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REDUCED SURVIVAL OF CHICKS OF OIL-DOSED ADULT LEACH'S STORM-PETRELS

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Birds with petroleum-coated plumage may ingest and/or inhale substantial amounts of the substance while preening (Hartung 1963); small amounts of ingested oil have resulted in marked physiological changes in nestling larids (Miller et al. 1978, Butler and Lukasiewicz 1979) and alcids (Peakall et al. 1980). Similar oil-induced physiological aberrations in adult birds may well impair reproductive success. In the present study, we examined the effect of sub-lethal oil ingestion by adult Leach's Storm-Petrels (*Oceanodroma leucorhoa*) on the survival and growth of their chicks.

Leach's Storm-Petrels are small (adult weight 45 g), pelagic-feeding, burrow-nesting procellarids with long incubation (45 days), and chick growth (63–70 days to fledging) periods (Palmer 1962). They are ideal subjects for the study of oil effects on reproduction because: (1) they feed on the surface, where oil slicks are located; (2) their burrow nest provides the chicks with a uniform environment, and allows easy access to both adults and chicks with little disturbance to the rest of the colony; and (3) like all procellarids, they lay only a single egg. Because of their low reproductive potential, members of this order may be particularly vulnerable to the impact of oil contamination.

Our study was conducted during the 1979 and 1980 breeding seasons on an island 12 km off the coast of Maine. We located nest burrows while the petrels were incubating eggs, and made a small opening (10 × 10 cm) into each nest chamber for easy access to the birds. A cedar shingle was placed over the hole, covered with the excavated soil, and weighted with a large painted stone.

Adult storm-petrels were banded within two days after their chicks hatched. Each burrow was randomly assigned to one of three groups: control burrows, burrows from which one adult was dosed, and burrows from which both adults were dosed. Adults from experimental burrows were given a single 0.1-ml dose of Prudhoe Bay crude oil (PBCO; chemical analysis in Peakall et al. 1982) by intubation. Adults from control burrows were sham-dosed, i.e., handled and intubated exactly like dosed birds except that nothing was put into the stomach. One-half of all control burrows had both adults sham-dosed while in the remaining control pairs only one adult was so treated.

Each treatment group was subdivided into two separate experiments. In the first experiment, adults were dosed while brooding two- to three-day-old chicks (chick body weight 10 ± 1 g). In the second, adults were dosed when their chicks were 10–15 days old (chick body weight 29 ± 3 g). Adults brooding young chicks were captured in their burrows during the day; those with older chicks were captured with a trap at night when they returned to feed their offspring. The trap allowed the returning adult to enter the burrow and feed its chick, but prevented it from leaving. Chicks were weighed when adults were dosed and at three-day intervals for 21 days thereafter. A sub-sample of adults was captured and killed at the end of the experiment. Livers, nasal glands, and adrenal glands were removed and weighed. In a final experiment, chicks weighing about 28 g (10–15 days of age) were dosed with 0.05 ml PBCO by intubation. Chicks were weighed at three-day intervals for 21 days, and their growth and survival were compared to those of sham-dosed control chicks.

The 0.1-ml dose level used for adults is equivalent to 2.5 ml/kg body weight and is intermediate to doses given to other wild and captive seabirds (0.3–5 ml/kg). Chicks were approximately one-half adult weight when dosed and were therefore given a 0.05-ml dose. Earlier studies on Herring Gulls (*Larus argentatus*; Miller et al. 1978, Butler and Lukasiewicz 1979) and Black Guillemots (*Cepphus grylle*; Peakall et al. 1980), used PBCO at this same 2.5 ml/kg dose level. All statistical comparisons, unless otherwise noted were done using ANOVA and Duncan's New Multiple Range Tests. Values appearing in the text are expressed as mean ± standard error with sample sizes in parentheses.

All chicks of control adults ($n = 16$) survived the 21-day experimental period. However, in the first experiment (adults brooding two- to three-day-old chicks), chick survival was reduced to 70% when one adult ($n = 23$) was dosed and to 52% when both adults ($n = 21$) were dosed ($P < 0.01$ for both groups using the test for differences in equality of two percentages). All mortality occurred within six days of dosing. The growth rates (g/day) for all chicks surviving to three days indicate that experimental birds gained significantly less weight than controls (mean weight gains were 1.5 ± 0.2 g/day for controls; 0.7 ± 0.2 g/day for chicks with one dosed adult, and 0.5 ± 0.2 g/day for chicks with two dosed adults; $P < 0.01$ for both groups). When data for chicks surviving to 21 days were considered, the only significant difference was that the growth rate at 6 days was lower (1.0 ± 0.3 g/day compared to a control value of 1.8 ± 0.1 g/day) for the group in which both parents were dosed. The control growth rates were similar to published values (Ricklefs et al. 1980).

In the second experiment (adults with chicks 10–15 days

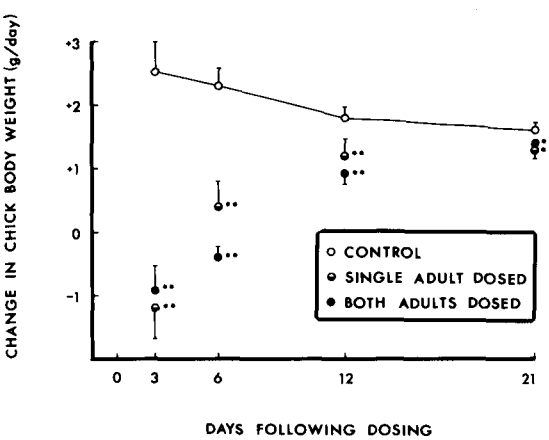

FIGURE 1. Growth data for Leach's Storm-Petrel chicks (initial age, 10–15 days when parents were dosed) from control burrows (open circles) and burrows in which one (half circles) or both (shaded circles) adults were fed a single 0.1 ml dose of PBCO. The zero point on the y-axis represents the mean chick weight at dosing (day 0) and the data for each interval (3, 6, 12, 21 d) represent the cumulative g/day weight change over the interval. Each point represents the mean ±SE of eight control chicks, eight chicks with a single parent dosed and nine chicks with both parents dosed. Significance levels: ** = $P <$ 0.005, * = $P < 0.05$.

TABLE 1. Growth data from control (sham) and oil-dosed Leach's Storm-Petrel chicks during the 1979 breeding season.[a]

Days after dosing	Control chicks (8)		Dosed chicks (16)	
	Wt (g)	Growth (g/day)	Wt (g)	Growth (g/day)
0	28.5 ± 0.6	—	28.2 ± 0.6	—
3	35.2 ± 1.4	2.2 ± 0.3	34. ± 1.4	2.1 ± 0.3
6	38.9 ± 1.4	1.8 ± 0.2	37.9 ± 1.6	1.7 ± 0.2
12	48.6 ± 1.	1.7 ± 0.1	47.4 ± 1.8	1.6 ± 0.1
21	62.5 ± 1.4	1.6 ± 0.1	60.8 ± 2.2	1.6 ± 0.1

[a] Data are expressed as mean ± SE, with the number of chicks in each sample in parentheses. Weight (g) refers to actual mean mass of control and dosed chicks at the weighing intervals. Growth (g/day) was calculated as the weight gain from day 0 to the respective 3, 6, 12, and 21 day intervals.

old) no chicks died. The rate of weight gain decreased significantly in all experimental chicks immediately after the first adult was dosed (Fig. 1). In fact, experimental chicks did not gain weight significantly during the six days following dosing. Differences in chick response between the two experimental groups (i.e., one or both adults dosed) were found only six days after dosing. With time, the differences in the rate of weight gain between the experimental and control groups decreased, but nevertheless remained significantly different even after 21 days. In contrast, the administration of 0.05 ml PBCO directly to chicks 10–15 days of age (n = 16) did not affect their weight gain during the 21-day period following dosing (Table 1).

Changes in organ weights were noted in the sub-sample of adult petrels collected 14–21 days after dosing with 0.1 ml PBCO. The nasal and adrenal glands were significantly hypertrophied in the dosed birds. The weight of the nasal gland was 774 ± 22 mg/kg adult body weight for controls (n = 11) compared to 966 ± 29 for experimentals (n = 7). The corresponding figures for the adrenal glands were 177 ± 8 and 215 ± 6 mg/kg. Both of these changes were significant at the 0.01 level (t-test). Liver weights were not significantly altered by exposure to PBCO. Mean body weights did not differ between control and experimental birds.

Our study shows decreased survival and reduced growth rates in chicks of oil-dosed adult Leach's Storm-Petrels. Direct transfer of the oil to the young is unlikely to account for the changes observed since the direct dosing of chicks did not affect their rate of growth. This lack of effect of oil ingestion on growth differs from that found with young Herring Gulls (Miller et al. 1978, Butler and Lukasiewicz 1979) and Black Guillemots (Peakall et al. 1980), therefore suggesting species-specific differences in toxicant sensitivity.

We suggest that the observed effects in both experiments were related to impaired ability of oil-dosed adults to provide food for their young. Lipid reserves are almost absent in newly-hatched storm-petrel chicks whereas they account for 25% of the total body weight in older (10–15 day) chicks (Ricklefs et al. 1980). Although young chicks require only about half as much energy as older chicks (Ricklefs et al. 1980), they probably have little capacity to withstand fasting without fat reserves. In contrast, plentiful fat reserves would permit larger chicks to survive a period of reduced feeding.

Increased mortality in younger chicks clearly indicates that oil contamination can affect reproduction in this species. Under conditions of additional stress, e.g., food shortage, depressed weight gain in older chicks might also be ecologically significant because reduced reserves of pre-fledging fat may lower post-fledging survival.

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