ROOSTING BEHAVIOR OF THE YELLOW-SHOULDERED BLACKBIRD

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Abstract.—In southwestern Puerto Rico, Yellow-shouldered Blackbirds (*Agelaius xanthomus*), Shiny Cowbirds (*Molothrus bonariensis*), and Greater Antillean Grackles (*Quiscalus niger*) use communal secondary (diurnal) and primary (nocturnal) roosts throughout the year. Secondary roosts usually are located in the subcanopy of trees near food sources, and may act as centers for integration of flock activity, particularly exchange of information about predator location. Roosting in shaded sites allows these dark-plumaged birds to avoid hyperthermia. Primary roosts are located in predator-free sites like small islands, electric power stations, or coconut palms (*Cocos nucifera*) with rat guards. Primary roosts of Yellow-shoulders were largest during the summer and fall, which reflects the concentration of the population around breeding colonies. Shiny Cowbirds used the same roosts, mainly from early summer through early fall (May–September). Yellow-shoulders do not stay in the nesting colonies at night unless they are incubating or brooding, but return to the communal roosts. During the non-breeding season (October–March) the population was more dispersed and used many roosts. Yellow-shoulders and Greater Antillean Grackles have similar roost-entering patterns, but Shiny Cowbirds arrive later, and their arrival is more synchronized. All three species apparently use the rapid light changes occurring around sunset as cues for roost-entering. All species were sensitive to disturbances in the roosts, and readily relocated to new sites when disturbed. Predator mobbing was common. For all three species roost-leaving is more synchronized than roost-entering.

The Yellow-shouldered Blackbird (*Agelaius xanthomus*) is endemic to Puerto Rico and Mona Island. The species decreased precipitously between 1940 and 1975 (Post and Wiley 1976), and this trend toward extinction has continued. In 1975 the main population center was in southwestern Puerto Rico. During the winter of 1974–1975, there were about 1,663 individuals using roosts around La Parquera (Post and Wiley 1977a). In 1981–1982 this number had decreased to 266 birds (pers. obs.). Censuses conducted in 1985–1986 indicate that the population may now be stabilizing around the latter figure (Silander 1986). The causes for the species' decline are discussed elsewhere (Post and Wiley 1976, 1977a, 1977b; Post 1981a, 1981b). The main factor affecting its status is brood parasitism by the Shiny Cowbird (*Molothrus bonariensis*) (Post and Wiley 1977b; Wiley 1985; Cruz et al. 1985).

Roosting is an important aspect of the Yellow-shouldered Blackbird's biology, especially as it shares roosts with its parasite, the Shiny Cowbird. In the nesting season the species leave roosts together, so cowbirds may follow Yellow-shoulders to their nest sites. In addition, prolonged association between host and parasite in roosts increases the probability

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of their synchronizing breeding seasons (Post and Wiley 1977b). Understanding the roosting patterns of both species will enable us to determine more effective ways of improving the status of the endangered blackbird.

Study Area and Methods

The study was conducted from 14 January 1973 to 15 February 1976. The study area extended along the southwestern coast of Puerto Rico from Bahía Montalva to Boca Prieta (Buye) (Fig. 1). We also visited inland roosts at Lajas and San Germán. The vegetation and climate of the region are described elsewhere (Post 1981b). To census roosts on offshore cays, we anchored a boat so that all flight-lines could be seen simultaneously. If this was not possible, we counted all flights on one side of the island, and returned the next day to cover the other side. One or two persons counted the birds, while another recorded. All birds were recorded at one-minute intervals as they entered the roost. Evening counts were conducted from 120 min before sunset to 40 min after sunset. We made morning counts from 30 min before sunrise until all birds had left the roost. To census birds using power station roosts, we counted birds after they had settled. All roost occupants could be seen, because they sat on exposed wires and superstructures. We used standard deviation as the measure of statistical dispersion.

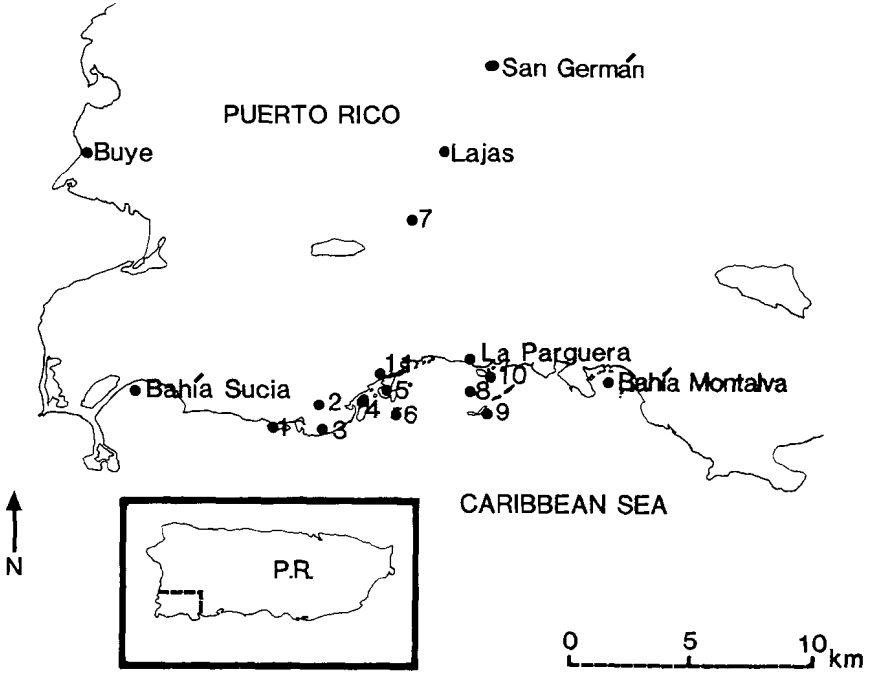

Figure 1. Study site in southwestern Puerto Rico. Key to numbered localities: 1 = Pitahaya, 2 = Salinas Arcelay, 3 = Punta Tocon, 4 = Isla Guayacan, 5 = Isla La Cueva, 6 = Collao, 7 = Lajas Experimental Station, 8 = Caballo Blanco, 9 = Cayo Enrique, 10 = Isla Magueyes, and 11 = Salinas Carlo.

RESULTS AND DISCUSSION

Secondary Roosts.—In Puerto Rico icterines use nocturnal and diurnal communal roosts throughout the year. Diurnal or secondary roosts (Ward and Zahavi 1973) were close to feeding grounds. For example, Yellow-shouldered Blackbirds, Greater Antillean Grackles (*Quiscalus niger*) and Shiny Cowbirds that fed in monkey enclosures on La Cueva Island roosted in a shoreline section of red mangrove (*Rhizophora mangle*) canopy, 20–40 m from the nearest feeding sites. The number of birds using this roost varied, but usually 25–100 birds, spread over about 600 m^2, were present at midday. Birds altered foraging bouts with variable lengths of stay in the secondary roosts, where they rested, preened and vocalized. Yellow-shoulders also occasionally carried food such as pieces of monkey biscuit into the secondary roost. Periodically groups of up to 20 birds would fly out to feed. Secondary roosts were used regularly only during the non-breeding season (October–April). When nesting, birds visiting the communal feeding sites usually returned immediately to their nests.

In secondary roosts icterines responded in concert to predators, including humans. When Turkey Vultures (*Cathartes aura*) or American Kestrels (*Falco sparverius*) flew over a secondary roost, all three species of icterines reacted by immediately becoming quiet and often diving as a group into denser vegetation. All three species jointly mobbed terrestrial predators. For example, we netted birds 25 m from a secondary roost on La Cueva, and when a captured Yellow-shouldered Blackbird screamed while being handled, grackles, cowbirds and Yellow-shoulders rapidly left the roost, flying within 5–10 m to mob us.

At the Lajas Experimental Station icterines utilized the upper canopy of several large oxhorn bucida (*Bucida buceras*) for secondary roosts. On El Guayacán Island flocks of Yellow-shoulders feeding in the monkey enclosures used stands of black mangroves (*Avicennia germinans*), 3–4 m high and 15 m distant, for secondary roosts. These trees did not provide as much shade as the red mangrove or oxhorn bucida roosts, but the birds found additional shade under the monkey shade structures in the enclosures where they fed.

On 15 February 1976, we recorded inter-individual distances for Yellow-shoulders perched next to each other on the cross-bars of shade structures in some monkey enclosures. The average distance between 21 birds was 12.4 ± 4.0 cm. Throughout the period of the study, in addition to allopreening, we observed occasional physical contact between Yellow-shoulders in secondary roosts.

Wetmore (1927) commented on the diurnal roosting of Yellow-shoulders, and pointed to its significance as a means of escaping the effects of midday insolation. Mist-netted Yellow-shoulders that were exposed to

more than 3 min of midday sun usually died. The use of daytime roosts may be crucial for dark-plumaged birds in the subtropics, especially when they forage in the open in the middle of the day.

Primary Roosts.—Yellow-shouldered Blackbirds, Shiny Cowbirds and Greater Antillean Grackles used nocturnal or primary communal roosts all year (Table 1). About the same numbers of Yellow-shoulders and grackles used the roosts throughout the year, but the number of Shiny Cowbirds varied with season. The largest numbers of cowbirds were in the communal roosts in the summer and fall, which corresponds to the breeding season of the Yellow-shoulder (Post 1981b). During the dry season (October–March) the Shiny Cowbirds probably move to moister areas outside the arid coastal zone. For example, the largest number of cowbirds recorded at any winter roost (3,525) was in San Germán on 12 February (Appendix).

Unlike secondary roosts, primary roosts were isolated; most were on small cays or mangrove peninsulas (Fig. 1). Icterines also roosted in electric transformer stations and in palm plantations. All of these sites were inaccessible to predators. Offshore mangrove cays and peninsulas were protected by water. Transformers were surrounded by chain-link fences, and the wires and steel beams of the structures were too smooth for climbing predators. These stations also were floodlit at night. Coconut palms (*Cocos nucifera*) that blackbirds used for roosting had metal rat guards.

Yellow-shouldered Blackbirds and other icterines roosted with other species like Gray Kingbirds (*Tyrannus dominicensis*) (Post 1982) and Mourning Doves (*Zenaida macroura*). Larger birds such as Cattle Egrets (*Bubulcus ibis*), Brown Pelicans (*Pelecanus occidentalis*) and Magnificent Frigatebirds (*Fregata magnificens*) often roosted on the same mangrove cays, but blackbirds did not roost in areas occupied by these species.

Yellow-shouldered Blackbirds and other icterines commonly flew together to their roosts. Along the coast, the final gathering points for roost flights were in the canopy of mangroves on the mainland opposite, and usually closest to the roost. The size of roost-bound flocks varied, and depended perhaps on the number of birds using the roost (Table 2), as well as nearness to sunset. Shiny Cowbirds formed larger flocks ($\bar{x}$ = 42) than did either Yellow-shouldered Blackbirds or Greater Antillean Grackles, although the largest Yellow-shoulder flock (150) was the same size as the largest cowbird flock. The average flock size of Yellow-shoulders ($\bar{x}$ = 32) was larger than the grackle's ($\bar{x}$ = 15).

Flight paths to the roosts varied according to the roosts' distances from the mainland gathering points and the wind conditions. Roosts close to the gathering point, and not separated by a wide stretch of water, were entered by flights 1–2 m above water. In departing for a roost far

Table 1. Seasonal variation in species composition of primary roosts on the southwest coast of Puerto Rico, 1973–1975.

Season	Period	No. of counts	Yellow-shouldered Blackbird		Greater Antillean Grackle		Shiny Cowbird	
			Average no.	Range	Average no.	Range	Average no.	Range
Winter	7 Dec–15 Feb	8	413 (29%)	147–1050	764 (53%)	28–1538	253 (18%)	2–897
Spring	15 Apr–14 May	4	431 (32%)	172–1074	824 (61%)	100–1365	94 (7%)	34–248
Summer	27 May–13 Aug	7	737 (29%)	120–1501	804 (31%)	446–1338	1020 (40%)	53–2175
Fall	1–7 Sept	3	955 (23%)	201–1663	563 (13%)	35–1446	2694 (64%)	782–4299

Table 2. Flock sizes of icterines entering primary roosts on the southwestern coast of Puerto Rico.

Date	Yellow-shouldered Blackbird			Greater Antillean Grackle			Shiny Cowbird		
	Number using roost	Average (±1SD) size of 10 largest flocks	Size of largest flock	Number using roost	Average (±1SD) size of 10 largest flocks	Size of largest flock	Number using roost	Average (±1SD) size of 10 largest flocks	Size of largest flock
14 Jan 73[1]	288	12.8 ± 2.9[1]	16	556	14.5 ± 7.9	35	168	13.1 ± 9.1	35
7 Feb 74[1]	510	15.9 ± 3.5	22	1177	19.7 ± 4.5	28	250	9.7 ± 3.3	15
15 Apr 74[1]	286	11.7 ± 5.2	25	677	16.0 ± 4.8	25	34	——	—
14 Jun 73[2]	1411	51.5 ± 20.0	100	517	10.9 ± 1.0	12	814	26.5 ± 8.5	40
17 Jul 73[2]	1501	44.0 ± 20.0	90	586	20.5 ± 5.8	30	2175	57.6 ± 24.4	90
7 Sept 73[2]	1663	58.5 ± 40.8	150	209	5.8 ± 2.7	10	4299	104.0 ± 25.5	150
$\bar{x}$	943	32.4 ± 15.4	67.2	620	14.6 ± 4.5	23.3	1290	42.2 ± 14.2	66

[1]La Parquera Harbor.
[2]Collao, adjacent to La Cueva.

offshore (over 250 m), birds at the gathering point flew up in mass, and continued to fly together at a height of 20–30 m. As the flock approached the roost, it gradually lowered altitude until it was 30–50 m off the roost cay, at which time it had reached a height of 0.5–1.5 m. When the headwind was too strong, the departing flocks would turn back repeatedly to the departure point.

When Yellow-shouldered Blackbirds flew low over the water and the wind was strong, they risked being engulfed by a wave. On 7 September 1973, we saw three Yellow-shoulders fall in the water as they flew to roost on Collao, with winds 25–33 km/h. When the birds were a short distance above the water, one bird fell in, about 40 m from Collao. It swam to the cay in 6 min 40 sec, against a strong southeast wind. A second bird fell in 30 m from Collao. It initially scampered, gallinule-like, over the water until its wings were wet and it sank, but it was able to swim to the island in 2 min 31 sec. A third bird fell in 20 m offshore, and was in the water 2 min 13 sec. All three swam strongly, with only their necks and backs out of the water. On 3 August 1975, we saw a Yellow-shoulder chase another into the roost, and about 5 m offshore, the pursuer attempted to grab the tail of the other bird, and knocked it into the water. These occurrences of adult Yellow-shoulders falling in the water may be related to their molting during August–September; with remiges missing overwater flight against a wind becomes hazardous.

The temporal behavior of Yellow-shouldered Blackbirds and Greater Antillean Grackles arriving at primary roost was similar (Table 3; Fig. 2). The average time of first arrival of both species was 104–105 min before sunset; 90% of the population were in the roost by 14 min before sunset, and the average last arrival in the roost was 1–2 min after sunset. The Shiny Cowbird arrived later (79 min before sunset) and completed its roosting movements in a shorter period (76 min vs. 102 min for each of the other species). The average light intensity for Yellow-shoulders arriving at five roosts was 5,768 foot-candles (fc). The average light intensity at the time that 90% of the Yellow-shoulders had arrived was 313 fc, and the average intensity on termination of flight was 79 fc. Tropical icterines, like temperate zone species, apparently use the rapid light changes taking place after sunset as cues for their roosting movements (Krantz and Gauthreaux 1975).

Because of the latitude, the seasonal variation in the time of sunset is slight (i.e., 1 h–25 min from 25 June to 16 November). This small difference is reflected in a lack of pronounced seasonal variation in the temporal pattern of roosting behavior (Fig. 3).

In the fall fewer and larger roosts were used than in other seasons; for example, the Collao roost apparently served the whole area from Pitahaya to La Parguera (Fig. 1). This roost began forming during the breeding season, and it was closest to the main breeding grounds on the

adjacent mainland (Salinas Carlo and Salinas Arcelay) and feeding areas on La Cueva and El Guayacán. Collao was not occupied in the winter or spring and at those times blackbirds used several smaller roosts such as Pitahaya, Bahía Montalva, Punta Tocón, Caballo Blanco, or Magueyes (Fig. 1). The use of many smaller roosts in the winter reflects more dispersed feeding patterns than in the summer, although individual birds flew long distances to certain preferred roosts. For example, during March and April 1974 male "OXOA" and female "AGOY" fed during the day in La Parquera, but flew 5 km nightly to roost at Bahía Montalva, rather than using the Caballo Blanco roost, 1 km from their feeding grounds.

Around La Parquera at least one roost was active all year: Magueyes, Caballo Blanco, or Cayo Enrique. Similarly, Bahía Sucia was a year-round roost, although like the roosts in La Parquera, numbers of birds using it varied with the season. The relative representation of each species is probably important in determining the permanence of a roost: although one species might abandon a roost, it could be maintained by the others. Yellow-shoulders use communal roosts even during the nesting season; males do not roost in the nest vicinity, and females stay only about 20 days, when they are incubating and brooding (Post 1981b).

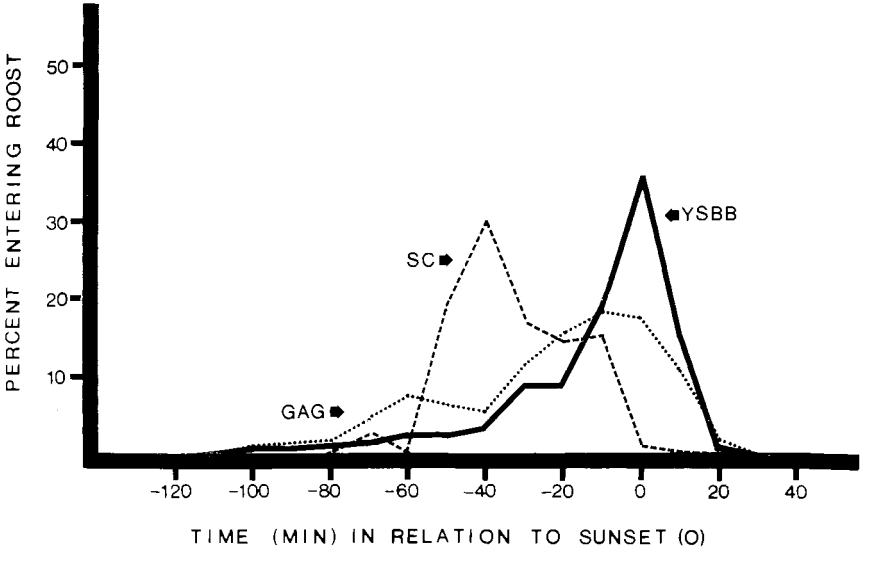

Figure 2. Roost-entering pattern of three species of icterines at Collao, 3 August 1975. Sunset at 1905 h. Numbers of birds entering roost were: Yellow-shouldered Blackbird (YSBB), 1044; Greater Antillean Grackle (GAG), 1107; Shiny Cowbird (SC), 1867.

Table 3. Comparisons between the evening roosting behavior of three species of icterines using primary roosts on the southwestern coast of Puerto Rico.

Variable	Yellow-shouldered Blackbird	Greater Antillean Grackle	Shiny Cowbird
Time of first arrival at roost[1]	−105 ± 19(15)[2,3]	−104 ± 15(16)	−79 ± 24(15)
Time by which 90% of birds had entered roost[1]	−14 ± 18(21)	−14 ± 16(20)	−18 ± 10(14)
Time of last arrival[1]	−1 ± 20(16)	2 ± 18(16)	−4 ± 13(15)
Average duration of roost flight (min)	102 ± 20(14)	107 ± 22(16)	76 ± 17(10)
Average rate of entry (bird/min)	6 ± 4(14)	7 ± 4(14)	17 ± 16(10)

[1]Minutes in relation to sunset.
[2]Values represent mean ± 1 SD.
[3]Values in parentheses are sample sizes.

The three icterine species were sensitive to disturbances at their roosts and switched to alternate sites, of which there were many nearby. For example, we found five roost sites within 3 km of La Parquera, each used only one at a time. The rapidity of response of blackbirds to disturbances in their roosts is shown by the following occurrence. On the evening of 8 May 1974, we gave distress squeaks and clapped our hands in the Magueyes roost. Many birds, mainly Greater Antillean Grackles, responded by flying overhead in mass, scolding and hovering above, then landing in nearby treetops to continue mobbing. At 12 min before sunset we started our boat motor and the noise again disturbed the birds, as flocks of 50–100 grackles and Yellow-shouldered Blackbirds flew out of the roost to Caballo Blanco, 440 m away. We then went to Caballo Blanco, where birds were still arriving from Magueyes. The roost-switching of these birds lasted until 3 min after sunset. Some flocks landed on Caballo Blanco only to fly up again, returning to the original roost on Magueyes, although most of the newly arrived flocks stayed.

Yellow-shouldered Blackbirds and other icterines roosting in mangroves occupied the lower and middle canopies, a height which varied from site to site. For example, on Collao Yellow-shoulders and Shiny Cowbirds roosted at 4.5–7.5 m where the mangroves were about 9 m high, whereas on Caballo Blanco, these two species roosted at 6–9 m in 12 m high mangroves. Roosting icterines used the inner parts of roosting cays, usually 5–10 m away from the water's edge. In tall mangroves, such as on Caballo Blanco, the subcanopy had few leaves and twigs and was little used by roosting icterines. Before dark roosting birds mainly rested and preened. Intense calling bouts by icterines were often alter-

nated with periods of silence. Roosting Yellow-shoulders used most of their vocalizations, and no special displays were associated with roosting.

In the morning, Yellow-shouldered Blackbirds and other icterines left the roosts during a shorter time compared to entering the roost (Fig. 4). Before leaving the roost, birds moved up to the tops of the mangroves and called continuously. Departing flocks flew up over the roost to an altitude of 20–30 m, often circled, then flew toward the mainland. After reaching the mainland, flocks of individuals moved toward their main feeding grounds, frequently stopping along the way to feed or rest. During December 1972–January 1973 the average time of arrival of the first birds on the feeding grounds on La Cueva was 27.9 ± 7.3 min after sunrise, or 39.9 ± 7.3 min after the birds left the roost on Caballo Blanco (N = 14 days). The average rate of travel over the 4.5 km distance between the roost and La Cueva was 117 ± 20 m/min.

CONCLUSIONS

The daily roosting movements of the subtropical Yellow-shouldered Blackbird are examples of diel migrational responses (Gauthreaux 1980). Daily periodicity in communal roosting is evident throughout the year.

Because Yellow-shouldered Blackbirds often feed in groups during the day, but also are subject to nocturnal predation, it is not possible to use this species to test Ward and Zahavi's (1973) hypothesis regarding the information transfer function of communal assemblages. However, it

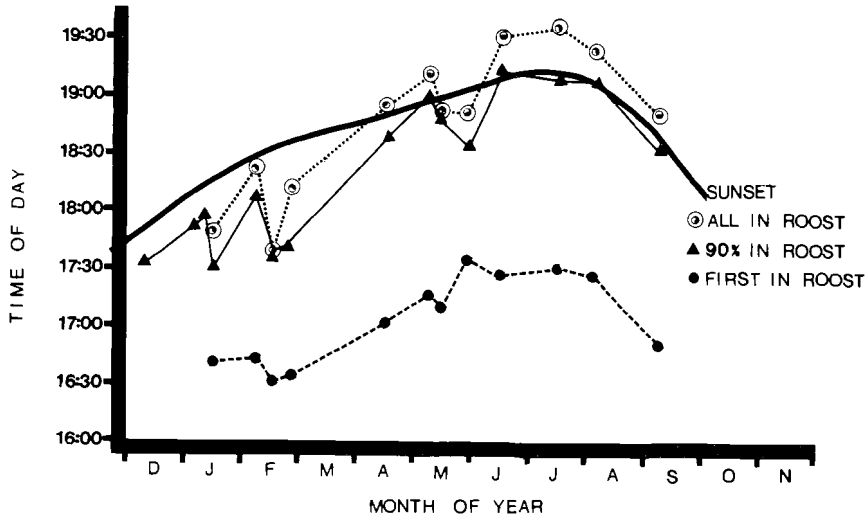

Figure 3. Seasonal changes in roost-entering behavior of Yellow-shouldered Blackbirds based on data summarized in Table 3. Solid line represents time of sunset.

is likely that predator avoidance is a significant factor in determining the location of nocturnal roosts of the Yellow-shoulder. This is deduced from: (1) their use of traditional predator-free roost sites that are often reached by long flights; (2) the blackbirds' sensitivity to predators in the roosts, and their readiness to mob intruders and to desert disturbed roosts; and (3) their sharing roosts with Gray Kingbirds, a species whose communal roosting appears to aid mainly in predator avoidance (Post 1982).

The secondary roosts used by Yellow-shoulders provide essential shade for these dark-plumaged birds. They also serve as refuges from raptors. Large shade trees near appropriate foraging areas may be important factors in determining the diurnal distribution of Yellow-shoulders and other icterines in the subtropics. Management plans for the Yellow-shoulder should consider the distribution of secondary and primary roosts, in relation to major communal feeding and nesting areas.

The relationship between the Yellow-shouldered Blackbird and the Shiny Cowbird in the communal roosts deserves further study. During the breeding season Shiny Cowbirds do not closely associate with foraging Yellow-shoulders. Yellow-shoulders are usually solitary feeders at

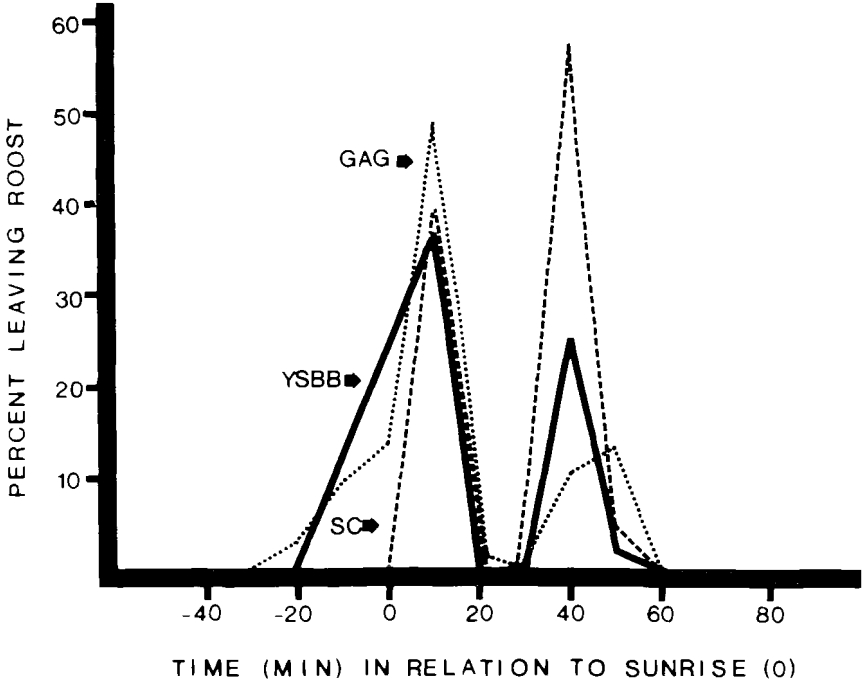

Figure 4. Roost-leaving pattern of three species of icterines at Caballo Blanco, 15 December 1974. Number of birds: Yellow-shouldered Blackbird (YSBB), 147; Greater Antillean Grackle (GAG), 506; Shiny Cowbird (SC), 45.

this time, and use arboreal, oriole-like foraging tactics (Post 1981b). Cowbirds usually feed on the ground and are more closely associated with Greater Antillean Grackles. Further, most Shiny Cowbirds (≥90% of the population) leave the southwestern coastal zone in the winter. When the bulk of cowbird population returns to the Yellow-shoulder breeding areas in the spring, communal roosting may allow rapid synchronization of the two species' breeding behavior. The communal roosts may be especially advantageous to any cowbirds that arrive after the blackbirds have already switched from communal to solitary foraging sites.

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Appendix. Summary of blackbird roost counts in southwestern Puerto Rico, 1965–1975.

Date	Locality	No. of Yellow-shouldered Blackbirds	No. of Greater Antillean Grackles	No. of Shiny Cowbirds
30 Jan 1965[1]	Magueyes	1537	4130	0
16 Feb 1973	Collao	178	28	2
19 Feb 1973	Collao	232	27	2
7 May 1973	Collao	1074	100	60
14 June 1973	Collao	1411	517	814
17 Jul 1973	Collao	1501	586	2175
7 Sept 1973	Collao	1663	209	4299
7 Feb 1974	Magueyes	510	1150	250
23 Feb 1974	Pitahaya	690	471	448
15 Apr 1974	Magueyes	286	677	34
6 May 1974	Collao	6	0	0
14 May 1974	Magueyes	191	1407	34
27 May 1974	Pitahaya	342	570	53
12 Jul 1974	Magueyes	120	1338	1180
16 Jul 1974	Pitahaya	420	446	62
20 Jul 1974	San Germán	0	1157	640
20 Jul 1974	Collao	25	20	0
4 Sept 1974[2]	Collao	1000	35	3000
25 Nov 1974	Collao	0	0	0
28 Nov 1974[2]	Caballo Blanco	150	250	30
7 Dec 1974	Pitahaya	1050	321	11
15 Dec 1974	Caballo Blanco	156	506	45
21 Dec 1974[2]	Bahía Montalva	300	750	450

5 Jan 1975	Bahía Montalva	284	1538	897
11 Jan 1975	Bahía Sucia	147	1513	203
12 Feb 1975	San Germán	6	3525	1175
12 Feb 1975	Lajas	7	405	45
15 May 1975	Caballo Blanco	172	1152	248
15 May 1975	Collao	63	0	5
22 Jun 1975	Collao	3	0	0
20 Jul 1975	Caballo Blanco	0	7	0
3 Aug 1975	Collao	1048	1106	1868
13 Aug 1975	Cayo Enrique	319	1062	989
17 Aug 1975	Bahía Montalva	2	530	1
28 Aug 1975	Pitahaya	0	0	0
1 Sept 1975	Bahía Sucia	201	1446	782

[1]Data collected by M. Gochfeld.
[2]Estimated value.