are all of normal width. The widening of some feathers takes place unevenly such that there is a thick and a thin dimension to the club tip, but only a few are so flattened as to be translucent.

The club-tipped feature is found in a less-developed form in the orange-brown earpatches of the other two subspecies of *Chlorochrysa calliparaea,* as well as in the much smaller orange earpatch of *Chlorochrysa phoenicotis* (which occurs west of the Andes in southern Colombia and northwestern Ecuador). In the earpatch of *Chlorochrysa nitidissima* (found west of the Andes in Colombia), the feature is weakly present in the portion that is brown and is not present in the portion that is black. I have also found well-developed club-tip feathers in the genus *Tangara.* For example, they occur in the earpatch and across the back of the neck in *Tangara cyanocephala* (a tropical species, which occurs in eastern Brazil, eastern Paraguay, and parts of Argentina) and, in a less developed form, under the eye of *Tangara parzudakii* (found in the subtropical zone from Venezuela to Ecuador). In addition, club-tipped feathers are found in the orange-brown cap of *Tangara ruficervix fulvicervix* and in a less-developed form in other subspecies of *Tangara ruficervix* (the species is found in the upper tropical and subtropical zones from Colombia to Bolivia). Poorly developed examples of what appear to be the same structure occur in the orange-yellow rump of *Tangara fastuosa* (a tropical species of eastern Brazil), the orange portion of the rump patch of *Tangara chilensis* (widely distributed throughout Amazonia), some orange feathers on the crown of *Tangara arthus pulchra,* and some orange-yellow feathers on the crown of *Tangara xanthocephala.*

Similar structures have been described in the Gouldian Finch (*Poephila gouldiae*) by Brush and Siefried (1968, Auk 85: 416), in *Rupicola rupicola, Pyroderus scutatus, Pipreola whitleyi,* and others by Olson (1970, Condor 72: 424), and can be found in a few birds-of-paradise, most notably *Paradisaea apoda salvadorii.*

It is significant that the club-tip structure is found primarily in small patches of intense coloration, almost always orange. Presumably the widening of the barbs and elimination of barbules accompanies heavy deposition of carotenoid pigments for display purposes. Olson found that in *Pyroderus scutatus* and *Rupicola rupicola* the medulla, a part of the feather normally very important to structural coloration, may be lost entirely in carotenoid-bearing portions of barbs. The pigments are deposited directly in the cells of the cortex. Brush and Siefried noted that "this modification consists of the reduction of potentially interfering pigments, especially melanin, the elimination of barbules, and the flattening of the barb to increase the exposed surface area". They also note that the production of carotenoids probably involves greater metabolic expense than the production of melanins, which could explain the evolution of such an efficient, localized, and highly specialized means of displaying pigments as the club-tipped feather. Melanins may in fact inhibit the formation of the structure, judging by its less distinct form in orange-brown feathers and absence in black feathers of the earpatch within *Chlorochrysa.*

Despite the occurrence of club-tipped feathers in quite divergent families, the pattern of occurrence within the *Tangara-Chlorochrysa* group suggests a close taxonomic relationship, and the character may be of use in analyzing this unwieldy (50 species) group. *Tangara* and *Chlorochrysa* have long been considered to be closely related (Miller 1919, Auk 36: 576). In view of this shared character and others, such as the waxy feathers mentioned by Storer, the three species of *Chlorochrysa* should be added to *Tangara.* Otherwise, considering the variety of characters exhibited by the 47 species currently lumped in *Tangara,* consistency demands that the genus should be split into several logically defined genera.

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A Field Study of the Effect of Crude Oil on Herring Gull (*Larus argentatus*) Chick Growth

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The immediate, lethal impact of oil pollution (e.g. oil spills) on seabird populations is well documented and has been reviewed by Bourne (1976). Sub-lethal or delayed effects of oil contamination, however, may have an impact on seabird populations as significant as mortality due to heavy external oiling. Hartung (1963) demonstrated that Mallards (*Anas platyrhynchos*) contaminated externally with as little

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as 6 g of labelled oil could ingest up to 2 g of the pollutant while preening. Other laboratory investigations by Hartung (1965) indicated that ingested oil significantly reduced egg production and hatchability. More recently, Miller et al. (1978a) demonstrated that a small oral dose of crude oil depressed growth rate in captive Herring Gull (*Larus argentatus*) chicks. Although Gorman and Simms (1978) were unable to observe oil-induced depression of growth rates in Herring Gull chicks, recent evidence indicates that differences in the chemical composition of various crude oils may explain these apparently contradictory results (Peakall et al. 1978). To assess accurately the biological impact of sub-lethal doses of pollutants on marine birds, however, studies of free-living populations are essential. The objective of the present study was to assess the influence of a single oral dose of weathered South Louisiana crude oil (WSLC: 1976 American Petroleum Institute reference oil weathered over seawater after Crocker et al. 1974) on several growth parameters of Herring Gull chicks that were raised in the wild.

Herring Gull chicks between 10 and 20 days of age (weight 200–500 g) were captured at the nest site on an island off Northeast Harbor, Maine, banded (U.S.F.W.S. bands), dosed (via stomach tube) with either 1 ml corn oil (control group), 0.8 ml corn oil + 0.2 ml WSLC, or 0.5 ml corn oil + 0.5 ml WSLC, and then released. Miller et al. (unpublished data) found that small oral doses of corn oil had no effect on gull chick growth. Chick body weight, culmen length, and middle toe length were recorded at dosing and at 4- or 8-day intervals following dosing. There were no significant differences between mean (±SE) initial weights for the control group ($\bar{x}$ = 324 ± 13 g, n = 24), the 0.2-ml group ($\bar{x}$ = 332 ± 17 g, n = 26), or the 0.5-ml group ($\bar{x}$ = 360 ± 17 g, n = 29). Similarly, there were no statistically significant differences between groups for initial culmen or toe lengths.

In addition to growth data, survival to 700 g or 20 days following dosing was recorded. Observations of chick behavior were also conducted to assess possible pollutant effects. To eliminate possible position effects, nest sites were selected so that control and treatment nests were interspersed. To minimize disturbance to experimental birds, nest sites were revisited briefly to collect growth data, and, after handling, recaptured chicks were carefully returned to holes or crevices in the talus substrate (near the nest site) that they used as hiding places.

Control birds demonstrated a mean weight gain of 7.8% per day, which is similar to the mean value of 6.5% per day calculated from data presented by Kadlec et al. (1969) for Herring Gull chicks of the same age. When compared to controls, both 0.2-ml and 0.5-ml birds showed depressed rates of weight gain 7–9 days after dosing (Fig. 1). Although the 0.2-ml group had recovered by days 11–13, 0.5-ml birds maintained a significantly lower rate of weight gain through 18–22 days. The mean weight gain for control animals ($\bar{x}$ = 485 ± 40 g, n = 15) at 18–22 days following dosing was not significantly greater than that of either the 0.2-ml chicks ($\bar{x}$ = 410 ± 25 g, n = 10) or the 0.5-ml group ($\bar{x}$ = 397 ± 17 g, n = 9). However, this may be due in part to our inability to match closely the initial weights of gull chicks in the field, and to the small final sample sizes in each group. Both treatment groups also exhibited significant decreases in rate of culmen growth on days 7–9 and 11–13 when compared to control birds (Fig. 1), but no significant differences occurred in the rate of toe growth. The 0.5-ml birds demonstrated a slightly lower survival (41%) to 700 g or 20 days following dosing when compared with control (62%) or 0.2-ml birds (65%). Finally, analyses of behavioral data did not reveal significant differences between control and treatment groups with regard to the duration of bouts of food soliciting, maintenance acts, or social interaction with parents.

The present study provides field confirmation of the inhibitory effects of crude oil ingestion on gull chick growth and supports similar, preliminary findings with free-living Black Guillemot (*Cepphus grylle*) chicks (Miller et al. 1978b). These results suggest that even small amounts of this pollutant could have a major impact on marine birds. Such small quantities could easily be ingested by chicks when fed contaminated food by adults or when drinking contaminated water. Oil could also be transferred from the feathers and feet of contaminated adults to the plumage of chicks, either directly during brooding or indirectly via contact with the nest site substrate; the chick could then ingest oil while preening. Although the depressed growth rate demonstrated in this study may not be directly related to mortality, smaller or lighter gull chicks may be less likely to fledge or survive other causes of heavy post-fledging mortality (Kadlec et al. 1969). Because gulls do not reproduce for several years following fledging, the delayed effects of crude oil contamination on the breeding population would not be apparent for some time after the initial exposure.

With regard to mechanisms of oil toxicity, laboratory studies indicate that ingested crude oil impairs osmoregulatory ability, decreases efficiency of intestinal transport, and results in hypertrophy of adrenal gland, nasal gland, and hepatic tissue (Miller et al. 1978a). Whether the observed depression in growth rate is a direct effect of pollutant-induced impairment of the organism's nutrient utilization and/or en-

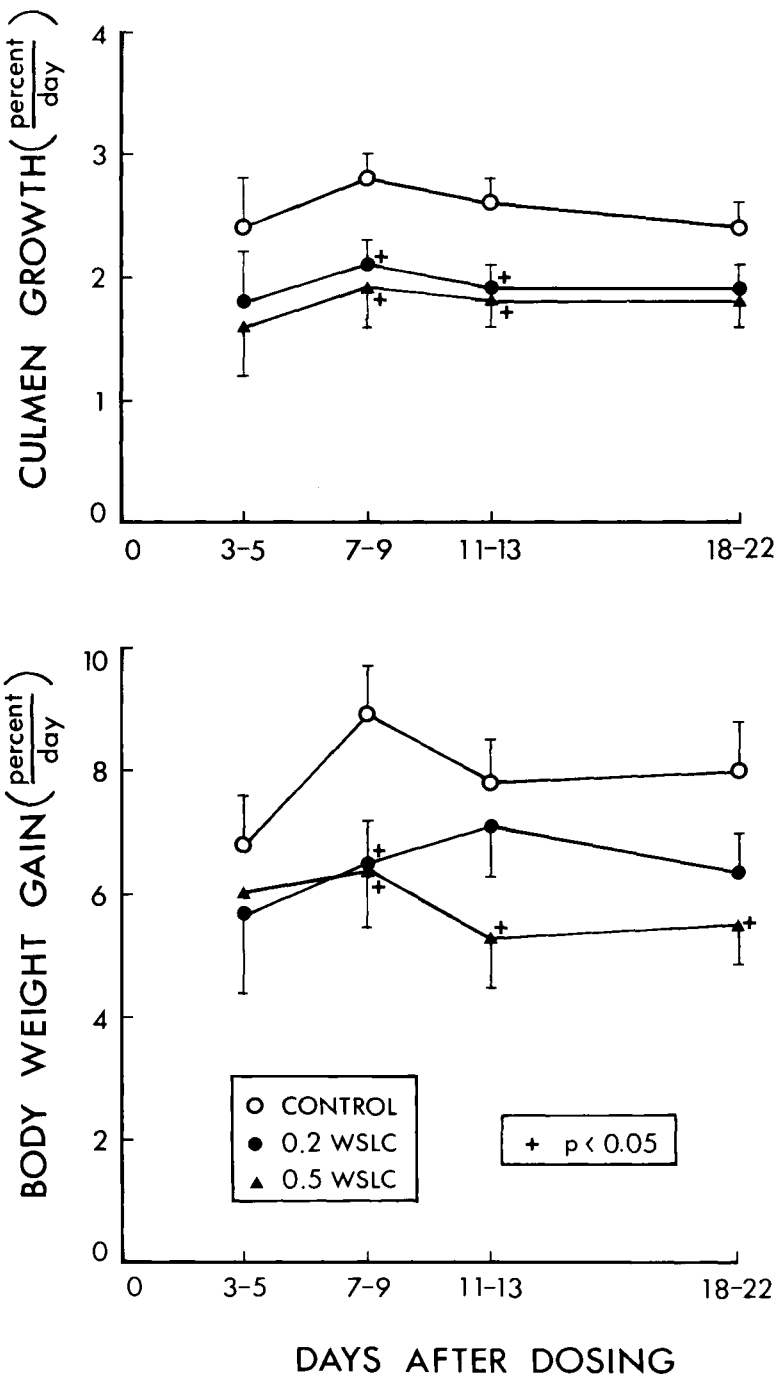

Fig. 1. Mean (±SE) rate of body weight gain and culmen growth for control and experimental Herring Gull chicks. Sample sizes for each point range from 9–22 birds ($\bar{x}$ = 16). Results of significant *t*-test comparisons between the control and each experimental group are indicated (+).

docrine system function, or an indirect result of non-specific stress in response to pollutant insult, remains to be determined.

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