mosa and *N. amethystina*). She found that, as in our study, the quantification of transit time of the solution could be observed by "simply examining the color of the excreta, which was clear and then showed red with time."

That we always clearly detected a small dose of dyed sugar solution in the color of feces of hand-fed chicks, and that we failed to detect any color changes in chick fecal sacs during our feeder presentation, suggest that parent sunbirds feed none or only negligible amounts of feeder sugar solution to their chicks. Moreover, no detectable amounts of sugar occurred in nestling esophagi or excreta fluid samples, despite the fact that we could simulate such a measurable effect through hand-feeding chicks with nectar. Therefore, we conclude that nectar is an exclusively parental food type in Orange-tufted Sunbirds. It has been suggested that hummingbirds feed nectar to their chicks (Hainsworth 1977). To our knowledge, however, no one has documented this empirically. Therefore, we suggest that our methodology can be used to determine whether adult hummingbirds feed nectar to their nestlings.

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Video Identification of Predators at Songbird Nests in Old Fields

FRANK R. THOMPSON III,[1] WILLIAM DIJAK, AND DIRK E. BURHANS
North Central Research Station, 202 Natural Resources Building, University of Missouri,
Columbia, Missouri 65211, USA

Nest predation is an important factor in the ecology of passerines (Martin 1988, 1993; Sherry and Holmes 1992) and has received much recent attention owing to concern about population declines (Peterjohn et al. 1995) and high levels of nest predation in Neotropical migrants (Donovan et al. 1995, Robinson et al. 1995). Studies that use artificial nests have attempted to identify predators with various methods, including photography, track samplers, imprint-receptive eggs, and poisoned eggs (see Major and Kendal 1996). Conclusions about real nests drawn from artificial nests may be misleading, however, because parental activity (Skutch 1949), nestling noise (Haskell 1994), or other characteristics of occupied nests may be important cues for predators. Attempts to use motion-sensitive cameras at real bird nests are problematic because frequent parental

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[1] E-mail: fthompson/nc_co@fs.fed.us

visits during incubation and brood rearing consume film rapidly, often before predation occurs (F. R. Thompson unpubl. data). Conventional movie or video cameras are also problematic because they require adequate light, and many predation events occur at night.

We used a subminiature video camera with infrared illumination to record predation at real songbird nests in old field habitats in Missouri. Here, we report the success of this system and present preliminary data on the identity of predators and on the timing of nest-predation events.

Methods.—We located bird nests in old fields on the 920-ha Thomas S. Baskett Wildlife Research and Education Center (38°45′N, 92°12′W) near Ashland, Missouri. Old fields were located in a matrix of forest. Approximately 43% of the landscape within a 10-km radius was forest, and the remainder was primarily pasture (F. R. Thompson unpubl. data). The Baskett Center has been the location of old field songbird studies since 1992 (Burhans 1996, 1997; Dearborn 1997). We studied Field Sparrows (*Spizella pusilla*) and Indigo Buntings (*Passerina cyanea*) because they are the most abundant nesting species in the study area. We searched for nests daily from April through August 1997. Nest locations were marked with plastic flagging tied at least 3 m from the nest. Nests were monitored daily during building and egg-laying stages.

We placed video cameras at nests from 3 May to 6 August 1997, after the laying period, to minimize nest abandonment owing to disturbance. We used six camera systems to simultaneously monitor up to six nests and moved cameras from fledged or depredated nests to new nests. We tried to start video cameras early in the incubation stage but placed them at later-stage nests if no incubation-stage nests were available. We monitored each nest daily until the young fledged or the nest was depredated or abandoned. If a nest with a camera was depredated, we attempted to make the next camera placement far away from that nest to avoid resampling the same predator. We also monitored success at nests without cameras ("non-camera" nests). Non-camera nests were monitored every two to three days until fledging approached and then daily during the last three days of the nestling period. Fledging at non-camera nests was documented during early morning visits by nestling begging calls, the sight of nestlings, parents carrying food, or parents chipping nearby. Fates at nests in which we did not observe these activities were classified as unknown. Fledging at camera nests was documented by the video cameras.

A video system consisted of a video camera with six infrared light-emitting diodes, a video recorder in a weatherproof case, a hand-held video monitor (Fuhrman Diversified, Inc., Seabrook, Texas), and a 12-volt deep-cycle marine battery. The video camera and infrared light-emitting diodes were placed in a camera housing that measured 32 × 32 × 60 mm. The infrared light was 950 nm and not visible to vertebrates. The camera housing was mounted on an articulating arm and connected to the video recorder and battery by an 18-m cable. A sleeve made from green camouflaged material covered the camera housing and articulating arm. The video recorder was a time-lapse recorder that operated at 6 frames per s, or one-quarter the speed of a standard VHS video. This allowed us to record for 24 h on standard T120 VHS videotape.

We mounted each camera and articulating arm on a wooden stake made from a small dead branch found at the field site. We placed the stake 0.5 to 1.0 m from the nest and extended the articulated arm so the camera housing was 25 to 50 cm from the nest. The camera was located close to the nest to provide adequate infrared illumination during the night. We positioned the camera to get the clearest view of the nest without altering nest concealment and as low as possible to be inconspicuous and to avoid creating a potential perch site for a predator. We placed the video recorder and battery 10 to 18 m from the nest. We changed the videotape daily and on every third visit replaced the battery with a fully charged battery.

Videotapes from the day of a predation event or suspected fledging date were later viewed in the lab to confirm the fate of the nest. We compared daily predation rates at camera-monitored and non-camera nests using the Mayfield method (1961, 1975). At non-camera nests, half the number of days between subsequent visits over which a nest was empty were added to the number of previous days the nest survived to obtain the total number of observation days. We calculated Mayfield estimates of daily predation rates and variances with program MICROMORT (Heisey and Fuller 1985) and compared daily predation probabilities between camera and non-camera nests with program CONTRAST (Sauer and Williams 1989). We included observation days from all nests but only considered losses that resulted from predation. Because studies of nesting success generally consider a nest to be successful if it fledges one or more young (Martin et al. 1997), we only considered a nest to be depredated in the daily predation analysis if it fledged no young.

Results.—We monitored 52 nests by video camera and 75 without video cameras between 17 May and 3 August 1997. Thirty-seven Field Sparrow nests were monitored with video cameras; 19 (51%) were partially or completely depredated, 1 (3%) was abandoned, and 17 (46%) were successful (i.e. fledged one or more young). At least 20 different predation events occurred at the 19 depredated nests. We monitored 44 Field Sparrow nests without video; 26 (59%) were depredated, 5 (11%) were abandoned, and 13 (30%) were successful. We monitored 15 Indigo Bunting nests by video; 8 (53%) were partially or completely depredated, 5 (33%) were abandoned,

TABLE 1. Number of Field Sparrow and Indigo Bunting nests depredated by predator during the incubation and nestling stages, and number of nests physically disrupted by predators.

Predator	Nesting stage		No. nests disturbed
	Incubation	Nestling	
Black rat snake (*Elaphe obsoleta*)	4	6	2
Prairie kingsnake (*Lampropeltis calligaster*)	1	3	0
Blue racer (*Coluber constrictor*)	0	1	0
Garter snake (*Thamnophis* sp.)	1	0	0
Raccoon (*Procyon lotor*)	1	1	1
Deer mouse (*Peromyscus* sp.)	0	1	0
Fox squirrel (*Sciurus niger*)	1	0	1
Unidentified mammal	0	1	1
Broad-winged Hawk (*Buteo platypterus*)	0	2	2
Barn Owl (*Tyto alba*)	0	1	1
Brown-headed Cowbird (*Molothrus ater*)	0	1	0
Total	8	17	8

and 2 (14%) were successful. We monitored 31 Indigo Bunting nests without video; 18 (58%) were depredated, 1 (3%) was abandoned, and 12 (39%) were successful.

We did not record 3 of the 28 predation events (two Field Sparrow and one Indigo Bunting) because of equipment problems. Two equipment failures resulted from cables gnawed by an unidentified animal, four were from moisture in the video recorder case, and four resulted from low batteries. Not all failures occurred on days that nests were depredated.

In 24 of the 25 predation events recorded on video, we identified the predator to species or genus (Table 1). Snakes caused 11 of 16 predation events at Field Sparrow nests and 5 of 7 depredations at Indigo Bunting nests. Black rat snakes (*Elaphe obsoleta*) and prairie kingsnakes (*Lampropeltis calligaster*) were the most abundant snake predators (Table 1). Mammals accounted for five predation events and avian predators for four (Table 1). One Field Sparrow nest was depredated twice. At this nest, a female Brown-headed Cowbird (*Molothrus ater*) attacked and pecked the chicks on nestling day 5 (day 0 = day of hatching). The chicks survived and the nest subsequently was depredated by a blue racer (*Coluber constrictor*) on day 8, during which time one chick successfully fledged.

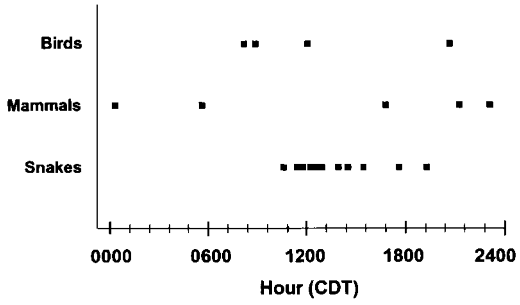

FIG. 1. Time of predation at Indigo Bunting and Field Sparrow nests by three predator groups in Missouri in 1997.

Snake predation was exclusively diurnal (1034 to 1735; mean 0133 CDT; Fig. 1). Both predation events by raccoons (*Procyon lotor*) occurred at night (0018 and 2115), as did predation by a mouse (*Peromyscus* sp.; 2307), an unknown mammal (0536), and a Barn Owl (*Tyto alba*; 2043). Other predation events occurred during daylight hours (Fig. 1).

Of a subsample of 16 nests where cameras were placed during the early incubation period, 10 predation events occurred during the nestling period and six during incubation. Predation also tended to occur late in the nestling period. Field Sparrows and Indigo Buntings have nestling periods of eight and nine days, respectively (Payne 1991, Carey et al. 1994). Mean nestling day of predation was 5.4 for Field Sparrows and 5.5 for Indigo Buntings (day 0 = day of hatching).

Single chicks escaped predation at four of the five nests that were depredated (i.e. partial brood predation) by snakes on nestling day 6 or later. Three of these fledgings were Field Sparrows and were later observed with their parents. The fourth fledgling was an Indigo Bunting that was not observed after fledging.

Several nests were visibly tipped, torn, or disrupted during predation events. Nests depredated by snakes tended to be intact; however, two nests depredated by large black rat snakes were visibly tipped or torn (Table 1). All three nests depredated by raptors were highly disturbed (Table 1). Mammal predation resulted in both disturbed and undisturbed nests. At a nest depredated by an unidentified mammal, the nest was pulled from the shrub and the camera was on the ground.

TABLE 2. Daily predation rate (± SD), number of observation days, number of nests, and results of chi-square tests comparing success of Field Sparrow and Indigo Bunting nests with versus without video cameras.

Treatment	Predation rate	No. of observ. days	No. of nests	χ^2	P
Field Sparrow					
Camera	0.037 ± 0.009	436	37	4.33	0.04
No camera	0.070 ± 0.013	370	44		
Indigo Bunting					
Camera	0.048 ± 0.018	145	15	0.29	0.59
No camera	0.060 ± 0.014	300	31		

Field Sparrow nests with cameras had a lower mean daily predation rate than nests with no cameras, whereas mean daily predation rates did not differ between Indigo Bunting nests with versus without cameras (Table 2).

Discussion.—We successfully used the video system described in this paper to monitor nest predation and to identify predators. Our results support hypotheses that snakes are important predators in old field habitats. Sutton (1960), Thompson and Nolan (1973), Best (1978), Wray and Whitmore (1979), and Zimmerman (1984) believed that snakes were the principal predators of bird nests at their old field sites, but they lacked direct evidence to support this notion.

We expected more predation by raccoons, Blue Jays (*Cyanocitta cristata*), and American Crows (*Corvus brachyrhynchos*) because of their abundance on the study area and because they have been implicated as predators of passerine eggs and nestlings (Gates and Gysel 1978, Wilcove 1985). We only detected two predation events by raccoons, however, and none by corvids. We will continue to monitor predation in old fields and, in addition, forested habitats to better determine the importance of these and other predators.

Some studies have considered a lack of disturbance to the nest site to be evidence of snake predation and disturbance to be evidence of mammalian predation (Thompson and Nolan 1973, Best 1978, Wray and Whitmore 1979, Marzluff 1988, Johnson 1997). Although our results generally followed this pattern, enough exceptions existed to cause us to question the reliability of identifying predators based on the level of nest disturbance. Two nests depredated by snakes were visibly disturbed, and one nest depredated by a raccoon was undisturbed and its fate unknown until we observed the videotape (see Payne 1991:9). Brown et al. (1998) used a similar video system in New Zealand and also concluded that interpretation of signs left at depredated nests was an unreliable method of identifying predators.

The fact that predation tended to occur late in the nestling period supports the belief that feeding visits by adults and/or vocal activity by chicks may serve as cues to nest predators (Skutch 1949, Young 1963, Horn 1968, Caccamise 1976). Sutton (1960) reported that a blue racer climbed onto his car, on which he had left begging, hand-reared Field Sparrow chicks while he searched for nests. Previous studies of Field Sparrows at the Baskett Center have shown that daily survival rates are lower during the nestling period than during incubation (Burhans 1996). Other studies have reported higher nest predation late in the nesting cycle (Young 1963, Horn 1968, Robertson 1972, Schaub et al. 1992) but also early in the nesting cycle (Holcomb 1972).

The frequency of predation late in the nestling stage indicates that conclusions about nest fate or number of fledglings produced based on nest condition alone can be wrong. Standard protocol is to classify a nest as successful if in the absence of other clues, the median date between the last nest check when the nest was active and the final nest check when the nest was empty is within two days of the predicted date of fledging (Martin et al. 1997). One predation event at a Field Sparrow nest occurred on nestling day 7 and four on nestling day 8 (of an 8-day nestling period). Two of these nests were depredated by snakes, and one nestling escaped from each nest. No young fledged from the other three nests. Had these nests not been monitored by video, or had we not assessed success by behavior of the adults or observed the fledglings, conclusions on nest fate and number of young fledged likely would have been wrong. We also observed partial predation events earlier in the nestling period where one young survived, including an Indigo Bunting at nestling day 7 and a Field Sparrow at nestling day 6.

Nest-monitoring activities may influence nest fate because observers may leave trails or other cues that attract predators (Westmoreland and Best 1985, Major 1990, Morton et al. 1993), or monitoring activities may scare predators from the vicinity of nests (Osborne and Osborne 1980, Morton et al. 1993). Our use of video cameras could have created additional cues such as perch sites or disruption of vegetation and nest concealment. We strived to minimize disruption of vegetation around nests when setting up cameras. However, if any meaningful difference existed in predation, it was in the opposite direction than expected. Camera-monitored nests had similar or lower rates of predation than non-camera nests (Table 2). A nonsignificant trend for lower predation of camera-monitored nests was also observed in a study of grassland birds (P. Pietz pers. comm.). It is not clear whether this is a biologically meaningful bias, or what the potential mechanisms are for lower predation at camera-monitored nests. A negative bias in predation rates could be problematic if cameras are being used to estimate predation rates or if the bias also results in a nonrepresentative sample of predators. Brown et al. (1998) used a similar video system and found no evidence of an effect on predation. Continued research with this video system should provide more information on this potential bias.

Nest fate can also be affected by abandonment in response to disturbance by observers or the presence of the video camera. Although we observed only a negligible amount of abandonment at camera-monitored Field Sparrow nests, 33% of the Indigo Bunting nests were abandoned. We believe one Field Sparrow and four Indigo Bunting nests were abandoned in response to the cameras. The fifth Indigo Bunting abandonment likely was due to the death of a parent because the failure occurred during the nestling stage. We believe the non-camera Field Sparrow nests were abandoned in direct response to cowbird parasitism. We did not observe this on camera nests because cameras were installed after the laying period. Species such as Indigo Buntings may be more prone to abandonment and less suitable for video monitoring. Our experience with Indigo Buntings suggests that they are prone to abandon their nests in response to any human disturbance during the nest-building, egg-laying, or early incubation stages.

We believe this video system is an effective method for identifying nest predators. We had few instances where the camera did not record predation events, and in all but one instance we were able to identify the predator. This system is a more reliable method for documenting predation and identifying predators than previously described methods, but it may be more labor intensive and costly. The initial cost of the six video systems was approximately $24,000, which does not include labor and transportation costs. Although substantial, this cost ultimately will be spread across many studies and years.

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Floater Males Engage in Extrapair Copulations with Resident Female Tree Swallows

COLLEEN A. BARBER[1] AND RALEIGH J. ROBERTSON
Department of Biology, Queen's University, Kingston, Ontario K7L 3N6, Canada

Floaters are sexually mature yet nonbreeding, nonterritorial individuals (Smith 1978). They are common in many passerine species and avian social systems (see Zack and Stutchbury 1992) but relatively little is known about them. Floating behavior ultimately arises through an excess of sexually mature individuals trying to procure a limited number of nesting sites (Brown 1969, Smith and Arcese 1989). It has been described as an alternative reproductive strategy to territoriality (Austad 1984) and as a behavior based on quality differences among individuals (Smith and Arcese 1989). Floaters are characterized by their frequent intrusions into occupied ter-

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[1] Present address: Department of Biology, Acadia University, Wolfville, Nova Scotia B0P 1X0, Canada. E-mail: colleen.barber@acadiau.ca