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SHORT-COMMUNICATION

Use of urban areas by two emblematic and threatened birds in the central Andes of Colombia

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ABSTRACT: The Turquoise Dacnis (*Dacnis hartlaubi*) and the Cerulean Warbler (*Setophaga cerulea*) are categorized as "vulnerable" at global scale. Habitat loss and degradation following rapid agricultural expansion and urban development are the main causes of their declines. In this note we present the first documented records of these species in urban green areas in South America. Our observations were undertaken between 2007–2014 during surveys of the avifauna of Armenia City in the central Andes of Colombia. We recorded Turquoise Dacnis on 19 occasions and Cerulean Warbler on 10. Most records were solitary males foraging in *Cecropia angustifolia* and *Inga ornata* trees, and some were associated with mixed species flocks. Both species used forest patches, parks and areas with scattered trees. Our observations suggest that cities may provide passage and/or wintering areas for these threatened species.

KEY-WORDS: Cerulean Warbler, conservation, threatened species, Turquoise Dacnis, Urbanization.

The Turquoise Dacnis, *Dacnis hartlaubi* (Sclater, 1855), is a Colombian endemic species with a disjunct distribution in the Andean mountains (Hilty & Brown 1986, Botero & Verhelst 2001). It inhabits low montane forest, secondary forests, and shade coffee agroecosystems between 1350 and 2200 m a.s.l. (Botero & Verhelst 2001, Cortés-Herrera *et al.* 2014, BirdLife International 2016a). The Cerulean Warbler, *Setophaga cerulea* (Wilson, 1810), is a Neotropical migrant, breeding in southern Canada and the United States, and migrating to Central America and northern South America during the winter (Restall *et al*. 2007, Colorado *et al.* 2014). In the wintering areas, the Cerulean Warbler occurs in low montane forest, traditional shade coffee agroecosystems, secondary forests, and scrubland habitats between 500 to 2000 m a.s.l. (Hilty & Brown 1986, Colorado *et al.* 2014, BirdLife International 2016b). The Cerulean Warbler and the Turquoise Dacnis are emblematic species used to promote bird friendly coffee shade plantations and habitat conservation for biodiversity, especially for migratory birds (Komar 2006, Sánchez-Clavijo *et al.* 2009). Notwithstanding, these two species are listed as "vulnerable" worldwide because of their small range (Turquoise Dacnis) and dramatic population declines as a result of habitat loss, degradation and fragmentation, following agricultural and urban expansion (Renjifo *et al.* 2014, BirdLife International 2016a, b); although in some cases they can be tolerant to some habitat modification (BirdLife International 2016a). However, there are no records of these species using parks and urban green areas in the Neotropics. In this note, we report their occurrence and regular use of small forest patches immersed in urban areas of the metropolitan area in a Neotropical city.

Armenia, the capital of the Quindío Department, is a city of 115 km^2 with a population of 372,344 people (DNP 2014a, b). It is located in the central Andes of Colombia at 1350-1550 m a.s.l., with an annual mean precipitation of 2163 mm, a mean temperature of 21.8°C and a relative humidity ranging between 76 and 81% (IDEAM 2014). The city was devastated by an earthquake (25 January 1999), but it has been expanding dramatically over the past ten years, causing a loss of 83 ha of forest area (Nieto *et al.* 2009). Currently, Armenia is a modern city characterized by large buildings that contrast

with small houses and green areas. However, this city has an unusual pattern of landscape configuration due to the presence of corridors of natural vegetation through the urban area (Figure 1), showing a strong connectivity pattern with its surrounding landscape. The urbanized area covers 997 ha, of which 314 ha are natural protected areas inside and around the city (Figure 1), which preserve 122 streams and 322 forest patches of native vegetation that serve as both a refuge and facilitating connectivity for biodiversity (Nieto *et al.* 2009). These areas also include coffee agroecosystems and linear patches of secondary forest dominated by *Guadua angustifolia*. There are other green areas within the city that include lawns, urban parks, and gardens (Table 1).

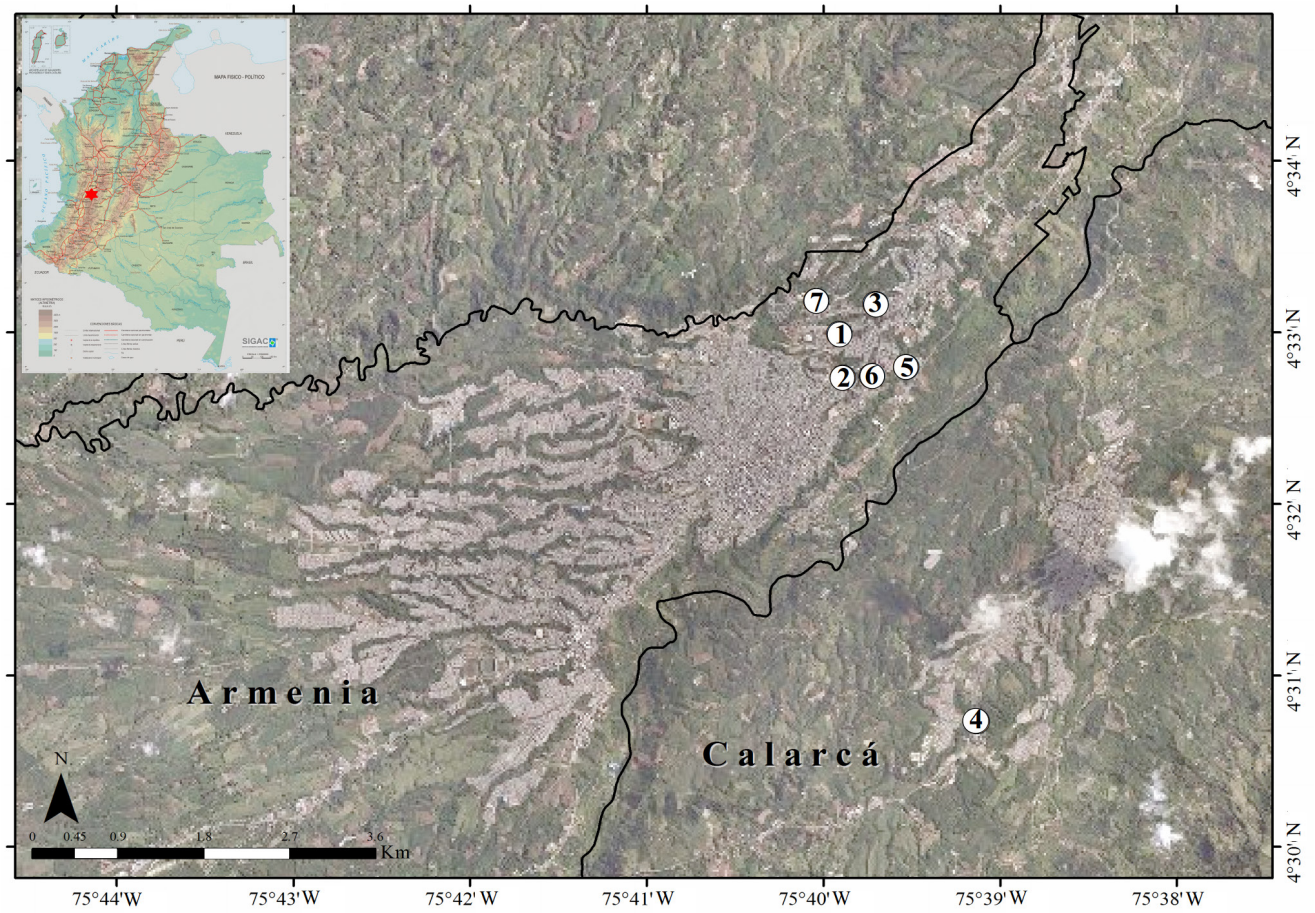

FIGURE 1. Map of the metropolitan area of Armenia city, Colombia, showing the corridors of native vegetation across the city and the surrounding landscape. Numbers indicate the sites where the Cerulean Warbler and Turquoise Dacnis were recorded (see details in Table 1).

During surveys of the avifauna and some birding trips in the urban parks and natural corridors of the Armenia city carried out between 2007 and 2014, we observed multiple individuals of both Turquoise Dacnis and Cerulean Warbler. Photos and video sequences to document these records were taken with Nikon D90 and Panasonic Fz70 cameras. We followed the birds and recorded the time, locality, habitat, behavior activity (*e.g.* perched, foraging, flying), the number of birds, sex, height relative to the ground level, and the tree species.

A total of 19 records of Turquoise Dacnis were recorded at six localities in the urban area of Armenia city (Table 1). This species was detected in the morning (06:00 to 09:30 h), either solitary (only males) or in pairs. It was seen in secondary forest, forest edges, shade-coffee plantations, and parks with dispersed trees (Table 1). Sometimes the males perched on the top of a tree and later flew to forest patches. Males were observed throughout the year, but more frequently in the transition between wet to dry season (October to January and May to July).

When males and females were together, they did not stay for more than 30 min in the same area, moving actively in the canopy or making long flights (30–150 m) using street trees as stepping stones to cross the highway. Male and female foraged together at midstorey levels in the canopy, searching and gleaning insects on the foliage of *Nectandra reticulata*, *Cecropia angustifolia*, *Inga ornata*, *Coussapoa villosa*, *Escallonia pendula, G. angustifolia*, and *Albizia carbonaria*, or hanging upside down on the leaves. Males were seen joining mixed species feeding flocks of insectivorous birds twice in the middle of the year (Table 1). The birds also searched for nectar resources such as *I. ornata*, *A. carbonaria*, and *Erythrina rubrinervia*, or eating the mature fruits of *Zanthoxylum rhoifolium* (Figure 2) and especially *C. angustifolia*. On one occasion a male was seen pecking the fruits of *N. reticulata*.

FIGURE 2. The Turquoise Dacnis and the Cerulean Warbler in urban forest patches of Armenia city, Colombia. (**A**) A male Turquoise Dacnis eating fruits of *Zanthoxylum rhoifolium* at Parque de la Vida; (**B**) A male Cerulean Warbler foraging for insects on the foliage at midstorey levels at *Jardín Botánico de la Universidad del Quindío*. Photos: Oscar H. Marín-Gómez.

We obtained 10 detections of Cerulean Warbler in four localities of Armenia city, mainly from November to January, principally single males, and 50% of the records were birds joining mixed species flocks (Table 1). They were solitary males foraging actively on the foliage of *I. ornata* at middle to canopy levels in the morning (Figure 2). This species was observed moving between vegetation patches, but apparently prefers forest patches and does not use parks or areas with scattered trees. Only once a solitary male was seen flying from the forest to a shade-coffee plantation. When a pair was observed, they foraged together with mixed-species flocks of insectivorous birds at the forest edge (Table 1).

This note is the first documented report for the Turquoise Dacnis and the Cerulean Warbler in the Neotropics using frequently natural small forest patches immersed in urban areas, principally as foraging sites or stepping stones to move among native forest patches. Both species have been observed in seven localities of continuous forest near shade-coffee plantations in Quindío (Arbeláez-Cortés *et al.* 2011, O. Marín-Gómez, pers. obs.) but they are uncommon in this department; and they had not been recorded previously in the urban area of Armenia (Marín-Gómez 2005).

Our results are congruent with the foraging strategies and behaviors previously published for both species, particularly the use of shade-coffee plantations as foraging areas and the habit of joining mixed flocks (Munves 1975, Botero & Verhelst 2001, Colorado *et al.* 2014). The obtained data also indicated that *C. angustifolia* and *I. ornata* are key food sources for insectivorous and nectarivorous birds, as they are abundant in the forest patches of the Colombian coffee region. *Inga ornata* is a tree frequently used in shade coffee plantations and yields a high food supply of nectar and insects for birds (Marín-Gómez 2007), and *C. angustifolia* is one of the most abundant pioneer species during forest regeneration, which is visited by a high number of frugivorous species.

We did not find preceding occurrences for these two species within urban areas (except one record of Turquoise Dacnis in the Jardín Botánico de Pereira), neither on eBird, excluding our own records (http://ebird.org/, accessed 2 February 2016), or in the recent reviews of the conservation status for species both from Colombia (Colorado *et al.* 2014, Cortés-Herrera *et al.* 2014) and the Americas in general (BirdLife International 2016a, b). Although in some cases these species have been reported as tolerant to habitat transformation, there is little evidence supporting this information (BirdLife International 2016a).

TABLE 1. Description of the localities and records of Turquoise Dacnis and Cerulean Warbler in the urban area of Armenia city, Colombia.

Locality	Area description	Species	Date	Time (h)	Observations/remarks
1. Calle 9 Norte, Barrio Profesionales. (4°32'59.6"N; 75° 39'56.4"W)	Small linear patch (2 ha) of second grown forest at 1522 m a.s.l., dominated by *Guadua angustifolia*, *Cecropia angustifolia*, *Albizia carbonaria*, *Inga ornata*, and *Eucalyptus globulus*, reaching 12 m height. This forest is immersed in an urban area with buildings of three to seven floors.	Turquoise Dacnis	24 Oct 2011	06:30–07:00	An adult male foraging inside the foliage of a *Nectandra reticulata* tree, and picking mature fruits. Later it flew to a *C. angustifolia* tree and ate some fruits during 2 min.
			01 Nov 2011	07:25–07:28	A male eating fruits of *C. angustifolia*.
			15 Nov 2011	07:30–07:40	An adult female foraging hung upside down and eating *C. angustifolia* fruits.
			17 Nov 2011	07:00–07:05	A male perched and preening on the top (~20 m) of *G. angustifolia*.
			29 Feb 2012	07:25–07:35	A pair was perched in a top of *G. angustifolia*, then they flew in the same way to another forest patch crossing the highway.
			31 Mar 2012	07:15–07:40	A pair foraging in an *I. ornata* tree. The female was gleaning on foliage, the male visited the flowers and fed the nectar legitimately -making contact with the reproductive structures. Then the female was searching insects in the inflorescences.
			11 May 2012	08:15–08:30	A male foraging in the foliage of a *N. reticulata* tree with a Red-eyed Vireo (*Vireo olivaceus*).
			12 May 2012	06:55–07:00	A male perched on a tree top.
2. Centro Deportivo Nueva Cecilia. (4°32'43.45"N; 75°39'53.35"W)	A green area with pastures for soccer and tennis fields, with some dispersed trees and a small secondary forest of 4 ha at 1499 m a.s.l., where *G. angustifolia*, *C. angustifolia*, and *E. globulus* dominate and reach 15 m height.	Cerulean Warbler	11 Jan 2013	09:40–09:50	A male foraging on foliage of *I. ornata* joined a flock of insectivorous birds as Red-faced Spinetail (*Cranioleuca erythrops*), Tropical Parula (*Setophaga pitiayumi*), Red-eyed Vireo, Golden Tanager (*Tangara arthus*), and Golden-faced Tyrannulet (*Zimmerius chrysops*).
		Turquoise Dacnis	10 Jan 2014	10:30–10:50	A male on the top of *C. angustifolia,* a female hung upside down leaves foraging insects.
			03 Feb 2014	08:20–08:30	A male searching nectar in flowers of *Erythrina rubrinervia*.
			06 Jun 2014	09:25–09:35	A male foraging on flowers of *E. globulus*.
3. Jardín Botánico de la Universidad del Quindío. (4°33'10.29"N; 75°39'41.6"W)	The largest green area (15 ha) immersed in the urban area at 1530 m a.s.l. The vegetation is characterized by secondary forest, abandoned coffee shade plantations, pastures, gardens, and shrubs. The canopy reaches 20 m height and is dominated by *G. angustifolia*, *C. angustifolia*, *Nectandra* spp., and *Ficus* spp. The campus is surrounded by building between 3 to 30 floors.	Turquoise Dacnis	18 Jul 2013	08:00–08:10	A male foraging on the foliage and inflorescences of *A. carbonaria*, together with Bay-headed Tanager (*Tangara gyrola*), and Blue-gray Tanager (*Thraupis episcopus*).
		Cerulean Warbler	01 Sep 2011	12:15–12:25	A pair foraging in the understory with Yellow-throated Vireo (*Vireo flavifrons*), Slate-throated Whitestar (*Myioborus miniatus*), and Golden-faced Tyrannulet. The male was searching on *Piper* sp. leaves, whereas the female was foraging on the top of a *Pinus patula*.
			14 Dec 2011	09:35-09:38	A male moving within the foliage of *G. angustifolia*.
			19 Feb 2012	16:50-16:55	A male foraging hung upside down on *I. ornata* leaves.

Locality	Area description	Species	Date	Time (h)	Observations/remarks
4. Jardín Botánico del Quindío, Calarcá. (4°30'44.3"N; 75°39'7.7"W)	A sub-Andean forest surrounded by coffee shade and sun plantations in the periurban area of Calarcá. This fragment has 13 ha at 1490 m a.s.l. *G. angustifolia*, *Coussapoa villosa*, *Ochroma pyramidale*, *Heliocarpus popayanensis*, *Solanum sycophanta*, *Croton magdalenensis*, *Anacardium excelsum*, *Nectandra* spp., *Persea* spp., and *Ocotea* spp. are dominant, and the canopy reaches 25 m height.	Turquoise Dacnis	17 Nov 2007	08:00–09:00	A male searching insects at midstorey level of a *C. villosa* tree.
			22 Jan 2011	09:00–09:02	A male foraging on the foliage of a *Escallonia pendula* tree.
		Cerulean Warbler	07 Jan 2007	10:30–10:40	A female foraging in the canopy foliage with Rufous-naped Greenlet (*Hylophilus semibrunneus*) and Blackburnian Warbler (*Setophaga fusca*), seen from an observation tower at 30 m to the ground.
			15 Nov 2009	09:00–09:05	A solitary male perched in the canopy.
			10 Jan 2010	08:35–08:40	A male flying from the forest to a shade coffee area, then it perched on the top of a *I. ornata* tree.
5. Parque de la Vida, Armenia. (4°32'48.24"N; 75°39'32.2"W)	A park with open green areas, dispersed tall trees, and a small second grown forest of 5 ha at 1522 m a.s.l.	Turquoise Dacnis	15 Jun 2013	09:35–09:50	A male eating fruits on the top of a *Zanthoxylum rhoifolium* tree with another frugivorous birds, such as Blue-necked Tanager (*Tangara cyanicollis*), Palm Tanager (*Thraupis palmarum*), Blue-gray Tanager, Green Honeycreeper (*Chlorophanes spiza*), and Black-billed Thrush (*Turdus ignobilis*).
			14 Oct 2013	07:19–07:23	A male gleaning on the foliage of *I. ornata*.
			16 Mar 2014	06:40–06:50	A male foraging on the top of *Z. rhoifolium*.
			12 Apr 2014	06:50–07:10	A male and a female foraging fruits and foliage of *Z. rhoifolium*.
		Cerulean Warbler	13 Oct 2014	09:00–09:08	A male foraging insects on foliage.
6. Parque Fundadores, Armenia. (4°32'45.76"N; 75°39'43.34"W)	A small urban park (1 ha) at 1524 m a.s.l., with tall trees (15 m) as *Araucaria* sp., *A. excelsum*, *C. angustifolia*, and *A. carbonaria*.	Turquoise Dacnis	12 Dec 2014	08:10–08:15	A male was perched on the top of a palm; later, it flew crossing the street towards trees in the Parque de la Vida.
7. Urbanización Mercedes del Norte, Armenia. (4°33'10.68"N; 75°40'2.44"W)	A periurban secondary forest surrounding the Hojas Anchas stream, dominated by *G. angustifolia* patches. This area has an extension of 6 ha at 1469 m a.s.l.	Cerulean Warbler	11 Nov 2008	10:15–10:30	A male joined a mixed flock at midstorey levels, with insectivorous birds as Golden-crowned Warbler (*Basileuterus culicivorus*), Golden Tanager, Montane Foliage-gleaner (*Anabacerthia striaticollis*), Streak-headed Woodcreeper (*Lepidocolaptes souleyetii*), Slate-throated Whitestar, Tropical Parula, Blackburnian Warbler, and Black-and-white Warbler (*Mnioltita varia*).
			04 Dec 2009	10:30–10:45	A male foraging joint to a mixed flock in an abandoned shade coffee plantation.

An interesting observation is the apparent sexual segregation in the habitat use of the Turquoise Dacnis. We only detected pairs and females in corridors of native vegetation in the periurban area (Figure 1), meanwhile males were seen adventuring to explore small patches and street trees. Previously, Hilty & Brown (1986) hypothesized a pattern of altitudinal segregation in which the females of the Turquoise Dacnis might be observed at higher elevations. The females have a dull and cryptic plumage that hinders its detection, which could be an explanation for that hypothesis. However, our observations suggest the presence of pairs during the wet (April to May) and the dry seasons (December; Table 1), showing no evidence to support the altitudinal segregation.

Although urbanization generally results in a loss of biodiversity and habitat, some cities can serve as a refuge for some native fauna and even for threatened species (Ives *et al.* 2016). However, urbanization has had profound effects on the diversity and density of species (Chace & Walsh 2006, Aronson *et al.* 2014), and the impacts on bird biodiversity can vary depending on demographic and socioeconomic characteristics of urban areas (Strohbach *et al.* 2009). In the case of Armenia, the fast urban expansion and building construction, boosted some years after the last strong earthquake, probably have had negative impacts on bird species, which are still unknown and need to be quantified. Urban sprawl, the extraction of wood and bamboo from natural forests, the construction of taller buildings resulting in collisions (Nieto *et al.* 2009), and predation by cats are some factors negatively affecting bird survival in urban areas (Chace & Walsh 2006). As noted by Ives *et al.* (2016) the presence of a population in a particular site is not necessarily an indication of its long-term viability in that location, but it can offer potential opportunities for conservation.

The lack of interest in studying urban birds in Latin America, particularly in Colombia, along with the scarce knowledge about their ecology and conservation (Ortega-Álvarez & MacGregor-Fors 2011, Delgado & Correa 2013), may explain the absence of records of these two species in cities, which have probably remained undetected for years. In the case of Armenia, the presence of both species could be facilitated by preserving natural forest habitats within the city, which are connected with a network of forest corridors, urban green areas, and the surrounding landscape (Figure 1). These areas are a refuge for about 190 forest bird species (O. Marín-Gómez, pers. obs.) and support mixed species bird flocks of which the Turquoise Dacnis and Cerulean Warbler form part. We highlight the importance of designating natural forest present within an urban area as green spaces aiming to protect biodiversity, as a conservation tool and urban planning, especially in regions where surrounding agricultural practices have removed most of the natural vegetation. Further research could be oriented to monitoring the bird populations in natural forest in contrast of those found in the urban core. Furthermore, a larger, follow-up study of other forest-dependent birds within the urban gradient in opposition to agricultural matrix would be very enlightening.

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