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Investigator Perturbation and Reproduction of the Cliff Swallow

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Measurement techniques of any type influence the value of the variable measured. This deviation must be understood so that an investigator can choose appropriate methods to reduce the experimentally induced error. Human perturbation has adversely affected reproduction in numerous avian species. Colony-nesters, especially nonpasserine waterbirds, appear particularly heavily affected. Recently, investigators of such phenomena have attempted to quantify their own impact upon procellariids (Ollason and Dunnet 1980), phalacrocoracids (Ellison and Cleary 1978), ardeids (Goering and Cherry 1971, Werschkul and McMahon 1976, Tremblay and Ellison 1979, Parsons and Burger 1982), larids (Kadlec and Drury 1968, Hunt 1972, Gillett et al. 1975, Robert and Ralph 1975), rynchopids (Safina and Burger 1983), and alcids (Cairns 1980). We are aware of no comparable data that relate directly to investigator-induced effects on colonial passerines. Although researchers of such species may be cautioned by data on nonpasserine species, these must be supplemented by data obtained for passerines.

During a study of the basic reproductive ecology of the Cliff Swallow (*Hirundo pyrrhonota*) in southern Texas, we observed colonies of sufficient size to permit determination of the effects of alternate data-collection methods on several reproductive parameters. Here we provide the results of that experiment as well as basic nesting data.

Four multiple-sectioned highway culverts in Goliad and Bee counties, Texas were chosen as study sites in March 1983; these were separated by a maximum straight-line distance of 72.5 km. Cliff Swallows built their enclosed mud nests high on concrete culvert walls near or at their juncture with passageway ceilings. A total of 1,239 nests and their contents was examined 3 times/week on alternate days from 19 April to 8 June 1983, the period of the first wave of reproductive activity of the study population. A flexible-head flashlight and inspection mirror allowed visual observation of nest contents. Nest condition, number of eggs, number of young, and subjective estimates of nestling age, condition, and parasite load were recorded.

Three treatments were used to assess the effects of nest perturbation on various nesting parameters. The

control group was disturbed only by the disruption of incubation and/or feeding schedules caused by the observational procedures. The experimental treatments chosen involved removal of portions of nest entrances. Removal of parts of *H. pyrrhonota* nests to facilitate examination of their contents has been employed previously (Myres 1957, Newnam 1980, Martin MS). These treatments may involve perturbation of the adults' time and energy budgets during the nestling period as energy devoted to nest repair must be added to other expenditures. This allows inferences to be drawn based on current ecological theory regarding energy expenditure. In treatment b (small breakage group) approximately 1.4 cm³ of dried mud was removed from the upper portion of the nest's neck at each visit. The entire neck was removed from each nest prior to viewing its contents in treatment B (large breakage group); this resulted in an approximately 4 × 5-cm opening in the upper nest wall. Treatments b and B were employed only after the first young hatched in a given nest. All nests within a passageway received the same treatment; these nests were separated visually, and in part auditorily, from nests in other passageways of the same culvert. This allowed different treatments to be used in sequential passageways while minimizing potential intertreatment effects and controlling for possible effects of culvert location.

Oviposition occurs daily in *H. pyrrhonota*; hatching occurs over 1–2 days, with 1 day being the usual period. *Clutch size* was defined as the maximum number of eggs seen in a nest. The *number of eggs hatched* was taken as the maximum number of young seen in a nest. Young missing from the nest prior to 18 days were considered fatalities, while those absent after 17 days arbitrarily were considered *fledged*. To minimize overall perturbation and maximize sample sizes, eggs and nestlings were not marked; thus *incubation* and *nestling periods*, although fully comparable between treatments, are not as precise as those figured by Nice's (1937) method. *Incubation period* was the number of days elapsed between the laying of the last egg and the last hatch. Each of the above actually or potentially underestimates the parameter involved. *Nestling period* was the number of days elapsed from the last hatch in a nest to the day (after the arbitrary minimum 17th day) the first young was absent or flew from the nest. When exact dates of nesting events were not known, resultant data were used only if accurately assignable within 24 h. Scheffe's multiple comparison test was used to rank means only after significant differences had been shown by analysis of variance. Statistical testing on the ratio *number fledged/number hatched* was performed on the arcsine transformation of the variable to insure normality and homogeneity of variances. All treatment differences were considered statistically significant at $P < 0.05$.

The first clutch of 1983 was completed on 6 April; by 25 April incubation was under way in the majority of active nests. On 8 June, fewer than 1% of the total hatchlings of the population remained in the nest. A second, less intense period of reproductive activity began in one culvert in late June but was excluded from our data. Descriptive statistics for the primary wave of reproduction are partitioned by treatment (control, b, B) and provided in Table 1. No differences existed between the control group and both experimental groups in clutch size. Group B had a significantly lower hatch and a longer incubation period than the control group. Treatments b and B resulted in nestling periods significantly shorter than that of the control group. Fewer young fledged from nests that received treatment B than from control and treatment b nests. The fledge/hatch ratio for nests of treatment B was significantly smaller than that for control and treatment b nests.

Treatment b means clearly were intermediate between those of control and B groups in 3 of 5 variables in which significant differences occurred (Table 1). In these categories, a continuum of responses to perturbation beyond that received by the control group presumably exists. The decrease in number fledged in treatment B is due largely to more total failures in that group (60.8% of all attempted nestings). Completely unsuccessful nests (no young fledged) for the control and b groups were 25.6% and 20.9%. Treatment b showed a significant difference from the control only in the length of the nestling period.

The differences between group B and the control group for incubation period and number hatched/nest are difficult to explain because no mud was removed from a nest until its first young hatched. The most likely explanation is that nest-building behavior by parents whose nest has been broken stimulates the same behavior in neighboring birds, even if their nests are intact (i.e. the nests contain no young so they have not been disturbed). Emlen (1952) noted that mud gathering in *H. pyrrhonota* was an exceptionally powerful social releaser; a single individual engaging in nest-repair activity would quickly cause neighboring birds to temporarily abandon feeding and initiate mud gathering and even unnecessary nest repair. We assume this behavior also occurs during the incubation period (oviposition occurs before nest completion in some nests) and, in part, contributes to a diminution in hatch and increase in incubation period.

Nestling period was the only variable significantly affected (shortened) by both levels of perturbation. If, as we hypothesize, parents are forced to diminish brooding and feeding time due to other perturbation-related demands on their time, one might expect an increase in the time necessary for young birds to reach the growth stage necessary to leave the nest.

TABLE 1. Means of reproductive variables of *Hirundo pyrrhonota* by treatment type.[a]

Variable	Control $\bar{x} \pm SE\ (n)$	Treatment b[b] $\bar{x} \pm SE\ (n)$	Treatment B[c] $\bar{x} \pm SE\ (n)$
Clutch size	4.21 ± 0.03 (681)	4.12 ± 0.05 (250)	4.09 ± 0.05 (308)
Number of young hatched/nest	3.51 ± 0.05 (657)	3.36 ± 0.08 (242)	3.22 ± 0.08 (304)
Incubation period	14.11 ± 0.06 (457)	14.15 ± 0.06 (214)	14.42 ± 0.06 (233)
Nestling period	21.57 ± 0.09 (491)	21.16 ± 0.13 (195)	20.81 ± 0.17 (123)
Number fledged/nest	2.24 ± 0.06 (668)	2.24 ± 0.09 (239)	1.08 ± 0.08 (311)
Number fledged/number hatched	0.64 ± 0.06 (668)	0.63 ± 0.09 (239)	0.33 ± 0.08 (311)

[a] Means above the same underline are not significantly different.
[b] Approximately 1.4 cm³ mud removed from each nest neck 3 times/week (alternate days).
[c] Entire nest neck removed from each nest 3 times/week (alternate days).

However, hunger also is postulated to act as a cue for fledging (Welty 1975: 354). It is possible that the perturbed nestlings, whose parents cannot feed them normally due to energetic and/or time constraints, might fledge earlier than control nestlings. Although we have no data for postfledging survivorship, it is likely that premature fledging adversely affects the survival of the young in the disturbed situation, and consequently, that overall mortality (both pre- and postfledging) in both experimental groups would be greater than that reflected in the category *number fledged* (Table 1).

Two obvious explanations exist to account for the minimal fledge of group B. Direct factors such as increased accessibility of young to avian predators (*Tyto alba, Otus asio, Bubo virginianus, Strix varia, Corvus cryptoleucus*) or increases in accidental falls from the nest may be involved. No support for or against increased accessibility was found, but there was evidence that nestlings occasionally fall when backing along a shortened nest neck to defecate (Arnold pers. comm., Sikes pers. comm.). This problem should be minimized by our procedure of initiating nest-neck breakage prior to the development of nestling mobility and nest familiarity.

Using data compiled by Emlen (1954) for Wyoming Cliff Swallows, we estimate that the nest necks removed in our experiment contained approximately 140 mud pellets. Replacement of the entire neck would require about 2.6 h and 3.3 kcal/nest for each full repair, using 1.26 kcal/h for the metabolic cost of nest-building in this species (Withers 1977). Some of the nests were still in partial disrepair two days after removing the neck, but most were completely renovated at the next scheduled observation. The total energy expenditure for an adult with nestlings averages 26.4 kcal/day (Withers 1977). With two days to rebuild the nest and doing half the work, a bird would need to increase its energy output by 0.8 kcal/day, i.e. only 3.3% above its normal value. During the nestling period in Withers' study, a parent was either foraging or in the nest 23.8 h/day. Assuming 10 h of darkness, approximately 13.8 h were available for foraging and parental duties. An additional 0.65 h/day requires a 4.7% increase in time necessary for the bird to carry out its share of nest repair. It should be noted that a further increase in time beyond that spent on nest repair is needed also if the energy lost through nest-building is to be replaced by extended foraging. (Because the time figures extend beyond the 24 h/day limit, we must postulate a decrease in time spent in the nest or an increase in foraging efficiency to overcome the problem.) Both the hypothesized increases in energy and in time seem miniscule when compared to the birds' total daily budgets. However, if the birds already are attempting to raise the maximum number of young possible under given (expected) energetic and time constraints, an additional requirement of 0.8 kcal and 39 min/day may be beyond their capabilities. Nest repairs then detract from time and energy normally given to other necessary activities and result in decreased care for the young. It is likely that the effects of perturbation contribute to both time and energy deficits, each one affecting individuals in different situations to varying degrees. Inadequate nutrition coupled with heavy ectoparasite (cimicid Hemiptera, argasid Acarina, unidentified lice) load surely contributed to nestling mortality. Chapman (1973) and Sikes and Arnold (in review), in fact, view rotation of culvert use by this species as a behavioral adaptation to minimize ectoparasitism. Nutritional constraints alone may not account for the differences in fledge success, but when coupled with high parasite load (in all treatments), many of the young birds in the highly disturbed nests did not fledge.

Major and minor investigator perturbation of *H. pyrrhonota* nests has significant effects on reproduc-

tive parameters of this species. We recommend special care in employing these methods for nest examination and suggest that other types of nest perturbation in other species may have similar, but as yet unquantified, results.

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Snail Kite Kleptoparasitism of Limpkins

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Kleptoparasitism is defined as the stealing of food from an individual by another individual (Rothschild and Clay 1952). Interspecific kleptoparasitism occurs in many animal groups but is particularly widespread among birds, especially when individuals of different species regularly congregate at feeding areas (Brockman and Barnard 1979). Here we report our observations of kleptoparasitism of Limpkins (*Aramus guarauna*) by Snail Kites (*Rostrhamus sociabilis*) at shallow lagoons near Crooked Tree (17°45′N, 88°35′W), Belize, Central America, from 7 to 21 May 1983. We relate the occurrence of this parasitic behavior to an apparently diminishing resource base shared by these two species.