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Weathered Oil: Effect on Hatchability of Heron and Gull Eggs

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Marshes along the Gulf of Mexico are essential nesting and breeding areas for many species of waterfowl. With increasing amounts of exploration and transport of petroleum along the Gulf coast has come a greater risk of contamination of these coastal marshes from an oil spill. The effect which spilled oil can have on waterbirds is well documented; each year great numbers of marine birds die as a result of oil spills (BOURNE et al. 1967, ALDRICH 1970, VERMEER & VERMEER 1974, OHLENDORF et al. 1978). Most mortality is immediate and obvious, and occurs within a few days after the spill. The probable cause of death is either exposure or resulting toxic effects from ingestion of the oil.

Oil pollution also may effect waterbird populations by impairing reproduction. Several field and laboratory studies have shown that microliter quantities of fresh oil applied to the eggshell surface will cause death of the embryo (ALBERS 1977, ALBERS & SZARO 1978, WHITE et al. 1979). Birds exposed to sublethal quantities of oil during the nesting season can transfer the oil from their feathers to their eggs causing failure of the eggs to hatch (KING & LEFEVER, in press). A single 200 mg oral dose of Bunker C oil, an amount birds might easily ingest by preening oil feathers, lowered the number of eggs laid and reduced hatchability of Japanese quail, *Coturnix coturnix japonica*, (GRAU et al. 1977).

Contact with weathered oil seems more likely for waterbirds than contact with fresh oil; however, the effects of weathered oil on embryo survival have only partially been explored. Results of one study showed that 20 µL of 4 week-old crude oil applied to the eggshell surface caused a significant decrease in embryo survival of mallard (*Anas platyrhynchos*) eggs (SZARO et al. 1979). In that study, oil was weathered under laboratory conditions using fresh water. To our knowledge, there have been no tests to determine the effects on egg hatchability of oil naturally weathered in marine habitats. The present study assesses the effects of external applications of naturally weathered crude oil on embryo survival of Louisiana heron (*Hydranassa tricolor*) and laughing gull (*Larus atricilla*) eggs.

MATERIALS AND METHODS

A Libyan crude oil was spilled into Redfish Bay, Texas when a pipeline ruptured on 13 October 1976, with 377 barrels of oil

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being released (HOLT et al. 1978). Samples of this oil were taken on the day of the spill (whole oil) and oil contaminated sediment samples were collected at regular intervals for two years following the spill. The weathered oil was stored in airtight vials at room temperature in the dark.

Since a previous study (WHITE et al. 1979) provided insight into the effects of fresh No. 2 fuel oil applied directly to Louisiana heron and laughing gull eggs, these species were selected for continued study of the effects of weathered oil. Sundown Island in Matagorda Bay, Texas, contained about 3000 pairs of Louisiana herons and 5000 pairs of laughing gulls in 1979 and served as our study area. The nesting chronology of the birds was followed from the onset of the nesting season so that adequate numbers of nests could be found in the early stages of incubation. On 19 April and 14 May Louisiana heron and laughing gull nests containing incomplete clutches were identified to assure that the embryos would be of uniform age when the eggs were oiled a few days later. Thirty-one heron and 46 gull nests were marked with numbered wooden stakes. Eggs were individually numbered with a non-toxic waterproof marking pen. Nest marking and egg treatment was completed as early in the day as possible to eliminate the possible bias of embryo death resulting from overexposure of the eggs to the hot sun.

Louisiana heron eggs were divided into 2 oil-treatment groups and a control group. On 23 April, 32 eggs were treated with whole oil, 27 eggs received 4 week-old weathered oil, and 32 eggs were treated with sea water. Each egg received 10 µL of oil or water dispensed from a microliter syringe onto the eggshell surface at the air cell end of the egg and allowed to run freely (ALBERS 1977). After the eggs were incubated by the adults for 12 days, all eggs were collected and opened immediately to ascertain embryo mortality.

Because of different nesting chronology, Louisiana heron eggs were collected and examined before the laughing gulls began to nest. Since significant results were obtained in the Louisiana heron portion of the study, we added another treatment group, 8 week-old oil, to the laughing gull test. Laughing gull eggs were oiled on 17 May. Thirty-five eggs were treated with whole oil, 17 eggs with 4 week old oil, 35 eggs with 8 week-old oil, and 31 eggs with sea water. Individual eggs were treated with 10 µL oil or sea water using the same techniques as those used for Louisiana heron eggs. Gull eggs were collected and examined for embryo mortality on 29 May.

RESULTS AND DISCUSSION

Application of weathered oil caused significant ($P<0.05$) embryo mortality in one Louisiana heron oil treatment group, but did not cause significant mortality ($P>0.05$) of laughing gull embryos (Table 1). Ten µL of 4 week-old crude oil caused 17% mortality of heron embryos compared to no mortality in the control group. The fertility rate of the 74 heron eggs we examined was 96%. Only 1 of the 71 fertile eggs had an advanced embryo (>12 days); therefore, age of embryos at time of treatment was uniform and did not bias statistical analysis. A severe thunderstorm with rain and winds to 95 kph (59 mph) destroyed 5 marked heron nests; 1 nest each was lost from the whole oil and 4 week-old weathered oil group, and 3 nests were lost from the control group. All destroyed nests were located in tall shrubs (*Baccharis* sp.) that had been blown down during the storm. We found no evidence of nest desertion resulting from our activities in the colony.

Table 1. Embryonic mortality of Louisiana heron and laughing gull eggs treated with 10μL weathered crude oil.

Species and group	N[a]	No. Dead	No. Infertile
Louisiana heron			
Control	21	0	3
Whole oil	29	2	0
Weathered oil (4 week)	24	5[b]	0
Laughing gull			
Control	31	0	0
Whole oil	35	3	0
Weathered oil (4 week)	17	1	0
Weathered oil (8 week)	31	2	0

[a] Number of eggs recovered after 12 days incubation.
[b] Significantly different from controls, P<0.05, Chi-square test.

The technique that worked well for obtaining uniform ages of Louisiana heron embryos did not work for laughing gulls. Since the sensitivity of embryos to the effects of oil is greatest during the early stages of incubation (SZARO & ALBERS 1977, HOFFMAN 1978), our laughing gull data were biased since nearly 60% of the embryos were at least mid-way through incubation when treated with oil. Therefore, survival of laughing gull embryos may have been greater than if the eggs had been treated at an earlier stage. In a previous study, laughing gulls were found to be more sensitive to No. 2 fuel oil than Louisiana herons (WHITE et al. 1979). There was no nest desertion of laughing gulls; all of the treated nests remained active throughout the observation period.

Simulated weathering studies have shown that the toxicity of oil is altered with time and the toxicity may increase or decrease depending on the composition of the oil. Samples of Prudhoe Bay crude oil and No. 2 fuel oil decreased in toxicity after 14 and 21 days of weathering (SZARO et al. 1979). However, the toxicity of the light Arabian and Iranian crude oil from the AMOCO CADIZ spill may increase directly with weathering (VANDERMEULEN et al. 1978). In preliminary studies, the unweathered Libyan (Brega) crude oil used in this test was found to be low in toxicity to amphipods (*Parhyale hawaiensis*)(LEE, pers. comm.). Irradiation and photochemical decomposition can produce increasingly toxic materials in the form of oxygenated derivatives which are more chemically and biologically active than the original oil (LARSON et al. 1976). The presence of such derivatives may be the cause of the observed increased toxicity of the weathered oil to Louisiana heron embryos.

Because the impact of an oil spill on waterbirds may persist for long periods, the chemistry and relative toxicity of weathered oil becomes increasingly important. Sheltered environments such as salt marshes and mangroves are the areas often affected by oil spills; residence times of over 10 years are predicted for some salt marsh areas (GUNDLACH & HAYES 1978). Beaches also are affected and preliminary estimates suggest that up to 7.5 kg of oil can be suspended under one square meter of sandy beach; as much as 900 metric tons (4800 barrels) of AMOCO CADIZ oil may be buried within sandy sediments of Brittany's beaches (VANDERMEULEN et al. 1978). Disturbance of the substrate such as light pressure, dredging, or digging in saltmarsh sediments and erosion of beaches can release oil trapped in the substrate. Potentially serious re-contamination of waterbird feeding and resting areas is possible for years after a spill. Results of this study showed that weathered crude oil applied to waterbird eggs caused embryo mortality and may, in fact, be more toxic than the unaltered oil.

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