

rumors in recent years. Ralph Morris (pers. comm.) saw none during an extended study of the seabirds of Little Tobago in 1975–76, but, to his surprise, encountered a single male in full display on 25 February 1981, close to the spot where we made our observations in 1979.

Single birds reared in isolation from conspecifics often form strong and persistent social bonds with their surrogate associates, using them as targets for species-characteristic displays in contexts of flocking, mating, and sexual activity. We can only guess what the post-fledging social environment of our displaying bird may have been, but with the colony in its terminal phase, possibly reduced to a single bird, opportunities for conspecific interactions must have been limited at best. We therefore speculate that the displaying oropendolas filled a gap in the social Umwelt of this individual, providing releasers for its innately programmed and motivated display movements. Superficially the Crested Oropendola is remarkably similar to the Greater Bird of Paradise in size, general coloration (rich browns and golden yellows predominating), vocalizations (raucous screeches and nasal calls), and even display movements (deep bows, spread wings, and forward tumbles). Birds of paradise, furthermore, are noted for a high frequency of misdirected displays and of hybridization in the wild and in zoos (Diamond, pers. comm.).

Oropendolas have been and remain abundant on Little Tobago, especially in the deciduous forest stands favored by the birds of paradise. Birds of paradise generally ignored and numerically dominant oropendolas on the islet (Dinsmore, M.S. thesis, Univ. Wisconsin, Madison, Wisconsin, 1967), but a single individual that strayed to Tobago in the early days of the colony was found associating with a flock of oropendolas (Baker 1923). Although birds of paradise dominated with mild but effective threat displays in all of four direct, between-species encounters observed by Dinsmore (1967), he speculated that behavioral interactions with oropendolas might become detrimental to the former as they, normally a lek species, decreased in numbers. French (pers. comm.) at one point suggested that oropendolas with their numerical dominance and similar displays might adversely affect the ability of birds of paradise to attract mates of their own species.

*Acknowledgments.*—We are grateful for information and suggestions to J. Davies, J. Dinsmore, R. French, R. George, R. Morris, and B. Worth.—JOHN T. EMLEN AND VIRGINIA M. EMLEN, Dept. Zoology, Univ. Wisconsin, Madison, Wisconsin 53706. Accepted 7 Mar. 1984.

*Wilson Bull.*, 96(3), 1984, pp. 483–488

**Nest spacing, colony location, and breeding success in Herring Gulls.**—In large-bodied, colonial-nesting *Larus* gulls, conspecific predation of eggs and chicks by neighbors represents a potential reproductive cost (Parsons, *J. Anim. Ecol.* 44:553–573, 1975). Egg and chick loss to neighbors can be substantial (Brown, *Ibis* 109:502–515, 1967; Parsons, *Br. Birds* 64:528–537, 1971), and such predation is particularly severe in high nest density areas (Hunt and Hunt, *Ecology* 57:62–75, 1976; Butler and Trivelpiece, *Auk* 98:99–107, 1981).

There are two principal differences between adjacent Herring Gull (*Larus argentatus*) colonies near Port Colborne, Niagara Co., Ontario, Canada. One colony (Canada Furnace) is on the mainland and nests are distributed over an area of about 4 ha. A nearby (0.6 km to the west) colony (Lighthouse) is insular and nests are concentrated on an elevated rock pile about 0.5 ha (see Morris and Haymes, *Can. J. Zool.* 55:796–805, 1977 for further details of the locations). Similar numbers of birds nest at each site (80–100 pairs in recent years) in association with Ring-billed Gulls (*L. delawarensis*). In 1981 we quantified the different

nest dispersion patterns at the two sites. We also obtained hatching and chick survival data for Herring Gull pairs that laid three-egg clutches during the egg-laying 'peak' at both locations. Our objective was to assess the probable influences of: (1) nest spacing pattern, and (2) colony location on these reproductive parameters.

*Methods.*—We used identical procedures at both colonies. Each location was visited daily from mid-April until early June 1981 and every 3 days thereafter. Eggs were marked when first found and their length and breadth measured to the nearest 0.1 mm with vernier calipers. The temporal distribution of clutch initiation was determined for all pairs at both locations.

Hatching and chick survival data were obtained for 23 pairs at Canada Furnace and 30 pairs at the Lighthouse. Each pair laid three-egg clutches during a 'peak' period of egg-laying in late April (see below). At Canada Furnace, most pairs ( $N = 16$ ) were on a boulder-covered shelf adjacent to Lake Erie or on a ridge next to a small, inland pond; the remainder ( $N = 7$ ) were on elevated knolls within a Ring-billed Gull colony. At the Lighthouse, each pair was within a 15-m radius of an observation blind. Nest checks for these pairs were carried out during the incubation and early brooding periods by walking to all nests. At the Lighthouse, a second observer was in the blind during nest checks and both observers remained in the blind for about 1 h after each visit. The purpose was to note the behavior of adults during and following our presence in the colony. Egg fates, hatching success, and chick losses were recorded during these visits until chicks in study nests were mobile. Thereafter, chick fates were determined from the blind (Lighthouse) or a portable platform (Canada Furnace) with the use of a spotting telescope. When chicks were not seen during two consecutive observation periods, a nest check was made to determine the fate of missing chicks. Chick fates were followed until the youngest chick within a brood was 21 days old.

Inter-nest distances of all Herring Gull pairs were measured at each colony in early August to avoid disturbance during the breeding season. At Canada Furnace, inter-nest distances were measured in the field for nests less than 15 m apart. More widely spaced nests were plotted onto a scaled aerial photograph of the site and inter-nest distances determined from the photograph. At the Lighthouse, inter-nest distances of all nests were measured in the field.

*Results.*—Ring-billed Gulls nested in association with Herring Gulls at both locations. At Canada Furnace, most of the 96 Herring Gull pairs were around the periphery of the Ring-billed Gull colony; the remainder were on elevated knolls within it. At the Lighthouse, all 87 Herring Gull pairs nested on an elevated rock pile immediately adjacent to the Ring-billed Gull colony. All Herring Gulls at both sites had another Herring Gull pair as their nearest neighbor.

*Nest dispersion patterns.*—A nearest-neighbor analysis (Clark and Evans, Ecology 35:445–453, 1954) showed that Herring Gull nests at Canada Furnace ( $N = 96$ ) were aggregated ( $R = 0.776$ ) while those at the Lighthouse ( $N = 87$ ) were evenly distributed ( $R = 1.26$ ). Each pattern was significantly different from random (statistic  $C = [CF] = 4.21$ ,  $C [LH] = 4.5$ ,  $P < 0.003$ ) and each was different from the other (ANOVA,  $F = 46.77$ ,  $P < 0.05$ ). Lighthouse pairs nested significantly closer to one another than Canada Furnace pairs (Mann-Whitney  $U$ -test,  $z = 19.45$ ,  $P < 0.0003$ ). The mean inter-nest distance ( $\bar{r}_A$ ) at Canada Furnace (12.11 m) was more than three times that at the Lighthouse (3.76 m).

*Timing of clutch initiation.*—The mean date of clutch initiation at Canada Furnace (28 April 1981,  $SD = \pm 7$  days) was not significantly different from that at the Lighthouse (30 April 1981,  $SD = 6.5$  days;  $t$ -test,  $P > 0.1$ ). While new clutches were laid through the end of May at both locations, more than half of the total number of clutches at each site ( $CF = 52\%$ ,  $LH = 56\%$ ) were initiated during a 9-day period of 22–30 April (Canada Furnace) and 27 April–5 May (Lighthouse). These dates were taken as the egg-laying 'peak' at each colony.

TABLE 1  
THE FATES OF HERRING GULL CHICKS THAT DIED OR DISAPPEARED BEFORE 21 DAYS OF AGE<sup>a</sup>

Colony site	Chicks lost (N)			
	Dead		Disappeared	Total
	Near own nest <sup>b</sup>	Near another nest		
Canada furnace	3 (11%)	9 (32%)	16 <sup>c</sup> (57%)	28
Lighthouse	13 <sup>d</sup> (68%)	2 (11%)	4 <sup>d</sup> (21%)	19

<sup>a</sup> Fifty-nine chicks hatched from 22, three-egg clutches at Canada furnace and 66 chicks hatched from 30, three-egg clutches at the lighthouse.

<sup>b</sup> Within 1.5 m of nest cup.

<sup>c</sup> 14 older than 4 days of age.

<sup>d</sup> All younger than 4 days of age.

The data which follow are based on the three-egg clutches noted earlier (CF = 23 pairs, LH = 30 pairs) that contained first eggs during the peak periods of egg-laying at each colony.

*Egg volume.*—Within-clutch comparisons of egg volume ( $V = LB^2 0.476$ ) for the 23, three-egg clutches at Canada Furnace (1st vs 3rd egg,  $t = 2.44$ ,  $P < 0.05$ ; 2nd vs 3rd egg,  $t = 2.75$ ,  $P < 0.05$ ) and the 30, three-egg clutches at the Lighthouse (1st vs 3rd egg,  $t = 3.79$ ,  $P < 0.05$ ; 2nd vs 3rd egg,  $t = 4.50$ ,  $P < 0.05$ ) showed that first and second eggs were significantly larger than third eggs. Comparisons of the volumes of first, second, and third eggs from clutches at Canada Furnace against their counterparts at the Lighthouse showed no differences (Mann-Whitney  $U$ -tests,  $P > 0.2$ ).

*Hatching and chick survival.*—One of the 23 clutches at Canada Furnace was destroyed by a rock slide. Hatching success of the remaining 22, three-egg clutches at Canada Furnace was marginally higher than that of the 30, three-egg clutches at the Lighthouse (number of clutches hatching 3, 2, 1 or 0 eggs, 1 and 0 eggs pooled,  $\chi^2 = 5.44$ ,  $df = 2$ ,  $0.1 > P > 0.05$ ). The primary factor contributing to egg failure at both colonies was addled eggs (CF,  $N = 4$ , 57%; LH,  $N = 15$ , 63%). The factor of second importance at Canada Furnace was eggs that “died” while pipping ( $N = 2$ , 29%) whereas, at the Lighthouse, it was eggs that disappeared before hatching ( $N = 4$ , 17%). No eggs disappeared at Canada Furnace.

Chick survival (to at least 21 days of age; Dexheimer and Southern, Wilson Bull. 86:288–290, 1974) at the Lighthouse ( $1.57 \pm 0.97$  chicks per pair) was significantly higher than that at Canada Furnace ( $1.41 \pm 1.08$  chicks per pair; Mann-Whitney  $U$ -test,  $z = -2.19$ ,  $P = 0.014$ ). The fates of chicks that failed to reach 21 days of age are shown according to known death or disappearance (Table 1). The distribution of losses due to these factors was significantly different at the two colonies ( $\chi^2 = 6.1$ ,  $df = 1$ ,  $P < 0.02$ ). Of chicks found dead at Canada Furnace, the majority ( $N = 9$ , 75%) were near nests other than their own. At the Lighthouse, the majority ( $N = 13$ , 87%) were found near their own nests. The difference in location of dead chicks was significant (Fisher test,  $P = 0.002$ ). Most chicks that disappeared at Canada Furnace ( $N = 14$ ) were older than 4 days of age; all those that disappeared at the Lighthouse ( $N = 4$ ) were younger than 4 days of age.

*Chick survivorship.*—Survivorship curves for chicks at the two sites are in Fig. 1. Chick losses at Canada Furnace occurred at a nearly constant rate over the 21 days after hatching, whereas at the Lighthouse, losses were highest in the 4 days following hatching. At Canada Furnace, eight (29%) chicks died or disappeared in the first 4 days after hatching; at

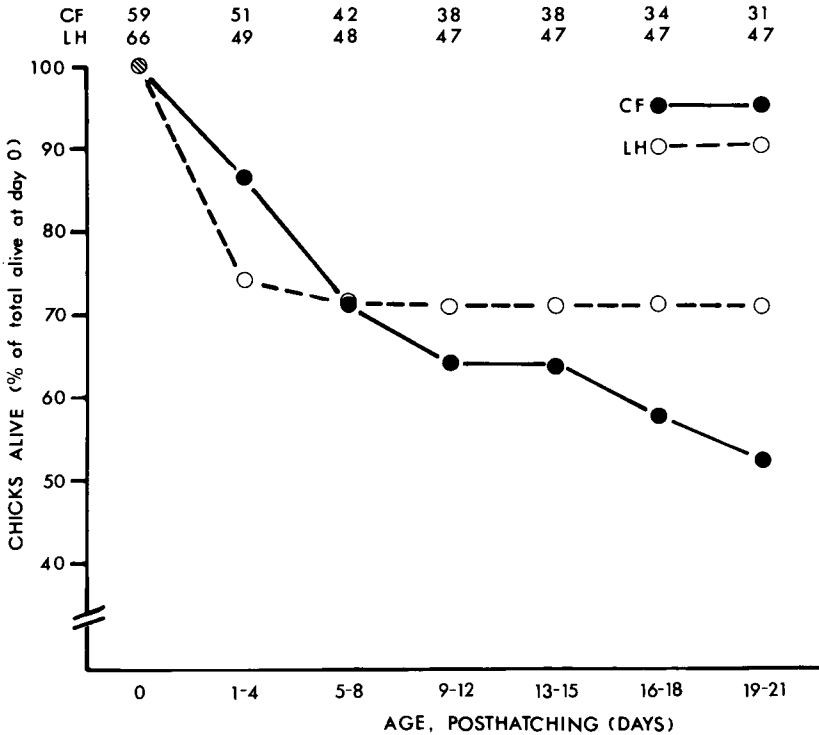


FIG. 1. Herring Gull chick survival through 21 days after hatching, for 22, three-egg clutches at Canada Furnace (CF) and 30, three-egg clutches at the Lighthouse (LH). The number of chicks alive at the start of each age class is shown at the top of the figure.

the Lighthouse, 17 (89%) chicks were lost during the same period. The rates of loss with respect to chick age (days) were different at the two sites (CF, linear regression,  $df = 6, r = 0.96, P < 0.05$ ; Lighthouse, negative exponential,  $df = 6, r = 0.71, P < 0.05$ ).

*Discussion.*—Differential breeding success of pairs within a larid colony can be explained by asynchrony in the seasonal timing of egg-laying (Coulson and White, Proc. Zool. Soc. London 136:207–217, 1961; Chardine and Morris, Ibis 125:389–396, 1983), clutch-size differences when clutches are initiated at the same time (Harris, Ibis 106:432–456, 1964; Brown 1967; Parsons 1975), age of parents (Davis, Ibis 117:460–473, 1975; Ryder, Wilson Bull. 87:534–542, 1975; Mills, Ibis 121:63–67, 1979), and nest location within a colony (Haymes and Blokpoel, Wilson Bull. 92:221–228, 1980; Pugsek, Behav. Ecol. Sociobiol. 13:161–171, 1983). In our between-colony study, we attempted to control for these confounding variables by restricting the comparison to selected pairs at each location. The pairs chosen were similar in their clutch-size, egg volume, and timing of clutch initiation.

Although numbers were small, more eggs disappeared at the Lighthouse than at Canada Furnace, a trend consistent with an earlier study (Morris and Haymes 1977). In 1981 more chicks were lost at Canada Furnace than at the Lighthouse. There were major differences

between the two colonies both in the age of chicks that disappeared, and in the age and location of dead chicks. At Canada Furnace, chick losses occurred at a constant rate over the 21-day post-hatch period, whereas, at the lighthouse, most chicks died or disappeared within 4 days of hatching.

Two factors likely contributed to these differences. First, Canada Furnace was on the mainland and people and dogs regularly trespassed through the site, often many times during a day (J. Bonisteel, pers. comm.). During these disturbances (several in our presence), mobile chicks scattered widely from their home nests and were attacked by other Herring Gull parents as they attempted to return. The constant loss of chicks from hatching to 21 days of age, and the greater number of dead chicks found away from their nest-sites, were likely related to these frequent disturbances. Conversely, at the Lighthouse, human disturbance was infrequent as the site is accessible only by boat. Furthermore, potential human intruders were hesitant to enter the colony as communal "mobbing" is common there. From our observations, this was not the case among the more widely dispersed pairs at Canada Furnace (cf. Anderson and Wiklund, *Anim. Behav.* 26:1207-1212, 1978).

Second, egg disappearance, chick disappearance prior to 4 days of age, and the large number of young chicks found dead near their own nests at the Lighthouse, implicate neighboring Herring Gull adults as the causative factor. Herring Gulls are known cannibals (Parsons 1971) and both cannibalism and attacks by neighbors are more likely to occur when nests are close together (Brown 1967; Hunt and Hunt, *Auk* 92:270-279, 1975). We suggest therefore that neighboring Herring Gulls were the primary factor contributing to both the death and disappearance of young chicks at the Lighthouse.

There are at least two alternative explanations for the differences in egg loss and chick survival patterns observed at the two colonies. These are: (1) differences in food availability, and (2) differences caused by investigator disturbance. Hungry chicks are particularly susceptible to attacks by neighbors (Hunt and McLoon, *Auk* 92:523-527, 1975). Although we have no data on food availability, shortages would be expected to have a similar impact on chicks at the two colonies as they are very close together and adults from them foraged in the same areas (see Morris and Black, *J. Field Ornith.* 51:110-118, 1980; Morris, unpubl.).

Investigator disturbance in seabird colonies has been implicated as a factor reducing both egg and chick survival (Robert and Ralph, *Condor* 77:495-499, 1975; Fetterolf, Wilson Bull. 95:23-41, 1983). We recognized this factor as a potential problem and chose pairs for the comparison (from those available as peak nesters) based on ease of investigator access. At Canada Furnace, nests were selected for visibility from a distance such that chick counts could be made with a spotting telescope. Closer approach to a particular nest was made infrequently and only when an obvious chick loss had occurred. At such times, chicks crouched in available rock cover adjacent to their nests. At the Lighthouse, pairs selected were all close to the observation blind and nest checks were usually unnecessary as dead chicks could be readily seen without leaving the blind. These procedures were designed to equalize negative effects of investigator disturbance. Our observations from the blind during and following nest checks at the Lighthouse, showed that mobile chicks also remained in the immediate vicinity of their nests, crouched among available rock cover. Adults at both locations always settled down and exhibited normal incubation and chick feeding behavior within minutes of our departure (cf. Chardine and Morris, Wilson Bull. 95:477-478, 1983). We think it unlikely, therefore, that the differences observed, particularly in chick survival data, can be explained either by differences in food availability or by differences in our activities within the colonies.

In Western Gulls (*L. occidentalis*), pairs whose chicks were killed by neighbors nested closer together than pairs that had no chicks killed (Hunt and Hunt 1975). In Glaucous-winged Gulls (*L. glaucescens*), high chick mortality due to conspecific aggression was most

common shortly after hatching and more frequent on small breeding territories than on larger ones (Hunt and Hunt 1976). In our study, the high incidence of young, dead chicks near their own nest at the Lighthouse suggests a higher risk there due to neighbor proximity. This is consistent with the observation that gulls nesting at high density fledge (on average) fewer chicks than pairs in low density areas (Butler and Trivelpiece 1981). However, while neighbor-interference was less frequent among the lower density Canada Furnace pairs, the pairs there apparently suffered excessive loss of mobile chicks because of easy access by humans and dogs to the mainland nesting location.

*Acknowledgments.*—We gratefully acknowledge the financial assistance of the Natural Sciences and Engineering Research Council of Canada (grant A6298 to R.D.M.). The logistic assistance of J. Bonisteel (lighthouse keeper) and C. Rutledge (marina operator) was greatly appreciated. M. Bidochka kindly helped with collection of some of the Lighthouse colony data. The manuscript benefited from the constructive comments of J. C. Barlow, J. Burger, J. Chardine, R. Knapton, and an anonymous reviewer.—RALPH B. SCHOEN AND RALPH D. MORRIS, Dept. Biological Sciences, Brock Univ., St. Catharines, Ontario L2S 3A1, Canada. Accepted 29 Feb. 1984.

*Wilson Bull.*, 96(3), 1984, pp. 488–493

**Nest-site selection and breeding biology of the Chipping Sparrow.**—Despite its extensive breeding range (Godfrey, *The Birds of Canada*, Natl. Mus. Can. Bull. 203, 1966) and frequent habit of nesting in man-made clearings, few studies of the breeding biology of the Chipping Sparrow (*Spizella passerina*) have been published. This study examines several aspects of Chipping Sparrow biology (e.g., chronology of the nesting cycle, breeding success, and nestling growth), and emphasizes relationships between nesting success and components of nest-site selection, such as nest height and orientation.

*Study site and methods.*—The study was done from 25 May–15 July 1981 and 25 May–8 July 1982 in Algonquin Provincial Park, Nipissing District, Ontario. Algonquin Park lies on the southern edge of the Canadian Shield in a transition zone between conifers typical of more northerly regions and southern hardwoods. White spruce (*Picea glauca*), white pine (*Pinus strobus*), and balsam fir (*Abies balsamea*) are dominants in the study area (see Maycock, *Ecology* 37:846–848, 1956, for a complete description of the local vegetation).

We located nests by observing adults during nest construction and by searching in suitable habitats. Nests were visited daily between 17:00 and 20:00. In 1981, nestlings were marked on their tarsi with a felt pen for individual identification, and each day we measured nestling weight, tarsus length (from tibiotarsus-tarsometatarsus joint to hallux), bill length (from anterior edge of nares to tip of culmen), and bill width (at anterior edge of nares). Adult measurements were based upon 30 specimens from Ontario in the collection of the Royal Ontario Museum (no difference between the sexes).

After the young had fledged, the heights of the nest and nest tree were measured or estimated, and orientation of each nest (i.e., the side of the tree in which it was built), was recorded. The nest was then collected and its composition analyzed.

For each nest, the percentage cover of each plant species within 1 m of the nest (including nest tree) was estimated. Nearby trees were characterized by the point-quarter method (Smith, *Ecology and Field Biology*, 3rd ed., Harper and Row, New York, New York, 1980). Within each quadrant, the distance from the nest to the nearest tree over 1 m tall was measured, the tree identified, and its height measured or estimated. (The nest tree was not included in the analysis.) A minimum height of 1 m was used because this was the lower