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FORAGING BEHAVIOR OF THE TORRENT TYRANNULET *(SERPOPHAGA CINEREA)* IN COSTA RICA

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Comportamiento de forrajeo del Mosquerito Guardarrios (*Serpophaga cinerea*) en Costa Rica.

Key words: Torrent Tyrannulet, *Serpophaga cinerea*, foraging behavior, Costa Rica.

Many tyrant flycatchers are associated with aquatic habitats and often reach their highest population density in wet places (del Hoyo *et al.* 2004). The Torrent Tyrannulet *(Serpophaga cinerea)*, a small flycatcher whose range extends from Costa Rica to northern Bolivia and northwestern Venezuela, is closely associated with forested, middle elevation (250–2000 m), fast-flowing mountain streams in Costa Rica (Ridgely & Gywnne 1989, Styles & Skutch 1989, Garrigues & Dean 2007). Foraging is done primarily from boulders located within the stream channel. Very little research has been conducted on any aspect of the ecology and behavior of this species. Skutch (1960) published a narrative on the species noting general natural history traits, especially reproductive ecology and behavior, but provided little foraging analysis other than anecdotal impressions. Smith (1971) enumerated 72 foraging maneuvers observed in Panama, the only known reference to its feeding behavior. Our initial objective was to observe Torrent Tyrannulets and describe how they search for and capture prey. These behaviors, including both maneuver type and sequence, are reflective, to varying extent, of diet composition, prey abundance and foraging success (Robinson & Holmes 1982, Sherry 1984, Hutto 1990).

METHODS

Observations were conducted at Parque Nacional Tapanti and vicinity on the northern slope of the Cordillera de Talamanca, Costa Rica (09°44'48"N, 83°46'59"W). Rainfall exceeds 7 m annually at the highest elevations in the park, producing numerous first through third order high gradient streams, the preferred habitat of this species. Stream order definitions are based on the widely used hier-

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archical classification system created by Horton (1945), and later modified by Strahler (1964, also see Allan 1995). Two of these streams were chosen as study sites. The Rio Quiri, a second order stream adjacent to Tapanti, flows swiftly through a narrow, steep-sided ravine among small to medium boulders. The surveyed reach of 1200 m is surrounded mainly by mature secondary forest and some primary forest with a partially open canopy above the stream. A 150-m segment is impacted on one side by an aquaculture operation. The nearby Rio Orosi, containing a surveyed reach of 3000 m and located within Parque Nacional Tapanti, is a third order stream that flows through a deep canyon surrounded by waterfalls and pristine primary rainforest with an open canopy above.

Foraging observations were conducted on focal individuals in January and February of 2003 and 2004. I noted each foraging maneuver of focal individuals while they were in view, along with start and stop times, using a digital recorder. Seventy-three focal observations were obtained totaling 1250 maneuvers. Although individuals were not banded, it is estimated that these observations derived from eight and seven pairs (16 and 14 individuals), respectively, for the 2003 and 2004 field seasons, based on territorial spacing within the stream reaches. Specific maneuver types were described and the proportion of each maneuver employed was determined. The percentage of foraging maneuvers that were the same as the preceding maneuver was also determined to see if maneuver selection was random, or perhaps influenced by characteristics of the previous maneuver including prey type, abundance and/or successful or unsuccessful attack.

Foraging maneuvers were recorded sequentially for observations collected in 2004. Observations that contained multiple types of foraging maneuvers (n = 18) were analyzed to determine if variation in foraging maneuver selection was random. The mean proportions of maneuvers different from the previous maneuver were analyzed with a one-sample t-test within the R statistical language (R Development Core Team, 2007).

RESULTS

Three foraging maneuvers were observed including picking, defined as an attempt to secure prey located on a substrate surface other than a leaf, aerial hawking which involved taking flight from a perch, catching an insect in mid air and returning to the same or a different perch following the attempt, and sally-glean which is also an aerial maneuver securing prey from a vegetative substrate. Based on 1250 maneuvers, picks composed 19.6% of maneuvers, aerial hawks comprised 71.2%, and sally-gleans were rarely used comprising only 1.2% of observed maneuvers (n = 73). The percentage of foraging maneuvers that was the same as the previous maneuver was significantly higher than expected if maneuvers were chosen at random ($t = 5.709$, $df = 17$, $P = 0.00026$). Their mean attack rate was 5.99 maneuvers per minute (minimum = 1.78, maximum = 14.14, SD = 2.50).

DISCUSSION

This species of tyrannulet often forages by aerial hawking from mid-stream boulders (del Hoyo *et al.* 2004). Smith (1971) observed 72 maneuvers in Panama and nearly half (46%) were aerial hawks. Use of this foraging tactic suggests a diet consisting of conspicuous adult, flying insects (Sherry 1984). Previous investigations of the Rio Quiri (Master *et al.* 2005) indicate that the insect orders Ephemeroptera and Trichoptera dominate the aquatic macroinvertebrate fauna and thus

potentially contribute many of the flying adult insects chosen by the tyrannulets. However, Buckton and Ormerod (in press) have found that Plumbeous Water Redstarts *(Rhyacornis fuliginosus)* rely heavily on invertebrates of terrestrial rather than aquatic origin. Sherry (1984), in a study of sympatric terrestrial insectivorous Neotropical flycatchers in Costa Rica, noted that species in the genus *Contopus* frequently used aerial hawking, and adult Odonates, whose nymphs are also aquatic, composed a major proportion of their diet. Those species specializing in aerial hawking in his study preferred to feed on swarms (patches) of adult insects that are typical of aquatic habitats (Sherry 1984). The extensive use of aerial hawking, both proportionally and in terms of repeated use of the same maneuver, suggests tyrranulets are pursuing similar or the same prey types repeatedly, which would be logical if they were exploiting insect swarms above the stream surface. The quickness of their maneuvers and minute size of the insects involved precluded actual identification of prey items from my observations but provide evidence that this species prefers small insects. The speed with which they engage in maneuvers is at the upper end of rates for aerial hawkers but relatively slow compared to other flycatching techniques such as gleaning (Robinson & Holmes 1982, Sherry 1984). The relatively low attack rate is characteristic of aerial hawkers who scan over larger spaces and longer distances than gleaners, spend more time searching, chase prey over comparatively long distances, and often fly back to the same perch before pursuing another item (Fitzpatrick 1980, Robinson & Holmes 1982, Sherry 1984). Thus, although the Torrent Tyrannulet exploits a unique niche among Central American flycatchers consisting of fast-rushing streams, their foraging behavior appears typical of Neotropical flycatchers using aerial hawking as their primary maneuver.

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