HATCHING SUCCESS OF GREAT BLACK-BACKED GULL EGGS TREATED WITH OIL

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INTRODUCTION

Oil pollution of aquatic environments has direct effects on local bird populations. Indeed, fouling by oil and ensuing death from exposure (Bourne, 1968) plus lethal and sublethal pathological consequences of ingesting oil are well documented (Hartung and Hunt, 1966; Croxall, 1977; Miller et al., 1978).

Although the direct effects of oil contamination are most obvious, indirect effects may be as critical to bird populations. Ingestion of oil by seabirds before nesting can cause reduction or temporary cessation of laying (Hartung, 1965; Grau et al., 1977). Transfer of oil from plumage or feet of the adults to the eggs may likewise reduce hatchability and productivity (Hartung, 1965). Coating an egg with oils reduces or prevents hatching (Gross, 1950; Hartung, 1965; Kopischke, 1972). Recently, however, even microliter amounts of oil applied to the eggshell have been shown to reduce drastically embryo survival (Albers, 1977; Szaro and Albers, 1977; Albers and Szaro, 1978; White et al., in press). Embryonic mortality is most severe when oiling occurs very early in development, with embryos becoming more resistant as they near hatching (Szaro and Albers, 1977; Albers, 1978).

Previous studies have determined survivorship of embryos after external application of oil to the egg surface, either in incubators or in the nest colony, at about one week post-treatment. A more complete measure of the effect of oil on embryonic survival and egg hatchability can be obtained by observing the fate of eggs through normal incubation and hatching. The purpose of this study was to measure under field conditions the effects of small quantities of oil on the hatchability of Great Black-backed Gull (*Larus marinus*) eggs.

METHODS

During May and June 1977, 60 nests of *Larus marinus* were studied on Appledore Island, Isles of Shoals, Maine. Nests containing two or three eggs were marked with numbered stakes, and all eggs were marked at both ends with a nontoxic indelible marker (Coon et al., in press). In 30 randomly selected nests all eggs were treated with 20 μl of No. 2 fuel oil (API Reference oil III). Four 5 μl droplets were applied to the top side of each egg as it lay in the nest. The remaining 30 nests served as controls.

Because Albers (1978) found that Mallard (*Anas platyrhynchos*) embryos were most sensitive to oiling before day 10 of incubation, efforts were made to conduct this study when most eggs in the colony were between 1 and 10 days old. Calculations based on nesting onset (McGill, 1977)

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TABLE 1.
Effect of No. 2 fuel oil on Great Black-backed Gull eggs.

Fate	Percentage of eggs[1]		
	20 μl	Control	1976[2]
Normal hatch	24 (21)[3]	78 (64)	76 (320)
Addled or dead			
Little or indetectable development	36 (31)	8 (7)	7 (27)
Considerable embryonic development	4 (3)	0 (0)	
Died during hatching	4 (3)	2 (2)	1 (3)
Lost during hatching period[4]	2 (2)	6 (5)	10 (47)
Unknown[5]	30 (26)	6 (5)	6 (26)
Totals	100 (86)	100 (83)	100 (423)

[1] Percentage of eggs and in () number of eggs in each category.
[2] From McGill, 1977.
[3] Significantly different from control ($\chi^2 = 44.8$, $P \leq 0.01$, d.f. = 1).
[4] Disappeared from nest at time it should have hatched, but no shell or chick found.
[5] Disappeared from nest between treatment and first visit during hatching time.

indicated that on 6 May, the day of treatment, approximately 95% of the gull eggs would be in this age group.

At hatching time, all nests were checked daily during mid-day. On each visit, the numbers of remaining eggs or chicks were recorded. Visits were continued until 7 June, when all eggs were hatched or determined to be addled.

RESULTS AND DISCUSSION

Of the 60 nests marked, 29 of the control and all 30 of the treated nests were relocated at hatching time. Treatment with No. 2 Fuel oil significantly affected the hatchability of eggs in the nests (Table 1) ($\chi^2 = 44.8$, $P \leq 0.01$). A 69% reduction in hatching success occurred among the treated eggs; 78% of the 83 control eggs hatched, while only 24% of the 86 treated eggs hatched. Data from a previous year for untreated eggs in the same colony show the same high hatchability (Table 1). Among both control clutches and clutches in 1976 more than two chicks hatched per nest, whereas among oil-treated nests only 0.7 chicks hatched per clutch.

Among the eggs that did not hatch, marked differences in their fates were found. Only 8% of the control eggs, compared with 40% of the treated eggs, were found addled. Of the latter nearly all embryos died early in development. While 30% of the treated eggs disappeared from the nest and surrounding area between treatment and the first visit at hatching time, i.e. their fates were unknown, only 6% of the control

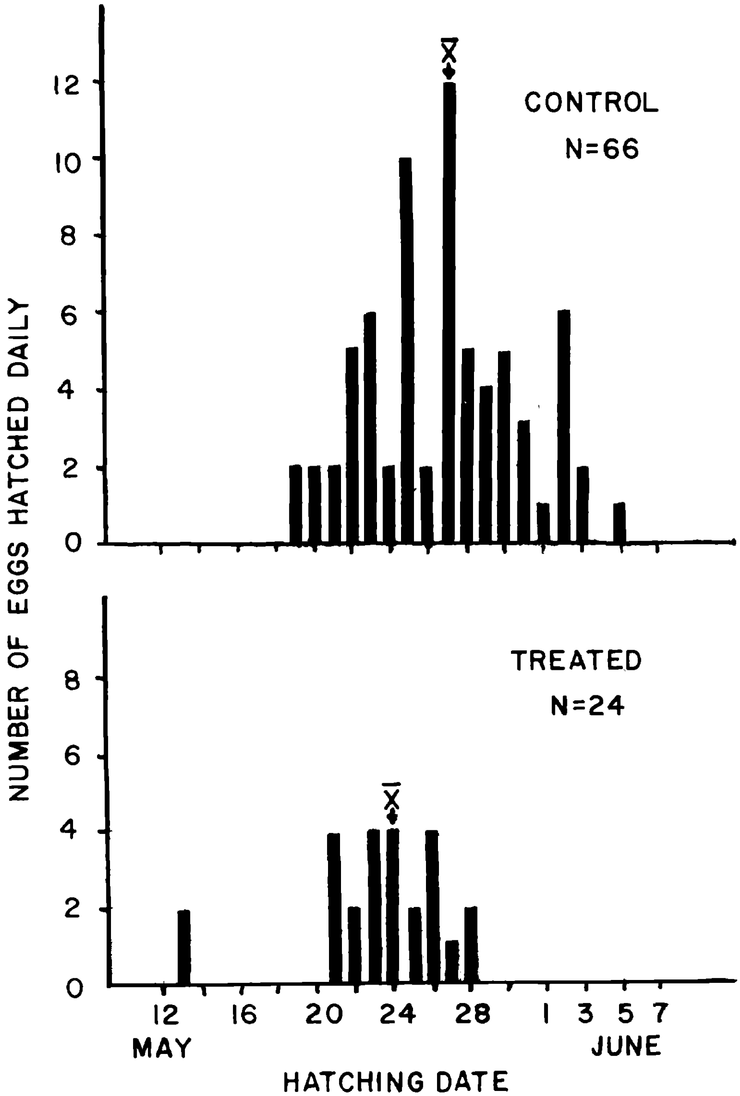

FIGURE 1. Hatching dates of control vs. treated Great Black-backed Gull eggs. Hatching dates were recorded for all chicks that hatched alive or that died during hatching. Chicks that hatched prior to 26 May, 24.4% of the 85 treated embryos and 32.5% of the 85 control embryos, were nine or more days of age at treatment (see text for explanation of determining age at treatment).

eggs disappeared during this interval. All fates of control eggs were again similar to the fates of untreated eggs in a previous year.

The only known difference between treated and control eggs was the oil treatment. Therefore all factors affecting mortality including weather, predation, accidental mishaps, and inappropriate parental behavior were assumed to affect both groups equally. The marked increase in disappearance of treated eggs before hatching might have resulted from early embryonic mortality and subsequent cracking or increased cannibalism of the oiled eggs.

The range of successful hatching dates for control and treated eggs is shown in Figure 1. The mean hatching date for untreated eggs was 27 May, whereas the mean hatching date for oiled eggs was 24 May. Age at time of treatment was calculated by backdating 29 days, the average length of incubation (McGill, 1977); thus only ages for embryos that survived to hatch could be calculated. The mean age at treatment for the control eggs was 7.9 days. Use of the same backdating procedure indicated that embryos that hatched from oiled eggs were 11.4 days old at treatment. Coon et al. (in press) reported a comparable two-to-three-day age difference after backdating from hatching dates of artificially incubated control and treated eggs.

Because treated and control nests were chosen randomly and were intermixed throughout the colony, the age distributions at treatment time of the two groups were expected to be the same. The apparent difference in age at treatment was probably not due to an actual difference in age, but reflects the death of most if not all of the younger aged oil-treated embryos. The skewed hatching dates and the abrupt termination of hatching among treated eggs compared to the wider spread of hatching dates among control eggs (Fig. 1) suggests a critical age for gull eggs below which the embryo will be killed by oil contamination and above which the embryo is likely to survive. Based on backdated ages all eggs that were oil-treated and survived to hatch were at least seven days old, and most were at least nine days old (i.e. hatched by 26 May), at the time of treatment. Thus the critical minimum age for these embryos to survive oiling seems to be about nine days. Nevertheless, oil treatment apparently causes some mortality even after the egg is nine days old; among eggs treated after nine days, 8% fewer treated eggs than control eggs hatched.

For Great Black-backed Gulls, the indirect effects of oil contamination are potentially a more serious threat to population stability than direct effects which lead to adult mortality. Although gulls are rarely killed by direct exposure to oil they frequently do become lightly oiled (Bourne, 1968), taking up to four weeks to rid themselves of oil (Dixon and Dixon, 1976). Thus, if oil contamination occurs early in the breeding season, the possibility of transferring oil to the eggs is high. Among Great Black-backed Gulls, if all embryos die early in incubation but the eggs remain intact in the nest, no second clutches of eggs are laid. Moreover, among pairs that lose all their eggs, renesting attempts are irregular, delayed, and often abandoned (McGill, unpubl. data). Thus, in addition to increasing the number of nonproductive pairs, oil contamination is quite likely to increase the number of partially productive pairs because as long as even one egg remains in a nest, renesting does not occur. Reduction in both the number of pairs with viable eggs and the number of viable eggs among remaining clutches, coupled with a typically low posthatching survival of gull chicks (McGill, 1977), can seriously reduce the reproductive output of gull colonies along the coast.

The dramatic results of this study of one species during a single reproductive season clearly indicate the need for an expanded research effort aimed at the critical questions of inadvertent oiling of eggs and/or chicks by parents, effects of types and amounts of oil on reproductive success in other species, and potential for population disruption of marine-nesting birds by oil contamination.

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