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SUPER-NORMAL CLUTCHES IN HERRING GULLS IN NEW ENGLAND

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Several authors have recently reported an unexpectedly high frequency of polygyny and female-female pairing in several species of gulls (*Larus* spp.). Polygyny is characterized by the building of double nests that are only a few centimeters apart (Shugart and Southern 1977, Shugart 1980), whereas female-female pairing is characterized by the laying of clutches of four to seven eggs in one nest (Hunt and Hunt 1977, Shugart 1980). One or both of these phenomena have been reported for Western Gulls (*L. occidentalis*) in southern California (Hunt and Hunt 1973, 1977, Hunt et al. 1980), Ring-billed Gulls (*L. delawarensis*) in eastern Washington (Conover et al. 1979), Manitoba (Koontz 1980) and the Great Lakes (Ryder and Somppi 1979), and Herring Gulls (*L. argentatus*) in the Great Lakes (Shugart and Southern 1977, Fitch 1980, Shugart 1980). Interpretation of these findings is hampered by the lack of information on the frequency of non-monomorous nesting in other gull populations (Shugart 1980).

We know of no other reports of double nests, and clutches of more than three eggs are known to be infrequent, but their precise frequency has not been reported on the basis of large samples. This note reports the frequency of super-normal clutches laid by Herring Gulls on the coast of New England.

Between 1963 and 1969, we conducted extensive and intensive studies of Herring Gulls on the New England coast between Rhode Island and eastern Maine (Kadlec and Drury 1968, Drury and Nisbet 1972, Nisbet and Drury 1972). Between 1970 and 1980, we continued to monitor Herring Gulls at several colonies in Massachusetts. In the course of these observations, we visited 83 colonies and examined more than 45,000 nests. Including data supplied by collaborators (see Acknowledgments), we have precise notes on clutch-sizes in 24,183 nests (Table 1).

About 60% of the counts in Table 1 were derived from complete surveys of small colonies containing 60-250 pairs. The remainder were obtained in sample areas within larger colonies, but the areas were selected to be representative by including both central and peripheral nests. Most of the counts were obtained on visits timed just before the first eggs in the colony hatched and thus included nests that had been started throughout the first 25-30 days of the season. At this time, most pairs should have had complete clutches. However, 11.5% of the nests contained one egg and 22% contained two eggs. In our experience, most one-egg clutches and some two-egg clutches encountered at this stage of the season are incomplete, either because the birds have not laid their last eggs or because one or two eggs have been lost. Hence the number of complete clutches in our sample was probably about 80% of the total, or about 19,000.

TABLE 1. Clutch-sizes of Herring Gulls in five areas of the New England coast, 1963-1980.

Area	Number of colonies	Number of nests with						Total
		c/1	c/2	c/3	c/4	c/5	c/6	
Rhode Island	5	337	723	2,836	9	1	0	3,906
S. Massachusetts ^a	10	340	867	3,389	7	0	1	4,604
Boston Harbor	8	393	581	1,797	9	0	0	2,780
N. Massachusetts ^b	17	1,226	2,261	6,066	17	0	0	9,570
Maine	29	488	952	1,879	4	0	0	3,323
Total	69	2,784	5,384	15,967	46	1	1	24,183
Percentage		11.5%	22.3%	66.0%	0.19%	0.004%	0.004%	

^a Islands in Buzzards Bay and south of Cape Cod.

^b Islands between Nahant and Cape Ann.

We found no double nests and only two clutches with more than four eggs: one clutch of five at West Island, Rhode Island, on 26 May 1963, and one clutch of six at Monomoy Island, Massachusetts, on 29 May 1980. We have no record or recollection of seeing any other clutches of five or six eggs. Hence, we estimate the frequency of clutches larger than four among New England Herring Gulls as less than 1 in 10,000 (0.01%) and probably about 1 in 20,000 (0.005%). We found clutches of four eggs at an overall average frequency of 0.19%, with no significant differences among geographical areas ($\chi^2_4 = 2.83$, $P > 0.4$; Table 1).

The data most comparable to ours are those of Shugart (1980), who checked 10,740 Herring Gull nests in colonies in the Great Lakes in 1978. He noted 33 double nests (0.3%) and 30 clutches of five to seven eggs (0.3%). Both these frequencies are significantly higher than those in our sample ($P < 10^{-16}$ and $P < 10^{-12}$, respectively, Fisher exact tests). Shugart found four-egg clutches at an overall average frequency of 0.4% (42/10,740), which is also significantly higher than in our sample ($\chi^2_1 = 11.15$, $P < 0.001$). Most of this difference resulted from a relatively high frequency (0.7%) of four-egg clutches in northeastern Lake Michigan, where the frequency of clutches of five to seven eggs was also disproportionately high (0.7%). In the other three areas censused by Shugart, the frequency of four-egg clutches was not significantly different from that in our sample (14/6,624 vs. 46/24,183, $\chi^2_1 = 0.04$, $P > 0.4$). These results support Shugart's conclusion that some four-egg clutches are associated with non-monogamous nesting, whereas others occur independently.

Several authors have suggested that polygyny and female-female pairing in gulls may arise from exposure to DDT metabolites or other toxic chemicals (Hunt et al. 1980, Shugart 1980, Fry and Toone 1981). These and other authors (Fitch 1980, Pierotti 1981) have also suggested that non-monogamous nesting may be an adaptive response to a local excess of females. The two hypotheses are not mutually exclusive, since exposure to DDT metabolites may lead to a sex ratio skewed in favor of females (Fry and Toone 1981). Our results are consistent with the first of these hypotheses, in that reported levels of DDE in Herring Gull eggs in New England have been much lower than those in the Great Lakes (Hickey and Anderson 1968, Szaro et al. 1979). However, Burger and Gochfeld (1981) found an excess of females at one colony in Maine (included in our study sample) and at three colonies in New York (just outside our study area). In light of this finding, our observation of a very low frequency of supernormal clutches in New England is inconsistent with the hypothesis that non-monogamous nesting would be a direct response to an excess of females. Further data are needed on clutch-sizes and sex ratios in gull populations with known levels of DDE contamination.

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CLUTCH SIZE OF THE GILDED FLICKER

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Since Short's (1965) extensive work on the genus *Colaptes*, all North American members of this genus have been considered conspecific with *C. auratus* (Mayr and Short 1970, Short 1982, American Ornithologists' Union 1983). The status of the five groups nonetheless remains open to question, particularly that of the *chrysoides* group (the Gilded Flicker) in southwestern United States and adjacent Mexico. Here I present data showing that Gilded Flickers have a markedly smaller clutch size than *C. a. auratus* and *C. a. cafer*. The difference is not explainable by the climatic or geographic factors that have been shown to influence geographic patterns in other species. Inasmuch as clutch size has a strong genetic basis (Van Noordwijk et al. 1980, Flux and Flux 1982), the magnitude and pattern of the difference suggest a discontinuity in the life histories of these taxa that may be indicative of reproductive isolation.

Clutch sizes were obtained from various North American oological collections (see below). Only clutches for which incubation was recorded to have been "slight," "just begun," or beyond, were used in order to ensure that the clutches were likely to be complete. I obtained data from 467 clutches, of which 57 were from *chrysoides* (primarily from Arizona) and the remainder from either the *auratus* or *cafer* groups (referred to below simply as *auratus*). Latitude and longitude of each locality were determined to the nearest degree. Climatic data, including total mean

annual precipitation (PPT), total mean annual actual evapotranspiration (AE), combined PPT for April, May, and June, combined AE for April, May, and June, maximum AE for three consecutive months in the year ("summer" AE), and minimum AE for three consecutive months in the year ("winter" AE) were derived for stations as close as possible (usually within 50 km) to each locality from the data given in Thornthwaite Associates (1964). AE is an index of primary productivity in terrestrial environments (Rosenzweig 1968); for details on the interpretation of AE values see Ricklefs (1980).

Clutch sizes were analyzed either by considering each clutch an independent sample or by combining all clutches for each degree of latitude and longitude (a latilong block) and using mean clutch size for clutches collected within the latilong. The latter procedure ensures greater independence of data involving the climatic variables, as the same climatic data were often used for all clutches within a particular latilong block.

The mean clutch size for the entire *auratus* sample was 6.5 eggs compared with 4.2 eggs for *chrysoides* (Table 1). This difference is highly significant by an analysis of variance, and remains so even after controlling for latitude in an analysis of covariance. Differences were similar when using the mean latilong clutch data (Table 1). As an additional control, I compared individual clutches of *auratus* and *chrysoides* taken from Arizona only; despite small sample sizes the difference between the two forms was still highly significant (Table 1). These latter data included clutches collected in 6 different years for *auratus* and 26 different years for *chrysoides*; thus they were not likely to have been the fortuitous result of yearly variation in clutch size.

Geographic variation in clutch size has been shown to be correlated with climatic variables, specifically winter AE, in both passerine communities (Ricklefs 1980) and in *C. auratus* (Koenig, unpubl.). Spearman rank correlations of all six climatic variables considered here with

TABLE 1. Comparison of clutch size of the Gilded Flicker with other forms of North American *Colaptes*.

	A		B		A/B ratio	F-value*	df
	Gilded Flicker	(n)	Other <i>Colaptes</i>	(n)			
All individual clutches							
Mean	4.20	(57)	6.49	(410)	.65	139.4***	1,465
Mean adjusted for latitude	4.84	(57)	6.39	(409)	.76	68.8***	1,463
Arizona clutches only							
Mean	4.19	(37)	5.25	(8)	.80	7.7**	1,43
Mean adjusted for latitude	4.16	(37)	5.42	(8)	.77	11.0**	1,42
Using mean latilong clutch data							
Mean	4.37		6.75		.65	38.2***	1,133
Mean adjusted for latitude	5.10		6.66		.77	18.6***	1,131
Mean adjusted for winter AE	4.62		6.72		.69	35.9***	1,131

* Comparisons by ANOVA; ** = $P < 0.01$, *** = $P < 0.001$.