

RISKS OF CLUSTERING IN THERMALLY-STRESSED SWALLOWS

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Small insectivorous birds may starve during cold weather (e.g., Dence 1946, Anderson 1965, Sealy 1966, Whitmore et al. 1977, Zumeta and Holmes 1978) because their high surface-to-volume ratios promote relatively rapid heat loss, and cold temperatures can drastically reduce food availability. Some birds respond to cold weather by roosting in tight clusters which effectively reduces each individual's surface-to-volume ratio and thereby its heat loss. This interpretation of clustering implies that all members of a cluster should benefit from this behavior. Here, we report observations of swallows clustering which suggest that membership in a cluster may be risky, making clustering a behavior of last resort. As part of these observations, we also report the association of non-breeding swallows with nests typical of their species, during clustering.

All observations were made between 11 and 15 May 1983, within 5 km of the University of Manitoba Field Station at Delta Marsh on the southern shore of Lake Manitoba. At that time, Tree Swallows (*Tachycineta bicolor*), Barn Swallows (*Hirundo rustica*), Cliff Swallows (*H. pyrrhonota*), and Bank Swallows (*Riparia riparia*) had arrived in abundance on spring migration, although local breeding by any of these swallows does not begin before late May or early June.

Weather conditions before 11 May had been seasonable, but between 11 and 15 May daytime highs ranged from only 0.5°C to 5.0°C. The daily high on four of the five days was a record minimum high for that date, based on 15 years of weather data recorded at the University of Manitoba Field Station. Northerly winds and rain, freezing rain, snow, or hail accompanied the cold temperatures on three of the five days. We did not attempt to measure insect abundance, but temperatures near freezing can reasonably be assumed to have drastically reduced numbers of volant insects.

On the evening of 13 May, we saw a flock of 30-40 Tree Swallows perched near an empty wooden box mounted on a pole 0.5 m off the ground. A round hole in the box gave it a superficial resemblance to a nest box, although it was approximately 10 times the usual volume. Six swallows were seen entering the box in a period of 10 min, but we do not know the total number of occupants that night. The following morning, we found two dead Tree Swallows outside the box, but none inside.

At mid-day on 15 May, we found one dead Tree Swallow on the ground under a cavity of a dead poplar (*Populus deltoides*) that had been used the previous year for nesting by Downy Woodpeckers (*Picoides pubescens*). From this cavity, we removed eight Tree Swallows, all stacked on top of one another. Only the two swallows at the bottom of the cluster were alive, but they were very weak. One of the live birds soon died and the other eventually recovered. Had we not removed the dead birds from on top of these two birds, both undoubtedly would have died in the nest cavity. Dence (1946) found 11 dead Tree Swallows in one nest box in New York during cold weather in May, and

during the same period of cold weather on which we report, Smith et al. (1984:46) reported nine dead Tree Swallows "packed into a single nest box after the storm" near Brandon, Manitoba.

The mean weight of the dead Tree Swallows we collected was 15.1 g (range 10.3-18.3). These values are substantially below breeding season mean weights of 21.4 g (range 18.5-24.2, $n = 103$; T. Quinney, pers. comm.), but are similar to weights of Tree Swallows found dead after unseasonable weather by Whitmore et al. (1977). The lack of food in the digestive tracts of the seven birds that were examined further supports the interpretation that the birds' death was ultimately due to lack of food.

We had one observation of Tree Swallows clustering when they were not associated with a nest cavity. At 19:30 on 13 May, we observed about 20 Tree Swallows perched in a tree. Two of the swallows were perched beside one another in direct contact while the remaining swallows were perched individually. A third swallow flew from its perch and landed on top of the two birds that were perched in contact, followed 30 s later by a fourth bird. After a period of 15 s during which the birds appeared to be struggling for position and were constantly vocalizing, the birds settled down and were still in the cluster 15 min later when we ceased watching them. Grubb (1973) reported similar observations of Tree Swallows.

At 18:00 on 14 May, we noticed ca. eight Barn Swallows clustered in an old Barn Swallow nest in a garage. All the birds were head-first in the nest, stacked at least two deep, and were vocalizing incessantly. Birds on the top of the cluster appeared to be attempting to force their way deeper into the cluster. None of the many other nests in the garage was occupied by swallows, and there appeared to be no unique features to the one that was occupied. The following morning, one dead Barn Swallow was found in the nest where the birds had clustered the day before. A subsequent search of seven other buildings in the area containing old Barn Swallow nests produced five dead Barn Swallows, three of which were in nests and two were found immediately below nests. All of these individuals had died recently.

Because of the association of Tree and Barn swallow clusters with their respective nest sites, we searched breeding sites occupied the previous year by Cliff and Bank swallows for evidence of clustering. None of the previous year's nests of either species remained intact. At one Cliff Swallow colony site, however, we found eight dead Cliff Swallows, two dead Barn Swallows, and one dead Bank Swallow on the ground below an overhanging roof. Elsewhere, Sealy (1966) reported finding dead Bank Swallows clustered in Bank Swallow nest cavities during cold spring weather. Collectively, these observations indicate that thermally-stressed swallows form clusters with conspecifics in conspecific nests when they are available, and that mortality of some cluster participants is a common occurrence.

Our observations suggest that the energetic advantages of joining a cluster are balanced by the risks of mortality from that association. One risk is of being trapped under other cluster members, as illustrated by the Tree Swallows we found under the cluster of dead birds. The energy they saved was obviously of no benefit if they were going to die in the nest cavity. Another risk involves the energy expenditures associated with struggling for position in a cluster that we observed for both Tree and Barn swallows. If that expenditure secures an individual an optimal position (surrounded, but not trapped, by warm bodies), it may more than pay for itself. For those birds unable to gain access to the interior of the cluster, the energy they expend in struggling in an attempt to gain this access may exceed any energy saved from being part of a cluster. This could have dire consequences for a bird whose energy reserves are already low before joining the cluster.

Although the four swallow species we discuss here regularly roost communally (Weatherhead, pers. observ.), they only form clusters under highly stressful conditions. We propose that, for these species, clustering is a last ditch, high risk behavior with net benefits being realized by only some of the participants. Some birds that roost communally regularly do so in clusters. It would be interesting to examine the structure of clusters in these species to see how individuals avoid the risks we have reported for swallows.

Finally, we point out the importance of nests as foci for cluster formation and the species-specificity of this association. Our observations were made before the breeding season. Also, Tree Swallows are common migrants but seldom breed at Delta Marsh. Thus, the birds' use of nests was apparently independent of any reproductive association. Furthermore, with regard to minimizing heat loss, Barn Swallows had better locations available in which to cluster than their open nests. Safety from predators or association of nests with warmth are two possible explanations for the formation of clusters in nests.

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DUNKING OF PREY BY BREWER'S BLACKBIRDS: A NOVEL SOURCE OF WATER FOR NESTLINGS

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Small birds lose relatively more water through evaporative respiration than do larger birds (Bartholomew and Cade 1963). As a result, nestlings can generally be expected to be under greater water stress than adults. One well known method of supplying nestlings with free water, in addition to that provided in their food, is for the adults to soak their belly feathers at watering sources; this behavior has been described in several species of sandgrouse (*Pterocles namaqua* and *P. burchelli* of the Kalahari Desert, as well as *P. alchata* and *P. senegallus* of Iraq; Cade and Maclean 1967, Maclean 1968) and in the Egyptian Plover (*Pluvianus aegyptius*; Howell 1979), and may occur in other species as well. Here, I describe a novel and potentially important method of supplying free water to young by Brewer's Blackbirds (*Euphagus cyanocephalus*): dunking of prey.

My observations were made at "Blompond," a small stockpond, about 350 m², built in 1970 adjacent to Hastings Reservation, Monterey County, California. This area has a Mediterranean climate with less than 2% of the average annual precipitation falling in June through September (Bradford 1974); during this season, the availability and occurrence of surface water are critical for much of the local avifauna (Williams and Koenig 1980). Brewer's Blackbirds have been recorded as nesting at Hastings in only five years since 1939, most recently in 1984. Nests have invariably been in a small colony of 5 to 10 pairs on

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or near a knoll, approximately 0.25 km away from what is now Blompond.

Every day between 24 June and 5 July 1984, during which time nestlings were being fed, I watched Brewer's Blackbirds in the vicinity of the pond. Their activities included drinking, bathing, and foraging in the grasses surrounding the pond, primarily for grasshoppers (Orthoptera: Acrididae). A large proportion of birds, however, apparently came to the pond to dunk grasshoppers in the water before flying to their nests and feeding the grasshoppers to their young.

I monitored the birds from 09:00-10:15, 12:00-13:45, and 15:00-16:15 on 30 June and from 14:00-15:30 on 2 July (5.5 h), and recorded their activities at the pond. A total of 48 visits by birds were observed: of these, two (4%) birds bathed, six (12.5%) drank, another six foraged at the pond's edge, and 35 (73%) arrived at the pond carrying grasshoppers and dunked them before returning to their nests (one after having foraged and caught prey along the edge of the pond). Birds often dunked prey repeatedly: the mean (\pm SD) number of dunkings was 3.4 ± 1.7 ($n = 12$). Both males and females engaged in dunking behavior: of the 35 cases recorded, 14 (40%) were performed by males. Birds were not seen to eat the grasshoppers following dunking, nor did they appear to swallow water while they were dunking prey. Thus, I infer that dunking behavior was directly associated with feeding of nestlings. Because these birds were not marked, I could not determine the frequency of dunking trips by individuals. The colony consisted of only about 10 nests, however, and it appeared as though individuals were repeatedly engaging in dunking behavior.

In order to measure the potential importance of this behavior, I captured 15 grasshoppers, weighed them, dunked them while holding them with a pair of tweezers, and then measured their weight gain (the amount of water picked up by dunking). The mean amount of water picked up was 0.062 ± 0.058 g per grasshopper, which was 34% of the prey's mean live weight (0.208 g). The average dry body mass of grasshoppers at Hastings was about 0.045 g (mean of 18 grasshoppers caught in insect traps at Has-