Article

Trophic behavior of insectivorous birds in agroforestry systems immersed in mesophilic forest

Claudio Romero-Díaz[1]
Saúl Ugalde-Lezama[2]
Rosa María García-Núñez[1§]
Uriel Marcos-Rivera[2]
Yessenia Cruz-Miranda[2]

[1]Master of Science in Agroforestry for Sustainable Development-Chapingo Autonomous University. Federal Highway Mexico-Texcoco km 38.5, Chapingo, Texcoco, Mexico. CP. 56230. Tel. 595 9521500. (favia-rd@hotmail.com). [2]Renewable Natural Resources Area-Soil Department-Chapingo Autonomous University. Federal Highway Mexico-Texcoco km 38.5, Chapingo, Texcoco, Mexico. CP. 56230. (biologist-ugalde@hotmail.com; urimr-93@hotmail.com; yessenia.cruzm@gmail.com).

[§]Corresponding author: blondynunez@gmail.com.

Abstract

In order to know the hunting techniques that birds use in the capture of their prey, from August (2018) to January (2019), the bird monitoring was applied, using systematic sampling, point count with fixed radius and intensive search. Observation frequency (FO) and relative abundance index (IAR) were determined. To determine association between birds and hunting techniques, Poisson regression analysis (ARP) was applied. To learn more important hunting techniques, principal component analysis (ACP) was applied. To determine differences between hunting techniques and infer if what is recorded is present, Kruskal-wallis and X^2 were applied. FO notes that the most frequent hunting techniques are collect (63.7%), inspect (15.32%) and boost (8.06%). The IAR suggests average values of 0.24; 0.25; 0.333; 0.142. The ARP suggests better fit models with an AIC= 49.506. The ACP explains 100% inertia. Kruskal-wallis shows differences in CT and CT-PT-BMM. The X^2 evidence that what is recorded is expected. There is evidence of sympatric coexistence in registered bird species because there is no competition for the resource or the hunting technique used to capture their prey.

Keywords: birdlife, foraging, hunting, sympatric.

Reception date: January 2020
Acceptance date: March 2020

Introduction

Globally due to a series of anthropic actions, the product of population development and the search to guarantee food security, unfavorable actions with the environment have been taken (Solomou and Sfougaris, 2015). Among such acts, chemicals have been applied that cause the extinction of various organisms (Donald *et al*., 2006). A negative response to agricultural intensification is the decrease in insectivorous bird populations, which in parallel increases the incidence of pests in agricultural fields (Miñarro, 2014).

In Mexico, due to the introduction of exotic species, expansion of monocultures, use of pesticides and mechanization of the agricultural system, the extinction of different bird species has been caused by altering the biological cycles of the environment (Mballa *et al*., 2011). Under such inconvenience, environmentally friendly ancestral production actions such as traditional agroforestry systems have been resumed.

These structures integrate in their composition vertical and horizontal strata in which a considerable number of birds can be housed that could function as biological control (particularly of agricultural pests; Gámez-Virués *et al*., 2007) favoring the conservation of species and providing a balance between agricultural production and biodiversity conservation (Ashworth *et al*., 2009).

It should be noted that, both in agricultural production systems and in natural areas, the low stratum is characterized by the presence of insectivorous birds. The richness and diversity of these species is determined by certain fluctuations that determine the food resource (Sekercioglu *et al*., 2002), presenting a spatial distribution based on the structural heterogeneity of the environment, this factor is linked to the availability of insects and by both to the temporary space distribution of birds (Manhães and Días, 2011).

It is noteworthy to mention that insectivorous birds given their trophic spectrum, in order to ensure their survival they use different hunting techniques that can range from hunting in flight to wood excavation, all based on trophic guilds and competition for the resource (Pineda-Pérez *et al*., 2014). The technique that some birds use to guarantee their energy proportion in a short time is described as optimal feeding (De Mendonca-Lima *et al*., 2004; Cabrera *et al*., 2006).

Thus, the optimal foraging theory indicates that birds employ techniques that demand a minimum energy expenditure and reward them with a greater nutritional contribution (González and Osbahr, 2013). In the same way, this theory indicates that such behavior has been determined by natural selection actions and consists of constraints and events that determine survival and reproductive success (Pineda-Pérez *et al*., 2014). An agroforestry system of traditional coffee is located in the municipality of Huatusco, Veracruz, Mexico.

This system is structured in a multi-layer spatial arrangement which could house a considerable number of birds, which could contribute as biological regulators of this system. However, so far there are no records where this important issue has been evaluated, much less where the trophic behavior used by birds to acquire their prey and ensure their survival is considered. For this reason, the objective of this work was to determine the hunting techniques used by birds during their feeding in coffee agroforestry systems in the region of Huatusco, Veracruz, Mexico.

Materials and methods

The study area is located between the geographical coordinates 19º 09' north latitude and 96º 57' west longitude at an altitude of 1 933 meters above sea level, belonging to the municipality of Huatusco, Veracruz, Mexico. For this study, three conditions were evaluated: traditional coffee (CT); Potrero (PT) and mountain mesophilic forest (BMM) in a total area of 32.42 ha. In each condition evaluated, a systematic sampling was applied to convenience with linear distances of 150 m between each point.

Bird monitoring was conducted monthly from August (2018) to January (2019) using point count with fixed radius and intensive search (Ramírez-Albores, 2009; Ponce *et al*., 2012; Ramírez-Albores, 2013; Alonso *et al*., 2017). This methodology consisted in the fact that the observer, when arriving at each sampling point, stood still for a minute and then traveled a radius of 25 m in search of specimens at the time they were feeding or trying to capture their prey (Remsen and Robinson, 1990; Johnson, 2000; Dreelin *et al*., 2018).

This scheme was carried out using 8 x 42 m binoculars with water vision Bushnell brand at a time of 07:00 to 16:00 h, a period in which the birds present greater forage activity (Gabbe *et al*., 2002; Chatellenaz, 2008; Santos *et al*., 2013). The observation frequency (FO) and relative abundance index (IAR) of the hunting techniques recorded were determined. To determine the possible association between the abundance of registered birds and hunting techniques employed; Poisson regression analysis (ARP) was applied, using the Stepwise polynomial variable selection procedure, the adjustment of the models was performed with the Akaike minimum criterion in R.13.0 (Akaike, 1969).

With the aim of establishing possible statistically significant differences between the hunting techniques evaluated and inferring if the recorded data are those that are potentially presented, X^2 and Kruskal-wallis analyzes were applied, this by virtue of not complying with the assumptions of parametric statistics; such analyzes were obtained using the JMP IN statistical software version 8.0. In order to know the main hunting techniques used during the foraging of the birds, a principal components analysis was applied, for this analysis the statistical software XLSTAT version 2018.7 was used.

Results and discussion

124 birds were observed using some hunting technique during the capture of their prey (CT= 78; PT= 28; BMM= 18); recording a total of seven hunting techniques (collect= 79, boost= 10, inspect= 19, drill= 5, climb down= 2, remove= 6, sweep= 3). FO notes that the most commonly used hunting technique for all three conditions is to collect (63.70%), followed by inspecting (15.32%) and boost (8.06%). The rest of the techniques exhibit lower values. The relative abundance index suggests average values IAR= 0.24; 0.25; 0.333; 0.142 respectively (Figure 1).

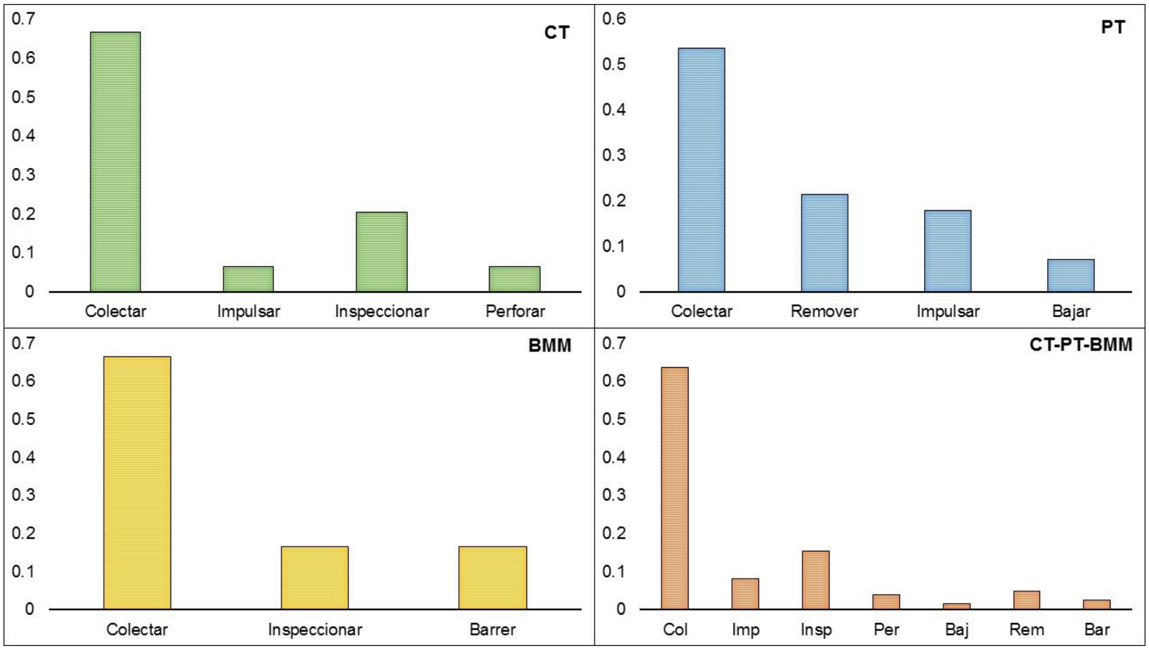

Figure 1. Relative abundance index for recorded hunting techniques.

The Poisson regression suggests that the best-fitted model has an AIC= 49.506. This GML shows that only two, three, three and two hunting techniques have an effect on the abundance of birds in the conditions under study (Table 1).

Table 1. Poisson Regression for hunting techniques exhibited by birds.

Variables	Estimate	Standard error	Z value	Pr(>|z|)	Significance
			CT		
Intercept	0.88811	0.24631	3.606	0.000311	***
Collected	0.13192	0.02913	4.528	0.00000594	***
Inspect	0.1296	0.02828	4.582	0.0000046	***
			PT		
Intercept	0.50036	0.13766	3.635	0.03587	*
Collected	0.21168	0.03218	6.578	0.00715	**
Boost	0.22182	0.03572	6.209	0.00842	**
Stir	0.21523	0.02874	7.488	0.00493	**
			BMM		
Intercept	0.13031	0.08385	1.554	0.26042	
Sweep	0.32277	0.03433	9.401	0.01113	*
Collected	0.2986	0.02238	13.341	0.00557	**
Inspect	0.32277	0.03433	9.401	0.01113	*
			CT-PT-BMM		
Intercept	1.09126	0.14638	7.455	8.98E-14	***
Collected	0.1015	0.01366	7.432	1.07E-13	***
Inspect	0.11144	0.02372	4.697	2.64E-06	***

The ACP (Table 2) explains in its first three axes a proportion of the accumulated variance of 100% of the variation present between the variables that make up and determine the hunting techniques (Figure 2).

Table 2. Main components of hunting techniques employed by birds.

Components	F1	F2	F3
	CT-PT-BMM		
Collected	0.70925523	0.2944773	0.6404999
Boost	-0.70487818	0.3093729	0.6383065
Inspect	-0.01018656	-0.9041966	0.426995
	Importance of the components		
Standard deviation	1.1569046	1.0474151	0.7513277
Proportion of the variance	0.4461428	0.3656928	0.1881644
Cumulative proportion	0.4461428	0.8118356	1

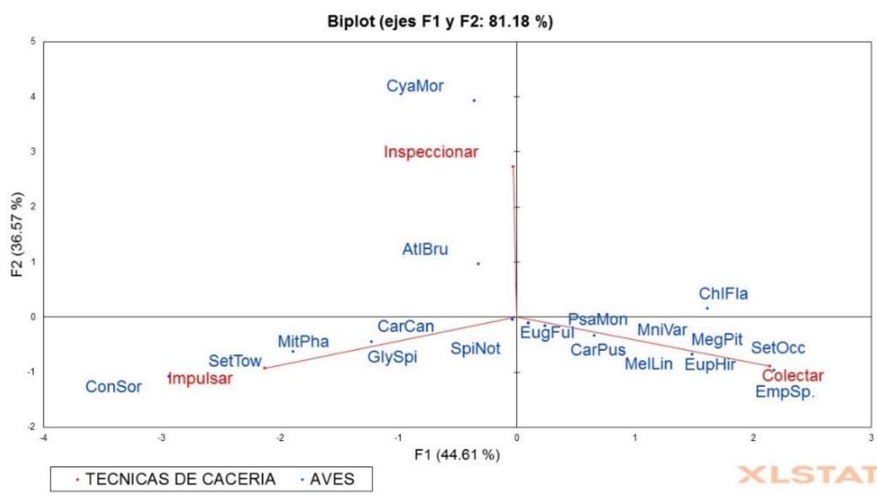

Figure 2. ACP graphic analysis of the fall techniques used by birds in CT-PT-BMM.

Kruskal-Wallis does not report differences in hunting techniques used in PT and BMM (*p*> 0.05), showing that the behaviors described are statistically similar. On the contrary, CT and CT-PT-BMM point out significant differences (Table 3).

Table 3. Kruskal-wallis for registered hunting techniques.

Chi square	Degrees of freedom	Prob > Chi square
	CT	
16.0655	7	0.0245*
	PT	
5.951	5	0.311
	BMM	
5.3125	3	0.1503
	CT-PT-BMM	
31.1835	10	0.0005*

The results of X^2 do not describe significant values in PT and BMM, reporting that the recorded techniques are those that potentially occur in the area. In contrast, CT and CT-PT-BMM describe significant data ($p< 0.05$; Table 4).

Table 4. Results of X^2 for hunting techniques used by birds.

Test	Chi square	Prob > Chi square	N	GL	Log- Verisimilitude	R square (U)
		CT				
Verisimilitude ratio	28.498	0.0187*	48	15	14.248859	0.2945
Pearson	24.781	0.053				
		PT				
Verisimilitude ratio	15.312	0.4292	28	15	7.6561895	0.2879
Pearson	14.286	0.504				
		BMM				
Verisimilitude ratio	8.282	0.2182	18	6	4.140978	0.2363
Pearson	7.5	0.2771				
		CT-PT-BMM				
Verisimilitude ratio	31.78	0.0233*	54	18	15.889955	0.216
Pearson	27.618	0.0681				

The trend in trophic behavior of birds is consistent with that reported by Sekercioglu *et al*. (2002); Manhães and Days (2011); De la Ossa *et al*. (2017); Torrens *et al*. (2017) described different hunting techniques that allow food coexistence, using different entomological resources that capture birds in a gregarious or solitary manner. However, these authors do not consider CT and its contrast with BMM, which provide various trophic niches (strata and plant substrates).

On which the birdlife carries out some specific strategies for obtaining various entomological dams in this particular region of Mexico, as suggested by Solari and Zaccagnini (2009); Fandiño *et al*. (2016); Seeholzer *et al*. (2017); Velasco *et al*. (2017) pointed out that the arrangement and structure of a heterogeneous vegetation will have various resources on which, birds can feed on a wide variety of insects (items), establishing various ecological interactions that allow them to coexist, partition or their case, trophic segregation, the first, allows them to mitigate ecological pressure, reducing competition and segregation.

Which could be corroborated in the records obtained in which it was observed that some birds used different strata for their feeding, specifically the upper one, which highlights the importance of the predominant plant structure in these analyzed systems, in the maintenance of species subject to protection special; while others of migratory type make use of the bass, so they seem to contribute, as habitat or edge effect (EB), in the conservation of the North American and local birds (Huatusco).

As noted by Pizo (2004); Dietsch *et al*., (2007); Telleria *et al*. (2011); Sainz-Borgo (2015) who found that certain birds prefer to feed in areas with EB, among which are some SAFs, which seem to reduce the ecological pressure on species with specific food niches, benefiting generalists in the use of modified areas, such as suggested by the avifauna reported in the present study, specifically in CT, transition from BMM and PT.

In this context, Camphuysen and Webb (1999); Ostrand (1999) show that birds form food guilds that function as catalytic indicators, specifically in those sites with a high number of prey, attracting other sympatric predators in the consumption of similar items, as suggested by Root (1967) who points out This behavior is explained by visual attraction, in which the birdlife uses prolonged hunting techniques, which are attractive to different species, increasing the interactions between them.

This could be corroborated in this study for birds that fed gregariously in the different plant strata present in CT and PT; however, this was not evident in BMM, due to the fact that the resources available in it are scarcer and possibly are distributed more homogeneously over their plant physiognomy, so that their distribution is more dispersed.

Therefore, the trends in hunting techniques used by birds during this study coincide with those reported by Cueto and López de Casanave (2002); Adamík and Korňan (2004); Pineda-Pérez *et al*. (2014) analyzed the trophic ecology of birds, finding that they employ more capture through collection, in contrast, Gabriel and Pizo (2005); Caicedo-Argüelles and Cruz-Bernate (2014).

From Mendonca-Lima *et al*. (2016); Jacoboski *et al*. (2016) suggest that some species, not precisely insectivorous, use different feeding techniques since they exhibit greater trophic flexibility favoring interspecific coexistence since they do not show overlapping of food niches, to this Revelo *et al*. (2017) comment that said behavioral pattern seems to be associated with the morphology exhibited by the different bird species, which allow them to access different items during their feeding.

For example, Montaldo (2005); Chávez *et al*. (2012); Pineda-Pérez *et al*. (2014) describe that the morphometry of the beak and legs are determinants in the capture of prey, which is linked to the structure of the habitat that provides it with food resources, as suggested by the observations of these approaches, in which it was possible appreciate how the individuals registered feeding used these anatomical structures to climb or access their prey in various trophic niches depending on the barriers that plant physiognomy represents.

As well as the degree of alteration present in the conditions under study, as postulated by Hernández *et al*. (2008) who point out that certain species have developed the ability to capture prey over short distances with the shortest possible time and minimum energy expenditure; others, on the contrary, require extensive forage experience before they can capture; some just wait for their prey to fall into their traps.

These behaviors are the result of the constant struggle for survival, defined by the finding, consumption, energy use, nutritional value, which are distributed space-time in a limited way, forcing birds to make decisions about what?, when?, where to eat? to achieve a balance between energy loss-gain, which allows them to discriminate those dams that do not meet their minimum optimization requirements.

Which is complemented by the search rate theory proposed-worked by Santacoloma and Quiroga (2009); Pineda-Pérez *et al*. (2014) who suggest that certain dams have developed the ability to camouflage, which has forced some birds to use different hunting techniques that allow them to compete for food to survive, in this sense in the present study it was observed that in BMM some prey insects had such ability.

So the birds used efficient capture techniques to minimize energy expenditure on the different strata-substrates present; as evidenced by De Mendonca-Lima *et al*. (2004); Cabrera *et al*. (2006); Mendonca-Lima and Hartz (2014) in studies on trophic spectra of birds in which they indicate that they employ hunting techniques that demand a minimum energy expenditure, rewarding this with a greater nutritional contribution, which according to Álvarez (2004); Frere *et al*. (2005); González and Osbahr (2013); Pineda-PÉrez *et al*. (2014); Ginnobili and Roffe (2016); Cruz-Miranda *et al*. (2017)

This would have implications for the adequacy of individuals, guaranteeing their survival and reproductive success, so Johnson *et al*. (2005); Fandiño *et al*. (2016) indicate in their hypothesis of breeding expenses, that insectivorous birds acquire feeding strategies during their breeding and breeding to guarantee their population viability, which consist of capturing large-sized prey to feed chicks, while in non-reproductive seasons They catch small insects to achieve optimization using different hunting techniques.

As the records in the present investigation suggest for some species (eg *Megarhynchus pitangua*, *Icterus auratus*, among others) which captured large-sized prey in PT for feeding their flywheels and for their maintenance, which evidences the relevance of these silvopastoral systems in the conservation of this taxonomic group for this particular area of Veracruz, Mexico, which is supported by Enríquez *et al*. (2006) who described that these types of systems provide food, the minimum requirements necessary for some wildlife species. Particularly birds, which according to the theory of the free distribution of Fretwell and Lucas (1970), these are distributed randomly in search of sites that offer a greater amount of possible resources that guarantee the survival of these organisms, so that Cabrera *et al*. (2006) mention that the choice of birds to remain in a certain system will also be determined by the quality of the food, distance between plots, number of predators present in the same space and time.

It was observed how certain species of generalist birds were feeding for short periods in the CT and PT area and subsequently returned to their ecological niche (BMM conserved zone). It can be seen how such systems function as trophic niches in which birds can find part of the home environment for their basic food functions.

Conclusions

It was possible to determine the hunting techniques used by the birds during their feeding in the agroforestry systems located in the particular region of Huatusco, Veracruz, Mexico. The study shows trophic coexistence among registered birds without competition for the resource and techniques used. This paper analyzes the first antecedents for future research where the theme of trophic behavior of birds under agroforestry systems is addressed.

Cited literature

Adamík, P. and Kornan, M. 2004. Foraging ecology of two bark foraging passerine birds in an old-growth temperate forest. Ornis Fennica. 81(1):13-22.

Akaike, H. 1969. Fitting autoregressive models for prediction. Annals of the Institute of Statistical. Mathematics. 21(1):243-247.

Alonso, T. Y.; Hernández, M. y Barrero, M. H. 2017. Diversidad de aves residentes y permanentes asociadas a un pinar natural de *Pinus tropicalis* y su relación con la estructura vertical de la vegetación. Rev. Cubana Cienc. Fores. 6(1):31-44.

Álvarez, M. R. 2004. Manejo sustentable del carpincho (*Hydrochoerus hydrochaeris*, Linnaeus 1766) en Argentina: un aporte al conocimiento de la biología de la especie desde la cría en cautiverio. Mastozoología Neotropical. 11(1):121-122.

Ashworth, L.; Quesada, M.; Casas, A.; Aguilar, R. and Oyama, K. 2009. Pollinator dependent food production in Mexico. Biological Conservation. 142(5):1050-1057.

Cabrera, R.; Durán, Á. y Nieto, J. 2006. Aprendizaje social y estrategias de forrajeo en parvadas de palomas: efectos de la cantidad de alimento. Rev. Mex. Psicol. 23(1):111-121.

Caicedo-Argüelles, A. y Cruz-Bernate, L. 2014. Actividades diarias y uso de hábitat de la reinita amarilla (Setophaga petechia) y la piranga roja (*Piranga rubra*) en un área verde urbana de Cali, Colombia. Ornitologia Neotropical. 25(3):247-260.

Camphuysen, C. J. and Webb, A. 1999. Multi-species feeding associations in North Sea seabirds: jointly exploiting a patchy environment. Ardea. 87(2):177-198.

Chatellenaz, M. 2008. Ecología alimentaria de dos especies simpátricas del género Basileuterus en el Noreste de Argentina. Hornero. 23(2):87-93.

Chávez-Villavicencio, C.; Séenz-Bolaños, C. y Spínola-Parallada. M. 2012. Segregación en aves insectívoras con base en la morfometría del pico y la longitud total. Aporte Santiaguino. 5(1):60-67.

Cruz-Miranda, Y.; Ugalde-Lazama, S.; Tarango-Arámbula, L. A.; Rosas-Rosas, O. C.; Buendía Espinoza, J. C. y Lozano-Cavazos, E. 2017. Modelo alternativo para determinar coexistencia y segregación trófica de dos felinos simpátricos: *Puma concolor* L. y *Panthera onca* L. Agroproductividad. 10(5):18-27.

Cueto, V. R. and López de Casanave, J. 2002. Foraging Behavior and microhabitat use of bird inhabiting coastal woodlands in Eastcentral Argentina. The Wilson Bulletin. 114(3):342-348.

De la Ossa, J.; De la Ossa-Lacayo, A. and Monroy-Pineda, M. 2017. Abundance of domestic dove (Columbia livia domestica Gmelin, 1789) in Santiago de Tolú, Sucre, Colombia. Rev. MVZ Córdoba. 22(1):5718-5727.

De Mendonca-Lima, A. and Hartz, S. 2014. Foraging behavioral of Phylloscartes ventralis (aves, Tyrannidae) in native and planted forests of southern Brazil. Iheringia, Serie Zoologia. 104(4):391-398.

De Mendonca-Lima, A.; Hartz, S. M. and Kindel, A. 2004. Foraging behavior of the white browed (*Basileuterus leucoblepharus*) and the Goldel-crowned (*B. culicivorus*) warblers in a semidecidual forest in southern Brazil. Ornitología Neotropical. 15(1):5-15.

De Mendonca-Lima, A.; Meneghel Boschilia, S.; Bernardo-Silva, J. and Baldissera, R. 2016. Effect of habitat heterogeneity on bird assemblages in a grassland-forest ecotone in Brazil. Acta Ambiental Catarinense. 13(1):1-8.

Dietsch, T.; Perfecto, I. and Greenberg, R. 2007. Avian foraging behavior in two different types of coffee agroecosystem in Chiapas, Mexico. Biotropica. 39(2):232-240.

Donald, P.; Sanderson, F.; Burfield, I. and Van Bommel, F. 2006. Further evidence of continent-wide impacts of agricultural intensification on European farmland birds, 1990-2000. Agric. Ecosys. Environ. 116(3-4):189-196.

Dreelin, R.; Shipley, J. and Winkler, D. 2018. Flight behavior of individual aerial insectivores revealed by novel altitudinal dataloggers. Frontiers Ecol. Evol. 6(1):1-7.

Enríquez, L.; Sáenz, J.C. y Ibrahim, M. 2006. Riqueza, abundancia y diversidad de aves y su relación con la cobertura arbórea en un agropaisaje domindado por la ganadería en el trópico subhúmedo de Costa Rica. Agroforestería en las Américas. 45(1):49-57.

Fandiño, B.; Fernández, J. M.; Thomann, M.; Cajade, R. y Hernando, A. 2016. Comunidades de aves de bosques y pastizales en los afloramientos rocoso aislados del Paraje Tres Cerros, Corrientes, Argentina. Rev. Biol. Trop. 65(2):535-550.

Frere, E.; Quintana, F. and Gandini, P. 2005. Cormoranes de la costa patagónica: estado poblacional, Ecología y Conservación. Hornero. 20(1):35-52.

Fretwell, S. and Lucas, H. 1970. On territorial behaviour and other factor influencing habitat distribution in birds. Acta Biotheoretica. 19(1):16-36.

Gabbe, A. P.; Robinson, S. and Drawn, J. 2002. Tree-species preferences of foraging insectivorous birds: mplications for floodplain forest restoration. Conservation Biol. 16(2):462-470.

Gabriel, V. and Pizo, M. 2005. Foraging behavior of tyrant flycatchers (Aves, Tyrannidae) in Brazil. Rev. Brasileira Zool. 22(4):1072-1077.

Gámez-Virués, S.; Bonifacio, R.; Curr, G.; Kinross, C.; Raman, A. and Nicol, H. 2007. Arthropod prey of shelterbelt-associated birds: linking faecal samples withbiological control of agricultural pests. Australian J. Entomol. 46(1):325-331.

González, J. and Osbahr, K. 2013. Composición botánica y nutricional de la dieta de Dinomys branickii (Rodentia: Dinomydae) en los Andes Centrales de Colombia. Revista U.D.C.A. Actualidad & Divulgación Científica. 16(1):235-244.

Hernández, M.; Bala, L. y Musmeci, L. 2008. Dieta de tres especies de aves playeras migratoriasen península Valdés, Patagonia Argentina. Ornitología Neotropical. 19(1):605-611.

Jacoboski, L.; De Mendonca-Lima, A. and Hartz, S. 2016. Structure of bird communities in eucalyptus plantations: nestedness as a pattern of species distribution. Braz. J. Biol. 76(3):583-591.

Johnson, M. 2000. Evaluation of an anthropod sampling technique for measuring food availability for forest insectivorous birds. J. Field Ornithol. 71(1):88-109.

Johnson, M.; Sherry, T.; Strong, A. and Medori, A. 2005. Migrants in Neotropical bird communities: an assessment of the breeding currency hypothesis. J. Animal Ecol. 74(2):333-341.

Manhães, M. and Dias, M. 2011. Spatial dynamics of understorey insectivorous birds and arthropods in a southeastern Brazilian Atlantic woodlot. Brazilian J. Ecol. 71(1):1-7.

Mballa, L.; Carranza-Álvarez, C. and Maldonado-Miranda, J. 2011. Perspectivas de la planificación para la Conservación del área Sierra del Abra Tanchipa. Ideas CONCYTEG. 6(78):1440-1455.

Mendonça-Lima, A.; Hartz, S. and Kindel, A. 2004. Foraging behavior of the white browed (Basileuterus leucoblepharus) and the Goldencrowned (B. culicivorus) warblers in a semidecidual forest in Southern Brazil. Ornitología Neotropical. 15(1):5-15.

Miñarro, P. 2014. Aves y agricultura: la importancia de mantener los pájaros en las pumaradas. Tecnología Agroalimentaria. 6(1):10-14.

Montaldo, N. 2005. Aves frugívoras de un relicto de selva subtropical ribereña en Argentina: manipulación de frutos y destino de las semillas. Hornero. 20(2):163-172.

Ostrand, W. 1999. Marbled murrelets as initiators of feeding flocks in Prince William Sound, Alaska. Waterbirds. 22(2):314-318.

Pineda-Pérez, F.; Ugalde-Lezama, S.; Tarango-Arámbula, L.; Lozano-Osornio, A. y Cruz-Miranda, Y. 2014. Ecología trófica de aves insectívoras en un área natural protegida de San Luis Potosí, México. Agroproductividad. 7(5):8-10.

Pizo, M. 2004. Frugivory and habitat use by fruit-eating birds in a fragmented landscape of southeast Brazil. Ornitología Neotropical, 15(Suppl):117-126.

Ponce, C.; Aguilar, V.; Rodríguez, T.; López, P. y Santillán, P. 2012. Influencia del fuego sobre la riqueza y diversidad de aves en un bosque templado en Puebla. Rev. Mex. Cienc. Forest. 3 (10):65-76.

Ramírez-Albores, J. 2009. Diversidad de aves de hábitats naturales y modificados en un paisaje de la Depresión Central de Chiapas, México. Rev. Biol. Trop. 58(1):511-528.

Ramírez-Albores, J. 2013. Riqueza y diversidad de aves en un área de la Faja Volcánica Transmexicana, Tlaxcala, México. Acta Zoológica Mexicana. 29(3):486-512.

Remsen, J. and Robinson, S. 1990. A classification scheme for foraging behavior of birds in terrestrial habitats. Studies in Avian Biology. 13(1):144-160.

Revelo, H.; Gallego, Z.; Castro, O. and Murillo, G. 2017. Morphometric variation in the assembly of passerine birds present in two zones of tropical forest with different degrees of disturbance. Rev. Cienc. 20(2):125-137.

Root, R. 1967. The niche exploitation pattern of the blue-gray gnatcatcher. Ecological Monographs. 37(4):317-350.

Sainz-Borgo, C. 2015. Nota: consumo de obreras *Eciton burchellii* (hymenoptera: formicidae) por varias especies de aves en condiciones urbanas. Ecotrópicos. 28(1-2):38-42.

Santacoloma, S. y Quiroga, B. 2009. Perspectivas de estudio de la conducta alimentaria. Rev. Iberoam. Psicología Cienc. Tecnol. 2(2):7-15.

Santos, B.; Hernández, R.; Lavariega, M. y Gómez-Ugalde, R. 2013. Diversidad de aves en cultivares de Santa María Yahuiche, Sierra Madre de Oaxaca, México. Rev. Mex. Cienc. Agríc. 6(1):1241-1250.

Seeholzer, G.; Claramunt, S. and Brumfield, R. 2017. Niche evolution and diversi_cation in a Neotropical radiation of birds (Aves: Furnariidae). Inter. J. Organic Evol. 71(3):702-715.

Sekercioglu, C.; Ehrlich, P.; Daily, G.; Aygen, D.; Goehring, D. and Sandi, R. 2002. Disappearance of insectivorous birds from tropical forest fragments. Ecology. 99(1):263-267.

Solari, L. y Zaccagnini, M. 2009. Efecto de bordes arbóreos y terrazas sobre la riqueza y densidad de aves en lotes de soja de Entre Ríos, Argentina. Revista BioScriba. 2(2):90-100.

Solomou, A. and Sfougaris, A. 2015. Bird community characteristics as indicators of sustainable management in olive grove ecosystems of Central Greece. J. Nat. History. 49(1):301-325.

Tellería, J. L.; Díaz, J.; Pérez-Tris, J. and Santos, T. 2011. Fragmentación de hábitat y biodiversidad en las mesetas ibéricas: una perspectiva a largo plazo. Rev. Ecosis. 20(2):79-90.

Torrens, Y.; Hernández, F. y Barrero, H. 2017. Diversidad de aves residentes permanentes asociadas a un pinar natural de *Pinus tropicalis* y su relación con la estructura vertical de la vegetación. Rev. Cubana Cienc. Fores. 6(1):31-44.

Velasco, A.; Talabante, C. y Viejo, J. 2017. Estudio de selección del hábitat de la especie exótica bengalí rojo Amandava amandava, Linnaeus, 1758 en Iberia central (Aves: Paseriformes). Boletín de la Real Sociedad Española de Historia Natural Sección Biológica. 3(111):85-94.