Study of the Foraging Ecology and Behavior of the Cerulean Warbler (*Dendroica cerulea*) in the Western Andes of Antioquia, Colombia

(2005-2006 Wintering Season)

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Contents

Abstract

I studied the foraging behavior of Cerulean Warbler (*Dendroica cerulea*), a migratory passerine of conservation concern, in the Cordillera Occidental of the Colombian Andes during the 2005/2006 nonbreeding period. *D.cerulea* was commonly found in the canopy of shaded cardamom and coffee plantations. Adult individuals, males, and birds in fresh plumage were more common than immature individuals, females, and those in worn plumage respectively. Most individuals observed were joining mixed species flocks and during overcast conditions. This warbler constantly flies between trees and rarely stops while foraging; it rapidly moves by making small hops along twigs and searching all surfaces for food. Even thought among the non-aerial maneuvers Lunge was the most commonly observed, these were performed without any noticeable preference; meanwhile Leap and Flush-Pursue prevailed among the aerial maneuvers. Though Snap was performed to manipulate big green larvae twice, Gulp was the most used food handling technique due to a sampling constraint for insectivorous birds. *D.cerulea* only used shading tree species, typically Guamos (*Inga* sp.) and Carboneros (*Albizia* sp.). Much research in all the distribution range of this species is still needed to enlarge the knowledge about its natural history and behavioral ecology in order to develop effective conservation efforts.

Introduction

Cerulean Warblers (*Dendroica cerulea*) are small, sexually dimorphic, Neartic-Neotropical migratory passerine birds (Hammel 2000). This species visits its wintering grounds in Colombia, Venezuela, Ecuador, Peru and Bolivia approximately from September to April each year (for recently dates for Colombia see Colorado & Cuadros 2004).

Most of the information about the natural- and life-history about this species comes from its breeding range in North America (among many examples see: Fleming 1907, Smith 1915, Paynter 1953, Austin 1971, and Wood *et al*. 2006 as one of the most recent), and the information coming from the wintering grounds it visits each year is scarce. Little is still known about its ecology while it lives in the Neotropics, and literally as Hammel *et al*. (2004) said "*A sense of urgency attends the study of species of concern, like the Cerulean Warbler*". Few published studies, and developed only in Venezuela, have been undertaken where some focus in basic aspects (as behavior or foraging) of the biology of *D.cerulea* have been kept in mind (Hammel *et al*. 2004, see Jones *et al*. 2000, 2002); and although there have been research in past years in Colombia, it has focused in extending the known distributional range of the species and obtaining general ecological information of the species (e.g.: Colorado & Cuadros 2004). Up to date, no detailed behavioral or ecological studies of *D.cerulea* have been made in the Colombian

wintering localities this species frequents. Based in the summarizing overview made by Hammel *et al*. (2004), and in a rapid references survey (finding that papers from North America vs. from South America vary at a rate of ca. 3:1) the comparison of the knowledge we have of the ecology of *D.cerulea* in its breeding range versus in its wintering grounds, shows us a huge disparity. *D.cerulea* is a species of conservation concern that as any other migratory bird needs full integration of research programs across political boundaries for its effective conservation (Levey 1994); conservation that needs basic information to be able to operates at its maximum (Wilson 2005).

Having in mind the big gap on detailed information about the ecology and behavior that *D.cerulea* presents while in the Neotropics, and the importance that Coffee and other shaded plantations have in the conservation of birds (Petit & Petit 2003), I developed a detailed non-systematic investigation about the foraging ecology and behavior of this bird in a shaded plantation ecosystem in the western Andes of Colombia during the non-breeding 2005-2006 season.

Methods

I developed this study at La Siuza farm in the municipality of Jericó in the eastern flank of the Cordillera Occidental of the Colombian Andes (5º 47' N, 75º 47' W). La Siuza farm holds a ~300 ha Cardamom-shade plantation (*Elettaria cardamomum*) surrounded by Coffee-shade plantations and small to medium native forest at an elevation of 1.500 m (Fig. 1). The shading tree species in the plantation are mostly Guamos (*Inga*); there are also some Aguacates (*Persea*), Mangos (Anacardiaceae), various species of Melastomes (Melastomataceae), some Nettle family species (Urticaceae), and pioneer trees as Yarumos (*Cecropia*). Some emergent Carboneros (*Albizia*) are seen in the plantations as well, and creek courses are skirted by bamboo Guadua lines (*Guadua angustifolia*). La Suiza farm is delimited by pastures and agricultural landscapes that end in the Cauca River to the east, and by an adjacent large-size well-conserved premontan forest called Las Nubes to the west. La Suiza farm suitable habitat are nowadays threatened due changes in economic activities by the new owners of the farm (see Final Considerations below). For a detailed locality description see item 2.2.2 in Colorado & Cuadros (2004).

Figure 1. La Suiza farm in W Andes of Colombia (a. Map showing Jericó municipality where la Suiza is located; b. Cardamom-shade plantation in La Suiza; c. Coffee-shade plantation in La Suiza; d. Native forest between La Suiza and Bosque Las Nubes).

From October 2005 to March 2006 I carried out 190 hours of observations looking for, and following, *D.cerulea* individuals in the study area; I non-systematically roved the main and all adjacent trails of La Suiza farm from dawn to 10:00 hours, and from 15:00 hours to dusk in search of individuals of this species. Every time a *D.cerulea* was observed, I followed it the maximum amount of time possible and recorded basic data about the bird as age and sex, plumage condition, and if had been previously ringed (due there have been intensive fieldwork with this species in this locality before); also date, hour, weather conditions, and habitat information were recorded. Following Altmann (1974) methods on focal-animal sampling, I recorded if the bird was foraging alone, in pairs, or if it was joining a mixed-flock; also the height of the foraging individual in the trees. Characteristics as the species composition and speed of mixed flocks, as

the visited/used plants and behavior among individuals, were also noted. I used categories proposed by Remsen & Robinson (1990) for food searching, foraging maneuvers, and food handling techniques to characterize and describe the foraging behavior of *D.cerulea*. All the observations and information were transcribed from field notebooks to an Excel (Microsoft Corporation) datasheet matrix. To try to perceive any preferences in *D.cerulea* behavior I used Chi-square tests (Fowler & Cohen 1996) based in observation frequencies; I made the following comparisons:

1. Individuals observed in sunny vs. in cloudy vs. in rainy vs. in clear weather conditions.
2. Individuals observed alone vs. in conspecific couples or groups vs. joining mixed flocks.
3. Performance of non-aerial maneuvers (Glean, Reach-up, Reach-out, Reach-down, Hang-up, Hang-down, Hang-sideways, Hang-upsidedown, Lunge).
4. Performance of aerial maneuvers (Leap, Sally, Flutter-chase, Flush-pursue, Screen).

I also gathered information about the vegetation in the study area and species used to forage and/or move through; these plants were initially identified in the field, and later with help of the Universidad de Antioquia herbarium staff people. The avifauna was constantly surveyed.

Results

I observed *Dendroica cerulea* individuals in 31 opportunities during the whole season (Fig. 2); I commonly found individuals of this species in Cardamom- and Coffee-shaded plantations (25,8% and 48,4% of all observations respectively), where only the canopy/shading tree species, like Guamos (*Inga*) and Carboneros (*Albizia*), were used to move and forage for insects. Interestingly I also found *D.cerulea* individuals quite often in a small, with no bushy understory, monoculture of Nogales (*Cordia*) (22,6%) situated between a medium size swamp and the Cardamom-shaded plantation (Fig. 3); finally few times (just 3,2%) I observed *D.cerulea* in emergent trees (Always Carboneros) outside the plantations. Additional vegetal species usually used by *D.cerulea* individuals were Melastomes (Melastomataceae), Mangos (*Mangifera indica*) and a species of Urticaceae (cf. *Boehmeria*).

Figure 2. Some hard to photograph *Dendroica cerulea* individuals luckily spotted by DCF in La Suiza during the 2005-2006 non-breeding season.

This warbler never used the Coffee (*Coffea arabica*) or the Cardamom (*Elettaria cardamomum*) shrubs themselves, excepting for just one occasion in January 27 when a *D.cerulea* adult male exhibited an agonistic behavior with a male bigger White-winged Becard (*Pachyramphus polychopterus*), and after falling from the canopy chasing each other in flight, the *D.cerulea* landed in the upper branches of a Coffee plant where it stayed for a couple of seconds before returning to forage in the canopy.

Figure 3. Plantation of Nogales where *Dendroica cerulea* was commonly observed.

I largely observed *D.cerulea* when there were general overcast conditions (77.4% of all observations) (Fig. 4), and it seems this bird highly prefers foraging under these conditions than under sunny, rainy, or clear ones ($?^2 = 45.51$, $p < 0.01$, 3df). Adult individuals (93,1%), males (90%), and birds in fresh plumage (74,2%) were more commonly observed than immature individuals, females, and those in worn plumage respectively (Fig. 5). Just 21,9% of my observations corresponded to alone individuals, and 6,2% to *D.cerulea* conspecific groups which only consisted in one observation of a couple of adult males in November 12; most of the observed individuals (71,9%) preferred to forage joining very concurred mixed species flocks ($?^2 = 22.56$, $p < 0.01$, 2df) (Fig. 6). 37 species were observed forming mixed flocks (gray species in Appendix 1); these mixed flocks could carry up to 26 species foraging together in the canopy of shaded, principally Coffee, plantations. One of these flocks, containing 7 individuals of *D.cerulea* (one female among six males) and 5 more migratory species, was foraging nearly a complete hour in the *Inga* trees of a Coffee-shade plantation in December 15 under highly overcast conditions.

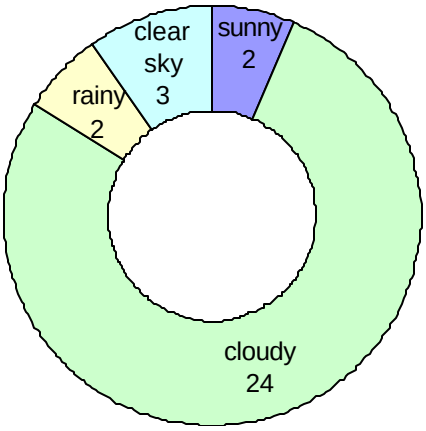

Figure 4. *Dendroica cerulea* observation frequencies under different meteorological conditions.

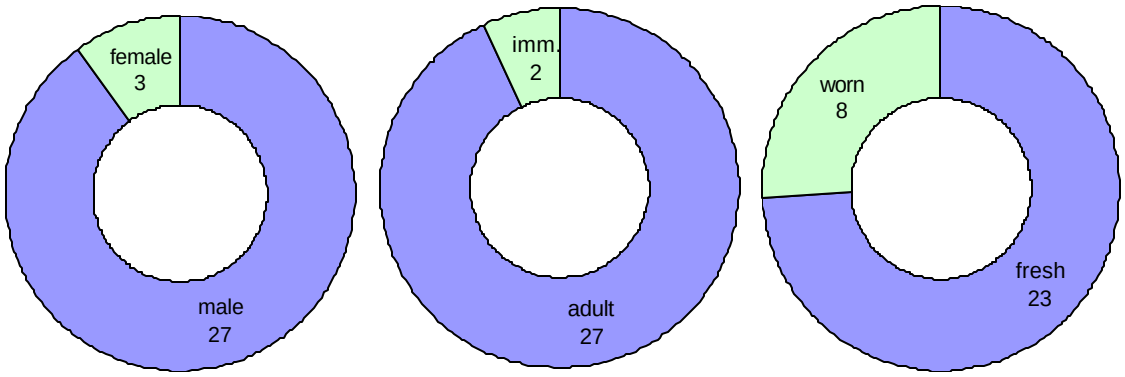

Figure 5. *Dendroica cerulea* observation frequencies of individuals for each sex (a), age (b) and plumage condition (c).

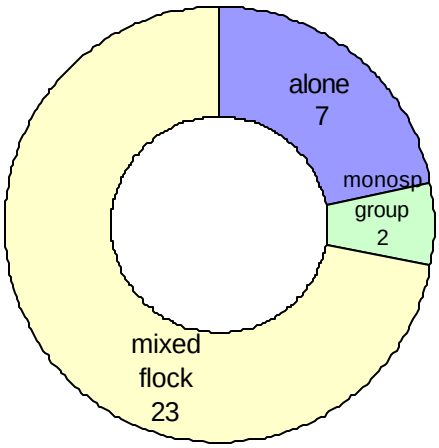

Figure 6. *Dendroica cerulea* observation frequencies of individuals alone, in conspecific, or mixed-species groups.

I found that *D.cerulea* is an indefatigable bird; this warbler constantly flies between trees and rarely stops while foraging; I only observed it to discontinue looking for food few times while sweeping its bill against the twig it was perched in, at an average rate of 0,5 times per minute. This bird usually forages at a height of 7,81 m, and keeping an average speed of 1,42 m/min; it rapidly moves making small hops along thin twigs and looking in all directions, searching all surfaces, for food. Individuals of *D.cerulea* particularly scanned the back of leaves of *Cordia* and *Inga* trees carefully, and in more than a few times twisted *Cordia* leaves taking them by the tip with its bill in search of small insects.

Searching for food, *D.cerulea* attacked using both near-perch (non-aerial), and aerial maneuvers. Among the non-aerial ones, there were only executed those restricted to the outside of the substratum; Lunge (16,7%) was performed almost all times I observed a *D.cerulea* foraging, as well as the three kinds of Reach (out, down and up: 15,5 - 13,2 - 11,5% respectively); the four types of Hang maneuvers (35,1%) where also very common, being Hang-sideways the more used (10,9%), and Hang-down almost always performed keeping the head in a very horizontal plane; Glean was performed in the 8,0% of all observations (fig.7). I did not observe any noticeable preference for any of the non-aerial maneuvers executed by *D.cerulea* ($?^2$ = 14,79, p > 0.05, 8df); furthermore, non-aerial subsurface maneuvers, as Probe, Gape, Chisel, Pull, among others, were never observed being performed during this study.

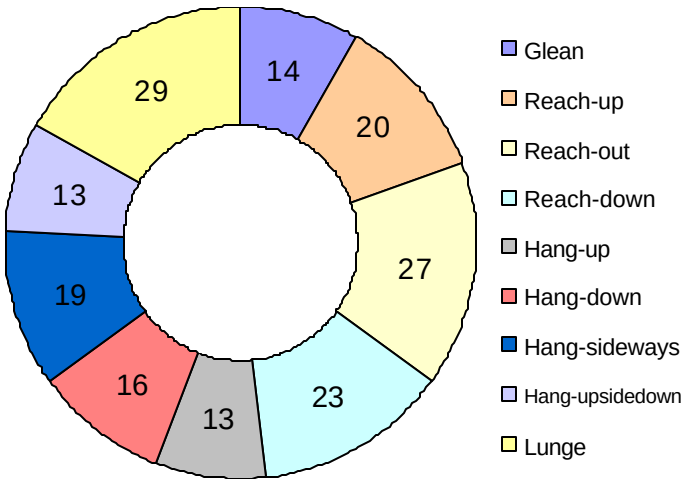

Figure 7. *Dendroica cerulea* observed frequencies of non-aerial maneuvers used to search for food.

Among the aerial maneuvers performed to obtain its food, *D.cerulea* used wing- and leg-powered ones; within the latter category Leap was executed 48,3% of all observations, and among the wing-powered ones Flush-pursue (48,3%) was evidently more used than Flutter-chase (3,4%); Screen and Sally were never

observed (Fig.8). In this group of maneuvers made at-flight, there were statistical significant differences in their performance rate ($?^2$ = 38,76, p < 0.01, 6df). A few Flutter-chases made by adult males in *Cordia* trees resulted in ca.50 cm vertically free falls.

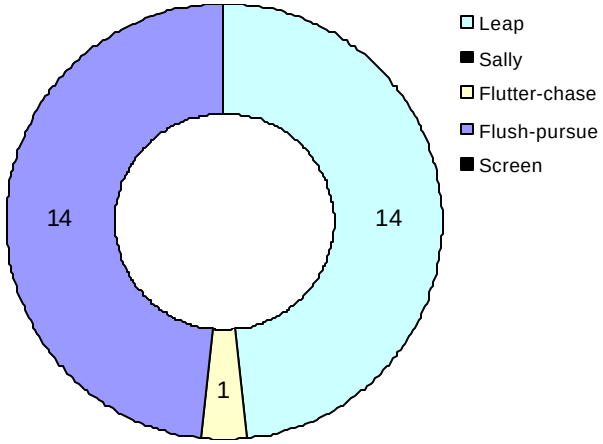

Figure 8. *Dendroica cerulea* observed frequencies of aerial maneuvers used to search for food.

Reliable identification of prey taken by individuals of *D.cerulea* was possible only twice (6,9% of observations), when adult males took green larvae, presumably Lepidoptera, from *Inga* tree leaves; Snap was the food-handling technique performed to manipulate these ca. 2.5 cm worms. In all remaining observations (93,1%), apparently small insects were taken, and Gulp is the theoretical supposed technique used in those cases. No other food-handling technique, as Shake, Jab, Clasp, Drink, among many others, was recorded; and even thought in on of my last field trips on March 17 the *Inga* trees were plentifully flowered, I never noticed nectar consumption, which I usually observed in several other birds. In one occasion, a *D.cerulea* adult male picked at some spider webs from the back of leaves of a *Cordia* tree; no prey observed.

Final Considerations

This study allowed knowing more about how *Dendroica cerulea* forages in its Neotropical lands while the wintering migratory season. This species proved to be a very Active Forager which uses specific maneuvers to search for, and catch, insects following the scheme of Remsen & Robinson (1990); all the information gathered about the natural- and life-history of this species while developing this project will help in suggesting and planning conservation initiatives as well as in the Neotropics as in its breeding range for this migratory warbler of conservation concern. It's important to highlight the constraints that exist when studying the diet

of insectivorous birds, and those are related with the difficult to obtain reliable prey data in the field due to the high speed at which the bird forages and the small size of prey; for many species that eat small insects, it can even be difficult to determine whether or not a prey item was captured at the end of an attack. For these reasons, most field studies of insectivorous birds, as this one, include only limited data on prey (Remsen & Robinson 1990). The importance that agricultural plantations and landscapes play for this species is very clear; all individuals were observed moving and foraging in the canopy shaded plantations of Cardamom and Coffee, and never were sighted considerably using native forests near the "monospecific" plantations. The shaded plantations as a whole have been noted as keystone resource for birds (Greenberg *et al*. 2000, Sherry 2000, Botero & Verhelst 2001, Carlo *et al*. 2004, Komar 2006), and *Dendroica cerulea* proved this to be true; the shaded plantations of Cardamom and Coffee in La Suiza farm holds a rich avifauna including more than 10 migrant species (see appendix 1), as well as a great diversity of insects, reptiles, amphibians, and mammals (Fig.9). Unfortunately La Suiza Cardamom shaded plantation is now being destroyed to use the lands for cattle ranching.

Figure 9. Some other species of interest from La Suiza. (a. several groups of *Alouatta seniculus*, up to 8 individuals each, can be observed/heard at the same time; b. *Cerdocyon thous* is commonly seen in the Cardamom-shade plantation; c. *Procyon cancrivorus* commonly prints its tracks in La Suiza).

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Appendix 1. Bird species recorded at La Suiza during this study.

Species	Evidence				Species	Evidence			
	Visual	Aural	Recording	Photo		Visual	Aural	Recording	Photo
Crypturellus soui		X			*Mionectes striaticollis*	X			
Tachybaptus dominicus	X	X	X	X	*Phylloscartes ophthalmicus*	X	X		
Bubulcus ibis	X				*Phyllomyias griseiceps*	X	X	X	
Butorides striatus	X				*Zimmerius chrysops*	X	X	X	
Coragyps atratus	X				*Poecilotriccus sylvia*	X	X	X	X
Cathartes aura	X				*Todirostrum cinereum*	X	X	X	X
Chondrohierax uncinatus	X			X	*Contopus virens*		X		
Buteo magnirostris	X	X	X	X	*Empidonax sp*	X			
Buteo platypterus	X				*Sayornis nigricans*	X			
Herpetotheres cachinnans	X	X		X	*Myiarchus cephalotes*		X		
Falco sparverius	X				*Myiarchus tuberculifer*	X	X		X
Falco rufigularis	X			X	*Pitangus sulphuratus*	X	X		
Ortalis colombiana		X			*Megarynchus pitangua*	X			
Laterallus albigularis		X			*Myiozetetes cayanensis*		X		
Aramides cajanea	X				*Myiodynastes maculatus*	X			
Porphyrio martinica	X	X	X	X	*Myiodynastes chrysocephalus*	X	X		X
Gallinula chloropus	X	X	X	X	*Legatus leucophaius*	X	X		
Jacana jacana	X	X	X	X	*Tyrannus melancholicus*	X	X		
Vanellus chilensis		X			*Pachyramphus rufus*	X			X
Tringa sp	X				*Pachyramphus polychopterus*	X	X		X
Columba cayennensis	X	X		X	*Stelgidopteryx ruficollis*	X			
Zenaida auriculata	X				*Troglodytes aedon*	X	X		
Columbina talpacoti	X				*Henicorhina leucophrys*	X	X	X	
Leptotila verreauxi	X				*Polioptila plumbea*	X		X	X
Aratinga wagleri	X				*Catharus fuscater*	X			
Forpus conspicillatus	X			X	*Turdus ignobilis*	X	X		
Brotogeris jugularis	X				*Turdus grayi*	X			
Pionus chalcopterus	X	X	X	X	*Cyanocorax affinis*	X	X		X
Piaya cayana	X			X	*Vireo olivaceus*	X			
Crotophaga ani	X				*Vireo leucophrys*	X			
Tapera naevia		X			*Hylophilus semibrunneus*	X			
Otus choliba		X			*Cyclarhis nigrirostris*	X		X	
Ciccaba virgata		X			*Vermivora peregrina*	X			
Nyctidromus albicollis		X			*Parula pitiayumi*	X			
Streptoprocne zonaris	X	X			*Dendroica fusca*	X			X
Phaethornis guy	X				*Dendroica cerulea*	X			X
Phaetornis longuemareus	X				*Mniotilta varia*	X			X
Doryfera ludovicae	X				*Seiurus noveboracensis*	X			X
Colibri delphinae	X			X	*Oporornis philadelphia*	X			
Colibri thalassinus	X				*Wilsonia canadensis*	X			X

Anthracothorax nigricollis	X				*Myioborus miniatus*	X	X		
Chlorostilbon mellisugus	X				*Basileuterus culicivorus*	X	X	X	
Amazilia tzacatl	X				*Coereba flaveola*	X			
Agyrtria franciae	X				*Chlorospingus ophthalmicus*	X			
Saucerottia saucerrottei	X				*Hemithraupis guira*	X			X
Adelomyia melanogenys	X				*Tachyphonus rufus*	X			
Chaetocercus mulsant	X				*Piranga rubra*	X	X	X	
Trogon collaris	X	X			*Piranga leucoptera*	X			
Momotus aequatorialis	X	X			*Ramphocelus dimidiatus*	X	X		
Malacoptila mystacalis	X	X	X	X	*Ramphocelus flammigerus*	X	X		X
Eubucco bourcierii	X	X	X	X	*Thraupis episcopus*	X	X		
Aulacorhynchus haematopygus	X	X		X	*Thraupis palmarum*	X	X		
Picumnus granadensis	X				*Anisognathus somptuosus*	X			
Melanerpes formicivorus	X	X			*Euphonia xanthogaster*	X	X		
Melanerpes rubricapillus	X				*Tangara gyrola*	X			
Veniliornis fumigatus	X				*Tangara arthus*	X			
Piculus rubiginosus	X	X			*Tangara vitriolina*	X			
Dryocopus lineatus	X	X	X		*Tangara cyanicollis*	X			
Synallaxis azarae	X			X	*Tangara nigroviridis*	X			
Cranioleuca erythrops	X			X	*Tangara vassorii*	X			
Margarornis squamiger	X				*Tangara heinei*	X			
Xenops rutilans	X			X	*Chlorophanes spiza*	X			X
Lepidocolaptes affinis	X				*Volatinia jacarina*	X			
Taraba major	X	X	X	X	*Sporophila intermedia*	X			X
Thamnophilus multistriatus	X	X	X	X	*Sporophila minuta*	X			
Thamnophilus atrinucha	X	X	X	X	*Tiaris olivacea*	X	X		
Dysithamnus mentalis	X				*Sicalis flaveola*	X			
Cercomacra parkeri			X		*Atlapetes rufinucha*	X			
Myrmeciza immaculata	X			X	*Buarremon brunneinucha*	X			
Grallaria guatimalensis		X			*Zonotrichia capensis*	X	X		
Grallaria ruficapilla		X			*Saltator albicollis*	X	X		X
Phaeomyias murina		X			*Pheucticus ludovicianus*	X			X
Tyrannulus elatus		X			*Icterus chrysater*	X	X	X	X
Mionectes oleagineus	X								