

COMPOSITION AND STRUCTURE OF BIRD FLOCKS IN A TEMPERATE FOREST OF CENTRAL CHILE

Composición y estructura de bandadas en el bosque templado de Chile central

FERNANDO MEDRANO^{1,2}, MARÍA A. VUKASOVIC^{3,4}, ROMINA CHIAPPE^{3,4} & CRISTIÁN F. ESTADES^{3,4}

¹Departamento de Biología Evolutiva, Ecología i Ciències Ambientals, Institut de Recerca de la Biodiversitat (IRBio), Facultat de Biologia, Universitat de Barcelona, Barcelona 08028, España.

²Red de Observadores de Aves y Vida Silvestre de Chile. Santiago, Chile.

³Unión de Ornitólogos de Chile (AvesChile). Santiago, Chile.

⁴Laboratorio de Ecología de Vida Silvestre. Facultad de Ciencias Forestales y Conservación de la Naturaleza. Santa Rosa #11315. La Pintana, Santiago, Chile.

Correspondencia: F. Medrano, fernandomedranomartinez@gmail.com

RESUMEN.- Formar bandadas es una adaptación de las aves para aumentar la eficiencia de forrajeo y disminuir la depredación. Pese a que en bosques tropicales existen numerosos estudios sobre la formación de bandadas, en bosques templados de Sudamérica esta conducta ha sido escasamente documentada. En este estudio describimos la composición de 77 bandadas encontradas en un paisaje forestal de la región del Maule entre 1999-2002, y analizamos si existen relaciones entre las abundancias dentro de las bandadas entre especies. Usando simulaciones de Monte Carlo analizamos la prevalencia de diferentes especies a formar bandadas y relacionamos la abundancia de las especies entre sí dentro de las bandadas. Cada bandada tuvo en promedio 10,5 individuos y la especie más frecuente fue *Aphrastura spinicauda*. Pese a que se ha señalado a *A. spinicauda* como especie nuclear, su abundancia sólo se relacionó con la de *Pygarrichas albogularis*. Por otro lado, se sugiere que la presencia de *Anairetes parulus* estimularía a otras especies a unirse a la bandada. Nuevos estudios son necesarios para conocer mejor la composición y estructura de las bandadas en otros sitios en Sudamérica.

Manuscrito recibido el 7 de diciembre de 2019, aceptado el 17 de mayo de 2020.

Bird flocks can be defined as groups of birds foraging together within and among resource patches (Morse 1970, Sridhar 2009, Colorado 2013). This behavior is considered a strategy by individual birds to increase their foraging efficiency by reducing the risk of predation, despite the fact the individuals could compete among themselves (Morse 1977, Sridhar 2009, Colorado 2013). These flocks can be monospecific (*i.e.*, composed of individuals of one species) or mixed, in which case there are two or more species involved (Hino 2000, Sridhar *et al.* 2009). Mixed flocks are believed to function as a mechanism to obtain the benefits of participating in a bird flock while avoiding intraspecific competition for food (Morse 1977, Powell 1985, Sridhar *et al.* 2009).

The composition and structure of flocks in tropical regions of South America has been widely researched with

ovenbirds, woodpeckers, tanagers, wrens, and tyrant-flycatchers being the most frequently studied species (*e.g.*, Davis 1946, Short 1961, Wiley 1971, Munn & Terborgh 1979, Alves & Calvacanti 1996, Maldonado-Coehlo & Marini 2004). However, in the temperate forests of South America, there are only two of such studies, both in the Argentinian Patagonia (Vuilleumier 1966, Ippi & Trejo 2003). These flocks were composed of ovenbirds, tyrant-flycatchers, woodpeckers, siskins, and tanagers (Vuilleumier 1966, Ippi & Trejo 2003). This note contributes to reducing this information gap by describing and analyzing the composition and the structure of flocks found in forests in the Mediterranean region of central Chile.

The study was conducted in the Maule region coastal range, Central Chile. The landscape is dominated by pine plantations (*Pinus radiata*), with the presence of a few

Table 1. Comparison between the observed and the expected abundances within winter flocks (N=77) in the bird communities of temperate forests of the Maule Region between 1999-2002. The expected abundance was modeled through a Monte Carlo analysis. In the "Relative abundance in flocks" column, numbers in bold represent different values than those expected by chance in the Monte Carlo simulation.

Common name	Scientific name	Mean abundance of individuals per flock (N)	Expected mean abundance in flocks (5-95% CI)
Chilean Flicker	<i>Colaptes pitius</i>	0.05	0.07 (0.01-0.12)
Thorn-tailed Rayadito	<i>Aphrastura spinicauda</i>	4.46	1.41 (1.20-1.61)
White-throated Treerunner	<i>Pygarrichas albogularis</i>	1.28	0.24 (0.14-0.33)
Des Murs' Wiretail	<i>Sylviothorhynchus desmursii</i>	0.37	0.32 (0.22-0.42)
Plain-mantled Tit-spinetail	<i>Leptasthenura aegithaloides</i>	0.25	0.14 (0.07-0.21)
Dusky-tailed Canastero	<i>Pseudasthenes humicola</i>	0.07	0.18 (0.09-0.26)
Tufted Tit-tyrant	<i>Anairetes parulus</i>	3.29	4.54 (4.23-4.84)
Patagonian Tyrant	<i>Colorhamphus parvirostris</i>	0.04	0.56 (0.43-0.69)
Dusky Tapaculo	<i>Scytalopus fuscus</i>	0.04	0.41 (0.29-0.53)
Ochre-flanked Tapaculo	<i>Eugralla paradoxa</i>	0.04	0.14 (0.07-0.21)
Chestnut-throated Huet-huet	<i>Pteroptochos castaneus</i>	0.01	0.10 (0.04-0.16)
Southern House Wren	<i>Troglodytes musculus</i>	0.25	0.92 (0.74-1.09)
Patagonian Sierra-finch	<i>Phrygilus patagonicus</i>	0.51	0.21 (0.12-0.29)

scattered deciduous *Nothofagus* forest patches (Donoso & Lara 1995, Estades & Temple 1999). While conducting point counts during the Austral winters (May-August) between 1999-2002, we recorded all bird flocks we encountered, and characterized them by the number of individuals of each species. We considered individuals as participating in a flock when they were observed moving together with a group of foraging birds (Sridhar *et al.* 2009). We usually lost sight of the group after a few minutes (up to 10 min), which we considered to be a sign of a moving flock, rather than a collection of birds behaving independently. Point counts had a 50 m fixed radius and were conducted during 5 min.

To analyze whether the relative abundance of birds within flocks was related to their relative abundance in the study area. We used the average winter abundance (ind/ha) for the mosaic of pine plantations and native forests for the aforementioned years. For field methods see Estades & Temple (1999) and Estades (2001). We used Monte Carlo simulations to estimate confidence intervals for the expected frequency of birds within flocks (Manly 1997). Our simulations were performed in Basic and, for each case, we used 10,000 iterations.

We further explored the tendency of the different species to join flocks in consideration of the abundance of the other species, by correlating their abundances in the observed groups. With this purpose, we used general-

ized linear models assuming a negative binomial distribution. The latter was due to the overdispersion (variance \gg mean) of count data for flocking birds (Zipkin *et al.* 2014).

During our study we recorded a total of 77 bird flocks, with a mean size of 10.6 individuals (3-39). The species mean richness was 3.5 species per flock, with a minimum of 1 (monospecific flocks) and a maximum of 7 species.

We recorded a total of 13 species in the studied flocks, the most frequent being the Thorn-tailed Rayadito (*Aphrastura spinicauda*), present in 94% of the flocks (mean = 4.5 individuals per flock). The second and third most frequent species were, respectively, Tufted Tit-tyrant (*Anairetes parulus*), recorded in 91% of the flocks (mean = 3.3 individuals per flock) and White-throated Treerunner (*Pygarrichas albogularis*), present in the 56% of the flocks (mean = 1.3 individuals per flock). We only recorded three monospecific flocks (3.9%), one with 5 Patagonian Sierra-finches *Phrygilus patagonicus* and two with 5 and 6 Thorn-tailed Rayaditos, respectively.

The results of the Monte Carlo simulations show that the average abundance of most species within flocks differed from what was expected by chance (Table 1). The Thorn-tailed Rayadito and White-throated Treerunner were significantly more abundant in flocks than what was expected by their relative abundances in the habitat. On

Table 2. Significance of the association between the abundance of different species within flocks. *, ** and ***: $p < 0.05$, $p < 0.01$ and $p < 0.001$, respectively. All relationships are positive. Only species for which a significant relationship was found are shown.

Common name	Thorn-tailed Rayadito	White-throated Treerunner	Des Murs' Wiretail	Plain-mantled Tit-spinetail	Tufted Tit-tyrant	Southern House Wren
Thorn-tailed Rayadito		**				
White-throated Treerunner						
Des Murs' Wiretail					*	
Plain-mantled Tit-spinetail					*	
Tufted Tit-tyrant						***
Southern House Wren						

the other hand, even though the Tufted tit-Tyrant was the second most abundant bird in the recorded flocks, it was the most abundant species in the habitat and, therefore, the Monte Carlo analysis indicated that its presence in flocks was lower than that expected by chance.

The abundance of some species within flocks was positively correlated with the abundance of other species (Table 2). Two groups of associations among birds were evident. First, the positive correlation between the Thorn-tailed Rayadito and the White-throated Treerunner, two species that forage mostly on trunks and branches (although they present differences in the micro-habitat use, as shown in Thomson *et al.* 2014), but which could be foraging on different items. The second group suggests the potential importance of the Tufted tit-Tyrant as an attractor for other foliage gleaners such as the Des Murs' Wiretail (*Sylviorhynchus desmursii*), the Plain-mantled Tit-spinetail (*Leptasthenura aegithaloides*), and the Southern House Wren (*Troglodytes aedon musculus*). No negative correlations were detected between the abundances of species.

In the studies conducted in southern temperate forests by Vuilleumier (1967) and Ippi & Trejo (2003), both Thorn-tailed Rayadito and White-throated Treerunner were the most frequent and abundant species in winter mixed-species flocks. Interestingly, the Tufted Tit-tyrant was not recorded in the flocks studied by these authors, and in a similar study conducted in *Polylepis besseri* forests in Bolivia, the species was present in only 3% of the recorded flocks (Herzog *et al.* 2002). These observations, plus our results, suggest that Tufted Tit-tyrants may join mixed flocks opportunistically. Thus, the presence of this species in 90% of the flocks recorded by us is likely due to the fact that, roughly, one out of two birds in our study site corresponded to Tufted Tit-tyrants.

Although the Thorn-tailed Rayadito and the White-throated Treerunner fit the general definition of “nuclear” species (*sensu* Moynihan 1962), their abundances in a

flock was only correlated to each other's abundance, but did not seem to influence the abundance of the rest of the species in a flock (Table 2). On the contrary, Tufted Tit-tyrants joined flocks with a lower abundance than expected by chance. However, when this species is abundant, it might be an incentive to forming flocks of birds with similar foraging strategies (Table 2) and, therefore, this species could be considered “nuclear” for foliage gleaners. This agrees with the results of Sridhar *et al.* (2012), who, by using meta-analysis techniques found that species within mixed flocks usually have similar foraging behavior.

Species from the Rhinocryptid family (Dusky Tapaculo *Scytalopus fuscus*, Ochre-flanked Tapaculo *Eugralla paradoxa*, and Chestnut-throated Huet-huet *Pteroptochos castaneus*) rarely joined mixed flocks, which agrees with the lack of records by Vuilleumier (1967) and Ippi & Trejo (2003) of these species or their sister taxa (Magellanic Tapaculo *Scytalopus magellanicus* and Black-throated Huet-huet *Pteroptochus tarnii*) in the flocks studied by them. The fact that all these birds are. These are highly territorial birds all year long, might explain their relative reluctance to join a moving flock, instead only following the other birds when they pass through their territories.

Finally, we did not record some passerines within the flocks, such as the Fire-eyed Diucon (*Xolmis pyrope*) and Austral Thrush (*Turdus falcklandii*). Probably flocking by these species does not present any adaptive benefit in our study area; the Fire-eyed Diucon was already recorded in mixed flocks in Bariloche (Vuilleumier 1967). However, it would be necessary to gather information in other environments to understand if the behavior of avoiding flocks is consistent.

This note gives new insights on the forest birds that join mixed flocks in Chile, providing additional information on their composition and structure. However, we still lack information for analyzing the differences between our study area and other habitats. Future studies should

focus on describing the composition and structure of mixed-species flocks in other places in Chile to allow for more thorough comparisons between-sites.

ACKNOWLEDGMENTS.- We thank Ana María Venegas, Jorge Tomasevic, and Martín Escobar for their field assistance. Caroline Sánchez reviewed a first draft of this manuscript. We also thank Jaime Jiménez and an anonymous reviewer, whose comments improved this manuscript. Fernando Medrano was funded by the Agencia Nacional de Investigación y Desarrollo (ANID)/DoctoradoBecasChile/2019-72200117.

LITERATURE CITED

- ALVES, M. & R. CAVALCANTI. 1996. Sentinel behavior, seasonality, and the structure of bird flocks in a Brazilian savanna. *Ornitología Neotropical* 7: 43-51.
- COLORADO, G. 2013. Why animals come together, with the special case of mixed-species bird flocks. *Revista EIA* (Colombia) 19: 49-66.
- DAVIS, D. 1946. A seasonal analysis of mixed flocks of birds in Brazil. *Ecology* 27: 168-181.
- DONOSO, C. & A. LARA. 1995. Utilización de los bosques nativos en Chile: pasado, presente y futuro. Pp. 363-387, in ARMESTO J., C. VILLAGRÁN & M.K. ARROYO (eds.). *Ecología de los bosques nativos de Chile*. Editorial Universitaria, Santiago, Chile.
- ESTADES, C.F. & S.A. TEMPLE. 1999. Deciduous forest bird communities in a fragmented landscape dominated by exotic pine plantations. *Ecological Applications* 9: 573-585.
- ESTADES, C.F. 2001. *Forest bird in landscape mosaic: theory and empirical evidence*. Tesis doctoral. Univ. of Wisconsin, Madison, EE.UU.
- HINO, T. 2000. Intraspecific differences in benefits from feeding in mixed-species flocks. *Journal of Avian Biology* 31: 441-446.
- IPPI, S. & A. TREJO. 2003. Dinámica y estructura de bandadas mixtas de aves en un bosque de lenga (*Nothofagus pumilio*) del noroeste de la Patagonia Argentina. *Ornitología Neotropical* 14: 353-362.
- MALDONADO-COELHO, M. & M. MARINI. 2004. Mixed-species bird flocks from Brazilian Atlantic forest: the effects of forest fragmentation and seasonality on their size, richness and stability. *Biological Conservation* 116: 19-26.
- MANLY, B.F.J. 1997. *Randomization, Bootstrap and Monte Carlo Methods in Biology*. 2nd Edition. Chapman and Hall/CRC. Londres, Reino Unido. 424 pp.
- MORSE, D. 1970. Ecological aspects of some mixed-species foraging flocks of birds. *Ecological Monographs* 40: 119-168.
- MORSE, D. 1977. Feeding behavior and predator avoidance in heterospecific groups. *BioScience* 27: 332-339.
- MOYNIHAN, M. 1962. The organization and probable evolution of some mixed species flocks of Neotropical birds. *Smithsonian Miscellaneous Collection* 143: 1-40.
- MUNN, C. & J. TERBORGH. 1979. Multi-species territoriality in Neotropical foraging flocks. *Condor* 81: 338-347.
- POWELL, G. 1985. Sociobiology and adaptive significance of interspecific foraging flocks in the Neotropics. *Ornithological Monographs* 36: 713-732.
- RALPH, C., G. GEUPEL, P. PYLE, T. MARTIN, D. DESANTE & B. MILÁ. 1996. *Manual de métodos de campo para el monitoreo de aves terrestres*. Forest Service, United States Department of Agriculture, California, Estados Unidos. 46 pp.
- SHORT, L. 1957. Interspecies flocking of birds of montane forest in Oaxaca, Mexico. *Wilson Bulletin* 73: 341-347.
- SRIDHAR, H., G. BEAUCHAMP & K. SHANKER. 2009. Why do birds participate in mixed-species foraging flocks? A large scale synthesis. *Animal Behaviour* 78: 337-347.
- SRIDHAR, H., U. SRINIVASAN, R. ASKINS, J.C. CANALES-DELGADILLO, C. CHEN, D. EWERT, G. GALE, E. GOODALE, W. GRAM, P.J. HART, K.A. HOBSON, R.L. HUTTO, S.W. KOTAGAMA, J.L. KNOWLTON, T.M. LEE, C.A. MUNN, S. NIMNUAN, B.Z. NISAM, G. PÉRON, V.V. ROBIN, A.D. RODEWALD, P.G. RODEWALD, R.L. THOMSON, P. TRIDEVI, S.L. VAN WILGENBUR & K. SHANKER. 2012. Positive relationships between association strength and phenotypic similarity characterize the assembly of mixed-species bird flocks worldwide. *American Naturalist* 180: 776-790.
- THOMSON R.F., J. BUSTOS-WEISSER, M.A. VUKASOVIC, C.F. ESTADES & A. GOSLER. 2014. Comparación del uso de la estructura vertical de la vegetación nativa y exótica por dos especies de furnáridos forestales. XI Congreso Chileno de Ornitología. La Serena, Chile.
- VUILLEUMIER, F. 1967. Mixed species flocks in Patagonian forests, with remarks on interspecies flock formation. *Condor* 69: 400-404.
- ZIPKIN, E.F., J.B. LEIRNESS, B.P. KINLAN, A.F. O'CONNELL & E.D. SILVERMAN. 2014. Fitting statistical distributions to sea duck count data: Implications for survey design and abundance estimation. *Statistical Methodology* 17: 67-81.