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No. 2 Fuel Oil Decreases Embryonic Survival of Great Black-Backed Gulls

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The great black-backed gull (*Larus marinus*) is widespread in the northern hemisphere, breeding south to Britain and Ireland on the European side of the Atlantic and to Long Island in the United States where populations have increased markedly during the last 50 years (DRURY 1973). With growing exploitation of oil resources, seabird populations are being increasingly threatened by accidental oiling of individuals and the subsequent contamination of their eggs and young. It is generally agreed that gulls and terns, which spend much of their time airborne, are less vulnerable to oil pollution than alcids and seaducks (BOURNE 1968, VERMEER AND ANWEILER 1975). Nevertheless, oiled great black-backed gulls were sighted after the *Argo Merchant* spill off Nantucket Island in December 1976, demonstrating that this species of gull can be affected by surface oil (GROSE AND MATTSON 1977). In this paper we wish to report results of two concurrent studies in which eggs of the great black-backed gull were externally contaminated with No. 2 fuel oil.

MATERIALS AND METHODS

Great black-backed gull colonies were located on Appledore and Smuttynose Islands, Isles of Shoals, Maine, during early May 1977. Ninety nests on Appledore Island were randomly assigned to three groups of 30. Each nest was marked with color-coded, numbered, plastic bird bands attached to lengths of wire inserted in the ground near the nest. Vegetation was not high enough to hinder relocation of nests. Eggs were marked on both ends with a waterproof marking pen for later identification. (We had previously used the same type of pen on mallard {*Anas platyrhynchos*} eggs and found its ink to be non-toxic.) Clutches in two groups were treated with either 5 µl or 20 µl of No. 2 fuel oil (API Reference Oil III). Clutches in the third group served as controls. The oil was applied by microliter syringe on the side of each egg as it lay in the nest. The 5 µl application was made at one location and the 20 µl application was made at four locations of 5 µl each (ALBERS 1977).

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We returned to Appledore Island 8 days later, opened all eggs in the three groups, and recorded the number of live and dead embryos. Eggs that did not contain visible embryos were presumed to have died very early in incubation. We assumed that the three groups would contain the same proportion of infertile eggs, and that this proportion would be low on Appledore Island (unpublished work of P. McGill).

Two hundred twenty-five great black-backed gull eggs were also collected from Smuttynose Island during our first visit and immediately transported to the Patuxent Wildlife Research Center, Laurel, Maryland, where they were artificially incubated within 18 hours of collection at 37.5° C and 55% relative humidity. After 36 hours in the incubator, No. 2 fuel oil was applied to two groups of 64 randomly selected eggs in 5 µl and 20 µl amounts. A third group of 64 eggs served as a control. Oil was applied in the laboratory as described above. All chicks were weighed and examined for gross external malformations within 24 hours of hatching. The age at treatment for chicks that hatched was estimated assuming an incubation period of 28 days (unpublished work of P. McGill). After 30 days all remaining eggs were opened and the embryos assigned to three broad age categories (1-9, 10-18, and 19-27 days of development).

RESULTS AND DISCUSSION

Of the 90 clutches marked on Appledore Island, 28 of the control, 26 of the 5 µl and 25 of the 20 µl No. 2 fuel oil-treated clutches were relocated (Table 1). The clutches treated with 20 µl of oil per egg had significantly ($P < 0.05$) poorer survival at 8 days post-treatment than the control clutches. Survival rate did not differ between control and 5 µl-treated clutches. In a similar study also done during spring 1977 in Maine (ALBERS AND SZARO in press), clutches of naturally-incubated common eider (*Somateria mollissima*) eggs treated with 20 µl of No. 2 fuel oil had significantly poorer survival than control clutches.

Both the 5 µl and the 20 µl oil applications significantly ($P < 0.05$) reduced hatchability of the artificially incubated eggs (Table 2). There was significantly ($P < 0.05$) more embryonic mortality in the 20 µl group during 1-18 days of incubation and in the 5 µl group at 10-18 days of incubation than in the control group. Eggs were not candled prior to treatment; consequently our best estimate of age at treatment is based on the back-calculated age of the control eggs that hatched. The mean age (±S.E.) at treatment of the hatched controls was 9.5 ± 0.75 days. The large number of control embryos that died within the first 9 days of development suggests that this age at treatment may be a high estimate. The mean ages at treatment of 5 µl-treated and 20 µl-treated eggs that hatched were at least 2 to 3 days older (11.4 ± 0.73 and 12.9 ± 0.82) than the hatched controls. This

TABLE 1

Embryo survival in naturally-incubated great black-backed gull eggs 8 days after treatment with No. 2 fuel oil

	No. of clutches	Survival Index	No. of eggs	Condition of embryo		
				Alive	Dead	Percent alive
Control	28	95.8	81	72	9	88.9
No. 2 fuel oil (5 µl)	26	90.3	72	58	14	80.6
No. 2 fuel oil (20 µl)	25	32.7*	72	29	43	40.3

Most clutches contained three eggs; however, some contained only two at the time of treatment. For each clutch, a percentage of the total embryos alive 8 days after treatment was computed. Clutch survival data were evaluated statistically after angular transformation, arcsin $\sqrt{X}$. This transformation is applicable to binomial data expressed as percentages and covering a wide range of values (STEEL AND TORRIE 1960). The Survival Index reported can be described by the following expression $(\sin(1/n\ \Sigma\ \arcsin\sqrt{\%}))^2$ and is a transformation back to the original scale. Statistical comparisons were made on the transformed scale, rather than on the reported values.

*Significantly different from control, $P < 0.05$ (Student's *t* test).

supports the earlier conclusions of Szaro and Albers (SZARO AND ALBERS 1977, ALBERS in press). Their studies with mallards and common eiders indicated that hatchability of oil-treated eggs increases as the age of the embryo at treatment increases. There were no significant differences in hatching weights, nor were there obvious morphological abnormalities in the chicks.

This study supports our previous work with mallards and eiders, and extends our generalization that microliter amounts of oil applied early in incubation will decrease the hatchability of eggs of a variety of species of birds (ALBERS 1977, ALBERS in press, ALBERS AND SZARO in press, SZARO AND ALBERS 1977, SZARO et al. in press). A subsequent study has demonstrated that

TABLE 2

Hatchability and embryonic mortality in artificially-incubated great black-backed gull eggs treated with No. 2 fuel oil. There were 64 eggs in each group.

	Control		No. 2 fuel oil			
			5 µl		20 µl	
	N	%	N	%	N	%
Dead, 1-9 days	11	17.2	15	23.4	26	40.6*
Dead, 10-18 days	1	1.6	13	20.3*	18	18.1*
Dead, 19-27 days	3	4.7	5	7.8	4	6.3
Dead, pipped	3	4.7	3	4.7	3	4.7
Alive, hatched	46	71.9	28	43.8*	13	20.3*

*Signficantly different from control, $P < 0.05$ (Chi-square test).

eggs of Louisiana herons (*Hydronassa tricolor*), sandwich terns (*Thalasseus sandvicensis*), and laughing gulls (*Larus atricilla*) are also sensitive to the embryotoxic effects of No. 2 fuel oil (WHITE et al. in press). In addition, we believe that our artificial incubation experiment demonstrates the usefulness of laboratory methods in predicting the effects of environmental contaminants on bird productivity.

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