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DIET OF NESTLING GREEN-AND-GOLD TANAGERS (*TANGARA SCHRANKII*), WITH NOTES ON NESTING BEHAVIOR AND SEED DISPERSAL

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Dieta de pichones de Tangara verde y dorada (*Tangara schrankii*), con notas de comportamiento de anidación y dispersión de semillas.

Key words: Green-and-gold Tanager, *Tangara schrankii,* nestling diet, flocks, ant-gardens, orchids, seed dispersal.

INTRODUCTION

Despite their importance to ecology and conservation, the diets and breeding behavior of many Neotropical birds are poorly known (Poulin *et al.* 1994). These gaps of ecological knowledge limit the understanding of foraging behavior, habitat requirements, and seed dispersal (Poulin *et al.* 1994, Deloria-Scheffield *et al.* 2001), as well as the ecosystem consequences of bird declines (Sekercioglu *et al.* 2004). Detailed dietary studies are specifically lacking in the most diverse genus endemic to the Neotropics, the *Tangara* tanagers (Isler & Isler 1987). Given the available methods (e.g., Ralph *et al.* 1985), dietary analysis is not logistically demanding within the context of an existing field study.

Here we present dietary information and nesting behavior on the Green-and-gold Tanager (*Tangara schrankii*) from a nest in a lowland humid rainforest in southeastern Peru. The Green-and-gold Tanager is a medium-sized tanager (19 g) inhabiting lowland *terra firme* and várzea forest in western Amazonia (Isler & Isler 1987, Ridgely & Tudor 1989). The species is primarily known to forage on fruits and insects in canopy flocks with other *Tangara* species, and is occasionally documented at forest edges or with understory *Myrmotherula* antwren flocks (Munn & Terborgh 1979, Munn 1985).

STUDY AREA AND METHODS

In 1999, Van Houtan researched mixed-species parrot flocks at the Tambopata Research

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FIG 1. Site of Green-and-gold Tanager nest near the Tambopata Research Center along the Tambopata River in southeastern Peru. Arrow points to *Asplenium serratum* L. fern (Aspleniaceae) under which the nest is located. Photo credit: K. S. Van Houtan.

Center (13°08'19"S, 69°36'28"W) along the Tambopata river, Dpto. Madre de Dios, Peru. On 10 August at 16:48 h, while observing a pair of Band-tailed Manakins (*Pipra fasciicauda*) and a Plumbeous Antbird (*Myrmeciza hyperythra*) bathing in an ephemeral pond, a female Green-and-gold Tanager was observed returning to a nest. From nest discovery to 26 September 1999, during the peak of the dry season, the nest and behavior of the attending female were observed. Nest site was monitored on 19 occasions yielding 15 observations (each > 2 h). The observer remained near the nest, never following the attending female on foraging trips.

Nine fecal samples were collected for dietary analysis: eight discarded fecal sacs and one undigested food offering found in the recently predated nest cup. Neither mist-nets nor emetics were used in order to impact nesting minimally. Rather, droppings were collected immediately after the chick defecated on the nest rim and the female left the area. Samples were stored in plastic 35 mm film canisters, and soon after immersed in 70% isopropanol. While this method provided fewer samples than desired, it was more successful than passive sampling attempts. In the absence of an observer, a 2-m^2 section of camouflage canvas cloth placed on the forest floor below the nest caught falling fecal material, but *Camponotus femoratus* ants persistently scavenged droppings to an arboreal carton nest within 10 m of the tanager nest (see Discussion).

Samples were dried in laboratory and examined in Petri dishes. Sample contents were separated with standard dissecting tools and viewed under magnification. Droppings encased in urea were prepared with water. Items were measured and photographed holding a digital camera to the eye piece of

TABLE 1. Prey items identified from droppings of 3 nestling Green-and-gold Tanagers (*Tangara schrankii*). Visual observations of attending female are not included.

Food items	Location	Occurrence		Diagnostic
		No items	No. items	
PLANTS				
Cecropiaceae				
Cecropia tessmani	Forest edges: mid-upper canopy	3	258	Seed
Orchidaceae	Várzea & terra firme: understory	2	45	Seed
Rubiaceae				
Psychotria officinalis	Várzea: understory	3	39	Seed, fruit
Piperaceae	Várzea: understory	1	5	Seed
Unknown items	n/a	3	3	Seed
ARTHROPODS				
Araneae	Varies	3	22	Chelicerae, genitalia
Hemiptera	n/a	2	10	Head, eyes, wings
Lepidoptera	n/a	2	3	Pupae, larvae

the dissecting scope. Arthropods were identified to order using Triplehorn & Johnson (2005), aided by Ralph *et al.* (1985). Arachnoidea were further keyed to genera from the entomology collection at the Museo de Historia Natural in Lima, Peru. Plant items were classified using a plant catalog of Manu National Park, Peru, maintained by the Center for Tropical Conservation at Duke University. Orchidaceae identification was aided by Arditti & Ghani (2000). Identification of several plant items was greatly enhanced by comparison to undigested samples as digestion rendered some items otherwise unrecognizable.

OBSERVATIONS AND RESULTS

The nest was beneath the base of an *Asplenium serratum* L. fern (Aspleniaceae) located 1.8 m above the ground in an unknown understory tree (Fig. 1). The nest tree measured 19 cm d.b.h. and contained multiple epiphytic *Ficus casapiensis* stems (Moraceae, 4 cm diam.). A single *Syngonium yurimaguensis* (Araceae, 2 cm diam.) specimen also grew from the fern base. The cup-shaped nest was made from rootlets – not previously documented (e.g., Marra 1990) – and dried fronds. Following Hansell's (2000) protocol, the nest diameter measured 11 cm and was 8 cm deep. The cup was 6 cm in diameter and 5 cm deep. Fern roots and senesced frond petioles (8 mm diam.) attached the nest on its bottom side. Live fronds concealed the nest on all but the south side; decayed leaves collected at the fern base concealed it from above.

Upon discovery, the nest contained one nestling that was a few days old, had closed eyes, and a dorsal ridge of white downy feathers. On 18 August, the chick was near fledging: almost fully plumed, flapping its wings, vocalizing when the female approached, and silently peering over the nest cup in the

female's absence. The next morning the chick was absent, and a food offering in the otherwise empty nest cup was collected. A Slate-colored Hawk (*Leucopternis schistacea*) that stymied feedings three days prior was the suspected predator (see below). A week later, the female had freshly lined the nest cup with rootlets. On 1 September (14 days after first record of empty nest), the female laid one egg, with another the following day. Chicks hatched after incubation of 15–17 days. The fate of this second nest was not determined (monitoring ceased for Van Houtan to receive medical treatment for leishmaniasis).

Foraging durations by the attending female varied in length (2–76 min, mean = 31 min, n = 15), being shortest at dawn and dusk and longer towards midday. On five occasions, the female supplemented a lengthy foraging trip (> 45 min) with a quick foray to a nearby *Psychotria officinalis* (Rubiaceae) shrub. Grasping harvested *P. officinalis* berries in foot, the adult ripped the berries open with its beak and then fed the now-prepared fruit to the nestlings (These visual observations are not included in the dietary data in Table 1). Immediately after receiving a meal, nestlings often defecated on or near the nest rim. Typically, the attending female consumed or carried away droppings, infrequently leaving samples available for collection. Uncommon to *Tangara* (Isler & Isler 1987), no male was observed attending the nest, not even during incubation.

On 16 August at 11:20 h, a Slate-colored Hawk calling from a nearby tree prevented the female from attending the nest. Presumably exercising caution in the hawk's presence, the female stealthily approached the nest on three separate attempts in a 20 min period, but never came within 5 m of the nest. At 17:20 h that day, after the hawk left the area, the female successfully fed the nestling, and. at 17:31 h. roosted on the nestling for the night. A Plumbeous Kite (*Ictinea plumbea*) and a Rufescent Tiger-Heron (*Tigrisoma lineatum*) were also observed near the adjacent ephemeral pond two weeks prior the suspected predation, but no further evidence links them to the nest.

Diet analysis shows a dominance of fruits, with some arthropods (Table 1). Cecropiaceae, Rubiaceae, Orchidaceae, and Piperaceae comprised over 90% of the items identified. *Cecropia* sp. (Cecropiaceae) seeds were the most frequent item identified. This is not surprising, as *Cecropia* fruits are known as dry season food sources for tanagers (Isler & Isler 1987). *P. officinalis* and Orchidaceae were other common items. Though *P. officinalis* is an established food source for birds (Loiselle *et al.* 1995), to our knowledge this is the first record of orchid frugivory in *Tangara* (e.g., Isler & Isler 1987, Nadkarni & Matelson 1989). Arachnoidea, Hemiptera, and Lepidoptera comprised 9% of the items identified. Arachnoidea (Sparassidae, Cternidae, Gnaphosidae, and Tetragnathidae) were the most diverse arthropod taxa identified. Less than 1% of the items found in droppings were not identified.

DISCUSSION

Considered collectively, several factors indicate the attending female foraged primarily in forest edges and várzea understory. *Cecropia*, the most common food item identified, is a mid-upper canopy tree that colonizes forest margins and water edges. *P. officinalis* and Piperaceae are understory plants in várzea and forest edges – neither plant exceeding 2 m in height. Among the spider prey, *Sparassidae* associate with known edge specialists, banana trees (Musaceae), and *Tetragnathidae* place orbs over water (Triplehorn & Johnson 2005). Lastly, the nest site itself was proximate to a pond, and by implication a canopy gap, demonstrating the nest site is a várzea edge (Fig. 1).

While the Green-and-gold Tanager is known to forage in both canopy and understory flocks, ecological knowledge of prey items identified in this study suggests the attending female did not forage with understory flocks. A majority of the prey were fruits from plants found in secondary forest. Understory flocks are not frugivorous (Powell 1985) and avoid forest edges and canopy gaps (Develey & Stouffer 2001). The dominant presence of *Cecropia* in the fecal samples, with a minor amount of insects, is consistent with Munn's (1985) visual observations of canopy flocks. As the observer in this study remained near nest (see Methods), our assessment here was not confirmed by visual observations, and only suggested from items identified in droppings.

Unsuccessful passive sampling of nestling droppings may reveal a complex seed dispersal pathway involving this tanager species and arboreal ants. Though the data are limited, at least three observations strongly favor this possibility. First, several ant species are known to disperse seeds, caching them in arboreal carton nests or "ant gardens" (Davidson 1988, Hölldolber & Wilson 1990). Three of the plant families identified in the droppings here – Orchidaceae, Rubiaceae, Piperaceae – are common to ant gardens and are thought to rely on ants for seed dispersal (Nieder *et al.* 2000, Nadkarni *et al.* 2001). Second, a close examination of the ant garden found proximate the nest in this study identified multiple *Peperomia macrostachya* (Piperaceae) stems sprouting from the nest. Seeds from nestling droppings seem a plausible origin for this *P. macrostachya* specimen as (i) Piperaceae seeds were identified in the fecal samples (but not identified below family level), and (ii) ants were observed carrying the tanager nestling droppings to the ant garden. Third, though this study does not resolve whether seeds ingested by birds will germinate, several studies document the viability of seeds ants scavenged from vertebrate droppings (Passos & Oliveira 2002, Martínez-Mota *et al.* 2004). As such, this potential tanager-ant seed dispersal complex warrants further study.

We caution broad interpretation from these data as they are limited. However, detailed dietary studies of this kind add important information that aid the understanding of species' behavior, diet, and ecosystem function.

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