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OCCURRENCE OF SUPERNORMAL CLUTCHES IN THE LARIDAE

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In recent years, female-female pairings have been discovered in Western Gulls (*Larus occidentalis*) (Hunt and Hunt 1977), Ring-billed Gulls (*L. delawarensis*) (Conover et al. 1979, Ryder and Somppi 1979), California Gulls (*L. californicus*) (Conover et al. 1979), and Herring Gulls (*L. argentatus*) (Fitch 1979). These associations occur when two females pair together rather than with male mates and both lay eggs in a mutual nest. It has yet to be determined whether female pairs are restricted to a small number of gull species or are widespread among the normally monogamous Laridae. Supporting the latter possibility is the recent discovery of female pairs among breeding Caspian Terns (*Sterna caspia*) (Conover 1983). Such female pairs are often identifiable because their nests contain supernormal clutches (4–6 eggs), double the normal clutch-size. Not all supernormal clutches (SNCs), however, result from female pairings. In a study of Ring-billed Gulls, 17% of the 5–6 egg clutches resulted from polygynous associations in which two or more females lay eggs in the same nest (Conover, in press). Furthermore, a polygynous group was found attending a SNC in the Brown Skua (*Catharacta skua*) (Bonner 1964). Hence, the presence of SNCs in a particular species may indicate that either female pairings or polygynous associations occur in that species. This is not necessarily the case, however, for a few SNCs may also result from adults rolling a foreign egg into their nest or from nest parasitism although normally neither event should cause a doubling of clutch-size, except for one-egg clutches.

In this study, I used clutch-size data to estimate the frequency of SNCs in different gull and tern species. Such information is useful in identifying those species in which female pairings or polygyny may occur. These data were also used to test the hypothesis that DDT contamination produces female pairings by feminizing male embryos (Fry and Toone 1981). If this is so, the frequency of female pairs and consequently SNCs should have increased since the late 1940s when DDT's widespread usage began.

METHODS

Definition of supernormal clutch.—Supernormal clutch, an imprecise term, has historically signified an unusually large clutch. This term has been applied mostly to birds which usually lay three-egg clutches; for these birds, most authors agree that clutches containing five or more eggs are supernormal but disagree on the inclusion of four-egg clutches. Hunt and

Hunt (1977) and Conover et al. (1979) have included them while Ryder and Somppi (1979) and Shugart (1980) have not. Therefore, a more precise definition is necessary, especially for studies of other species which do not lay a three-egg clutch. Bonner (1964) considered a three-egg clutch to be supernormal in the Brown Skua, a species which lays two eggs.

I use the following definition: a supernormal clutch exceeds the modal clutch-size by more than 50% with the exception that a two-egg clutch shall only be considered supernormal if 90% of the individual females lay a single egg. Hence, if the modal clutch-size contains 2, 3, or 4 eggs, then SNCs must contain at least 4, 5, or 7 eggs, respectively.

Data collection procedures.—Clutch-size data used in this study came from two sources. First, data were gathered from most of the major museum egg collections in North America. For each egg set examined, I recorded the clutch-size, species, year, and collection site. While either I or my technicians examined most egg sets, some additional data were furnished by the staff of museums which I was unable to visit. Data from egg collections represent pre-DDT conditions because few egg sets have been collected since 1940.

The remaining data on clutch-size frequencies for gulls and terns were obtained by literature search. Excluded from this analysis were some reports in which: (1) fewer than 50 nests were sampled in those species where sample sizes were already so large that such studies added little; (2) the number of nests of each clutch-size was not given or was estimated rather than counted directly; (3) nests were not randomly selected or for some were not representative of that species due to some unusual situation (such as studies prompted by an unusual event like birds nesting out of season or after a natural disaster); (4) the count was made either before most of the clutches were completed or after many of the eggs had hatched; or (5) the reliability of the data was uncertain (i.e., misidentified species, mathematical errors, etc.). Reports, however, that contained small inconsistencies in the data (such as totals not adding up exactly) were included if the error had little effect on SNC frequencies. When reports gave sequential clutch-size data from the same colonies, I selected data from the day when the highest proportion of the clutches was complete or when the greatest number of nests was counted, providing that this day did not occur after many of the eggs had hatched.

To determine whether SNCs have increased in frequency since DDT's widespread use, all clutch-size data in the post-1950 literature and post-1950 breeding reports from the Royal Ontario Museum were compared to that in the pre-1940 literature and to the museum data using a Chi-square test corrected for continuity. If this test proved invalid for a particular species, due to a low expected frequency, the Fisher-exact probability test was used. Data collected during the 1940s were usually excluded, as DDT was just coming into use during this decade; this exclusion had little effect on the results because only a small number of studies were conducted during this period.

RESULTS

SNCs in gulls.—Evidence of supernormal clutches of five or more eggs was found in both museum egg collections and in the literature (Appendix) for seven gull species: Laughing (*Larus atricilla*), Common Black-headed (*L. ridibundus*), Mew (*L. canus*), Ring-billed, California, Herring, and Western gulls. In three additional species, the Glaucous-winged (*L. glaucescens*), Glaucous (*L. hyperboreus*), and Great Black-backed (*L. marinus*) gulls, some SNCs were found in the museum egg collections though not in the literature, owing to a lack of published reports on the clutch-size distribution for the latter two species. Furthermore, SNCs consisting of four eggs were reported in the Black-billed Gull (*L. bulleri*), Silver Gull

(*L. novaehollandiae*), and Black-legged Kittiwake (*Rissa tridactyla*), species which predominantly lay two-egg clutches. Likewise, some two-egg SNCs have been found in the Swallow-tailed Gull (*Creagrus furcata*), a species that usually lays only one egg. No SNCs were found in either the literature reports or egg collections for Lesser Black-backed (*L. fuscus*), Kelp (*L. dominicanus*), and Sabine's (*Xema sabini*) gulls.

In egg collections, SNCs were most common in Ring-billed (4.0% of all clutches), California (2.7%), and Laughing (1.9%) gulls. In the pre-1940 literature, SNCs were most frequent in Laughing (1.0%) and Ring-billed (0.5%) gulls, and in the post-1950 literature were most common in Ring-billed (1.9%), Western (1.8%), and Herring (0.3%) gulls.

SNCs in terns.—SNCs occurred in almost all tern species (Appendix). In both the museum egg collections and in the literature, SNCs of five or more eggs were found for the Gull-billed (*Sterna nilotica*), Common (*S. hirundo*), Roseate (*S. dougallii*), and Least (*S. antillarum*) terns. Furthermore, 5–6 egg clutches occurred in museum egg sets of the Forster's Tern (*S. forsteri*) although no literature reports on clutch-size distribution were found for this bird. In contrast, no SNCs were found in the egg collections of Black Terns (*Chlidonias niger*) but SNCs were reported in the nesting data collected by the Royal Ontario Museum.

In those tern species where two eggs formed the most common clutch-size—the Caspian, Arctic (*S. paradisaea*), Sandwich (*S. sandvicensis*), and Least terns—four-egg clutches (which are considered supernormal) were found in all species. Likewise, one-egg clutches predominate in the Royal (*S. maxima*), Elegant (*S. elegans*), White-fronted (*S. striata*), Black-naped (*S. sumatrana*), Sooty (*S. fuscata*) terns and the Brown Noddy (*Anous stolidus*); two-egg supernormal clutches have been reported in all of these species but the White-fronted Tern. Hence, SNCs occurred in all terns which were examined, except this last species.

In the egg collections, SNCs were most common in the Royal Tern (38.8%), Sandwich Tern (6.7%), Roseate Tern (3.7%), and Brown Noddy (3.4%). In the pre-1940 literature, SNCs were most common in the Least (7.1%), Roseate (1.9%), Royal (1.4%), Caspian (0.9%), and Sandwich (0.6%) terns. Since 1950, however, the highest frequencies of SNCs have been reported in the Sooty (12.3%), Elegant (6.7%), Caspian (2.1%), and Royal (1.7%) terns.

Change in SNC frequencies since 1950.—Based on pre-1940 and post-1950 literature reports, SNC frequencies have decreased significantly since 1950 in the Sandwich ($\chi^2 = 5.63$, $P < 0.05$), Roseate ($\chi^2 = 9.88$, $P < 0.01$), and Least ($P < 0.05$, Fisher test) terns. In contrast, SNCs have significantly increased in post-1950 literature reports in the Caspian Terns nesting in the U.S. ($\chi^2 = 5.73$, $P < 0.05$) and in Herring Gulls ($\chi^2 = 23.71$, $P < 0.01$). Surprisingly, all 43 of the reported SNCs in Herring Gulls since

1950 have been found in the Great Lakes and Ontario; 0.3% of the over 15,000 nests surveyed in this region since 1950 consisted of SNCs. Prior to 1940, no Herring Gull SNCs were found among the 72 museum egg sets collected from the Great Lakes or the 777 nests from that area reported in the literature.

Comparing the post-1950 literature with the pre-1940 egg collections revealed a higher SNC frequency in the egg collections for most gull and tern species, a result which was not surprising since many egg collectors did not collect clutches randomly. Nonetheless, in one species, the Western Gull, the SNC frequency was significantly higher in the post-1950 literature than in the egg collections ($P < 0.01$, Fisher test).

DISCUSSION

Supernormal clutches occurred in most of the gull and tern species examined, albeit in low frequencies. SNCs were found in both literature reports and egg collections for many species, thus providing independent confirmation of their occurrence.

These two sources of clutch-size data, however, pose potential problems which necessitate caution in using the results of this study to estimate SNC frequencies for many of these species. For example, in the literature reports, the paucity of clutch-size studies for most species results in a high proportion of data coming from a small area and for only a few breeding seasons. Given possible geographic and yearly variation in intraspecific clutch-size, such data may not be representative of the species as a whole. Moreover, SNC frequencies may change between the early and late part of the incubation period causing variability among studies if the eggs were counted at different times (Ryder and Somppi 1979; Conover, in press). I tried to minimize this latter problem by excluding those studies known to be conducted either early in the incubation period or when many of the eggs had already hatched. While these procedures may minimize the problem, the potential bias remains and may affect interspecific comparisons of clutch-sizes based on literature reports.

Problems with clutch-size data from museum egg collections are somewhat different. Here, hundreds of egg collectors have gathered eggs from numerous locations during the last century, minimizing the bias of single-source data. Egg collection data are probably more representative of each species as a whole, allowing for more accurate interspecific comparisons of clutch-size and SNC frequencies. However, SNCs are probably over-represented in the egg collection data, for many collectors were not concerned with randomly sampling clutches in a colony and, instead, sought completed and unusual clutches. Consequently, SNC frequencies for any given species cannot be accurately determined from egg collections, and comparisons between pre-1940 egg collections and the post-1950 literature can be used only to document substantial increases but not decreases in SNC frequencies since 1950.

Origin of SNCs.—Many authors have speculated on the origin of SNCs. Some have felt these clutches are the work of a single female (Glegg 1925, Marples and Marples 1934, Robinson 1934b). Most authors, however, have suggested that these large clutches occur because eggs from different females end up in the same nest, basing this hypothesis on both the large clutch-sizes and the unusual variation in egg coloration and marking patterns within some SNCs (Jones 1906, Willett 1919, Bancroft 1927, Munro 1936, Beretzk 1957, Smith 1975, Conover et al. 1979, Penland 1981).

Some authors have hypothesized that these large clutches were created when a foreign egg fell or was rolled into a nest, a phenomenon which has been demonstrated by marking eggs in only the Mew Gull (Trubridge 1980), Caspian Tern (Penland 1981), and Sooty Tern (Brown 1975). While some SNCs undoubtedly result from the above and similar occurrences—eggs falling into nests, being rolled in by the incubating birds, or from nest parasitism—in most cases these events should only increase the original clutch-size by one egg and hence not create a SNC, except in species that normally lay one-egg clutches.

Another explanation for SNCs was proposed by Hunt and Hunt (1977) when they showed that most SNCs in Western Gulls were produced by female-female pairings. Other authors have supported this conclusion, finding female-female pairs in Ring-billed Gulls (Ryder and Somppi 1979, Conover et al. 1979), California Gulls (Conover et al. 1979), Herring Gulls (Fitch 1979), Black-legged Kittiwakes (K. Chardine, pers. comm.), and Caspian Terns (Conover 1983). Some SNCs also result from polygyny in the Ring-billed Gull (Conover et al. 1979; Conover, in press), and in the Sandwich Tern (Smith 1975). Further, Nethersole-Thompson (1946) observed three adults attending a four-egg clutch in Mew Gulls; unfortunately the birds were not sexed, rendering it unclear if this was a polygynous association or a three-female group similar to the one discovered in Ring-billed Gulls by Conover (in press). Hence in most species which have been investigated, SNCs have usually resulted from multi-female associations (either polygyny or female-female pairings). The results of this study raise the possibility that female-female pairings or polygyny may occur in many gull and tern species. Furthermore, SNCs are not unique to the Laridae. Unusually large clutches have also been reported in Procellariiformes (Allen 1961, Rice and Kenyon 1962, Warham 1962, Tickell and Pinder 1966, Fisher 1968), Pelecaniformes (Snow 1960), and other Charadriiformes (Charateris 1927, Eggeling 1929, Jourdain 1936, Bonner 1964, Drent et al. 1964, Hussell and Woodford 1965, Scott 1974, Sealy 1976, Erwin 1977). Clearly, more research is needed on the origin of SNCs in many species.

Changes in SNC frequencies since 1950.—Fry and Toone (1981) speculated that DDT may have caused an increase in female-female pairings in gulls by feminizing male embryos to the extent that these individuals do not breed as adults. If correct, the frequency of female-female pairs, and therefore SNCs, should be higher since the 1940s when DDT became widely used. For most gull and tern species, my results do not support this hypothesis. Since 1950, SNC frequencies have increased significantly in only three species: Western Gulls and Herring Gulls nesting in the Great Lakes, and Caspian Terns breeding in the United States. Of course, this recent increase in SNC frequencies in these three species may be due to causes other than DDT or female pairings. Both of these gull populations, however, nest in areas which have had problems with DDT pollution. In the Western Gull, SNCs have been reported primarily in colonies along the southern coast of California, an area which has suffered from high DDT pollution originating from the sewer systems of Los Angeles (Fry and Toone 1981). Also indicative of the high organochlorine levels in the food chain of this area is the documented problem of eggshell thinning in Brown Pelicans (*Pelecanus erythrorhynchos*) (Risebrough et al. 1971, Jehl 1973) and Double-crested Cormorants (*Phalacrocorax auritus*) (Gress et al. 1973) nesting in the area. In the Herring Gull, SNCs have only been reported in the Great Lakes but not in European colonies or in colonies located along the east coast of North America (Appendix). Herring Gulls nesting in the Great Lakes also have had a lower reproductive success than gulls nesting elsewhere, a problem which has been attributed to high levels of organochlorines in their tissues and eggs (Keith 1966, Gilbertson 1974, Gilbertson and Hale 1974, Gilbertson and Fox 1977, Gilman et al. 1977). In the Caspian Tern, SNCs have increased in frequency since 1950 in U.S. colonies but not in those located in Canada and Finland (Conover 1983). One might suspect that Caspian Terns breeding in the U.S. had higher DDT concentrations than those breeding in the more pristine parts of Canada or Finland, but there is little information on the subject. Thus, DDT or some other pollutant may have caused an increase in SNCs in Western Gulls, Herring Gulls breeding in the Great Lakes, and possibly in Caspian Terns breeding in the U.S.; for most gulls and terns, this apparently is not the case.

SUMMARY

This study examined the frequency of supernormal clutches (SNCs) in gulls and terns by checking egg collections and literature reports. Supernormal clutches were defined as clutches that contained at least 50% more eggs than the modal clutch-size, except that a two-egg

clutch was considered supernormal if 90% of the individual females lay a single egg. While SNCs were found in 15 of 18 examined gull species and 14 of 15 tern species, they constituted less than 1% of the clutches in most of these species. Most studies which have documented the causes of SNCs have shown that SNCs usually resulted from female pairings or polygynous associations. These results suggest that female pairings or polygyny may be widespread among the Laridae, as well as other normally-monogamous waterbirds. This study also tested the hypothesis that DDT has caused an increase in female pairings. If correct, there should be an increase in SNC frequencies since the late 1940s when DDT became widely used. In the Western Gull, the Great Lakes population of Herring Gulls, and the U.S. Caspian Tern population, there has been a significant increase in SNC frequencies since 1950. These two gull populations breed in areas which have had pollution problems and where high levels of organochlorines have been found in the eggs and tissues of these birds. For most gull and tern species, however, there has been no significant increase in SNC frequencies since 1950. Hence, this study's findings do not disprove this hypothesis but indicate that any pollutant-induced increase in female pairings probably is limited to a small number of species.

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APPENDIX

CLUTCH-SIZE DISTRIBUTION IN GULLS AND TERNS

Species	Source	No. nests	$\bar{x}$ Clutch-size	Frequency (%) 1-egg	2-egg	3-egg	4-egg	5-egg	+6-egg
Gray Gull (*Larus modestus*)									
Post-1950	Howell et al. 1972	182	1.5	46.7	51.6	1.6	0.0	0.0	0.0
Laughing Gull (*L. atricilla*)									
Pre-1940	Egg sets	425	2.9	3.5	16.5	72.2	5.9	1.4	0.5
	Mackay 1893, 1895, 1896, 1897b, 1898, 1899; Cahn 1922	392	3.0	3.8	12.2	69.6	13.3	1.0	0.0
Post-1950	Dinsmore and R. Schreiber 1974, E. Schreiber et al. 1979	932	2.6	6.7	29.0	64.0	0.2	0.0	0.0
Black-billed Gull (*L. bulleri*)									
Post-1950	Black 1955; Beer 1965, 1966	1383	1.9	26.3	62.5	10.7	0.4	0.0	0.0
Common Black-headed Gull (*L. ridibundus*)									
Pre-1940	Egg sets	647	2.9	3.7	7.6	85.8	2.6	0.2	0.2
Post-1950	Weidmann 1956; Goodbody 1955; Ytreberg 1956, 1960; Lundberg and Vaisanen 1979	1217	2.8	4.6	14.1	80.7	0.4	0.1	0.0
Mew Gull (*L. canus*)									
Pre-1940	Egg sets	403	2.7	6.4	15.1	76.7	0.7	0.7	0.2
	Belopol'skii	65	2.5	10.8	32.3	56.9	0.0	0.0	0.0
Post-1950	Ytreberg 1960, Belopol'skii et al. 1972, Campbell 1970	1327	2.8	5.0	14.5	80.3	0.1	0.1	0.0
Ring-billed Gull (*L. delawarensis*)									
Pre-1940	Egg sets	674	2.7	14.1	17.4	58.9	5.6	2.7	1.3
	Willett 1919, Moffitt 1942	575	—	←	99.5	→		0.5	0.0

APPENDIX
CONTINUED

Species	Source	No. nests	$\bar{x}$ Clutch-size	Frequency (%) 1-egg	2-egg	3-egg	4-egg	5-egg	+6-egg
Post-1950	R.O.M. reports*	38,919	2.9	1.4	10.0	87.8	0.7	0.2	0.03
	Johnston and Foster 1954, Broadbooks 1961, Vermeer 1970, Ryder 1975, Haymes and Blokpoel 1978, Blokpoel et al. 1980, Conover (in press)	6933	2.8	5.5	15.7	74.6	2.6	1.0	0.60
California Gull (*L. californicus*)									
Pre-1940	Egg sets	264	2.6	9.1	33.7	49.6	4.9	2.7	0.0
	Dawson 1923	489	2.1	13.1	59.3	27.4	0.2	0.0	0.0
Post-1950	Johnston and Foster 1954, Johnston 1956, Vermeer 1970, Conover (in press)	1943	2.7	5.7	23.2	69.5	1.5	0.1	0.0
Herring Gull (*L. argentatus*)									
Pre-1940	Egg sets	478	2.6	13.2	15.7	68.8	1.9	0.2	0.0
	Dutcher and Bailey 1903, Strong 1923, Wolfe 1923, Wood 1924, Braund and McCullagh 1940, Belopol'skii 1961, Campbell 1968	1415	2.6	1.6	36.6	61.3	0.4	0.0	0.0
	Gross 1940	10,966	1.9	34.2	38.6	27.3	0.02	0.0	0.0
Post-1950	Drost et al. 1961, Harris 1964, Keith 1966, Brown 1967, Campbell 1968, Baerends and Drent 1970, Vermeer 1971, Gilbertson and Hale 1974, Parsons 1975, Spaans and Spaans 1975, Gilman et al. 1977, Teeple 1977, Ryder and Carroll 1978, Haymes and Blokpoel 1978, Spitzer 1978	3928	2.7	6.0	18.9	74.8	0.3	0.1	0.0
	R.O.M.*	5071	2.6	12.1	21.6	63.7	2.5	0.04	0.06
	Shugart 1980	10,707	—	←— 99.3 (1- to 3-egg) —→			0.4	←— 0.3 (5- and +6-egg) —→	

APPENDIX
CONTINUED

Species	Source	No. nests	$\bar{x}$ Clutch-size	Frequency (%) 1-egg	2-egg	3-egg	4-egg	5-egg	+6-egg
Lesser Black-backed Gull (*L. fuscus*)									
Pre-1940	Egg sets	129	2.8	3.9	9.3	86.8	0.0	0.0	0.0
Post-1950	Harris 1964, Brown 1967	432	2.7	4.6	16.7	78.2	0.5	0.0	0.0
Silver Gull (*L. novaehollandiae*)									
Post-1950	Wheeler and Watson 1963, Mills 1973, Nicholls 1974	954	2.0	24.6	58.9	15.9	0.5	0.0	0.0
Western Gull (*L. occidentalis*)									
Pre-1940	Egg sets	855	2.9	2.6	14.0	82.3	0.9	0.1	0.0
Post-1950	R. Schreiber 1970, Harper 1971, Hunt and Hunt 1973	386	2.8	8.3	15.0	70.5	4.4	1.5	0.3
Kelp Gull (*L. dominicanus*)									
Pre-1940	Egg sets	112	2.1	33.0	25.0	41.1	0.9	0.0	0.0
Post-1950	Fordam 1964	310	2.4	9.0	42.9	48.1	0.0	0.0	0.0
Glaucous-winged Gull (*L. glaucescens*)									
Pre-1940	Egg sets	248	2.6	13.7	16.9	65.7	2.8	0.4	0.4
	Pearse 1929, Jewett et al. 1953	197	2.3	18.2	35.6	46.2	0.0	0.0	0.0
Post-1950	Drent et al. 1964, Thoresen and Galusha 1971	5106	2.6	8.5	24.4	67.0	0.1	0.0	0.0
Glaucous Gull (*L. hyperboreus*)									
Pre-1940	Egg sets	215	2.4	12.1	38.1	47.9	1.4	0.5	0.0
Great Black-backed Gull (*L. marinus*)									
Pre-1940	Egg sets	189	2.7	5.3	18.0	75.7	0.5	0.0	0.5

Appendix
Continued

Species	Source	No. nests	$\bar{x}$ Clutch-size	Frequency (%) 1-egg	2-egg	3-egg	4-egg	5-egg	+6-egg
Black-legged Kittiwake (*Rissa tridactyla*)									
Pre-1940	Egg sets	218	2.1	25.2	39.4	33.5	0.9	0.9	0.0
	Belopol'skii 1961	577	2.0	22.5	58.8	18.4	0.3	0.0	0.0
Post-1950	Cullen 1957; Coulsen and White 1958a, b; Coulsen 1961; Maunder and Threlfall 1972	588	2.0	13.1	76.9	10.0	0.0	0.0	0.0
Sabine's Gull (*Xema sabini*)									
Pre-1940	Egg sets	115	2.4	17.4	27.0	53.9	1.7	0.0	0.0
Swallow-tailed Gull (*Creagrus furcatus*)									
Post-1950	Harris 1970	>2000	1.0	99.9	0.1	0.0	0.0	0.0	0.0
Gull-billed Tern (*Sterna nilotica*)									
Pre-1940	Egg sets	141	2.9	2.8	23.4	61.0	12.4	0.0	0.7
	Glegg 1925	100	—	←	92.0	→	4.0	4.0	0.0
Caspian Tern (*S. caspia*)									
Pre-1940	Egg sets	282	2.2	12.8	53.5	33.0	0.7	0.0	0.0
	Conover 1983	691	—	←	99.1	→	0.9	0.0	0.0
Post-1950	U.S. colonies (Conover 1983)	5664	—	9.5	41.9	46.3	←	2.4	→
	Canadian colonies (Conover 1983)	1817	1.9	23.0	68.8	7.9	0.3	0.0	0.0
Royal Tern (*S. maxima*)									
Pre-1940	Egg sets	412	1.5	60.9	28.4	10.2	0.2	0.2	0.0
	Pemberton 1922, Bancroft 1927	73	1.0	98.6	1.4	0.0	0.0	0.0	0.0
Post-1950	Kale et al. 1965, Buckley and Buckley 1972	1245	1.0	98.3	1.7	0.0	0.0	0.0	0.0

APPENDIX
CONTINUED

Species	Source	No. nests	$\bar{x}$ Clutch-size	Frequency (%) 1-egg	2-egg	3-egg	4-egg	5-egg	+6-egg
Elegant Tern (*S. elegans*)									
Pre-1940	Egg sets	380	1.0	99.4	0.3	0.3	0.0	0.0	0.0
Post-1950	Gallup and Bailey 1960	30	1.1	93.3	6.7	0.0	0.0	0.0	0.0
Common Tern (*S. hirundo*)									
Pre-1940	Egg sets	548	2.7	9.8	23.5	56.0	8.9	1.1	0.5
	Mackay 1898, Witherby 1910, Rowan et al. 1918–1919, Marples and Marples 1934	3235	2.3	14.2	37.9	46.8	1.0	0.1	0.0
Post-1950	Vermeer 1967; LeCroy and Collins 1972; Lemmentyinen 1973a; Morris et al. 1976, 1980; Haymes and Blokpoel 1978	951	2.6	7.7	23.4	68.0	0.7	0.1	0.0
	R.O.M. reports*	5094	2.4	17.1	26.8	54.9	1.0	0.1	0.02
Arctic Tern (*S. paradisaea*)									
Pre-1940	Egg sets	347	2.2	11.5	55.3	30.8	2.0	0.3	0.0
	Bickerton 1912, Marples and Marples 1934, Pettingill 1939	401	1.7	38.9	54.6	6.5	0.0	0.0	0.0
Post-1950	Bengsten 1971; Joensen and Preuss 1972; Lemmetyinen 1973a, b; Coulson and Horobin 1976	1477	1.9	23.6	67.6	8.7	0.1	0.0	0.0
Forster's Tern (*S. forsteri*)									
Pre-1940	Egg sets	291	2.7	9.3	22.3	62.2	4.1	1.7	0.3

APPENDIX
CONTINUED

Species	Source	No. nests	$\bar{x}$ Clutch-size	Frequency (%)					
				1-egg	2-egg	3-egg	4-egg	5-egg	+6-egg
Sandwich Tern (*S. sandvicensis*)									
Pre-1940	Egg sets	281	1.3	77.6	15.7	6.0	0.7	0.0	0.0
	Bickerton 1912; Carroll 1917; Robinson 1930, 1934a; Marples and Marples 1934	5617	1.4	57.2	42.2	0.6	0.0	0.0	0.0
	Bunyard 1909	400	—	← 99.2 →		0.8	0.0	0.0	0.0
Post-1950	Ansingh et al. 1960	1150	1.1	95.0	5.0	0.0	0.0	0.0	0.0
White-fronted Tern (*S. striata*)									
Post-1950	Mills and Shaw 1980	180	1.2	81.0	19.0	0.0	0.0	0.0	0.0
Black-naped Tern (*S. sumatrana*)									
Post-1950	Brant 1962	118	1.0	99.2	0.8	0.0	0.0	0.0	0.0
Roseate Tern (*S. dougallii*)									
Pre-1940	Egg sets	241	2.3	3.7	62.7	29.9	3.3	0.4	0.0
	Mackay 1895, 1896, 1897a; Marples and Marples 1934	1088	2.0	28.1	45.4	24.5	1.7	0.2	0.0
Post-1950	Robertson 1964, Britton and Brown 1971, LeCroy and Collins 1972	825	1.5	54.2	45.1	0.5	0.2	0.0	0.0
Least Tern (*S. antillarum*)									
Pre-1940	Egg sets	644	2.3	5.6	59.3	34.6	0.3	0.0	0.2
	Tout 1947 (as cited by Hardy 1957)	28	2.3	21.4	39.3	32.1	7.1	0.0	0.0
Post-1950	Swickard 1972, Massey 1974, Napier 1978, Massey and Atwood 1981	798	2.0	14.9	66.5	18.3	0.1	0.1	0.0

APPENDIX
CONTINUED

Species	Source	No. nests	$\bar{x}$ Clutch-size	Frequency (%) 1-egg	2-egg	3-egg	4-egg	5-egg	+6-egg
Sooty Tern (*S. fuscata*)									
Pre-1940	Egg sets	669	1.0	97.5	1.8	0.3	0.3	0.1	0.0
	Watson 1908	≈9429	1.0	99.7	≈0.3	0.0	0.0	0.0	0.0
1940s	Sprunt 1948	"thousands"	1.0	99.7–99.8	0.1–0.3	0.0	0.0	0.0	0.0
Post-1950	Brown 1975	81	1.1	87.7	12.3	0.0	0.0	0.0	0.0
Black Tern (*Chlidonias niger*)									
Pre-1940	Egg sets	633	2.8	2.8	18.3	77.1	1.7	0.0	0.0
Post-1950	R.O.M. reports*	881	2.6	9.9	20.9	67.8	1.2	0.2	0.0
Brown Noddy (*Anous stolidus*)									
Pre-1940	Egg sets	294	1.1	96.6	1.4	0.7	1.0	0.3	0.0
Post-1950	Brown 1975	11,932	1.0	98.5	1.5	0.0	0.0	0.0	0.0

* Royal Ontario Museum (Ontario Nest Records Scheme).