

Short Communications

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Group Roosting Behavior of Yellow Tyrannulets (*Capsiempis flaveola*)

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ABSTRACT.—For 4 consecutive evenings in southern Nicaragua, a group of three Yellow Tyrannulets (*Capsiempis flaveola*) roosted in the same plant, and always arrived approximately 45 min before last light. Pre-roosting behavior appeared stereotyped and included mutual preening and a peculiar manner of hopping over one another. These three birds presumably left the roost around first light each morning. Received 4 May 2004, accepted 6 October 2004.

Despite the large amount of time birds spend at roost sites and their presumed vulnerability while asleep, little is known about roosting behavior of most species, especially those in the Neotropics. Skutch (1989) provides a general overview of avian roost sites and behavior, especially of Neotropical passerines. Among the Tyrannidae, Skutch (1989) reported “sleeping in contact” in both Platyrinchinae (Common Tody-Flycatcher, *Todirotum cinereum*) and Tyranninae (Social Flycatcher, *Myiozetetes similis*; Tropical Kingbird, *Tyrannus melancholicus*), whereas “sleeping in pairs” (i.e., roosting in close proximity, but not in contact) was noted in Tyranninae (Gray-capped Flycatcher, *Myiozetetes granadensis*; Boat-billed Flycatcher, *Megarhynchus pitangua*) and Elaeniinae (Yellow-bellied Elaenia, *Elaenia flavogaster*). In these examples, the roosting groups consist of a few individuals known or suspected to be paired or related. Cooperatively breeding birds may be particularly prone to roosting in contact (Skutch 1989), but few tyrannids are reported or suspected to breed cooperatively (2–3 species out of >375), and these species may not always do so (Thomas 1979, Ricklefs 1980, Brown 1987; J. A. Mobley pers. comm.). Migratory kingbirds (Tyranninae: *Tyrannus* spp.) have been observed roosting in large groups during the non-breeding sea-

son (Skutch 1989, Mayer 2004). Some tropical tyrannids that build covered or globular nests also roost (either individually or with young) in these structures year-round (Fluvicolinae: Sulphur-rumped Flycatcher, *Myiobius sulphureipygius*; Skutch 1989), and Eyeringed Flatbills (Platyrinchinae: *Rhynchocyclus brevirostris*) sometimes build a different type of nest for roosting than for breeding (Skutch 1960). I describe here observations of the roosting behavior of a group of three Yellow Tyrannulets (Elaeniinae: *Capsiempis flaveola*), whose roosting behavior has not been described previously.

The Yellow Tyrannulet (7.9 g) is a sexually monomorphic, open-cup-nesting, lowland tyrannid, resident from eastern Nicaragua south across northern South America, and disjunctly(?) from Bolivia east into southeastern Brazil (Ridgely and Gwynne 1989, Ridgely and Tudor 1994, Hilty 2003). In Central America, it lives in pairs or small (possibly family) groups in lowland thickets, overgrown pastures, and forest edges (Skutch 1960, Ridgely and Gwynne 1989; SW pers. obs.), but is often associated with bamboo in South America (Ridgely and Tudor 1994; SW pers. obs.). The observations reported here were made in the evening, 6–9 April 2004, at the confluence of the Rio Bartola and Rio San Juan, Refugio Bartola, Depto. Rio San Juan, Nicaragua (10° 58' N, 84° 20' W; 30 m asl). Daytime temperatures were approximately 30° C, dropping to 22–25° C at night; there was no precipitation during this period. Observations were made at the edge of a clearing, where an overgrown pasture and secondary forest growth met. The 1.5-ha pasture was adjacent to the Rio San Juan, and consisted mostly of grasses (1.5–2 m high) interspersed with clumps (1.5–3 m high) of an unidentified slender, woody legume with finely pinnate leaves and yellow flowers.

On 6 April, at 17:40 CST (~15 min before sunset; 35 min before complete darkness),

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three Yellow Tyrannulets appeared, giving many single “wit” or “weet” notes. These vocalizations, while having a quality characteristic of the species, were unlike the typical two-syllabled calls given while foraging and at other times of the day. In contrast to the shy behavior of this species described by Skutch (1960), the birds were unwary, and gave no indication of being disturbed by my presence 15 m away. While making many short flights and hops through the vegetation, the group quickly converged on the roost plant, a thin woody legume (2.2 m high) entwined by a vine with cordate leaves. The birds all perched on the same branch 1.5 m above ground, which placed them at the lower edge of the plant’s foliage. The birds’ position left them completely exposed on three sides, but leaves from the plant and associated vine provided total cover from above—roost-site characteristics that Skutch (1989) reported for several other tyrannids.

Upon alighting on the roost branch, the birds appeared to “jockey” for position, frequently hopping over one another. This could have been an effort to gain the center position, but it was not uncommon for two birds to engage in this hopping while the third looked on from a branch a few centimeters away. This hopping behavior appeared highly stereotyped: a bird hopped over a single adjacent bird, and the hopping bird alit as close as possible to the bird it hopped over. Sometimes the hopping bird simply walked quickly over the back of its neighbor, but more typically the hopping was of the same character as that of the hopping exhibited by some male manakins (Pipridae) at leks. During this time, the birds frequently vocalized and faced opposite directions, but after 7 min they became silent and all faced the same direction. Once settled, the three birds were in direct contact with each other and the contour feathers were fluffed out somewhat. The birds remained in this position, eyes open and looking about, until total darkness. The most common position for the group entailed all birds facing the same direction, the middle bird looking straight ahead, and both outer birds looking away from the center one; this was the position the birds were in at the end of my observations on all 4 evenings. Roosting in direct contact with other individuals has been noted in both elae-

niine and tyrannine tyrannids, and most often involves young siblings, or young and their parents; adult mated pairs apparently roost less often in direct contact with each other (Skutch 1989).

During the next 3 evenings, the birds arrived slightly earlier (17:20–17:30), did not vocalize as much as on the first evening, and were always settled by 17:35. It was not possible to determine whether the birds always approached the roost site from the same direction or traveled together, but each evening they appeared synchronously from the vegetation surrounding the roost plant. A few sporadic observations of Yellow Tyrannulets in the pasture during the day were all of single individuals, but it was difficult to determine whether or not other individuals were nearby in thick vegetation. The birds always roosted in the same plant and alternated daily between roosting on one of two branches that were only a few centimeters apart. On one evening, after the birds had already settled, the birds were flushed from the roost by a pair of Grayish Saltators (*Saltator coerulescens*). The tyrannulets returned, briefly jockeyed for position, engaged in some mutual preening, and settled again within 4 min. Roost site fidelity in birds is not uncommon (Skutch 1989, Willis and Oniki 2003), but because I was only able to check the roost site for these 4 consecutive days, I do not know how frequently the site was used otherwise.

I was unable to determine precisely when the birds left the roost in the morning. On 2 mornings, I checked the roost at 05:30 (~25 min after first light) and the birds were already gone. I made one check of the roost at 04:30 (total darkness) with a flashlight, and the birds were still asleep at the roost. Thus, these birds probably left the roost somewhere around first light.

Despite observing the tyrannulets at close range with binoculars, I was unable to detect any differences in plumage or behavior that might suggest something about the relationship of the birds. Yellow Tyrannulets breed at almost any time of year (in Costa Rica) and lay two eggs per clutch (Skutch 1960); thus, it is not likely that this was a group of three young siblings roosting together, as Skutch (1989) describes for a group of Rusty-margined Flycatchers. Only the female is thought

to incubate eggs in Yellow Tyrannulets, but the male helps feed the nestlings (Skutch 1960). Extra-pair helpers at the nest are not known for Yellow Tyrannulets, and generally are rare among tyrannids (Brown 1987). Thus, I may have been observing two adults with one young, one adult with two young, or three adults. Either of the first two scenarios suggests that the young stay with their parents until their plumage appears (at least under field conditions) identical to that of the adult.

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Foraging by a Red-tailed Hawk along a Wetland Edge: How Large a Duck can be Captured?

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ABSTRACT.—A Red-tailed Hawk (*Buteo jamaicensis*; estimated mass 1,000–1,200 g) failed to kill a Red-breasted Merganser (*Mergus serrator*; estimated mass 1,150 g) that it captured in shallow water (<25 cm), but evidently dispatched a starving Red-necked Grebe (*Podiceps grisegena*; mass 645–660 g). These observations are pertinent to estimating the upper mass limit for successful foraging in water. *Received 9 April 2004, accepted 2 September 2004.*

Falconers were familiar with prey selection centuries before ideas about “optimal foraging”

were formalized (e.g., Krebs and Davies 1978). Originally, their interest was practical and involved questions such as what size prey a hawk could bring to the table. Much later, with the rise of wildlife management programs, raptor enthusiasts turned to broader ecological questions, including the impact and selective effects of predators on prey populations (e.g., Rudebeck 1950, 1951; Craighead and Craighead 1956; Luttich et al. 1970). In a classic study involving four species (*Accipiter nisus*, *Falco columbarius*, *F. peregrinus*, *Haliaeetus albicilla*), Rudebeck (1950, 1951) reported that an average of 19% (range: 14–33%) of birds captured for prey “exhibited injury, abnormality, or abnormal behavior.” From this he concluded that raptors probably selected weak or unfit birds in numbers dis-

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proportionate to their representation in the natural population. That viewpoint has become conventional wisdom (e.g., Mansell 1980) despite cautions that “the general idea that predators cull the injured and sick may be in part a phenomenon of what catches the human eye” (Drury 1998:163).

I report the behavior and prey choice of an immature Red-tailed Hawk (*Buteo jamaicensis*) that foraged in atypical habitat. Over the winter of 2002–2003, the hawk took up residence in a swampy woodland in Annapolis, Maryland, often perching 8 m high in a large oak (*Quercus* sp.) at the edge of a tidal, brackish water embayment. On 7 April 2003, at about 15:00 EDT on a cold (5° C) and rainy afternoon, the hawk jumped from its perch and plunged into the water about 30 m away. My initial view was obscured by vegetation, but much splashing ensued. Two min later I watched the soaked hawk struggle ashore with great difficulty, flapping its wings and hopping on one foot, the other being imbedded in the back of a still-living male Red-breasted Merganser (*Mergus serrator*; expected mass 1,150 g; Titman 1999). The strike had been made within 2 m of shore, probably in water <25 cm deep. After several minutes, the hawk dragged the merganser onto dry land and then stood over it for a few minutes, seemingly exhausted. It then “mantled” and attempted to finish the kill by severing the neck. But at the last minute the merganser struggled, like a wrestler avoiding being pinned, which nullified the effort. For the next 5 min, the hawk remained motionless, and then attempted the kill again with the same negative results. Once more it rested for 5–8 min, during which time the merganser occasionally ventured a weak flap, which elicited no response. The attempt to dispatch the merganser was repeated several more times, always ending in a stalemate. After 48 min, and with darkness approaching, the hawk suddenly gave up and flew away. The merganser lay motionless for about 30 sec, then shuffled into the water and swam out of sight, looking rumped and listing slightly to one side. At the site, I found no sign of blood and only a few merganser feathers.

Six days earlier I had found a dead, adult male Red-necked Grebe (*Podiceps grisegena*) 28 m from where the merganser was attacked; this was 60 m from the hawk’s perch. The

grebe had been in the area for about 5 days previously, often diving in very shallow water within a few meters of shore. On examining the carcass, which was on shore and just above the high tide line, I judged that it had been dispatched by a raptor, and not scavenged by a mammal. The body had been ripped open from the back, the neck severed, and there were bill marks on the end of the scapula and ribs (cf. Blohm et al. 1980). The grebe was emaciated and, had it not been killed, would have soon died of starvation. Its gizzard contained a few well-ground fragments of beetle exoskeleton and two fresh amphipods about 7 mm long. The condition of the amphipods indicates that it had been capable of diving until a short time before its death and, therefore, had been killed. The carcass weighed 565 g and was lacking heart, lungs, part of the liver, and most of the intestine; part of the right breast and leg had been devoured. By extrapolating from data on the body composition of Eared Grebes (*P. nigricollis*; Jehl 1997) and comparing the mass of the intact and eaten parts of the Red-necked Grebe, I calculated that 90 g of muscle was missing and that the intact bird weighed 645–660 g. A healthy grebe in winter would be expected to weigh about 1,330 g (Stout and Nuechterlein 1999).

Red-tailed Hawks (average mass 1,000–1,200 g, depending on sex) feed mainly on small mammals, but have been known to take prey (e.g., jackrabbits) weighing up to about 2,000 g (Preston and Beane 1993). They have been reported occasionally (usually from prey found in the nest) to feed on several species of dabbling ducks, including Northern Pintail (*Anas acuta*; Bent 1937), and, in one instance, on a grebe (Luttich et al. 1970). In those reports, details of prey size, health, and the conditions of capture were not given. Sargeant et al. (1993) reported that certain raptors in the Prairie Pothole region may “prey extensively on adult ducks.” Red-tailed Hawks were among the raptor species mentioned, but evidence for their involvement was circumstantial. Murphy (1994) observed a Red-tail feeding on an adult female Gadwall (*A. strepera*) in a prairie; the circumstances suggested that it had been caught on land nearby. He also saw an immature Red-tail capture a young Blue-winged Teal (*A. discors*) from a swim-

ming brood, and then transport it with great difficulty to shore. The average mass of pintails is 800 g (female) to 1,000 g (male; Austin and Miller 1995), mass of female Gadwalls is about 700 g (J. R. Jehl, Jr. unpubl. data), and that of teal ducklings is <400 g (Rowher et al. 2002).

A buteo's ability to capture and dispatch prey must be much greater on land than in water, where its normal killing behavior would be hampered. In the present case, a Red-tailed Hawk (1,000–1,200 g) failed to kill a Red-breasted Merganser (1,150 g) but killed a starving Red-necked Grebe (645–650 g). This suggests that the upper size limit for a Red-tailed Hawk to capture healthy prey in aquatic situations may be about 800 g. This is about 80% of its mass and approximately the average mass for large dabbling duck species. Additional observations would be instructive.

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Adult Gray Jay Captures an Adult Black-capped Chickadee

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ABSTRACT.—We observed an adult Gray Jay (*Perisoreus canadensis*) that had captured an adult Black-capped Chickadee (*Poecile atricapillus*) in Algonquin Provincial Park, Ontario, Canada, during winter. Aerial pursuit of small, adult birds and an instance of capture and predation of a juvenile bird by a Gray Jay have been reported previously. Here, we present the first documented case of capture of a seemingly uninjured, adult bird. Received 22 March 2004, accepted 12 October 2004.

The Gray Jay (*Perisoreus canadensis*) is well known for its diverse diet. Foods cited in the literature include arthropods, berries, carrion, nestling birds, fungi (Strickland and Ouellet 1993); a blood-stained weasel (Bent 1946); an injured Green-winged Teal (*Anas crecca*; Ouellet 1970); a well-decomposed seal carcass (Ouellet 1970); live deer mice (*Peromyscus maniculatus*; Gill 1974); blood-engorged winter ticks (*Dermacentor albipictus*; Addison et al. 1989); and insects caught in the air, flycatcher-style (Lawrence 1968, Strickland and Ouellet 1993). When available, eggs, nestlings, and weak-flying fledglings of many bird species are commonly eaten (Ouellet 1970, Strickland and Ouellet 1993).

It has been suggested that predation of adult birds by Gray Jays may be more regular than previously thought (Ouellet 1970, Barnard 1996). Here, we report the details of an adult Gray Jay that had captured an adult Black-capped Chickadee (*Poecile atricapillus*) during winter, which contributes to knowledge of the capture of independent vertebrate prey by Gray Jays.

On 26 February 2004, while birding along a road south of Lake Opeongo, Algonquin

Provincial Park, Nipissing District, Ontario, Canada (45° 37' N, 78° 21' W), our attention was drawn to a distress call that was loud, high-pitched, squeaky, and repeated quickly with few pauses. Upon turning toward the call, we were surprised to see a Gray Jay standing on top of a Black-capped Chickadee. The sound was given by the distressed chickadee as it attempted to escape the jay's grasp. One of the jay's feet appeared to be placed around the chickadee's neck, whereas the other foot grasped somewhere along the belly. We observed this act from about 10 m away, on a snow-covered, plowed roadway for approximately 5 sec, after which time the jay released the chickadee. The jay initially hopped away quickly and then flew off, while the chickadee, apparently unharmed, flew immediately to dense cover located 5 m away and disappeared. It is likely that the movement of a nearby photographer scared the jay. We suspect that if the jay had not been startled, it would have killed the chickadee.

Both the jay and the chickadee were probably initially attracted to seeds and bread that had been thrown along the plowed portion of the road. Two Gray Jays and up to a dozen Black-capped Chickadees had been visiting the road throughout the day, and during ~1 hr of watching the jays and chickadees earlier that same day, we did not witness any aggressive interactions, despite the fact that the birds fed within meters of each other. We did not observe the events prior to those described above; therefore, we do not know how the jay captured the chickadee.

The jay was uniquely color-banded, as part of a long-term study of Gray Jay nesting biology and behavior (see Strickland and Waite 2001), and belonged to a pair that was building a nest approximately 200 m from where the observation occurred. We observed this pair add material to their nest about 45 min before our observation, and we observed them again near the observation site a few minutes

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before the incident occurred. In the excitement of the moment, neither of us noted whether the jay standing on the chickadee was the male or the female.

Based on a comparison of the characteristics of the distress call that we heard given by the captured chickadee with the auditory descriptions of the major call types of chickadees outlined in the literature (Hailman 1989, Smith 1991), the call we heard was most similar to the “squeal” delivered by trapped adults of the Boreal Chickadee (*P. hudsonica*; Ficken et al. 1996), Mountain Chickadee (*P. gambeli*; McCallum et al. 1999), and Chestnut-backed Chickadee (*P. rufescens*; Dahlsten et al. 2002). Smith (1993) described squeals given by distressed, young Black-capped Chickadees soon after they fledge, but did not describe adult squeals. The duration of the noisy interaction we witnessed was likely too short (i.e., only about 5 sec) to attract attention from other birds; there have been reports of jay predation on birds during which distress calls lasting from 1 to 5 min elicited a mobbing response by nearby birds (Ehrlich and McLaughlin 1988, Curry 1990, Barnard 1996).

Barnard (1996) reported a juvenile Gray Jay that captured, killed, and consumed a juvenile Magnolia Warbler (*Dendroica magnolia*) that was capable of quick, sustained flight. This is the only previous report of an uninjured bird being captured by a Gray Jay (Barnard 1996). Strickland and Ouellet (1993) noted that small, adult birds are usually ignored by Gray Jays, although energetic, unsuccessful, aerial pursuits of Boreal Chickadees and Common Redpolls (*Carduelis flammea*) occasionally occur. Pike (1978) observed an adult Gray Jay capture an injured Black-capped Chickadee. The chickadee was already injured when it was found in a mist net—probably, the author explains, as a result of being pecked by a Gray Jay. When the chickadee was placed on the ground to recover, a Gray Jay grabbed it with its feet, and pecked on the chickadee’s head several times before it flew off with it (Pike 1978).

Predation of adult or fledgling birds by other jay species has been reported elsewhere: Mourning Dove (*Zenaidura macroura*; DuBowy 1985), Yellow-rumped Warbler (*Dendroica coronata*; Johnson and Johnson 1976), Purple

Finch (*Carpodacus purpureus*; Downs 1958), and House Sparrow (*Passer domesticus*; Master 1979) by Blue Jay (*Cyanocitta cristata*); Pygmy Nuthatch (*Sitta pygmaea*) and Dark-eyed Junco, gray-headed morph (*Junco hyemalis caniceps*) by Steller’s Jay (*Cyanocitta stelleri*; Carothers et al. 1972); Northern Mockingbird (*Mimus polyglottos*) by Florida Scrub-Jay (*Aphelocoma coerulescens*; Curry 1990); European Starling (*Sturnus vulgaris*), Cliff Swallow (*Petrochelidon pyrrhonota*; Ehrlich and McLaughlin 1988), and Hermit Thrush (*Catharus guttatus*; McLandress and McLandress 1981) by Western Scrub-Jay (*Aphelocoma californica*); and an unknown sparrow by Mexican Jay (*Aphelocoma ultramarina*; Roth 1971). Use of the feet by jays to restrain avian prey, demonstrated by the Gray Jay in our observation, has been noted previously for Steller’s Jay (Carothers et al. 1972), Blue Jay (Master 1979, DuBowy 1985), Florida Scrub-Jay (Curry 1990), Western Scrub-Jay (Ehrlich and McLaughlin 1988), and Gray Jay (Pike 1978, Barnard 1996). By using their feet to restrain prey, the jays’ bills are free to strike and kill their victims (McLandress and McLandress 1981, Ehrlich and McLaughlin 1988).

During periods of inclement weather in winter, some jay species appear to be attracted to small birds as a food source (Roth 1971, Carothers et al. 1972). The weather prior to and during our observation was not unusually harsh relative to average winter weather patterns for the area, suggesting this was not a contributing factor. Similarly, Johnson and Johnson (1976) and Master (1979) concluded that inclement weather was not a contributing factor to their observations of Blue Jay predation on birds. Inclement weather in winter should not influence Gray Jay predation on birds, given that this species relies on food cached throughout large, year-round, multi-purpose territories to survive harsh, boreal-forest winters (Strickland and Ouellet 1993). It is also highly unlikely that hunger was a motivating factor for this aggressive interaction because these jays were highly subsidized by artificial feeding, and they were demonstrating their superior nutritional state by nesting ahead of all other Algonquin Gray Jay pairs ($n = 20$) under observation at that time (R. D. Strickland pers. comm.).

Our observation, combined with observations by Barnard (1996) and Strickland and Ouellet (1993), suggest that Gray Jays capture small, adult passerines opportunistically throughout the year. This is the first documented instance of a seemingly uninjured adult bird being captured by a Gray Jay. These kinds of observations advance our understanding of interactions among species. Additional study is needed to reveal the frequency with which the Gray Jay preys on adult birds, and the environmental factors that influence this behavior.

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Flight Display Song of the Vermilion Flycatcher

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ABSTRACT.—A number of authors have qualitatively described the songs of Vermilion Flycatchers (*Pyrocephalus rubinus*) given during flight display, but no spectrograms or quantitative analyses are available. We present such a description based on displays of 14 different males. Our analysis confirms the impressions of earlier authors that the flight song is closely similar to that given by perched birds, but also revealed an important difference: most flight display songs also included an extra element known as the *peent* vocalization. The *peent* is also an alarm call, given during male-male and male-female interactions, as well as during foraging bouts. Besides reporting on the common use of *peent* vocalizations by perched Vermilion Flycatchers, we now describe the frequency and use of *peent* vocalizations in flight display songs. Received 4 March 2004, accepted 29 October 2004.

The repertoire of displays by the Vermilion Flycatcher (*Pyrocephalus rubinus*) includes a conspicuous flight display given during the breeding season (March to August, AARC pers. obs.). This display has been described (De Benedictis 1966, Smith 1967) and related to “territorial proclamation” (Smith 1970: 488). Anecdotal observations (AARC pers. obs.), where a male seems to respond with a flight display to a neighbor’s flight display, support the idea that individuals use this behavior in a male-male context. An interesting feature of flight displays is that they are accompanied by vocalizations. These vocalizations are considered to be closely related to the Regularly Repeated Vocalization, which is normally sung from a perch (Smith 1967, 1970). To add to our knowledge on the nature of songs uttered during flight displays, we present spectrograms of these songs ($n = 14$ males).

Our study was carried out in the Bosque de San Diego Metepec (19° 18' N, 98° 15' W),

Tlaxcala, México, from 6 March to 11 April 2001. Most observations and recordings were conducted from 08:00 to 11:00 or from 16:00 to 18:00, when birds were more active. Most males ($n = 11$) were banded and identified by their color-band combinations, whereas three males were identified by their choice of song post. Color-banded males typically used the same song perches; these perches were never used by other males, suggesting that the method for identifying unbanded males was appropriate. We mapped all territories and documented the number of neighbors for each male (mean = 2.57 ± 1.28 SD, range: 0–4). The territories were mapped by registering which perches were commonly used by males, noting male-male interactions (i.e., calling) that commonly occurred at territorial boundaries, and recording chases between territory owners and intruding males. A neighbor was defined as a male that had at least part of his territory adjacent to that of the focal male.

We recorded songs with a Sennheiser Me66 microphone and a Marantz PMD221 cassette recorder. Each male ($n = 14$) was recorded during one, 30-min period of observation. If the focal male had not performed a flight display within 30 min, we shifted to another focal male. This was done until all 14 males were recorded. All the males were paired, and although there were differences in the date each male was recorded, all 14 were recorded before their mates commenced nest construction.

Our sample size varied considerably between individuals (from 5 to 16 songs recorded per individual); however, we analyzed an equal number of songs per bird. We used either the whole sample (when $n = 5$ songs) or randomly selected five songs per individual (when $n > 5$ songs) resulting in a total of 70 songs analyzed. Songs were digitized on a PC computer using a sampling rate of 22,050 Hz. Songs were high-pass filtered with a cut-off frequency of 2.8 kHz. All variables were mea-

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TABLE 1. Song variation among male Vermilion Flycatchers was statistically significant for most parameters, but variation in the number of *peent* vocalizations was only marginally significant ($n = 14$ males). Data from recordings made at Bosque de San Diego Metepec, Tlaxcala, México, 6 March–11 April 2001.

| Parameter | Mean \pm SD | Statistics: ANOVA or Kruskal-Wallis |
|--------------------------------------|-----------------|---------------------------------------|
| Song duration (sec) | 0.43 \pm 0.11 | $H = 40.61$, $df = 13$, $P < 0.001$ |
| Minimum frequency (kHz) | 3.49 \pm 0.18 | $F_{13,56} = 6.58$, $P < 0.001$ |
| Maximum frequency (kHz) | 5.97 \pm 0.21 | $F_{13,56} = 7.80$, $P < 0.001$ |
| Number of total elements | 6.55 \pm 0.65 | $H = 42.27$, $df = 13$, $P < 0.001$ |
| Number of <i>peent</i> vocalizations | 0.74 \pm 0.50 | $H = 21.87$, $df = 13$, $P = 0.057$ |
| Number of common elements | 5.81 \pm 0.85 | $H = 36.61$, $df = 13$, $P < 0.001$ |

sured on spectrograms calculated with AVISOFT (Specht 2002) software (FFT: 128; frequency resolution: 125 Hz; temporal resolution: 4 ms; window: Hamming). We measured song duration, minimum and maximum frequency, number of total song elements, number of *peents*, and number of common elements (Table 1). Means are presented \pm SD.

Flight display songs had the same basic structure and shared the same elements as the ones uttered while perched (Fig. 1A; Smith 1967). Elements found both in songs produced during flight displays and in songs uttered while perched are referred to as common elements. Songs had a mean of 6.55 elements \pm 0.65 (range: 5–8, $n = 70$), of which 5.81

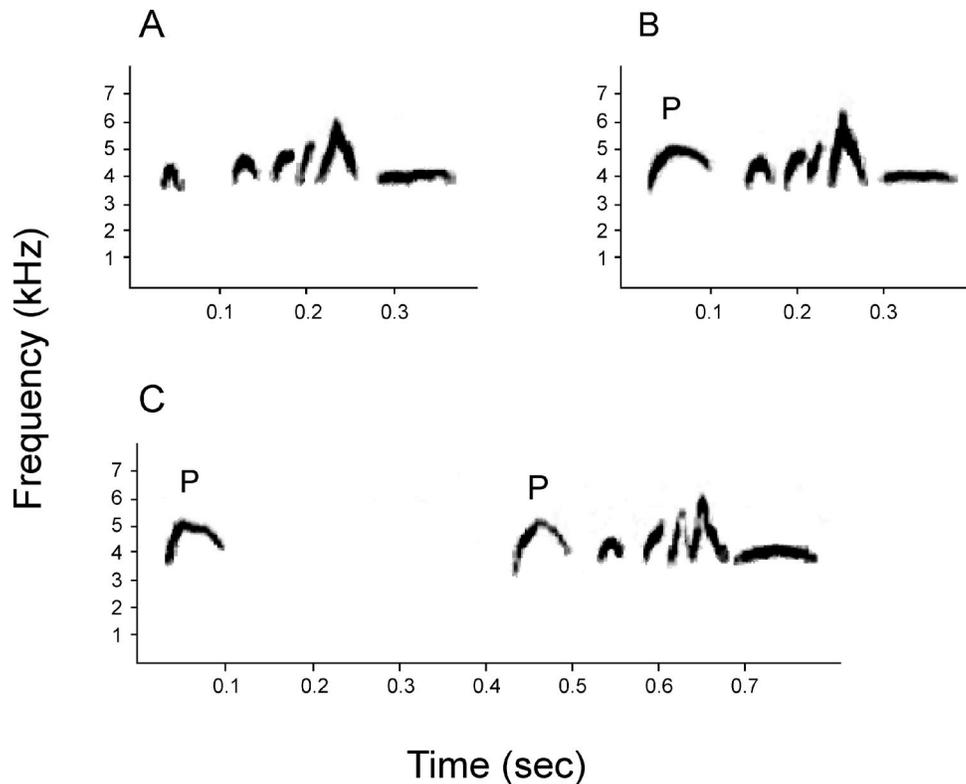


FIG. 1. Songs of Vermilion Flycatchers given during flight displays have a number of common elements (i.e., elements also found in songs given at a perch) and may include the *peent* vocalization. “A” represents a song with common elements. Spectrograms “B” and “C” represent songs that have one or two *peent* vocalizations (P). Recordings were made at Bosque de San Diego Metepec, Tlaxcala, México, 6 March–11 April 2001.

± 0.85 were common elements (range: 5–7, $n = 70$). Songs had a mean of 0.74 ± 0.50 *peent* vocalizations (range: 0–2, $n = 70$). In our study, 71.3% of the flight display songs had the *peent* vocalization; 68.5% had only one *peent* vocalization, 2.8% had two, and 28.7% lacked the *peent* vocalization. Songs lasted between 0.25 and 0.95 sec (mean = 0.43 ± 0.11), the minimum frequency ranged between 3.0 and 3.8 kHz (mean = 3.49 ± 0.18), and the maximum frequency ranged between 5.5 and 6.4 kHz (mean = 5.97 ± 0.21).

The *peent* vocalization has been previously described by Smith (1967; Fig. 1B, C) and is an alarm call, is given in male-male and male-female interactions, and when foraging (Smith 1967, Wolf and Jones 2000; AARC pers. obs.). As part of another study (AARC, CMG, and K. Riebel unpubl. data), we recorded songs of perched Vermilion Flycatchers given during the dawn chorus, and none of 119 songs included the *peent* vocalization. Thus, the *peent* does not constitute an element in songs of perched birds (AARC pers. obs.; see also Smith 1967).

All males sang at least one song with a *peent* vocalization; most individuals ($n = 13$) gave 0–1 *peents*. We found only one male that sang flight songs with a range of 1–2 *peent* vocalizations. Most males ($n = 8$) had either 5–6 ($n = 5$ males) or 6–7 ($n = 3$ males) common elements; four males had 5–7 ($n = 3$ males) or 6–8 ($n = 1$ male). All the songs of two males contained five common elements. Songs with a greater number of *peent* vocalizations had fewer common elements. We found a negative correlation between the number of common elements in a song and the number of *peent* vocalizations ($r = -0.60$, $P = 0.023$, $n = 14$), suggesting a trade off be-

tween these two groups of elements. We also found a negative correlation between the number of neighbors and the total number of elements in a song ($r = -0.63$, $P = 0.016$, $n = 14$), suggesting that different numbers of elements in songs may convey different messages to male Vermilion Flycatchers.

Finding a call (the *peent* vocalization) incorporated into a stereotyped song opens the question of whether this represents a variation in repertoire—whereby males modify song structure in different contexts. The relative importance of the *peent* vocalization and the number of elements in flight display songs in male-male and male-female communication must be addressed with playback experiments.

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