FOREIGN OBJECTS IN BIRD NESTS

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ABSTRACT.—Up to 10% of the Ring-billed Gull (*Larus delawarensis*) and 6% of the California Gull (*L. californicus*) nests in some Washington colonies contained pebbles or other round foreign objects. These foreign objects, or pseudo-eggs, were more similar in size and shape to gull eggs than were randomly selected pebbles. Nests containing pseudo-eggs were most common in colonies where pebbles littered the ground. Pseudo-eggs were also more common in 1- and 2-egg clutches than in 3-egg clutches. In many respects, the gulls treated the pseudo-eggs as they did their own eggs. If pseudo-eggs were placed outside a nest, the adults rolled them back. If all eggs were removed from the nest, Ring-billed Gulls continued to incubate nests containing pseudo-eggs but not empty nests. These results provide more support for the hypothesis that these objects occur in nests because birds mistake them for eggs than for the hypothesis that these objects benefit the birds by acting as incubation stimuli. *Received 2 October 1984, accepted 5 April 1985.*

FOREIGN objects such as rocks and exotic eggs occasionally have been found inside the nests of incubating birds, particularly among ground-nesting species. Knight and Erickson (1977) found stones and pine cones inside the nests of Canada Geese (*Branta canadensis*) nesting in Washington state. Coulter (1980) found stones in the nests of Western Gulls (*Larus occidentalis*) in the Farallon Islands in California and also in the nests of Common Terns (*Sterna hirunda*) on Great Gull Island in New York. Sugden (1947) found stones in the nests of American Avocets (*Recurvirostra americana*) in Utah. He also discovered eggs, apparently from other species, in some California Gull (*Larus californicus*) nests.

Henceforth, I will refer to these foreign objects found inside nests as pseudo-eggs. A pseudo-egg is defined as any object greater than 2 cm in both width and length that sits entirely within the nest cup. Objects that are incorporated into the nest cup or protrude through it are not considered pseudo-eggs.

I used the relatively high frequency of pseudo-eggs in the nests of Ring-billed (*L. delawarensis*) and California gulls in several Washington and Oregon colonies to examine this phenomenon and to answer the following questions. (1) What are the physical characteristics of pseudo-eggs, and how do they differ from randomly selected objects? (2) Do pseudo-egg frequencies differ among colonies or between Ring-billed and California gulls nesting in the same colony? (3) Where do the pseudo-eggs come from? Do they originate near the nest, or are they brought in from greater distances? (4) Are pseudo-eggs found with equal frequency in nests with different-size clutches? And (5) Do incubating gulls treat pseudo-eggs like their own eggs? That is, will they roll back pseudo-eggs if they are placed outside the nest? Will gulls continue to incubate nests containing only pseudo-eggs? The answers to these questions, in turn, shed light on one of the most intriguing questions about this phenomenon: Why do birds not only tolerate these objects in their nests but bring them there in the first place?

METHODS

The experiments were conducted in 1980 and 1981 in five Ring-billed and California gull colonies located in Washington and Oregon: Island 18, Island 20, Little Memaloosa, Potholes Reservoir, and Threemile Canyon colonies. These colonies are described elsewhere (Conover et al. 1979). All observations and experiments were conducted in May when the gulls were at least halfway through the incubation period.

Pseudo-egg characteristics.—Fifty pseudo-eggs were randomly collected from Ring-billed Gull nests in the Island 20 colony, as were 50 pebbles from the ground surface in the same part of the colony. This was done by establishing a numbered grid system in the colony or subcolony that was to be surveyed and selecting 50 grid points from a table of random numbers. The nearest pseudo-egg to that point and the nearest pebble lying on the surface were then collected. All collected objects were weighed and measured. To assess whether the gulls were randomly

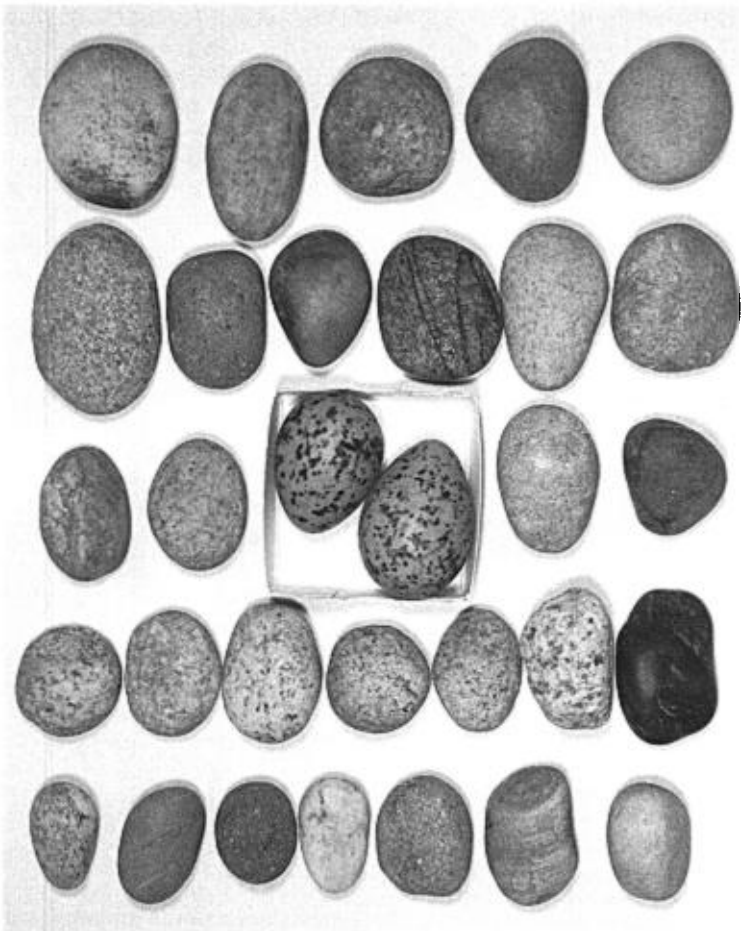

Fig. 1. Ring-billed Gull eggs (in box) and randomly collected pseudo-eggs.

selecting objects for pseudo-eggs, I used a Student's *t*-test to determine whether the sizes or weights of pseudo-eggs were significantly different from those of the pebbles outside the nest.

Pseudo-egg frequencies.—I examined the interspecific or intraspecific differences in pseudo-egg frequencies. The question of where the objects for pseudo-eggs originated was addressed by comparing the frequency of nests with pseudo-eggs to the type of substrate found near the nests. If objects for pseudo-eggs come from near the nest, then nests containing pseudo-eggs should be rare in areas devoid of suitable objects. For example, the gulls at the Potholes Reservoir colony nested on sand dunes, and rocks or other suitable objects for pseudo-eggs were rare inside the colony. Suitable objects for pseudo-eggs were also rare at the Little Memaloosa colony, which was on solid rock. In contrast, parts of the colonies on Island 18, Island 20, and Three-mile Canyon were situated in a pebble-strewn area where suitable objects were numerous. I compared the frequency of nests containing pseudo-eggs in the pebble-strewn areas to nests in other areas where pebbles were lacking using a Chi-square contingency table corrected for continuity.

Retrieval of pseudo-eggs.—In this experiment I examined whether the gulls individually recognized their pseudo-eggs and would roll them back into their nests when the pseudo-eggs were placed outside. I removed pseudo-eggs from several Ring-billed and California gull nests at the Island 20 and Three-mile Canyon colonies and placed them 5–15 cm outside each nest. I also took eggs from other nests and placed them the same distance outside. All nests were checked after 10–12 h to see how many eggs and pseudo-eggs had been rolled back into the nests. Retrieval rates for eggs and pseudo-eggs were compared using a Chi-square contingency table corrected for continuity.

Relationship between pseudo-egg frequencies and clutch

TABLE 1. Weight and size of Ring-billed Gull eggs, pseudo-eggs (n = 59), and randomly selected pebbles from outside the nest (n = 64).

	Ring-billed Gull eggs ($\bar{x}$)	Pseudo-eggs ($\bar{x}$ ± 95% CI[a])	Randomly selected pebbles ($\bar{x}$ ± 95% CI[a])	t
Weight	—	104.4 ± 14.2	79.5 ± 27.6	1.60
Length	5.85	5.56 ± 0.29	4.77 ± 0.45	2.90
Width	4.18	4.26 ± 0.21	3.51 ± 0.35	3.66
Depth	4.18	2.90 ± 0.16	2.23 ± 0.26	4.39

[a] CI = confidence interval.

size.—To determine whether pseudo-eggs occurred with equal frequency in nests with different-size clutches, I examined nests in randomly located plots in pebble-strewn areas of the Island 18, Island 20, and Three-mile Canyon colonies and recorded the percentage of 1-, 2-, and 3-egg nests that contained pseudo-eggs. Chi-square tests were then conducted to determine whether the frequency of nests containing pseudo-eggs varied significantly among nests with different clutch sizes.

Incubation of pseudo-eggs.—In this experiment I examined whether gulls would continue to incubate their nests after all of their eggs had been removed and only their pseudo-eggs remained. Eggs were removed from 23 Ring-billed Gull nests at Island 20; 11 contained pseudo-eggs and the rest did not. The nests were checked later to determine whether they were still being incubated. An excellent opportunity occurred on the fourth day, when it rained for several hours; a dry nest was a clear indication that it had been incubated almost continuously for the last several hours.

RESULTS

Pseudo-egg characteristics.—All foreign objects found in gull nests were round, smooth objects (usually pebbles; Fig. 1). Pseudo-eggs from Ring-billed Gull nests differed significantly from pebbles randomly selected from inside the colony in length, width, and depth but not in weight (Table 1). Pseudo-eggs were less variable in size and shape and were closer to the size and shape of an actual Ring-billed Gull egg than were randomly selected pebbles (Table 1). In fact, the mean length and width of Ring-billed Gull eggs (based on egg-dimension data from Vermeer 1970) lie within the 95% confidence interval of the mean length and width of pseudo-eggs but not of randomly selected pebbles.

Pseudo-egg frequencies.—At the Island 18 and 20 colonies, the frequency of nests with pseudo-eggs did not vary significantly between 1980 and 1981 for either Ring-billed Gulls ($\chi^2 = 0.45$, df = 2 in this and in all other tests unless otherwise indicated, $P > 0.05$) or California Gulls ($\chi^2 = 1.36$). Consequently, data from both years were combined for the rest of this study.

In California Gulls, 1.0% of the examined nests (n = 2,503) contained pseudo-eggs, as did 3.8% of the Ring-billed Gull nests (n = 2,182). The difference between the two species was statistically significant ($\chi^2 = 13.89$, $P < 0.01$). There were also intraspecific differences in pseudo-egg frequencies. The frequency of nests containing pseudo-eggs varied significantly among Ring-billed Gull colonies ($\chi^2 = 45.98$, df = 3, $P < 0.01$) and California Gull colonies ($\chi^2 = 78.68$, df = 4, $P < 0.01$). Pseudo-eggs were very common in all of the colonies with a pebble substrate (Table 2); 6.7% of the Ring-billed Gull nests and 1.6% of the California Gull nests in these areas contained them. In contrast, in areas with a sandy or solid rock surface only 2 pseudo-eggs were found among the 967 Ring-billed Gull nests examined and none among the 951 California Gull nests. These differences in pseudo-egg frequency between pebble and nonpebble areas were statistically significant for both Ring-billed ($\chi^2 = 60.50$, $P < 0.01$) and California gulls ($\chi^2 = 13.89$, $P < 0.01$). These results indicate that the presence of pebbles near a nest increases the probability of that nest containing pseudo-eggs, presumably because most pseudo-eggs originate from near the nest site.

Retrieval of pseudo-eggs.—Forty percent of the Ring-billed Gulls rolled the pseudo-eggs back into their nests less than 12 h after I placed the pseudo-eggs outside; 67% rolled back their own eggs (Table 3). This difference was not statistically significant ($\chi^2 = 3.34$). In California Gulls, 45% rolled back pseudo-eggs and 51% rolled back their own eggs; this difference also was not statistically significant ($\chi^2 = 0.00$).

Relationship between pseudo-egg frequencies and clutch size.—The frequency of pseudo-eggs varied significantly among different-size clutches in both Ring-billed ($\chi^2 = 37.02$, $P < 0.01$) and California gulls ($\chi^2 = 21.57$, $P < 0.01$). The frequency of pseudo-eggs was higher in nests containing 1 or 2 eggs than in those containing 3 eggs (Table 4).

Incubation of pseudo-eggs.—Four days after all eggs were removed from 11 Ring-billed Gull nests so that only pseudo-eggs remained, 8 of

TABLE 2. Frequency of nests containing pseudo-eggs in different colonies.

Colony	Substrate	California Gull nests		Ring-billed Gull nests	
		No. examined	% with pseudo-eggs	No. examined	% with pseudo-eggs
Little Memaloosa	Solid rock	236	0.0%	—	—
Three-mile Canyon	Pebble	211	6.6%	159	10.7%
Island 18	Pebble	636	1.1%	824	5.7%
Island 20	Pebble	705	0.6%	232	7.8%
	Sand	212	0.0%	604	0.2%
Potholes Reservoir	Sand	503	0.0%	363	0.3%

the nests (73%) were still being incubated. In contrast, after all eggs were removed from 12 nests not containing pseudo-eggs, incubation of all of these nests ceased within the 4-day observation period. This difference was statistically significant ($\chi^2 = 10.37$, $P < 0.01$).

DISCUSSION

One of the most intriguing questions of the pseudo-egg phenomenon is why birds not only tolerate the presence of foreign objects in their nests but actively bring them into their nests. One hypothesis is that the gulls recognize pseudo-eggs as foreign objects but keep them in the nests because they benefit the birds. For example, Coulter (1980) observed that gulls incubating three eggs had longer incubation bouts, fewer resettlings, and greater hatching success than those incubating smaller clutches. He speculated that foreign objects are added to the nest by incubating gulls and that these objects are an important incubation stimulus in 1- or 2-egg clutches.

My finding that pseudo-eggs were more common in 1- and 2-egg clutches than in 3-egg clutches supports this hypothesis. The hypothesis, however, does not explain some of my other observations. For example, if this hypothesis is correct, why do gulls continue to incubate nests after all eggs have been removed and nothing remains but pseudo-eggs? Also, I found that pseudo-egg frequencies were much lower in colonies or subcolonies that lacked a pebble substrate. If pseudo-eggs provide a benefit to the birds, then gulls lacking suitable objects near their nests should bring them from farther away.

The second general hypothesis is that bringing and keeping pseudo-eggs in the nest is maladaptive and occurs because gulls mistake the pseudo-eggs for something else, such as for food (mistaken-food hypothesis) or their own eggs (mistaken-egg hypothesis). The mistaken-food hypothesis is an extrapolation of Sugden's (1947) and Twomey's (1948) hypothesis for the presence of exotic eggs in gulls' nests. They noted that California Gulls regularly eat eggs, and Twomey once observed a California Gull

TABLE 3. Frequency with which eggs and pseudo-eggs were rolled back into nests within 12 h after being placed outside.

	Clutch size			
	1	2	3	Total
California Gulls				
No. eggs removed	6	25	10	41
% rolled back	67	56	30	51
No. pseudo-eggs removed	3	7	1	11
% rolled back	67	43	0	45
Ring-billed Gulls				
No. eggs removed	9	23	25	57
% rolled back	67	65	68	67
No. pseudo-eggs removed	0	10	10	20
% rolled back	—	50	30	40

TABLE 4. Frequency of pseudo-eggs in nests containing different-size clutches.

	Ring-billed Gulls	California Gulls
1-egg clutches		
No. examined	95	92
% with pseudo-eggs	8.4	7.6
2-egg clutches		
No. examined	356	418
% with pseudo-eggs	12.3	2.4
3-egg clutches		
No. examined	1,030	790
% with pseudo-eggs	3.6	0.9

regurgitate a duck egg near its nest. They speculated that if a regurgitated egg landed inside the nest cup, the gull might incubate it along with its own eggs. According to this hypothesis, a gull must mistake a pebble for an egg, swallow it, and regurgitate it near the nest cup. It seems unlikely, however, that gulls regularly mistake pebbles for food. In addition, gulls do not start to regurgitate food around the nest until after the chicks hatch (Miller and Conover 1983), but it is during the incubation period that pseudo-eggs occur. It is unlikely that these events would occur often enough to account for the pseudo-egg frequencies found in this study (up to 10% in some Ring-billed Gull colonies). Finally, gulls generally forage away from the colony, so most pseudo-eggs should originate from outside the colony; I found, however, that pseudo-eggs came from near the nest site.

The other possibility is that pseudo-eggs occur because the birds cannot clearly discriminate between them and their own eggs (mistaken-egg hypothesis). Hence, these objects are rolled into the nest and incubated because the bird mistakes them for its own eggs. The strongest support for the mistaken-egg hypothesis comes from the finding that gulls treat pseudo-eggs like their own eggs. If pseudo-eggs are placed outside the nest, gulls roll them back in; if all eggs are removed, gulls continue to incubate nests containing only pseudo-eggs. It is unclear why gulls would do these things unless they mistook the pseudo-eggs for real eggs. Also, the mistaken-egg hypothesis would predict that objects for pseudo-eggs come from near the nest site, as was found in this study. The mistaken-egg hypothesis also could account for Hanson and Eberhardt's (1971) observation of two Canada Goose nests that were incubated while containing rocks but no eggs. The mistaken-egg hypothesis, however, does not explain why pseudo-eggs should be more common in 1- and 2-egg nests than in 3-egg nests.

If the mistaken-egg hypothesis is correct, these gulls exhibit a surprising inability to distinguish between their own eggs and other objects. In contrast, some terns can discriminate between their own eggs and those of other conspecifics (Buckley and Buckley 1972). Ring-billed Gulls, however, do not have this ability and will readily accept conspecific eggs placed inside their nests (Miller and Conover 1983). Nevertheless, the adoption of pebbles seems more extraordinary. Although the pseudo-eggs are approximately the same size, shape, and color as real eggs, there are still substantial differences (Fig. 1). Adoption of pebbles may occur, however, because little is lost in reproductive fitness if a gull mistakenly brings a pebble into its nest. But if a gull makes the opposite mistake and leaves an egg outside the nest owing to a failure to recognize it, the gull's loss in reproductive fitness is substantial. Hence, if a gull is in doubt about the identity of an object outside the nest, its reproductive fitness may be increased by bringing the object into the nest.

ACKNOWLEDGMENTS

I thank D. E. Aylor, D. O. Conover, M. C. Coulter, B. W. Kent, and K. Vermeer for their comments on an earlier draft of this manuscript. Part of this project was conducted while the author was on an NSF National Needs Postdoctoral Fellowship.

LITERATURE CITED

BUCKLEY, P. A., & F. G. BUCKLEY. 1972. Individual egg and chick recognition by adult Royal Terns (*Sterna maxima maxima*). Anim. Behav. 20: 457–462.

CONOVER, M. R., B. C. THOMPSON, R. E. FITZNER, & D. E. MILLER. 1979. Increasing populations of Ring-billed and California gulls in Washington state. Western Birds 10: 31–36.

COULTER, M. C. 1980. Stones: an important stimulus for gulls and terns. Auk 97: 898–899.

HANSON, W. C., & L. L. EBERHARDT. 1971. A Columbia River Canada Goose population 1950–1970. Wildl. Monogr. 28: 1–55.

KNIGHT, R. L., & A. W. ERICKSON. 1977. Objects incorporated within clutches of the Canada Goose. Western Birds 8: 108.

MILLER, D. E., & M. R. CONOVER. 1983. Chick vocal patterns and non-vocal stimulation as factors instigating parental feeding behaviour in the Ring-billed Gull. Anim. Behav. 31: 145–151.

SUGDEN, J. W. 1947. Exotic eggs in nests of California Gulls. Condor 49: 93–96.

TWOMEY, A. C. 1948. California Gulls and exotic eggs. Condor 50: 97–100.

VERMEER, K. 1970. Breeding biology of California and Ring-billed gulls: a study of ecological adaptation to the inland habitat. Can. Wildl. Serv. Rept. Ser. 12: 1–51.