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FREQUENCY AND DISTRIBUTION OF POLYGYNY IN GREAT LAKES HERRING GULLS IN 1978

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ABSTRACT.—Polygynous mating in Herring Gulls has been found only in northern Great Lakes breeding colonies. In 1978, I censused 21 colonies in northern Lake Michigan and Lake Huron to provide a baseline from which to gauge any future changes in the distribution and frequency of polygyny. Among 10,740 nests, I found 33 (0.3%) double-nests. Double-nests are two contiguous nest cups that contain eggs and are attended by one male and two females. I also found 30 (0.3%) nests with more than four eggs. These nests usually are attended by only two females (female associations). Polygynous groups and female associations were concentrated in northeastern Lake Michigan.

The simultaneous occurrence of polygyny and female associations in Great Lakes Herring Gulls differs from the situation in other gull species in which only female associations have been described.

Polygyny in Herring Gulls (*Larus argentatus*) was first documented at a colony in northern Lake Michigan in 1976 (Shugart and Southern 1977). In 1977, the 1976 polygynous group returned and nested on the same territory, and two polygynous groups at the same colony were observed (Fitch, in press). In order to establish a baseline for assessing any future changes in the frequency and geographic distribution of polygyny in northern Lake Michigan and Lake Huron, I censused Herring Gull colonies in 1978.

STUDY AREA AND METHODS

Twenty-one Herring Gull colonies in four regions were censused. Colony names, north latitude and west longitude in each region include: Region 1) western Lake Michigan—Hat Island (45°06′, 87°19′), Jack Island (45°10′, 87°16′), Big and Little Sister Islands (45°12′, 87°10′); Region 2) northeastern Lake Michigan—Bellows Island (45°06′, 85°34′), Gull Island (45°42′, 85°50′), Trout Island (45°47′, 85°42′), Whiskey Island (45°49′, 85°37′), Squaw Island (45°51′, 85°36′), Pismire Island (45°46′, 85°27′), Hat Island (45°48′, 85°18′); Region 3) Straits of Mackinac—Goose Island (45°55′, 84°26′), St. Martin Shoals (45°57′, 84°34′), Green Island (45°50′, 84°45′), Point LaBarbe Island (45°50′, 84°46′); Region 4) western Lake Huron—Calcite Point (45°25′, 83°46′), Gull Island (45°03′, 83°14′), Sugar Island (45°03′, 83°13′), Thunder Bay Island (45°02′, 83°12′), Grassy Island (45°02′, 83°26′), Sulfur Island (45°00′, 83°25′).

Censuses were conducted when the majority of each colony was in the last two weeks of incubation. I recorded the clutch size at active nests and the frequency of single and double-nests. An active nest was cup-shaped, lined with fresh vegetation, and contained intact eggs that were not incorporated into the lining. A double-nest consisted of two cups, 30–60 cm center-to-center, that were adjoined with nest material; each cup contained one to four eggs. These criteria were used because a monogamous pair may build several nests prior to laying (e.g., Paynter 1949), which may be adjoined (pers. observ.), but lay eggs only in one. The remaining nests fall into disrepair.

The colonies were censused during the last two weeks of incubation because egg laying in larger colonies (500+ pairs) may extend over a two- to three-week period (e.g., Paynter 1949), and a late visit permitted accumulation of data for the greatest number of completed clutches. Undetected egg loss may result in underestimating the frequency of active double-nests and nests with more than three eggs.

After censusing colonies, I observed and captured individuals incubating at 11 double-nests and four single nests that contained five or six eggs. Captured birds were sexed through unilateral laparotomy (Bailey 1951), banded with standard U.S. Fish and Wildlife Service bands and color bands, and released.

Frequency data were analyzed using log-likelihood ratios. Cells containing zero were simply assigned a value of zero in summation (see Sokal and Rohlf 1973).

RESULTS

In 1978, 33 (0.3%) of 10,740 nests were double-nests. (Each double-nest is counted as one nest in Table 1). I captured, sexed, and observed attending birds at 11 of these nests, and each was attended by one male and two females. Similar trios were also studied and captured at each of four other double-nests in 1976 and 1977. I am therefore confident that a double-nest indicates the presence of a trio. Trios of one male and two females are termed polygynous groups in this paper.

In addition to double-nests, I also found 30 (0.3%) single nests containing five to seven eggs and 42 (0.4%) containing four eggs. This was unusual because one female usually lays only three eggs per clutch (Paludan 1951, Harris 1964, Baerends et al. 1970). I captured and sexed birds at four single nests containing five or six eggs and at each found only two females. These females were sim-

TABLE 1. Frequency and distribution of single and double-nests in northern Lake Michigan and Lake Huron Herring Gull colonies in 1978. Numbers in parentheses indicate percent of subtotal under each area and percent of total under totals column.

	Census area				
	1 Western L. Michigan	2 Northeastern L. Michigan	3 Straits of Mackinac	4 Western L. Huron	Totals
Number of colonies	4	7	4	6	21
Area subtotals	1,627	4,116	1,822	3,175	10,740
Double-nests[1]	1 (0.1)	28 (0.7)	4 (0.3)	0	33 (0.3)
Single nests with:					
<4 eggs	1,617	4,036	1,815	3,167	10,635
4 eggs	5 (0.3)	28 (0.7)	3 (0.2)	6 (0.2)	42 (0.4)
5–7 eggs[2]	4 (0.2)	24 (0.6)	0	2 (0.1)	30 (0.3)

[1] H_0:frequency of double-nests is independent of census area: Areas 1, 2, 3, 4, $G = 38.76$, $P < 0.001$; Areas 1, 3, 4, $G = 8.06$, $0.01 < P < 0.03$; Areas 1, 4, $G = 5.80$, $0.01 < P < 0.03$; other comparisons $0.05 < P$.
[2] H_0:frequency of nests with 5–7 eggs is independent of census area: Areas 1, 2, 3, 4, $G = 28.49$, $P < 0.001$; Areas 1, 3, 4, $G = 6.47$, $0.03 < P < 0.05$.

ilar (M. Fitch, pers. comm.) to female associations described for other gull species (Hunt and Hunt 1977, Ryder and Somppi 1979, Conover et al. 1979). I assume that the remaining 26 clutches of five to seven eggs also were attended by only two females. Although several instances of polygamous groups attending supernormal clutches have been reported (Nethersole-Thompson and Nethersole-Thompson 1942, Smith 1975, Conover et al. 1979, M. Fitch, pers. comm.), capture data show that nests containing more than four eggs usually are attended only by females (Hunt and Hunt 1977, Ryder and Somppi 1979, Conover et al. 1979, this paper). For brevity, I refer to two females attending more than four eggs without a male as a female association.

Four eggs in a single nest (Table 1) may have been laid by a monogamous female (Paludan 1951, Harris 1964, Brown 1967). Alternatively, they may have resulted from accidental laying by a second female (e.g., Behle and Goates 1957, Baerends et al. 1970), female associations (Hunt and Hunt 1977), brood parasitism (Conover et al. 1979), loss of eggs from a clutch with more than four eggs (Schreiber 1970), or retrieval of loose eggs displaced from a neighbor's nest (pers. observ.). I did not investigate the origin of nests with four eggs.

Twenty-eight (85%) of the 33 polygynous groups and 24 (80%) of the 30 apparent female associations (five- to seven-egg clutches) were located in northeastern Lake Michigan (Table 1). Comparison of the frequency of polygynous groups and female associations by area (see Table 1) shows a concentration of each in the northeastern Lake Michigan region, suggesting that local factors were involved.

DISCUSSION

Many studies of gulls provide complete data regarding the number of eggs found in nests (e.g., Paynter 1949, Paludan 1951, Behle and Goates 1957, Vermeer 1963, Harris 1964, Ludwig and Tomoff 1966). Nevertheless, I have found few instances of polygyny (Nethersole-Thompson and Nethersole-Thompson 1942) or nests with more than four eggs (Moffit 1942, Johnson and Foster 1954, Dyunin *in* Bianka 1967) prior to the recent proliferation of reports (Schreiber 1970, Hunt and Hunt 1973, 1977, Shugart and Southern 1977, Morris and Haymes 1977, Conover et al. 1979, Ryder and Somppi 1979; single instances in Vermeer 1970, Chamberlin 1975). Four-egg nests were found in some of these studies, but as I indicated, their origin is uncertain. It seems premature to conclude that supernormal clutches and double-nests have been widespread in the past but were overlooked. Rather, the recent reports probably represent increases in the incidence of these phenomena.

A second possibility, which may contribute to the rarity in past literature of supernormal clutches and double-nests, is that these phenomena occur irregularly as I found them in the Great Lakes Herring Gulls, and censuses were not done repeatedly over large enough areas to discover the isolated instances. A distribution similar to that which I found in the Great Lakes was sug-

gested originally for supernormal clutches (Schreiber 1970, Hunt and Hunt 1973) and female associations (Hunt and Hunt 1977) in the Western Gull (*Larus occidentalis*). Until more census data are available from which the spatial and temporal pattern of non-monogamous affiliations can be established, firm conclusions cannot be drawn regarding their general occurrence and significance in gull sociobiology.

The simultaneous occurrence of polygyny and female associations among Herring Gulls in the Great Lakes (Table 1) differs from reports of non-monogamous associations in other gull species in which female associations occur without polygyny. At present, the simplest explanation for female associations in gulls, and polygyny in Herring Gulls, is that both are manifestations of a surplus of females in an area (see Hunt and Hunt 1977). If this is true, then territorial and courtship behavior related to maintenance of long-term pair bonds in monogamous gulls may hinder, but not prevent, formation of polygynous groups (Fitch 1979). The contrast between the Great Lakes Herring Gulls' formation of polygynous groups and the lack of polygyny in other gulls may simply represent slight differences in courtship or territorial behavior.

If polygynous groups and female associations do result from female surpluses, how could a surplus of one sex come about? Food stress, combined with different phenologies of energy input in reproduction by males and females or sexual differences in migration and return to colonies, may temporarily skew the sex ratio under natural conditions (see Mills 1973, Coulson and Wooller 1976). In the Great Lakes, the presence of toxic chemical contaminants in Herring Gulls (Keith 1966, Ludwig and Tomoff 1966, Hildebrandt and Fay 1977, Gilman et al. 1977) may also contribute to reduced male survivorship relative to females through physiological differences between sexes in lipid and lipophilic toxic chemical dynamics (Wurster et al. 1965, Gish and Chura 1970).

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LITERATURE CITED

BAERENDS, G. P., P. H. DRENT, P. GLAS, AND H. GROENWOLD. 1970. The Herring Gull and its egg. Behav. Suppl. 17.

BAILEY, R.E. 1951. Surgery for sexing and observing gonad condition in birds. Auk 70:497–499.

BEHLE, W. H., AND W. A. GOATES. 1957. Breeding biology of the California Gull. Condor 59:235–246.

BIANKI, V. V. 1967. Gulls, shorebirds and alcids of Kandalaksha Bay. Proc. Kandalaksha State Reservation, No. 6. Transl. from Russian, Israel Prog. Sci. Transl. 1977.

BROWN, R. G. B. 1967. Breeding success and population growth in a colony of Herring and Lesser Black-backed gulls *Larus argentatus* and *L. fuscus*. Ibis 109:502–515.

CHAMBERLIN, M. L. 1975. The breeding ecology of Herring Gulls in northern Lake Michigan. M.S. thesis, Central Michigan Univ., Mt. Pleasant.

CONOVER, M. R., D. E. MILLER, AND G. L. HUNT, JR. 1979. Female-female pairs and other unusual reproductive associations in Ring-billed and California gulls. Auk 96:6-9.

COULSON, J. C., AND R. D. WOOLLER. 1976. Differential survival rates among breeding Kittiwake Gulls *Rissa tridactyla* (L.). J. Anim. Ecol. 46:205–213.

FITCH, M. A. 1979. Monogamy, polygyny and female-female pairs in Herring Gulls. Proc. Colonial Waterbird Group 3:44–48.

GILMAN, A. P., G. A. FOX, D. B. PEAKALL, S. M. TEEPLE, T. R. CARROLL, AND G. T. HAYMES. 1977. Reproductive parameters and egg contaminant levels of Great Lake Herring Gulls. J. Wildl. Manage. 41:458–468.

GISH, C., AND N. J. CHURA. 1970. Toxicity of DDT to Japanese Quail as influenced by body weight, breeding condition and sex. Toxicol. Appl. Pharmacol. 17:740–751.

HARRIS, M. P. 1964. Aspects of the breeding biology of gulls, *Larus argentatus*, *Larus fuscus* and *Larus marinus*. Ibis 106:432–456.

HILDEBRANDT, T. D., AND L. D. FAY. 1977. Chemical residues in Herring Gull eggs from the Great Lakes. Mich. Dep. Nat. Res. Wildl. Div. Rep. 2766.

HUNT, G. L., JR., AND M. W. HUNT. 1973. Clutch size, hatching success and eggshell-thinning in Western Gulls. Condor 75:483–486.

HUNT, G. L., JR., AND M. W. HUNT. 1977. Female-female pairing in Western Gulls (*Larus occidentalis*) in southern California. Science 196:1466–1467.

JOHNSTON, D. W., AND M. E. FOSTER. 1954. Interspecific relations of breeding gulls at Honey Lake, California. Condor 56:38–42.

KEITH, J. A. 1966. Reproduction in a population of Herring Gulls contaminated by DDT. J. Appl. Ecol. 3(Suppl.):57–70.

LUDWIG, J. P., AND C. S. TOMOFF. 1966. Reproductive success and insecticide residues in Lake Michigan Herring Gulls. Jack-pine Warbler 44:77–84.

MILLS, J. A. 1973. The influence of age and pair-bonding on the breeding biology of the Red-billed Gull *Larus novaehollandiae scopulinus*. J. Anim. Ecol. 42:147–162.

MOFFIT, J. 1942. A nesting colony of Ring-billed Gulls in California. Condor 44:105–107.

MORRIS, R. D., AND G. T. HAYMES. 1977. The breeding biology of two Lake Erie Herring Gull colonies. Can. J. Zool. 55:796–805.

NETHERSOLE-THOMPSON, C., AND D. NETHERSOLE-

THOMPSON. 1942. Bigamy in the Common Gull. Br. Birds 36:98–100.
PALUDAN, K. 1951. Contributions to the breeding biology of *Larus argentatus* and *Larus fuscus*. Vidensk. Medd. Dan. Naturhist. Foren. 114:1–28.
PAYNTER, R. 1949. Clutch-size and the egg and chick mortality of Kent Island Herring Gulls. Ecology 30:146–166.
RYDER, J. P., AND P. L. SOMPPI. 1979. Female-female pairing in Ring-billed Gulls. Auk 96:1–5.
SCHREIBER, R. W. 1970. Breeding biology of Western Gulls (*Larus occidentalis*) on San Nicolas Island, California, 1968. Condor 72:133–150.
SHUGART, G. W., AND W. E. SOUTHERN. 1977. Close nesting, a result of polygyny in Herring Gulls. Bird-Banding 48:276–277.
SMITH, A. J. M. 1975. Studies of breeding Sandwich Terns. Br. Birds. 68:142–156.
SOKAL, R. R., AND F. J. ROHLF. 1973. Introduction to biostatistics. W. H. Freeman and Co., San Francisco.
VERMEER, K. 1963. The breeding ecology of the Glaucous-winged Gull (*Larus glaucescens*) on Mandarte Island. B. C. Prov. Mus. Occas. Pap. 12.
VERMEER, K. 1970. Breeding biology of California and Ring-billed gulls: a study of ecological adaptation to inland habitat. Can. Wildl. Serv. Rep. Ser. 12.
WURSTER, D. H., C. F. WURSTER, AND W. N. STRICKLAND. 1965. Bird mortality following DDT spray for Dutch Elm disease. Ecology 46:488–499.

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