returned.

In 1970, all pairs accepted the colored eggs and incubated them during laying and 6 days post-laying. Of 48 tests during laying and 42 tests post-laying (Fig. 1), one pair incubated a yellow egg 19 minutes instead of the 20 minutes observed in the other 89 tests.

DISCUSSION

Antarctic weather dictates the need for intensive incubation behavior if eggs of Antarctic species are to develop properly in sub-freezing temperatures. Because Adelie Penguins have strong attachments to nest sites before egg

laying, the species provides unique opportunities for study of the external and internal factors related to development of incubation behavior.

There seems to be no evidence that penguins lack color vision, and the fact that several species have colored bills and feathers suggests strongly that they can differentiate colors. Moreover, Levick (1915) did experiments with colored rocks which suggested that Adelie Penguins preferred red. The ability of several individuals to quickly perceive and eliminate colored eggs from the nest supports the idea that color vision is present, but characteristics of these test eggs such as sheen, size, or the crack in the egg were not properly evaluated in these tests. There is little doubt, however, that the plastic eggs were recognizable as unlike their own when in the same nest bowl with a real egg.

It is well known that birds are not very selective in egg color or size (Tinbergen, 1961:144–159), but some birds which are parasitized regularly readily reject eggs unlike their own (Swynnerton, 1918). Ducks are more likely to reject unlike experimental eggs during laying than during incubation, presumably because the brooding drive is less strong (Weller, 1959:352).

Although the nest bowl is clearly important as a pair center for Adelie Penguins, they must become physiologically ready to accept an egg when it appears in the nest. Apparently there is no innate recognition of color or size of the egg. We infer from these brief experiments that Adelie Penguins, as in many other birds, incubate objects of any color which appear in the nest. The rejection behavior of several highly aggressive males in 1969 and 1970 may reflect lack of development of the incubation drive in males at this stage and longer experience in nesting. The external and internal factors that cause the change from aggressive to incubation behavior remain unknown.

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GAYLORD MEMORIAL LABORATORY, UNIVERSITY OF MISSOURI, PUXICO, MISSOURI 63960 AND DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY, IOWA STATE UNIVERSITY, AMES, IOWA 50010, 13 SEPTEMBER 1971.

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A recent addition to the list of Life Members of the Wilson Society is Dr. James A. Pittman. Dr. Pittman earned his bachelor's degree at Davidson College, and his M.D. at Harvard Medical School and is currently Head of the Office of Research and Education, Veteran's Administration as well as Professor of Medicine at Georgetown University. He is the author of over 150 papers in the medical and physiological literature, particularly thyroid physiology. His interests in ornithology also involve avian endocrine physiology. Dr. Pittman says that his interest in birds, in biology, and in The Wilson Society were aroused and stimulated by George Sutton and Franklin McCamey in Orlando, Florida in the latter days of World War II. Dr. Pittman is married (Mrs. Pittman is also a Professor of Medicine) and has two children.