Research Training Group in Animal Behavior, Indiana Univ. for support, and the owners of Oak Ridge Ranch for access to birds nesting on their property.

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Wilson Bull., 109(2), 1997, pp. 332–337

Communal roosting behavior of the Cave Swallow in El Salvador.—In autumn 1994, I located more than 5000 Cave Swallows (*Hirundo fulva*) at each of two nocturnal roost sites in El Salvador. Here I provide information on the communal roosting behavior of the species and roost-site characteristics on previously unknown wintering grounds in Central America. Roosting of many species of New World swallows has not been described. The winter roosting habits of migratory North American swallows likewise are sparsely known. This study provides the first description of the winter roosting habits of the Cave Swallow.

Study area and methods.—I conducted the study in a 2500 km^2 region of the coastal plain of El Salvador below 100 m elevation, from Río Paz, Ahuachapán, in the west (13°45′N, 90°08′W), to Estero El Espino, Usulután, in the east (13°10′N, 88°15′W). This area is mostly agricultural flatlands with little natural habitat, except for 38,000 ha of man-

grove forests associated with several large bays and estuaries. The coastal plain is interrupted by two small mountain ranges, the Cordillera del Bálsamo in the Department of La Libertad, and the Colinas de Jucuarán east of Estero El Espino. I did not survey the seacliffs or hills in these sections of the El Salvador coast. Climatic information for the study area is provided by Holdridge (1977), who placed it within the hot humid subtropical forest zone. This zone has a marked and regular rainy season from May to October. Rainfall during this period varies from 1400 mm to 2000 mm, or 270 mm average per month. In November, rainfall drops to 50 mm, and generally no accumulation is recorded for December through April. The median temperature from September through February is 26°C, with daily high temperatures often above 30°C.

I use the term "roost" to mean a "communal roost," a central sleeping area to which several dispersed groups or individuals converge, as defined by Ward and Zahavi (1973). I located roost sites by following swallow flocks in the late afternoon, and by triangulation when more than one flight line was evident. A team of four field assistants and I generally searched along the coast and coastal plain for foraging swallows 3–6 days a week between 4 Oct. and 10 Dec. 1994. We watched Cave Swallows flying to roost on eight evenings (four evenings at each of two sites). We located sleeping birds on two evenings at one site. I calculated the height of swallows circling above roost sites by estimating the angle at which I observed the birds at their zenith, and then measuring the distance between my observation point and their horizontal position (the roost site).

At one of the two swallow roost sites, I obtained six voucher specimens by searching for sick or dead birds at the roost site, and collecting sleeping birds by hand or with a hand-held dip net. The specimens are deposited at the Museo de Historia Natural de El Salvador and the Univ. of Kansas Natural History Museum. To determine the source population, I compared the six specimens to study skins from all known breeding populations of Cave Swallow.

Results.—I saw Cave Swallows on 14 out of 21 field days from 1 Nov. until the end of field work on 10 Dec. I saw none on nine field days preceding 1 Nov. I located one roost at the Hacienda Chahuantique south of Jiquilisco, Usulután (13°18′N, 88°35′W), and another at the Hacienda Monteshasta, 500 m north of Playa Miravalle, Sonsonate (13°37′N, 89°38′W). The roosts, each estimated by direct counts and extrapolation to hold 5000–8000 birds, were located 2.0 km and 0.6 km from the coast, respectively. At the first site, on 17 and 18 Nov., Cave Swallows dropped in to the roost over a cultivated field of sorghum (*Sorghum vulgare*, called maicillo by local farmers), but I could not see that they actually slept on the sorghum plants, which resemble corn. I saw about 140 Cave Swallows flying toward this roost on 1 Nov. at 17:05 h (CST), 5 km away at Puerto El Triunfo. At the second site, from 7–9 Dec., I observed Cave Swallows sleeping on the leaves of mature plants of a thin-stalked variety of sugar cane (*Saccharum officinarum*) known locally as "1312" in parts of a 28 ha cane plantation. I had seen more than 50 Cave Swallows flying toward this roost on 8 Nov. at 17:20 h, 2 km away near Barra Siega.

Cave Swallow behavior was similar on each of five evenings. Five to eight thousand Cave Swallows began appearing above the roost approximately 30 min before sundown and then seemed to forage in a loose flock covering as much as 1000 ha. They flew approximately 30 m above the ground, often chirping or emitting a song that resembled the warbling of captive Budgerigars (*Melopsittacus undulatus*). On the three evenings we were able to observe the flocks at close range (18 Nov., 8 and 9 Dec.), the swallows were quite vocal as they gathered above the roost, except when a Merlin (*Falco columbarius*) was nearby. No swallows of other species were detected at the roosts.

During the 30 min before sunset (approximately 17:30 h), the flock slowly became denser. At sunset the birds began to fly in one direction around the roost site, forming a large wheel.

The direction of revolution was not noted, but I recall it to be counterclockwise. The flock continued condensing, causing the wheel to shrink, at the same time gaining altitude with each revolution. After having risen about 1000 m in 15 min, the flock began to drop, rapidly spiraling downward, on several occasions forming a shape that looked like the funnel of a tornado. Groups would occasionally break the fall by swooping upward. During the descent, the swallows divided into groups of 50 to 200 birds which reached the roost at intervals between 17:48 and 18:10 h. The last birds to enter the roost circled more than 1000 m above the ground until about 40 min after sunset. As the groups reached about 5 m above the ground, having dropped at a very steep angle, their path of descent leveled off with the birds planing nearly horizontally over the roost and dispersing in several directions. It was virtually dark when most birds entered, and many groups arrived unobserved. At both roosts I conservatively estimated that the swallows attained a height of 1000 m prior to settling, but some may have reached as much as 1500 m. While I observed the roost from a distance of between 1000 and 1500 m, the birds reached about 45° above the horizon.

Groups of swallows settling at different times occupied separate "patches," or sections, of the cane field, often separated from other groups of roosting swallows. At the Playa Miravalle roost, these patches were spread over an area of at least 14 ha (350 m × 400 m) of cane field. Of 25 Cave Swallows I observed perched in the sugar cane roost, only four (two groups of two) were close to other birds (minimum distance 30 cm). The birds perched an average 2.5 m above the ground (N = 10, SE = 0.1 m, range 2.0–3.0 m) on both green and dead leaves. The height of the cane plants ranged from 3.0 m to 4.5 m.

The history of the cane field suggests that the roost site changes frequently. The cane was planted only 12 months earlier. Part of the roosting area was scheduled for burning and harvesting beginning on 12 Dec. The roost therefore had to move, but cane fields in this region mature at various times between November and March, and adjacent lots suitable for swallow roosting would be available during this time period. If roosting takes place in sorghum, swallows would also encounter harvesting in December and possibly January. Sorghum fields are rotated to other crops, so the swallows would have to seek another roost substrate such as sugar cane.

I observed two instances of mortality. One Cave Swallow killed by a dog on or near the beach on 8 Dec. was probably ill or severely fatigued. It weighed only 14.5 g, 25% less than the five other specimens examined. The bird may have just completed its migration, arriving exhausted. Only once did I see Cave Swallows on the ground, at the impoundments of the El Zope experimental mariculture station, where a flock of swallows had briefly landed in a dry, salty impoundment, fluttering their wings above them in a posture typical of mud-gathering. A second mortality at the roost site occurred when a Cave Swallow collided with nearby electrical lines on 9 Dec.

Discussion.—Of the North American swallows, the Barn Swallow (*Hirundo rustica*), Tree Swallow (*Tachycineta bicolor*), and Purple Martin (*Progne subis*) are known to sleep in large communal roosts on the wintering grounds (Forbush 1929, Rudebeck 1955, Haverschmidt 1968, Hill 1988, Ridgely and Tudor 1989, Hill 1993). Neotropical species often sleep in small family-sized groups (Skutch 1989), although large communal roosts have been reported for four species: Gray-breasted Martin (*Progne chalybea*) (Cherrie 1916, Dickey and van Rossem 1938, Hill 1988, pers. observ.), Southern Rough-winged Swallow (*Stelgidopteryx ruficollis*) (Skutch 1989), White-winged Swallow (*Tachycineta albiventer*) (Cherrie 1916), and Black-collared Swallow (*Atticora melanoleuca*) (Cherrie 1916).

All six El Salvador specimens of Cave Swallow belonged to the race *H. f. pelodoma*, which breeds in Texas, New Mexico, and northeast México. Cave Swallows roost at breeding caves during and shortly after nesting in Texas (Selander and Baker 1957) and New Mexico (West 1995). Cave Swallows from this or any other population have never been reported

roosting in vegetation. In one respect, the roosting behavior of the Cave Swallows differed markedly from other swallow species. Under natural conditions, communally-roosting swallows have been reported sleeping in close proximity to others of their own species, sometimes in physical contact (Bates 1895, Sage 1895, Weir and Weseloh 1986, pers. observ. of Gray-breasted Martins). In contrast, the Cave Swallows observed in this study slept widely dispersed, with each bird usually occupying its own space of many square meters. I have not encountered a description of individual swallows sleeping widely dispersed within a roost as in the Cave Swallow roost at Miravalle. While we could discern no direct effect of a falcon that was present on this "individual" distance, a case has been reported where Barn Swallows, roosting as one flock in a corn field, split into several roosting groups when a predator (also a falcon) was present (Rolls and Rolls 1977).

Other aspects of the roosting behavior of the Cave Swallows were similar to behavior described for several other swallows. For example, I observed in the Cave Swallows the same three phases described by Loske (1984) for Barn Swallow pre-settling flight behavior: initial aimless flight by many individuals, formation of a tight flock with subsequent acrobatic maneuvers, and the final descent. Barn Swallows and Southern Rough-winged Swallows also form communal roosts in sugar cane (Haverschmidt 1968, Ridgely and Tudor 1989, Skutch 1989). Similarly, these two species also perform elaborate group flight patterns, attaining great height before spiraling down into their roosts after sunset (Bent 1942, Skutch 1989). Just as I have described Cave Swallows singing in flight as they gather over the winter roost site, Selander and Baker (1957) described them singing in flight above cave entrances during the breeding season in Texas. They described a "complex melodic warble" lasting three seconds. I never heard Cave Swallow vocalizations while they foraged away from roost sites. After alighting in the roost, the swallows were silent. In contrast, Barn Swallows have been described as most vocal *after* settling in nighttime roosts (Bates 1895; Bent 1942; Loske 1984, 1986). Purple Martins also vocalize after gathering in the roost (Fisher 1907, Forbush 1929, Stone 1937).

Cave Swallow roosting behavior seems specialized for avoiding discovery: although they are noisy and evident at sunset, they disappear from the roost by flying up and out of range of unaided human vision before returning to sleep. They silently enter the roost after dark and sleep dispersed over a large area in a virtually unpenetrable habitat. We located only 25 perched Cave Swallows in 4 h of nighttime searching along the edges of the cane fields. The twisting, high-speed aerial dive performed just before entering the roost may serve to discourage predation, as was suggested for starlings and other communally-roosting species by Zahavi (1971).

The information-centre theory of Ward and Zahavi (1973) has been shown to explain communal breeding and foraging behavior in the Cave Swallow's close relative, the Cliff Swallow, *H. pyrrhonota* (Brown 1988). The theory also appears to fit the observed roosting behavior of the Cave Swallow and would suggest the presence of additional roost sites. By regularly switching among established roosts, individual birds learn more about potential feeding sites. The theory holds that the commune thus advertises itself to attract daily newcomers, who contribute new knowledge of food resources to the entire commune. Roost advertising was evident in the pre-settling flight behavior of Cave Swallows, as the birds were noisy and visible from a relatively great distance (Ward and Zahavi 1973). The two roosts discovered so far are separated by about 150 km and a small mountain range and are thus unlikely to provide regular interchange of commune members. I suspect several additional roosts existed within the study area.

Weatherhead (1983) disputed the qualification of complex flight displays as roost advertising behavior and suggested instead that the pre-settling flight displays of communally-roosting birds is a "jockeying for position and testing of status" to establish a dominance

hierarchy. But in the Cave Swallow, and perhaps other communally-roosting swallows, I suggest that both Ward and Zahavi's and Weatherhead's theories apply. Weatherhead's hypothesis applies best to the downward spiralling, when darkness and altitude must reduce the "advertising" effect of the flight behavior, and the impressive group flight acrobatics seem appropriate for a competition of dominance.

This study provided the first description of winter roosting behavior of the Cave Swallow and demonstrated that the winter distribution of the Texas and northeastern México race *H. f. pelodoma* includes the Pacific coastal plain of El Salvador. It remains to be determined, however, the full size of the winter population of the Cave Swallow in El Salvador, including specific locations of additional roost sites.

Acknowledgements.—Field work for this study was supported by a research fellowship from the Wildlife Conservation Society and Caribbean Conservation Corporation, and by a grant from the Explorer's Club Youth Activity Fund. Field assistants included Juan Pablo Domínguez, Fabricio Pérez Rosa, José Roberto Rivera Muñoz, Ana Lorena Rosales Lara, and Salvador Emilio Sánchez Lara. Invaluable support for the field work was provided by José Ballón, Edward H. Burtt, Jr., Angélica Henríquez Lara, Nicholas Komar, Wilfredo Rodríguez, René Salgado, René Toledo, and Don Joaquín Pacas for permission to explore his cane fields at Playa Miravalle. I especially thank Carlos Roberto Hasbún, chief of the El Salvador Servicio de Parques Nacionales y Vida Silvestre, and A. Townsend Peterson of the Univ. of Kansas Natural History Museum for help in obtaining the necessary collecting permits. A. Townsend Peterson assited greatly with the borrowing of specimens and the identification of subspecies. I also thank Edward H. Burtt, Jr., Nicholas Komar, A. Townsend Peterson, and Steve West for helpful comments on the manuscript.

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Wilson Bull., 109(2), 1997, pp. 337–339

Piping Plovers produce two broods.—Piping Plovers (*Charadrius melodus*) typically raise only one brood per season, although they may renest if the first clutch is destroyed (Wilcox 1959, Cairns 1982, Haig 1982). Other Charadriidae such as Killdeer (*Charadrius vociferus*) and Snowy Plover (*Charadrius alexandrinus*) are known to raise two broods per season if early nest attempts are successful (Nickell 1943, Warriner et al. 1986). The following observations may be the first documentation of Piping Plovers successfully producing two broods in a single breeding season.

Piping Plovers were observed at two sites. Griswold Point, owned and managed by the Nature Conservancy, is a 1.5 km × 30 m-wide barrier beach on Long Island Sound at the mouth of the Connecticut River in Old Lyme, Connecticut (utms 73000 m N, 24000 m E). Nesting activity has been consistently located on a 30 m × 300 m section of the beach. The second site, Assateague Island National Seashore (NS), is on barrier island situated along the coast of Maryland and Virginia. The 35 km Maryland portion of Assateague Island is primarily owned by the National Park Service (NPS), with additional ownership by the Maryland state park system (utms 424500 m N, 49500 m E). The northern section (9.5 km × 550 m on average) of Assateague Island is managed by the NPS as a primitive area with limited access and is the primary Piping Plover nesting area.

Griswold Point has been intensively monitored since 1982, with an average of three pairs of plovers nesting annually. The area was almost devoid of vegetation and could easily be surveyed. Observers distinguished individual birds by distinctive color patterns, particularly neck bands, and the birds' use of particular territories. Before 1991, some Piping Plovers were observed with a single United States Fish and Wildlife (USFWS) metal leg band. Piping Plover monitoring was initiated at Assateague Island National Seashore in 1985, with an average of 21 breeding pairs annually. In 1994, at Assateague Island National Seashore,