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FEMALE-FEMALE PAIRINGS IN CASPIAN TERNS

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ABSTRACT.—The frequency and cause of supernormal clutches were investigated in two Caspian Tern (*Sterna caspia*) colonies in the Pacific Northwest. Over 4% of the nests contained four eggs and 0.8% contained five to six eggs. Trapping and sexing all attendants at two three-egg nests, two four-egg nests, and one five-egg nest revealed that the three-egg nests were incubated by heterosexual pairs and the supernormal clutches (four to six eggs) by female-female pairs. Although supernormal clutches in Caspian Terns were rare throughout North America before 1940, they have increased in frequency since 1950 in the U.S. but not in Canada.

Female pairings occur when one female associates with another instead of with a male during the breeding season. Both females lay eggs in the same nest, often producing a "supernormal" clutch of four to six eggs, twice the normal number. The two females share parental responsibilities including incubation duties, territorial defense, and care of any chicks resulting from promiscuous matings with males (Hunt and Hunt 1977). This phenomenon has been discovered in four gull species: Western Gull (*Larus occidentalis*; Hunt and Hunt 1977), Ring-billed Gull (*L. delawarensis*; Ryder and Somppi 1979, Conover et al. 1979a), California Gull (*L. californicus*; Conover et al. 1979a) and Herring Gull (*L. argentatus*; Shugart 1980).

Heretofore, female pairs have been reported only in gulls. In this study, I surveyed Caspian Tern (*Sterna caspia*) colonies in eastern Washington and Oregon in order to determine the relative frequency of supernormal clutches and if they resulted from female pairings. I also examined whether the frequency of supernormal clutches had increased since 1950, an expected occurrence if DDT contributed to the frequency of female pairings in this species by feminizing male embryos, as Fry and Toone (1981) have hypothesized, or by causing higher male mortality.

METHODS

I surveyed two Caspian Tern colonies during 1981, one located in eastern Washington at the Potholes Reservoir and the other in Oregon along the Columbia River at Three-mile Canyon. The location of these colonies is described elsewhere (Conover et al. 1979b). I counted the clutch sizes of all nests at the time when the first chicks were hatching (23–27 May). These data were then used to determine the frequency of supernormal clutches in each colony. B. C. Thompson also provided data on his surveys of the Three-mile Canyon colony on 26 May 1977 and 17 May 1978.

To determine whether female pairs were responsible for supernormal clutches, I trapped terns that were incubating three of these large clutches in the Potholes colony, either by using a walk-in funnel trap placed on the nest or by noosing the incubating birds (Miller 1974). These birds were sexed by laparotomy, after which they were released.

If DDT had contributed to the frequency of female pairings in Caspian Terns, an increase in their frequency would be expected since the 1940s, when DDT usage became widespread. Direct data on the frequency of female pairs in past years do not exist but indirect data are available. Female pairs often produce supernormal clutches; by monitoring the frequency of such clutches, changes in the frequency of female-female pairings can be assessed. Consequently, I searched the literature for reports of clutch sizes of Caspian Terns both before 1940 and after 1950. I also gathered data on the clutch sizes of Caspian Terns from the egg collections of several North American museums. Frequencies of supernormal clutches were compared using the chi-square test corrected for continuity.

RESULTS

Supernormal clutches occurred at both Caspian Tern colonies in eastern Washington and Oregon (Table 1). At the Three-mile Canyon colony, 5.6% of the clutches surveyed from 1977–1981 contained four eggs and 0.9% contained five to six eggs. At the Potholes colony, 2.1% contained four eggs and 0.4% had five to six eggs.

At the Potholes colony, supernormal clutches did not occur during the early part of the incubation period; on May 4, I found 109 nests

TABLE 1. Frequency of different-sized clutches in two Caspian Tern colonies in Washington and Oregon.

Colony (year)	n	Percent frequency of different-sized clutches					
		1 egg	2 eggs	3 eggs	4 eggs	5 eggs	6 eggs
Potholes Reservoir, WA (1981)	242	9.1	44.2	44.2	2.1	0.4	0.0
Three-mile Canyon, OR (1977)	39	10.2	53.8	30.8	5.1	0.0	0.0
Three-mile Canyon (1978)	190	8.4	41.6	43.7	5.3	0.5	0.5
Three-mile Canyon (1981)	90	10.0	55.6	26.7	6.7	0.0	1.1
Total	561	9.1	45.8	40.3	4.1	0.4	0.4

but no supernormal clutches. Ten days later, there were 217 nests including three with four eggs and one with five eggs. Thereafter the frequency of supernormal clutches increased slowly; by May 27 as the first chicks were hatching, there were 242 nests including five nests with four eggs and still the single nest with five eggs.

I trapped and banded all incubating birds at two four-egg nests and one five-egg nest; I found female pairs at all nests. I also trapped and sexed birds incubating two three-egg nests; both were attended by heterosexual pairs. Despite repeated daily observations of these nests during the next two weeks, no additional birds were seen at any of them; hence, no cases of polygyny were detected.

The presence of supernormal clutches in Caspian Terns is not limited to the Pacific Northwest (Table 2). In California, 2.5% of the nests contained four eggs and 0.4% contained five to six eggs. In Michigan, 1.3% of the nests contained four or more eggs. In Canada and Finland, 0.2–0.3% of the nests contained four eggs but only one clutch of five or six has been reported in either country. The frequencies of supernormal clutches reported in the U.S. are significantly higher than in Canada ($\chi^2 = 31.84$, $P < 0.01$) and in Finland ($\chi^2 = 4.35$, $P < 0.05$).

Supernormal clutches were rare in Caspian Terns before 1940 (Table 2). I have data for almost 1,000 nests in Canada and the U.S. before 1940 (mostly from the U.S.), and only 0.8% of these clutches contained four eggs; no clutches of five or more were reported. For instance, approximately 150 nests were checked in two Caspian Tern colonies in eastern Washington and Oregon before 1940 (Willett 1919,

TABLE 2. Frequency of different-sized clutches before 1940 and after 1950.

Reference	Area (year)	n	Percent frequency of different-sized clutches					
			1 egg	2 eggs	3 eggs	4 eggs	5 eggs	6 eggs
Post-1950 clutch sizes								
Canadian colonies								
Evans et al. (1970)	Manitoba (1969)	310	28.7	69.0	2.3	0.0	0.0	0.0
D. V. Weseloh, (unpubl.)	Ontario (1980)	661	13.6	76.2	9.4	0.8	0.0	0.0
Royal Ontario Museum (unpubl.)	Ontario (1974–1977)	301	54.2	40.9	5.0	0.0	0.0	0.0
Blokpoel (1981)	Ontario (1978)	545	14.1	75.2	10.6	0.0	0.0	0.0
Total		1,817	23.0	68.8	7.9	0.3	0.0	0.0
U.S. colonies								
Gill (1972)	California (1971)	449	25.4	52.6	19.2	2.5	0.2	0.2
Shugart et al. (1978)	Michigan (1975–1978)	2,170	8.3	40.0	50.3	⊢——	1.4	——⊣
Penland (1976)	Washington (1975–1976)	2,484	7.7	40.7	49.0	2.1	0.5	0.0
This study	Washington (1981)	561	9.1	45.8	40.3	4.1	0.4	0.4
Total		5,664	9.5	41.9	46.3	⊢——	2.4	——⊣
European colonies								
Soikkeli (1973)	Finland (1970–1972)	365	11.0	40.0	48.5	0.3	0.3	0.0
Pre-1940 clutch sizes								
Museum egg-sets	Mostly U.S. (1860–1940)	282	12.8	53.5	33.0	0.7	0.0	0.0
Palmer (1916)	Utah (1915)	25	0.0	100.0	0.0	0.0	0.0	0.0
O'Donoghue and Gowanlock (1919)	Manitoba (1918)	250	⊢—100.0—⊣		0.0	0.0	0.0	0.0
Willett (1919)	Oregon (1918)	100	⊢——	99.0	——⊣	1.0	0.0	0.0
Pemberton (1922)	Texas	100	⊢——	100.0	——⊣	0.0	0.0	0.0
Lewis (1925)	Labrador (1923)	25	⊢—100.0—⊣		0.0	0.0	0.0	0.0
DeGroot (1931)	California (1926)	141	24.1	51.8	20.6	3.5	0.0	0.0
Decker and Bowles (1932)	Washington (1932)	50	⊢——	100.0	——⊣	0.0	0.0	0.0
Total		973	⊢——	99.2	——⊣	0.8	0.0	0.0

Decker and Bowles 1932); only one supernormal clutch (four eggs) was found. This frequency is significantly lower ($\chi^2 = 4.34$, $P < 0.05$) than that found in my study, although both were conducted in the same area. A comparison of breeding reports throughout North America for the pre-1940 and post-1950 years indicates a significant increase in the frequency of supernormal clutches in the U.S. ($\chi^2 = 8.73$, $P < 0.01$) but not in Canada ($\chi^2 = 2.99$).

DISCUSSION

My findings enlarge the array of birds where female pairings have been detected. Moreover, with the exception of Western Gulls, female pairings have been reported only in inland-nesting populations. The reason for this is unknown. It may result from some factor in these colonies or it may be an artifact of search effort, because inland gull populations are highly studied.

While I found only female pairs incubating supernormal clutches in Caspian Terns, some supernormal clutches may also result from other causes. In gulls, a few clutches of five or six eggs result from polygyny and some four-egg clutches are produced by heterosexual pairs and from nest parasitism (Conover et al. 1979a). Some supernormal clutches may also occur in Caspian Terns if nests are washed out, when remaining birds roll into their nests eggs that are not their own (Cuthbert, pers. comm.). Such did not occur in the colonies I studied, because the Caspian Tern nests were situated high enough that none of them flooded.

Since female pairings often produce supernormal clutches, the frequency of such clutches can be used as an index to measure the extent of female pairings in other Caspian Tern populations. Clutch frequency data from different studies must be interpreted with caution owing to the variability of supernormal clutches during the incubation period and vulnerability of different colonies to flooding. Nevertheless, data provided by pooling results from several studies should be accurate enough to demonstrate broad trends, especially when the data are fairly consistent as they are in this study.

These clutch size data show that since 1950, supernormal clutches have been reported in colonies in the Pacific Northwest, California, Michigan, and in part of the Great Lakes but not in Canada. The lack of supernormal clutches in Canada may be partly due to the generally smaller clutch sizes found there.

Supernormal clutches have not always been so common. I found no reports in the literature of five- or six-egg clutches in Caspian Terns before 1940, nor did museum data on egg sets collected before 1940 reveal any. Furthermore, museum data are probably not a random selection of egg clutches; collectors sought complete clutches and the unusual. Hence, one might expect large clutches to be over-represented in museum egg sets. For this reason, the absence of five-egg clutches and the paucity of four-egg clutches in these sets further indicates that supernormal clutches were rare before 1940.

There is some evidence that in gulls, female pairings result from a shortage of breeding males (Hunt et al. 1980; Conover and Hunt, unpubl.). If this is true for Caspian Terns, the presence of female pairings in a population may indicate that the sex ratio of breeding adults is skewed.

Why should there be a shortage of breeding males in Caspian Tern populations of the United States? Possibly, for reasons yet to be determined, male Caspian Terns now suffer higher mortality rates than females. Alternatively, some male embryos may have been "feminized." Fry and Toone (1981) showed that DDT can feminize gull embryos, and they hypothesized that this may prevent these individuals from breeding as adults. Whether DDT would similarly affect male tern embryos is unknown. My finding that supernormal clutches were rare before DDT use and have subsequently increased, failed to disprove the hypothesis that this pesticide has contributed to the problem.

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RECENT PUBLICATIONS

A Celebration of Birds/The Life and Art of Louis Agassiz Fuertes.—Robert McCracken Peck. 1982. Walker and Co., New York. 178 p. $30.00. This book was prepared in order to accompany a major exhibition of Fuertes' work, which opened at the Academy of Natural Sciences of Philadelphia a year ago. As stated by Thomas Peter Bennett, President of The Academy in his Foreword, "*A Celebration of Birds,* both as an exhibition and a book, presents Fuertes as artist, explorer, and naturalist. It chronicles his development and maturation as an artist and illustrates his highly admired painting technique. Representative field studies, preliminary drawings, and final works, which had been previously dispersed, have been reunited here for the first time. These works, accompanied by the artist's field notes, letters, and journal entries, provide new insights into Fuertes' career and into the process of artistic creation itself." The text and the illustrations of this handsome book are equally valuable. Peck has written a comprehensive biography of Fuertes and a critical assessment of his work. Plentiful illustrations, excellently reproduced in monochrome or full color, delight the eye, show how Fuertes worked, and reaffirm his stature as *the* pre-eminent American bird artist. Roger Tory Peterson has provided an appreciative introduction. Selected bibliography, index. If you are interested in this book, watch for the exhibition as it tours American museums.

A survey of the vertebrates of Morgan Swamp, Ashtabula County, Ohio.—Timothy O. Matson. 1982. Kirtlandia No. 35, p. 1–20. **Breeding birds of Ohio's Lake Erie marshes.**—Elliot J. Tramer and Eric J. Durbin. 1982. Kirtlandia No. 37, p. 55–87. Both paper covered, $2.00 apiece ($6.25 for entire volume, including Nos. 36 and 38). Source: Kent State University Press, Kent, Ohio 44242. These two papers are issued with two others (on herpetology and fossil plants) in the occasional publication of the Cleveland Museum of Natural History. Matson gives a briefly annotated list of birds and other vertebrates inventoried in a two-year study of a large swamp in northeastern Ohio. Tramer and Durbin describe 24 marshes and report the status of the bird species found therein during a one-summer survey. Their findings are useful baseline data that should aid the management and bolster appreciation for these wetlands.