JUVENILE MORTALITY IN A RING-BILLED GULL COLONY

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COLONIAL sea birds are characteristically long lived once they have fledged, but the period from hatching to fledging is a critical one in which heavy mortality may occur. The nature and circumstances of juvenile mortality was one of the objectives of a study of nesting Ring-billed Gulls (*Larus delawarensis*) made on Green Island in Mackinack Straits, Michigan, in July of 1952 by Mr. Carl Jacoby and the author. Supplementary observations were made by the author in June, 1953, and June, 1955.

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Green Island in 1952 was a narrow "J"-shaped sand and gravel bar about ½ mile in length, covered for the most part with a dense growth of grasses and shrubs. The main part of the island was inhabited by Herring Gulls (*Larus argentatus*) whose nests were scattered at intervals of two to ten meters among the grasses, weeds and driftwood behind the beaches. An oval-shaped area constituting the hook of the "J" was occupied by a nesting colony of about 850 pairs of Ring-billed Gulls crowded into a space of about 1200 square meters with nests often only about 0.45 meters apart (center to center). The central part of the Ring-bill colony was essentially without bushes, and by July the grass vegetation had been heavily trampled and puddled by the birds. A broad zone of low scrubby bushes of *Cornus stolonifera* with a moderate understory of grasses (*Elymus canadensis*) surrounded this central barren.

Casual observations made on walking through the colony on July 2 revealed many dead chicks of various sizes and in various stages of decay. In order to quantitate this mortality, four plots each three meters on a side were staked out at representative points in the colony. Blinds were set up at the edge of two of these plots for direct observation of the birds. A number of chicks resident in the plots were painted on the legs for individual identification, and adults were sprayed with colored India ink shot from a water pistol by the observer in the blind. Dead chicks were collected from the plots, counted, and measured for rough age determination.

STATISTICAL RESULTS

A total of 37 dead chicks was collected from the 36 square meters of the four plots. Since territory size on 20 square meters watched from blinds during the incubation stage (1953) averaged 1.2 square meters, the number of initial territories present on the four plots in 1952 was about 30, and the indicated juvenile mortality was approximately 1.25 birds per territory. A plotting of the size distribution of these dead birds as measured by tarsal

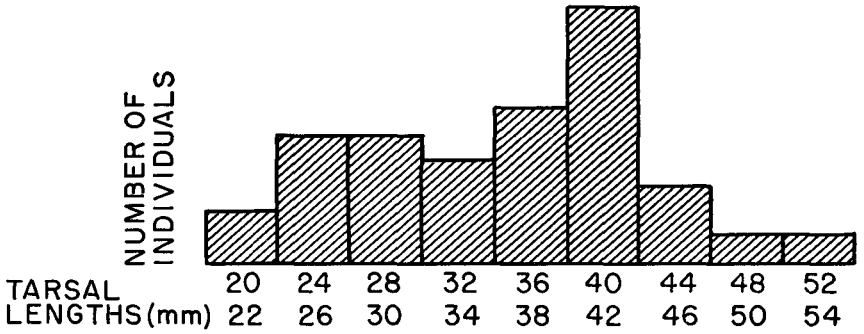

FIG. 1. Representation of age categories (by tarsal length) among Ring-billed Gull chicks picked up dead in the nesting colony.

length (Figure 1) indicates a distributed mortality with the greatest losses occurring in the middle size group, birds which were large enough to wander from the home territory but too small to protect themselves effectively. On the basis of this mortality curve it seems likely that deaths subsequent to our check (determined as at approximately the two-thirds point of the nesting stage) amounted to about five birds on the 36 square meters bringing the estimated total of deaths of juveniles on this area to 42, and the mortality per original territory to 1.40 for the season. This is actually a minimum figure since it excludes all deaths for which the carcasses were removed or obliterated by scavengers; Herring Gulls were observed to eat a number of Ring-bill chicks at the colony edge, and adult Ring-bills themselves were suspected of occasional cannibalism. Thus the actual figure probably approximates or exceeds 1.50.

Surviving chicks were estimated on July 5 and July 11, 1952, on the basis of observations made from blinds on 16 territories. The number of young birds on these 16 territories was 21, an average of 1.3 per territory. One of these had 3 young, three had 2 and twelve had 1. The absence from this tally of territories with no young is no indication that complete brood loss does not occur, since destitute parents apparently abandon their territories and do not return to build new nests as has been reported for the Herring Gull by Paludan (1951). The increase in average territory size in the colony center from 1.2 square meters during incubation (June, 1953) to 2.0 in the latter part of the nestling stage (July, 1952) is thought to reflect the occurrence of such nest failures. If we assume that complete losses of this order of magnitude did occur in 1952 before our counts were made, the 21 chicks recorded actually represent the survival of $\frac{2.0}{1.2} \times 16$, or 27 instead of 16 pairs. This survival should be further revised on the basis of mortality occurring in the last one-third of pre-fledging life, after our

TABLE 1

NESTING SUCCESS AT THE GREEN ISLAND RING-BILLED GULL COLONY IN 1952

	No. of pairs (out of 100)	Eggs Produced a	Eggs Hatched	Chicks Fledged	Eggs Lost	Chicks Lost
	A	B	C	D	E	F
Successful	60[b]	180[c]	?	67 (37%)	?	?
Unsuccessful	40[b]	120[c]	?	0	?	?
Total	100	300[c]	217[e]	67[d] (22%)	83[f]	150[d]

a—Refers to the final clutch when re-laying occurs.

b—Based on increase in territory size of persisting pairs from 1.2 square meters in egg stage to 2.0 square meters in nestling stage.

c—based on an assumed clutch size of 3.0.

d—Measurements made on sample plots.

e—Sum of totals of columns D and F.

f—Difference between columns B and C.

checks were made. According to our data in Figure 1, this would amount to about three birds. Actual survival to fledging in the colony in 1952 was thus apparently in the order of $^{18}/_{27}$, or 0.67 young birds per pair that started the nesting season.

No data are available on clutch size in the Green Island colony in 1952, but it was 2.9 in 1953 (20 nests, mostly in mid- or late-incubation). Full clutches are recorded in the literature as generally 3. The occasional clutches of 2 may often result from losses during incubation, and the rare reports of 4, 5 or 6 may well represent irregular deposition in nests by more than one female. Our findings of about 1.50 deaths and 0.67 survivals per pair seem to indicate a hatch of about 72 per cent of eggs laid (assuming a clutch of 3.0) and a survival to fledging of about 22 per cent of eggs laid and 31 per cent of eggs hatched. Within the group which was successful in raising at least one chick the survival to fledging was 37 per cent of eggs laid (Table 1). Repeat laying is known to occur in several species of gulls after loss of the first set, and our figures must be interpreted as representing survival from the eggs of the final clutch if and when more than one was produced.

OBSERVATIONS ON BEHAVIOR

A strong development of territorial defense in these birds seems to account for most of the mortality observed. A detailed mapping of territories on the plots watched from blinds indicated that, until their chicks were fledged, each pair of adult Ring-bills vigorously defended a territory around the nest site against all intruders, both young and old. Even small chicks trespassing within these bounds were vigorously attacked and in many instances killed directly. Older chicks took part in the territorial activity, attacking

other young birds and even adults much larger than themselves. Trespassers were almost invariably subordinate in these encounters and retreated submissively.

Territorial boundaries remained definite and were well recognized by both owners and neighboring residents long after the young had hatched and scattered or trampled the crude nest into obliteration. Generally, at least one member of a pair was on hand, but there were many occasions when both birds were absent and the territory left undefended. At such times, neighboring adults characteristically extended their proprietary activity to include the temporarily deserted area, and in so doing frequently attacked the resident young birds. The first adult birds to return after a general exodus from the colony (as when flushed by the observer) freely occupied and defended an area encompassing as many as three or four adjacent territories until their neighbors had returned and claimed their own. Under such circumstances confusion reigned, and chicks were obliged to crouch or be severely buffeted until their parents returned.

The frequency of attacks increased as chicks became more independent and wandered beyond the boundaries of the parents' territories. Half-grown chicks often wandered off voluntarily, especially when their territories possessed no shade, to gather with others of similar age into groups of a dozen or more individuals under the bushes. However, feeding by the parents generally, if not invariably, took place on the home territory, and the chicks were often obliged to run a gauntlet of vicious attacks through three or four territories before reaching home. The greatest mortality occurred at this stage. Older chicks wandered much farther afield, even swam as much as 100 meters out into the lake for periods of four hours or more. Homing orientation developed concurrently and the return trip often involved the traversing of considerable stretches of occupied territory in which attacks were frequent and vicious. By this time, however, the birds were better able to care for themselves and fatal injury was apparently infrequent (Figure 1).

Aside from the infanticide described above, the only agent of mortality detected was the Herring Gull. The two gull species had divided the island between them, and segregation was complete except for a few Herring Gulls which periodically established beach-heads along the shore line bordering the Ring-bill colony. These birds wandered back and forth along the beach, occasionally penetrating a few feet inland and snatching any Ring-bill chicks which ventured within their reach. We watched about half-a-dozen chicks being killed in this way, but do not believe it was a major factor in the total mortality. In 1953 one pair of Herring Gulls actually established a territory at the edge of the Ring-bill colony and destroyed a considerable number of chicks. It is interesting and perhaps significant that Herring Gulls

characteristically ate chicks which they killed or found dead, while Ring-bills were never observed to eat the chicks they killed.

The general picture of chick destruction here depicted is similar to the situation described by Kirkman (1937) in the Black-headed Gull (*Larus ridibundus*), which, like the Ring-bill, nests in crowded colonies. Similar, though perhaps less severe, persecution of young is apparently characteristic of various other species of gulls.

Discussion

The production of 0.67 fledged young per breeding pair in the Green Island Ring-bill colony would at first appear to be low and perhaps to suggest abnormal conditions for survival. Data on adult mortality rates could provide a basis for evaluating this production by indicating the recruitment rate necessary to maintain the population. Published analyses of banding data on this species (Ludwig, 1943) are, however, inadequate for these purposes.

Although we lack the necessary data for evaluating fledging rates in the Ring-bill, it is profitable to examine the available records for the closely-related Herring Gull. Studies of nesting success in Maine by Paynter (1949) revealed a fledging rate of slightly less than 1.0 birds per nesting pair. In Europe Paludan (1951) obtained figures of 0.5 or less in Denmark; Darling (1938) had 0.78 in his studies in 1936 and 0.96 in 1937 in Scotland; Lockley found a production of less than 0.33 fledgings per pair on Skokholm in Wales.

Marshall (1947), Paynter (1947, 1949), Paludan (1951) and Hickey (1952) have analysed banding returns on the Herring Gull for information on adult mortality and population turnover rates. Their results have been distressingly variable. In general the American studies have produced results which call for recruitment rates in the order of 1.0 to 1.5 per breeding pair per year, while Paludan's studies of birds banded in Denmark show lower adult mortality and hence imply lower recruitment rates. Paludan demonstrates that with the 15 per cent annual mortality of adult gulls from Denmark, each nesting pair would have to produce only 0.5 to 1.0 fledglings per year to maintain the population. Hickey (1952) in evaluating the discrepancies between results obtained by American and European workers proposes that the differences are at least in part attributable to the inferior wearing qualities of the American bands, and concludes that the Danish figures are more reliable. However, Paludan (1951) questions this interpretation because of the similarities of shape of the two mortality curves. In any event, our fledging rate of 0.67 per year for the Green Island Ring-bill gull chicks does not appear to be far out of line with the performance of at least some populations of Herring Gulls.

Even though the fledgling survival of the Green Island colony be essentially normal, it is profitable to speculate on factors affecting the chick mortality. Young Ring-bills seem to be able to absorb a great deal of physical punishment, but any extraneous factor which might serve to accentuate the aggressive attacks of territorial defenders or to lower the resistance of the chicks might have serious effects on survival of juveniles. Two such factors appear to contribute importantly to the infanticidal destruction of young birds in the Green Island colony. These were: 1) scarcity of shade in the central area, and 2) disturbance of territorial stability by nonavian intruders.

As already noted, nearly all of the grassy vegetation present in the central part of the colony at the beginning of nesting was obliterated by early July through puddling and trampling by the nesting birds. The flats exposed by this denudation were largely abandoned by chicks almost as soon as they could walk, and were quite uninhabited during the intense heat of mid-day. Recently-hatched chicks in one nest close to a blind succumbed after three hours of direct exposure to the noon-day sun and were subsequently pecked and tossed aside. Young birds only a few days out of the egg sought the shade of nearby bushes and the associated grass tufts when their parents were away; they commonly crowded into the shade of our blinds and even crawled into them under the sides. Aside from the occasional direct death, the effects of this exposure to intense solar heat would undoubtedly weaken the birds and reduce their resistance to the rough treatment they receive as they return home.

Also important were the effects of disturbances of territorial stability caused by human intruders. Young birds of all ages readily leave their territories on disturbance and may be driven from their homes for distances of many meters. The return of the adults may be inordinately prolonged by the continued presence of the intruder, but more important, the young are eventually obliged to return through a series of territories occupied by vicious defenders. Many of the young, indeed, may fail to find their way back at all. Of six medium-sized chicks painted for individual recognition and released on their home territories as I entered the colony on June 10, 1955, none returned the same day and four failed to return the second day. It is conceivable that these birds were fed by other adults elsewhere in the colony, but no evidence of such behavior was observed near the blinds. It is likely then that the disturbance created by our own intrusion into the colony significantly contributed to the mortality as here reported.

Summary

Juvenile mortality was measured, and mortality factors were studied, in an island colony of 850 pairs of Ring-billed Gulls in northern Michigan.

Thirty-seven carcasses of dead juvenile gulls were collected in plots cover-

ing 36 square meters of the colony area, indicating a total mortality, when corrected for subsequent deaths, of about 1.50 chicks per nesting territory. All size classes were represented among the carcasses collected, but the highest mortality apparently occurred in middle-sized birds, those large enough to move away from the nest but too small to defend themselves effectively against adult attack. Counts of chicks on two study plots revealed about 0.67 survivors per territory at fledging. Comparison with published data on the Herring Gull suggests that this low production rate may be adequate to maintain the population and hence normal for the species.

Vigorous defense of the small, tightly-massed territories against both young and old intruders was the direct cause of the great majority of juvenile deaths. Predation by Herring Gulls was a secondary factor.

Wandering of young from their territories during the absence of the parents indirectly contributed to juvenile mortality by necessitating returns for feeding through the defended territories of other birds. Destruction of shading vegetation and intrusion of the colony by human observers induced forced movements of chicks and thus aggravated the conditions producing mortality.

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