first became intense during the 1920's as birds began to shift from aquatic habitat to cropland to feed. Wheat and other cereal grains are now an integral part of the diet of this species particularly during autumn. Agricultural tillage has also affected diet composition in wetland habitat. Krapu (1974b) reported that wild millet (barnyard grass) formed 71% of the diet of breeding Pintail hens feeding in tilled basins. This annual grass is a dominant species in annually tilled wetland basins. Grains of wild millet are eaten from spring through fall during periods when tilled basins are flooded.

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TICKS AS A FACTOR IN NEST DESERTION OF CALIFORNIA BROWN PELICANS

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In 1975, heavy infestations of ticks (*Ornithodoros capensis*) caused Brown Pelicans (*Pelecanus occidentalis*) in Texas to desert their nests and to abandon their colony (King et al. 1977). This finding stimulated us to investigate whether *Ornithodoros* ticks could also be affecting pelican reproduction at our other study area in the Gulf of California, where we have frequently observed nest desertion. We report here that *O. denmarki*, a species closely related to *O. capensis*, does infest Brown Pelicans on Isla San Lorenzo Norte, and may have contributed to nest desertion during 1976.

Isla San Lorenzo Norte is in the Gulf of California, Mexico (28°42'N, 112°56'W) between the islands of Salsipuedes and San Lorenzo. The Brown Pelican breeding colony there is one of the largest in North America: in 1970 we estimated that the colony contained 16,000 nests.

In 1974 and 1975, observers and crews banding young pelicans reported seeing ticks on the ground near nesting sites. Although no pelicans were thoroughly examined, ticks were not observed on the 7,340 young birds banded between 1970 and 1975. An intensive search for ticks in pelican nesting areas was not made until 1976, when ticks were collected between 5 and 15 April. In order not to disturb nesting pelicans, we searched for ticks only in canyons where pelicans had nested in previous years. We found adults and nymphs in every major canyon where pelicans had nested in 1975. They also were present in one canyon where birds had nested in 1974, but not in 1975 and 1976. Ticks were most easily collected from beneath the larger rocks near pelican nests, but were found also in pelican nest material and in litter beneath old nests. In previous seasons, tick numbers must have reached high levels in individual nests, as over 100 exoskeletons were present in the litter under many nests. Live ticks were most abundant in lower portions of drainages that emptied into the ocean; they were least numerous in the higher elevations of interior canyons.

Larvae raised from adult ticks collected from Isla San Lorenzo Norte were identified as *O. denmarki*. This species has been recorded in several areas along the Pacific Coast of North America including Islas Rasa and Calaveras, Gulf of California, Mexico (Kohls et al. 1965). A closely related species in the genus *Ornithodoros*, but not true *O. denmarki*, has been found at two locations in Oregon (Clifford et al. 1970, Radovsky et al. 1976) and in California (Marshall and

Nelson 1967). Pelicans were not listed as hosts in any of these reports.

Two samples of ticks were submitted to Rocky Mountain Laboratory for viral isolation. One sample was collected from an area where pelicans nested in 1974 but not in 1975. The other sample was taken from 1975 nest sites. Three isolations of a virus were made from 15 tick pools prepared from the 1974 nest site sample, and 19 additional isolates were recovered from 33 tick pools prepared from the 1975 sample. Through immunofluorescence and complement fixation tests, all of these isolates were shown to be related to Rasa virus of the Hughes serological group (Hughes et al. 1964, Clifford et al. 1970). Specific identification is pending. No serological tests are planned to determine avian susceptibility to this virus, but Clifford et al. (1968) found that in chickens (*Gallus gallus*), the Rasa virus produced only sporadic viremia and, with one exception, did not kill any chicks.

Reproductive failure of Brown Pelicans between 1969 and 1974 was well documented on the Pacific coasts of California and Baja California (Keith et al. 1970, Jehl 1973, Anderson et al. 1975). The major cause of reproductive failure was the breakage of eggs due to shell thinning by DDE. In the Gulf of California, however, our unpublished data and those of D. W. Anderson (pers. comm.) have shown that productivity in colonies has varied among years. Low productivity, when it occurred, was primarily the result of adults deserting their nests and abandoning their eggs or young. Desertion of nests within local areas was usually gradual, occurring over a 3–4 week period. On some occasions, desertion tended to move progressively through a neighborhood of nests. Each year since 1973, we have observed a complex pattern of nest desertion within the colony; the rate of desertion differed considerably among canyons. This "canyon effect" suggests the existence of factors in some canyons or within birds in some canyons that intensify the rate of nest desertion. It appears that a heavy infestation of ticks in nests could contribute to nest desertion.

Usually, pelicans did not behave abnormally before abandoning their nests. In one canyon, however, pelicans appeared restless before finally deserting; they scratched and preened more frequently than birds in other canyons. The senior author measured nesting behavior in three areas prior to desertion from 13 to 15 April 1976. Five morning and five afternoon observations were made at 15 min intervals; incubating or scratching-preening behavior was recorded. Desertion occurred in all three areas, but was greatest in the canyon where scratching-preening behavior was observed from 32 to 68% of the time. All 17 nests in this canyon were deserted by 24 April. In the remaining canyons where observations of scratching-preening behavior varied from 4 to 16%, 22 of 61 nests were deserted by 24 April. Because nesting pelicans are sensitive to human intrusion, we did not enter canyons where desertion was observed to compare tick density among nests and among canyons.

The distribution of ticks in the colony and within nesting canyons may be an important factor in determining their effects on pelicans. In 1976, while collecting ticks where pelicans had nested in 1974 and 1975, we found that ticks were absent from short stretches of some canyons. Most commonly, a few individuals were found under larger rocks, and occasional areas were found with 50 to 75 ticks under almost every rock. Pelicans nesting in areas where ticks are abundant may be subjected to greater parasitism and thereby be more likely to desert their nests than pelicans in other areas. Tick abundance also could be a factor in influencing the annual distribution of nests in the colony. Each year pelicans have concentrated their nests in somewhat different areas of the colony. Even within canyons, birds have congregated at different places from those where they nested the year before. Similarly, Converse et al. (1975) and Feare (1976) reported the 1973 abandonment of 5,000 Sooty Tern (*Sterna fuscata*) nests containing eggs and young in a colony of 400,000 pairs on Bird Island in the Seychelles. They found numerous ticks in the deserted portion of the colony but few or none in adjacent areas where reproduction was normal. Not only did ticks cause desertion, they remained so abundant in following years that the terns did not reoccupy the area through 1976 (C. J. Feare, pers. comm.).

In summary, our observations suggest that *O. denmarki* may be an important environmental factor influencing the distribution and success of Brown Pelican nests in the Gulf of California. More information on these relationships may be unobtainable without seriously disturbing and destroying large numbers of nests.

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BULL SNAKE PREYS ON ROUGH-WINGED SWALLOW NEST

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The Rough-winged Swallow (*Stelgidopteryx ruficollis*) typically nests in burrows excavated in steep banks; these nests are relatively inaccessible to assault by predators. Nesting failure has, however, been attributed to the longtail weasel (*Mustela frenata*; Lunk, Nuttall Ornithol. Club Publ. 4, 1962), black snake (*Coluber flagellum*; Bailey, The birds of Florida, p. 116, Williams and Wilkins, Baltimore, 1925), and possibly the common sand crab (*Ocypode albicans*; Bent, U.S. Natl. Mus. Bull. 179:424–433, 1942). To my knowledge, there is no published record of predation on Rough-winged Swallow nests by the bull snake (*Pituophis melanoleucus sayi*).

The incident reported here occurred in Story Co., Iowa. I found a Rough-winged Swallow nest at the end of a burrow (68 cm deep) in a stream bank. The nearly perpendicular bank extended 53 cm above and 125 cm below the burrow's entrance before sloping outward to the stream edge. I inspected the nest contents periodically, without altering the structure of the burrow or the natural character of the bank. By 12 June, the female had completed her clutch of four eggs and was actively incubating. At 0730 on 17 June, I discovered a bull snake coiled in the nest burrow; when the snake was removed, the nest was found to be empty. The parent birds were not seen in the vicinity.

The 133-cm snake was dissected within 3 h of discovery and was found to be a gravid female carrying 14 eggs in the oviducts. Four broken, white eggshells and their contents (undoubtedly those of the Rough-winged Swallow) were present in the anterior portion of the digestive tract; little digestion had taken place. (Eggs are crushed as they pass through the esophagus of the bull snake; Smith, Univ. Kansas Mus. Nat. Hist. Misc. Publ. 9:250–253, 1950.) The digestive tract contained little else, and there was no evidence that an attending adult bird had been eaten. Black snakes will take adult Rough-winged Swallows on the nest (Bailey 1925), but in this instance the adult bird either escaped the bull snake or, more likely, was absent from the nest when it entered the burrow. During my inspections of the nest contents, the incubating adult, when present, would move passively aside and make no attempt to escape. Bull snakes are diurnal (Smith 1950); thus, the nest was entered between dawn and 0730 on the day the snake was discovered, or on the day preceding with the snake remaining in the burrow overnight.

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