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Short Communication

Interspecific associations between two globally Vulnerable grassland specialists: *Alectrurus risora* (Vieillot, 1824) and *Alectrurus tricolor* (Vieillot, 1816) (Passeriformes, Tyrannidae)

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Abstract

Neotropical grasslands are among the most threatened ecosystems worldwide, and their degradation has particularly affected grassland specialist birds. *Alectrurus tricolor* and *Alectrurus risora* are two globally Vulnerable tyrant flycatchers associated with these environments, whose ranges partially overlap in southern Paraguay. Despite their ecological similarity, interspecific interactions between these congeners have not previously been documented. Here, we report repeated interspecific associations between *A. tricolor* and *A. risora* based on field observations conducted between November 2023 and August 2025 at two localities in southern Paraguay. Eight independent association events were recorded, most involving one individual of each species, although some included two *A. risora* individuals. Birds remained in close spatial proximity, shared perches, moved in a coordinated manner, and engaged in simultaneous aerial foraging. In some cases, the movement of one individual appeared to flush arthropod prey subsequently captured by the other. Territorial behavior was also observed, including the active expulsion of another grassland bird species by *A. risora* while associated with *A. tricolor*. Most observations occurred during the austral autumn–winter period, when prey availability may be reduced. These behavioral patterns suggest that the association may provide ecological benefits related to foraging efficiency, prey detection, or vigilance. Additionally, ongoing habitat reduction affecting *A. tricolor* may contribute to increased heterospecific associations under changing environmental conditions. Our observations represent the first documented evidence of repeated syntopic association between these two *Alectrurus* species and provide new insights into the behavioral ecology of threatened Neotropical grassland birds.

Key words: Avian behavior, grassland birds, Neotropics, syntopy

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Introduction

Neotropical grasslands and their associated bird communities are among the most threatened ecosystems globally, primarily due to ongoing habitat loss and transformation (Peacock et al. 2024). Within these systems, grassland specialist species such as *Alectrurus tricolor* and *Alectrurus risora* are partic-

ularly vulnerable, as they depend on specific vegetation structure for foraging, reproduction, and survival (Farnsworth et al. 2020a, 2020b).

A. tricolor and *A. risora* are two tyrant flycatchers characteristic of these ecosystems and are currently classified as Vulnerable (BirdLife International 2024a, 2024b). *A. tricolor* is distributed across central South America, occurring in northern Bolivia, southern Brazil (south to Paraná), and eastern Paraguay (Farnsworth et al. 2020a; Cacciali and Sforza 2025). In contrast, *A. risora* has a more restricted distribution, largely confined to southern Paraguay and northeastern Argentina, where it inhabits wet grasslands, savannas, and marshy environments (Di Giacomo et al. 2010, 2011), and a recent record in the Brazil-Uruguay border probably triggered by the influence of regional grassland fires (Mäder et al. 2026). Both species currently co-occur in southern Paraguay (Codesido and Fraga 2009), which may represent the only region where their distributions overlap, as *A. tricolor* has not been documented in Argentina for several decades (Bodrati and Monteleone 2023).

Despite their ecological similarity and partial spatial overlap, interspecific interactions between these species remain poorly documented, and their potential functional significance is unknown. Both species are aerial insectivores that rely on perch-based foraging strategies, which may facilitate interactions under certain ecological conditions. The present study was prompted by a field observation in which two males, one of *A. tricolor* and one of *A. risora*, were recorded using the same microhabitat simultaneously. This unexpected co-occurrence raised the question of whether these congeners can occur in syntopy, a condition not previously documented for the genus. Here, we document repeated interspecific associations between *A. tricolor* and *A. risora* and describe their behavioral context and potential ecological significance.

Methods

Fieldwork was conducted at two sites in southern Paraguay with confirmed presence of both *Alectrurus tricolor* and *A. risora*: Estancia Algarrobo (November 2023 to September 2024) and Guyra Retã Natural Reserve (GRNR) (March 2025 to April 2026), both located within the Mesopotamian grasslands ecoregion (Fig. 1) (Sforza et al. 2025). These areas are characterized by a heterogeneous mosaic that includes extensive natural grasslands and savanna-like structures embedded within forest formations (Esquivel et al. 2007; Sforza et al. 2025). This savanna is predominantly composed of herbaceous vegetation developing on silt-clay soils, with grasses dominating the landscape and a scattered presence of woody shrubs and small trees, resulting in structurally complex open habitats (BirdLife International 2026). Among the most representative plant genera are *Paspalum*, *Andropogon*, and *Axonopus* (Poaceae), with rushes (*Juncus*) and sedges (Cyperaceae) dominating the wetland areas (Benítez et al. 2021; Sforza et al. 2025).

Surveys combined systematic searches with complementary active search methods to maximize detection probability. Given the extremely low detectability of *A. tricolor* in Paraguay, previously reported as a major limitation for applying standard survey approaches (Sforza et al. 2025), reliance on transects alone was considered insufficient. Therefore, in addition to directed searches along accessible grassland patches, observers conducted opportunistic move-

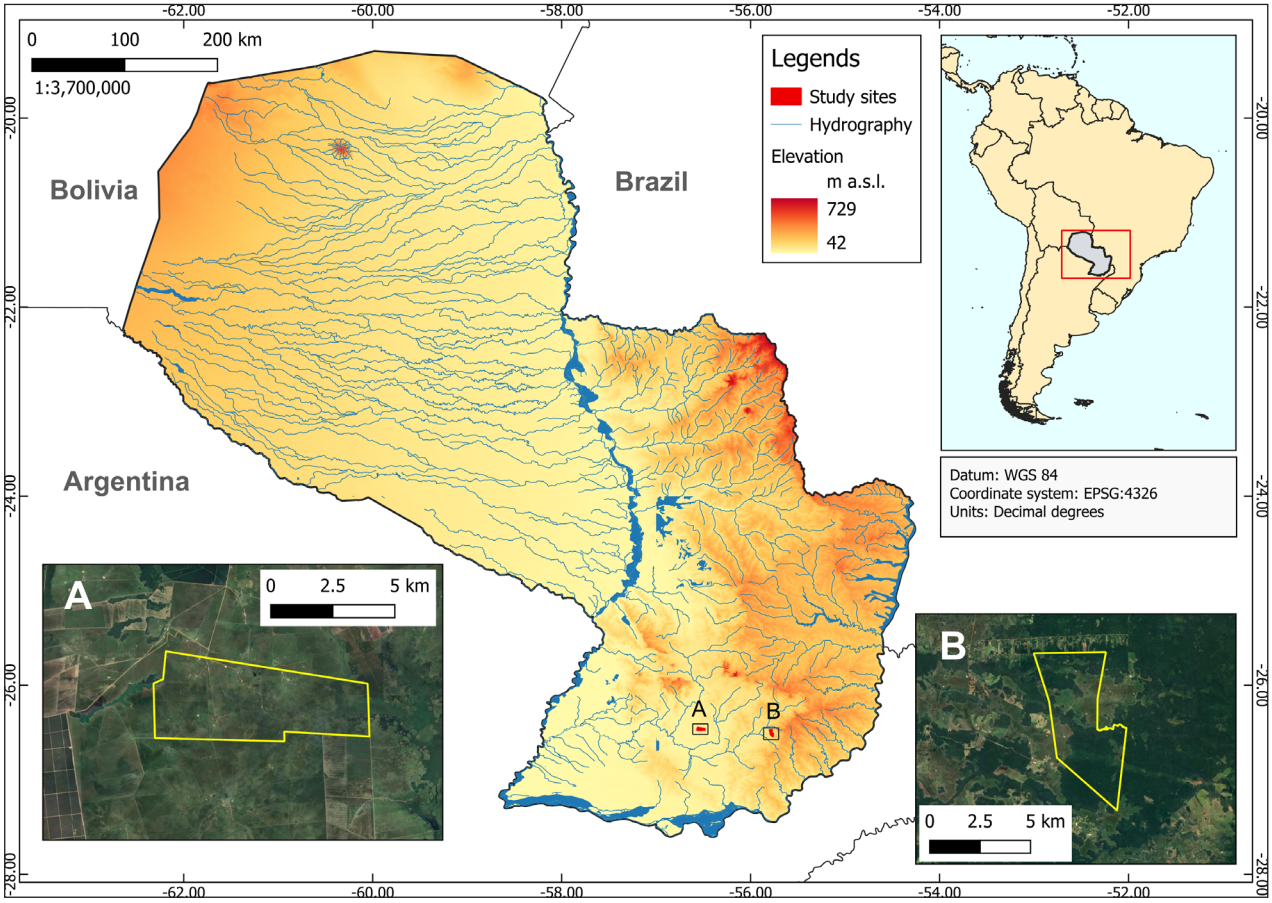

Figure 1. Study areas in southern Paraguay. **A.** Estancia Algarrobo; **B.** GRNR.

ments across suitable habitats to increase encounter rates. This approach follows previous studies in the region that incorporated non-systematic search efforts to improve detection of rare or elusive individuals (Sforza et al. 2025).

Interspecific associations between *A. tricolor* and *A. risora* were recorded opportunistically during both systematic surveys and active searches. An association event was defined as the simultaneous occurrence of individuals of both species within the same microhabitat. Because individual identification was not possible, observations obtained on different days were treated as independent events, acknowledging that repeated detections of the same individuals cannot be excluded.

Results

During the study period, a total of ~600 h of field surveys were conducted over 22 sampling months. *Alectrurus tricolor* was recorded on 22 independent occasions (20 records at Guyra Retã Natural Reserve and two at Estancia Algarrobo), whereas *A. risora* was recorded on 19 occasions, all between March and August 2025. Interspecific associations between the two species were documented on eight independent occasions, representing 36.4% of all *A. tricolor* records and 42.1% of all *A. risora* records.

We recorded the eight interspecific associations between *A. tricolor* and *A. risora* between November 2023 and August 2025 (Table 1). Most of the recorded events (6/8) involved two individuals, one of each species (Fig. 2), whereas the

Table 1. Records of interspecific associations between *A. tricolor* and *A. risora* during surveys conducted at the study sites.

Date	Coordinates (°S, °W)	Species composition	Observed behaviors
14 Dec 2023	-26.4717°S, -56.5427°W	*A. tricolor* (male), *A. risora* (male)	Perching, territorial
30 Apr 2025	-26.4948°S, -55.7813°W	*A. tricolor* (male), *A. risora* (female)	Perching, foraging, aerial capture, movement
1 May 2025	-26.494°S, -55.7800°W	*A. tricolor* (male), *A. risora* (female)	Perching, preening, movement
10 Jul 2025	-26.4953°S, -55.7829°W	*A. tricolor* (male), *A. risora* (male) and (female)	Perching, movement, active foraging
28 Jul 2025	-26.4952°S, -55.7819°W	*A. tricolor* (male), *A. risora* (male) and (female)	Perching, active foraging, aerial capture
29 Jul 2025	-26.4959°S, -55.7822°W	*A. tricolor* (male, *A. risora* (male)	Perching, active foraging, aerial capture, preening
31 Jul 2025	-26.4932°S, -55.7796°W	*A. tricolor* (male), *A. risora* (male)	Perching, preening, active foraging
1 Aug 2025	-26.4935°S, -55.7800°W	*A. tricolor* (male), *A. risora* (male)	Perching, active foraging

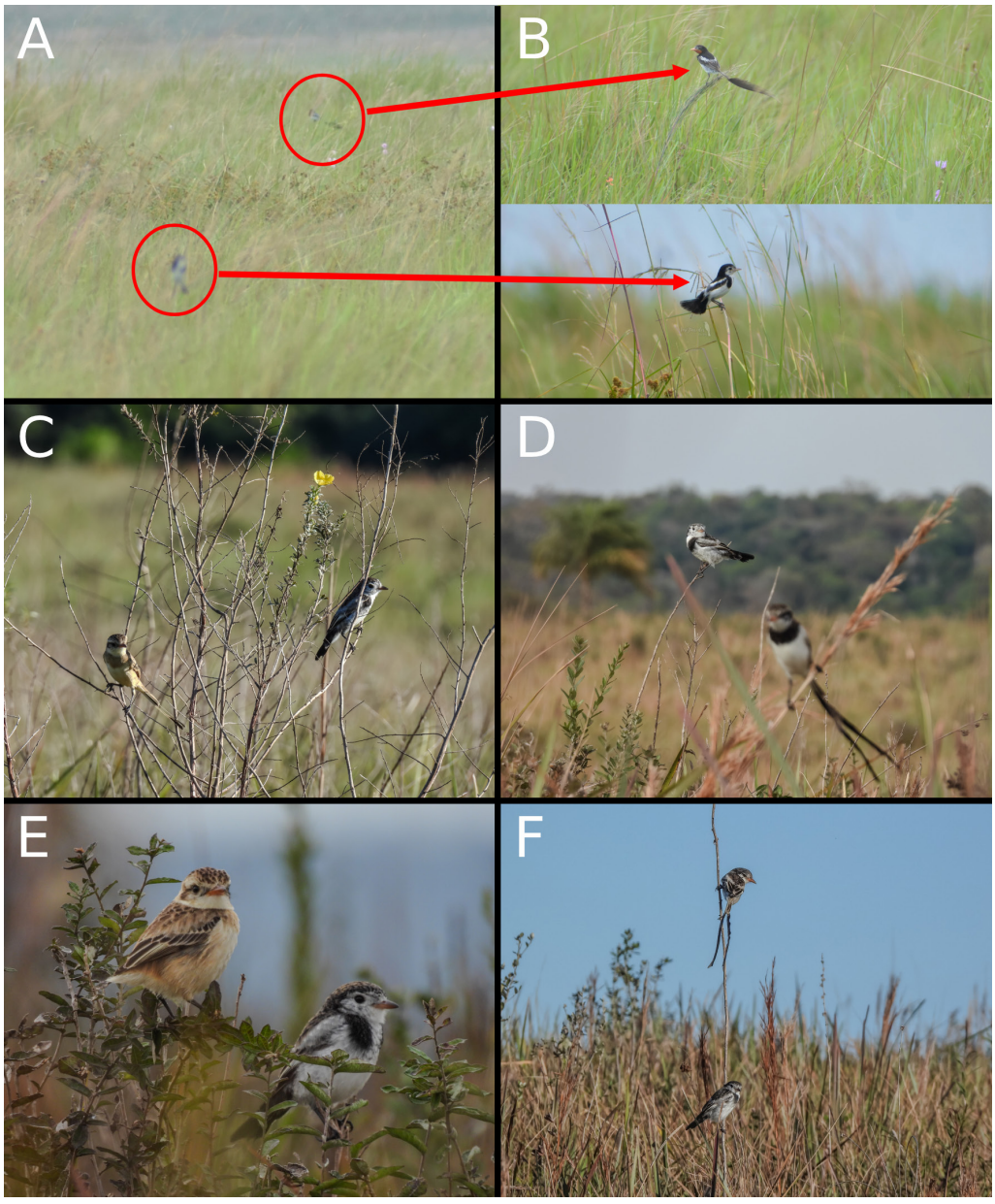

Figure 2. Photographs of *A. tricolor* in association with *A. risora*. **A.** Blurred image of two males; **B.** Detailed views of *A. risora* (above) and *A. tricolor* (below); **C.** Female *A. risora* (left) with male *A. tricolor* (right); **D.** Male *A. tricolor* (left) and male *A. risora* (right); **E** Female *A. risora* (left) with male *A. tricolor* (right); **F** Male *A. risora* (above) and male *A. tricolor* (below).

remaining events (2/8) involved three individuals, with *Alectrurus risora* represented by two individuals. Inter-individual distances ranged from less than 1 m to approximately 6 m. Individuals frequently maintained close proximity over extended periods and often re-approached each other following brief separations.

Observed behaviors included coordinated movements, shared use of perches, and simultaneous foraging. During foraging bouts, individuals actively searched for prey and performed aerial sallies to capture arthropods. In several instances, the movement of one individual appeared to flush prey, which was subsequently captured by another individual in close proximity. Preening behavior was also recorded during some association events. A noteworthy behavior was observed during the first observation (14 Dec 2023), when two males (*A. risora* and *A. tricolor*) were perched approximately 1 m apart. An individual of *Emberizoides ypiranganus* then approached the *A. tricolor* individual, and the *A. risora* individual promptly expelled the newcomer from the area.

Finally, *A. tricolor* was consistently recorded throughout the study period at GRNR. In contrast, *A. risora* was observed only between March and August, with no records between September and February.

Discussion

The observations presented here add to the limited evidence of interspecific associations between *A. tricolor* and *A. risora*. In this context, our results, based on observations recorded on eight different days, and at two different locations, provide further evidence that such associations may occur repeatedly and involve sustained spatial proximity, shared perching, territorial defense, and coordinated movements during foraging. The behavioral patterns observed are consistent with interspecific foraging associations described in insectivorous birds. Similar associative behavior has previously been reported for *A. risora* in Argentina, where individuals were observed following army ants and armadillos together with other grassland bird species, apparently exploiting prey flushed by their movements (Di Giacomo and Di Giacomo 2006). Such observations support the hypothesis that *A. risora* can participate in facultative foraging associations and provide additional ecological context for the interactions documented here.

Mixed-species associations can provide benefits such as increased efficiency in prey detection and capture, as well as reduced predation risk through collective vigilance (Sridhar et al. 2009). In species that employ short aerial sallies from perches, such as many tyrant flycatchers (Gabriel and Pizo 2005; Ferrari et al. 2022), the activity of one individual may increase prey detectability for nearby individuals, facilitating capture. This mechanism suggests the possibility of trophic facilitation between *A. tricolor* and *A. risora*, which is consistent with the coordinated foraging and aerial prey capture observed in this study. However, the functional significance of these interactions remains to be tested.

Additionally, although interspecific association may be a natural response to increase survival rates (Piassi et al. 2022), habitat degradation, fragmentation, and reductions in territory quality can also substantially influence avian social behavior, sometimes promoting stronger interspecific associations among bird species. In disturbed environments, where food resources become patchier and predation risk or energetic stress may increase, birds may benefit from joining

mixed-species flocks or other heterospecific associations that enhance foraging efficiency, information sharing, and predator detection (Goodale et al. 2015; Swift et al. 2020). Several studies have shown that birds inhabiting degraded or fragmented habitats may exhibit altered interspecific interaction networks as an adaptive response to reduced habitat quality (Gentry et al. 2019; Richardson et al. 2022). For example, selective logging and forest fragmentation can modify the structure and strength of associations within mixed-species flocks, sometimes increasing dependence on heterospecific social interactions (Mokross et al. 2014; Borah et al. 2018). In this case, habitat reduction has been documented for *A. tricolor* (Cacciali and Sforza 2025), potentially favoring its association with *A. risora*.

It is important to note that most of the observations took place during the austral autumn–winter period, which corresponds to cooler and drier conditions in the region. Seasonal variation in insect availability is well documented in tropical systems, where insect biomass typically peaks during the rainy season and declines during drier periods (van Dijk et al. 2024). Under such conditions of reduced prey availability, interspecific associations may provide advantages by increasing foraging efficiency, for instance through improved prey detection, as suggested by the coordinated behaviors observed in this study. The apparent seasonal presence of *A. risora*, with records restricted to March–August, is consistent with previous studies describing the species as rare and possibly seasonal in the region (Azara 1805; Bertoni 1926; Esquivel et al. 2007). In Argentina, Di Giacomo and Di Giacomo (2004) documented seasonal movements of *A. risora* during the austral winter, suggesting that local abundance may vary substantially throughout the year. The concentration of our records during the cooler months may therefore reflect broader seasonal movements within the species' range rather than solely local changes in detectability or habitat use. This pattern highlights the need for long-term and systematic monitoring to better understand the population dynamics and temporal use of the landscape by this species.

Given that both *A. tricolor* and *A. risora* are classified as Vulnerable and depend on natural grasslands, one of the most threatened ecosystems in the Neotropics (Medan et al. 2011; Parr et al. 2014; Phifer et al. 2017; Foucher et al. 2023; Villalba-Martinez et al. 2024), documenting such interspecific associations provides valuable insights into their behavioral ecology. Although repeated observations across different days suggest that these associations are not isolated occurrences, further studies are needed to assess their frequency, drivers, and deeper understanding of the ecological significance.

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References

Azara F de (1805) Apuntamientos Para la Historia Natural de Los Páxaros del Paraguay y Río de la Plata (Tomo 2). Imprenta de la Viuda de Ibarra, Madrid, 562 pp.

Benítez B, Vera MI, Vogt C, Pereira Sühsner CD, Rivarola AC (2021) Diversidad florística en pastizales de la Reserva para Parque Nacional San Rafael, Paraguay. Steviana 13: 39–74. https://doi.org/10.56152/StevianaFacenV13N2A4_2021

Bertoni A (1926) Apuntes ornitológicos I. Sobre migración de aves en el Paraguay. El Hornero 3: 396–398. https://doi.org/10.56178/eh.v3i4.163

BirdLife International (2024a) *Alectrurus risora*. The IUCN Red List of Threatened Species 2024: e.T22700303A277302613. https://www.iucnredlist.org/species/22700303/277302613 [accessed on 2 April 2026]

BirdLife International (2024b) *Alectrurus tricolor*. The IUCN Red List of Threatened Species 2024: e.T22700300A277250124. https://www.iucnredlist.org/species/22700300/277250124 [accessed on 2 April 2026]

BirdLife International (2026) Site factsheet: Parque Nacional San Rafael. https://datazone.birdlife.org/site/factsheet/20562-parque-nacional-san-rafael [accessed on 2 April 2026]

Bodrati A, Monteleone D (2023) El Yetapá Chico (*Alectrurus tricolor*): ¿extinto en Argentina? Nuestras Aves 68: 38–43. https://nuestrasaves.avesargentinas.org.ar/home/article/view/1011 https://doi.org/10.56178/na.vi68.1011

Borah B, Quader S, Srinivasan U (2018) Responses of interspecific associations in mixed-species bird flocks to selective logging. Journal of Applied Ecology 55(6): 2871–2881. https://doi.org/10.1111/1365-2664.13097

Cacciali P, Sforza L (2025) Assessment of habitat suitability for the globally threatened Cock-tailed Tyrant *Alectrurus tricolor* (Passeriformes: Tyrannidae). Bird Conservation International 35: e37. https://doi.org/10.1017/s0959270925100269

Codesido M, Fraga RM (2009) Distribution of threatened grassland passerines of Paraguay, Argentina and Uruguay, with new locality records and notes on their natural history and habitat. Ornitología Neotropical 20: 585–595.

Di Giacomo AS, Di Giacomo AG (2004) Extinción, historia natural y conservación de las poblaciones del Yetapá de Collar (*Alectrurus risora*) en la Argentina. Ornitología Neotropical 15: 145–157.

Di Giacomo AS, Di Giacomo AG (2006) Observations of Strange-tailed Tyrants (*Alectrurus risora*) and other grassland birds following army ants and armadillos. Journal of Field Ornithology 77(3): 266–268. https://doi.org/10.1111/j.1557-9263.2006.00052.x

Di Giacomo AS, Vickery PD, Casañas H, Spitznagel OA, Ostrosky C, Krapovickas S, Bosso AJ (2010) Landscape associations of globally threatened grassland birds in the Aguapey river Important Bird Area, Corrientes, Argentina. Bird Conservation International 20(1): 62–73. https://doi.org/10.1017/s0959270909990177

Di Giacomo AG, Di Giacomo AS, Reboreda JC (2011) Effects of grassland burning on reproductive success of globally threatened Strange-tailed Tyrants *Alectrurus ri-*

sora. Bird Conservation International 21(4): 411–422. https://doi.org/10.1017/s0959270910000584

Esquivel A, Peris SJ, Fraga R, Clay RP, Bodrati A, Del Castillo H, Klavins J, Velázquez MC, Madroño A (2007) Status of the avifauna of San Rafael National Park, one of the last large fragments of Atlantic Forest in Paraguay. Bird Conservation International 17(4): 301–317. https://doi.org/10.1017/s095927090700086x

Farnsworth A, Langham G, de Juana E (2020a) Cock-tailed Tyrant (*Alectrurus tricolor*), version 1.0. In: del Hoyo J, Elliott A, Sargatal J, Christie DA, de Juana E (Eds) Birds of the World. Cornell Lab of Ornithology, Ithaca. https://doi.org/10.2173/bow.cottyr1.01

Farnsworth A, Langham G, de Juana E (2020b) Strange-tailed Tyrant (*Alectrurus risora*), version 1.0. In: del Hoyo J, Elliott A, Sargatal J, Christie DA, de Juana E (Eds) Birds of the World. Cornell Lab of Ornithology, Ithaca. https://doi.org/10.2173/bow.stttyr1.01

Ferrari A, Motta-Junior JC, Siqueira JO (2022) Seasonal variation in the foraging behavior of neotropical tyrant flycatchers (Tyrannidae) in a Cerrado fragment, Brazil. Ethology Ecology & Evolution 35(2): 222–229. https://doi.org/10.1080/03949370.2022.2026480

Foucher A, Tassano M, Chaboche PA, Chalar G, Cabrera M, Gonzalez J, Cabral P, Simon AC, Agelou M, Ramon R, Tiecher T, Evrard O (2023) Inexorable land degradation due to agriculture expansion in South American Pampa. Nature Sustainability 6: 662–670. https://doi.org/10.1038/s41893-023-01074-z

Gabriel VA, Pizo MA (2005) Foraging behavior of tyrant flycatchers (Aves, Tyrannidae) in Brazil. Revista Brasileira de Zoologia 22(4): 1072–1077. https://doi.org/10.1590/S0101-81752005000400036

Gentry KE, Roche DP, Mugel SG, Lancaster ND (2019) Flocking propensity by satellites, but not core members of mixed-species flocks, increases when individuals experience energetic deficits in a poor-quality foraging habitat. PLoS ONE 14(1): e0209680. https://doi.org/10.1371/journal.pone.0209680

Goodale E, Ding P, Liu X, Martínez A, Si X, Walters M, Srinivasan U (2015) The structure of mixed-species bird flocks, and their response to anthropogenic disturbance, with special reference to East Asia. Avian Research 6: 1–14. https://doi.org/10.1186/s40657-015-0023-0

Mäder A, Almansa FAC, Silva FC (2026) Redescobrimento da Tesoura-do-campo (*Alectrurus Risora*) no Rio Grande Do Sul, Brasil, após mais de um século sem registros. Nuestras Aves 71. https://doi.org/10.56178/na.v71i.1172

Medan D, Torretta JP, Hodara K, de la Fuente EB, Montaldo NH (2011) Effects of agriculture expansion and intensification on the vertebrate and invertebrate diversity in the Pampas of Argentina. Biodiversity and Conservation 20: 3077–3100. https://doi.org/10.1007/s10531-011-0118-9

Mokross K, Ryder TB, Côrtes MC, Wolfe JD, Stouffer PC (2014) Decay of interspecific avian flock networks along a disturbance gradient in Amazonia. Proceedings of the Royal Society B 281: e20132599. https://doi.org/10.1098/rspb.2013.2599

Parr CL, Lehmann CER, Bond WJ, Hoffmann WA, Andersen AN (2014) Tropical grassy biomes: Misunderstood, neglected, and under threat. Trends in Ecology & Evolution 29(4): 205–213. https://doi.org/10.1016/j.tree.2014.02.004

Peacock J, Macleod R, Davies GM, Boorsma T, Tonra CM (2024) Habitat selection of three Neotropical grassland birds is dependent on vegetation structure and resources. Diversity 16: e229. https://doi.org/10.3390/d16040229

Phifer CC, Knowlton JL, Webster CR, Flaspohler DJ, Licata JA (2017) Bird community responses to afforested eucalyptus plantations in the Argentine pampas. Biodiversity and Conservation 26: 3073–3101. https://doi.org/10.1007/s10531-016-1126-6

Piassi PM, Batisteli AF, Gussoni COA, Pizo MA (2022) Effects of the association between *Mimus saturninus* and *Furnarius rufus* on their foraging and alert behaviors. Ornithology Research 30: 239–247. https://doi.org/10.1007/s43388-022-00090-5

Richardson KE, Roche DP, Mugel SG, Lancaster ND (2022) Social dynamics of core members in mixed-species bird flocks change across a gradient of foraging habitat quality. PLoS ONE 17(1): e0262385. https://doi.org/10.1371/journal.pone.0262385

Sforza L, Paredes J, Cristaldo G, Cacciali P (2025) Intento de estimación poblacional de *Alectrurus tricolor* (Vieillot, 1816) (Passeriformes: Tyrannidae) en el sur de Paraguay. Kempffiana 21(1): 1–9. https://museonoelkempff.org/museo/wp-content/uploads/2025/07/Articulo-Sforza-et-al_Alectrurus_21_1_2025.pdf

Sridhar H, Beauchamp G, Shanker K (2009) Why do birds participate in mixed-species foraging flocks? A large-scale synthesis. Animal Behaviour 78: 337–347. https://doi.org/10.1016/j.anbehav.2009.05.008

Swift RJ, Anteau MJ, Roche EA, Sherfy MH, Toy DL, Ringelman KM (2020) Asymmetric benefits of a heterospecific breeding association vary with habitat, conspecific abundance and breeding stage. Oikos 129(10): 1459–1470. https://doi.org/10.1111/oik.07256

van Dijk LJ, Vos RA, Frago E, Scheper J (2024) Temperature and water availability drive insect seasonality across a temperate and a tropical region. Proceedings of the Royal Society B 291: e20240123. https://doi.org/10.1098/rspb.2024.0090

Villalba-Martinez CJ, Merino A, Etchevers JD (2024) Afforestation of a floodplain system in Paraguay with eucalyptus: Effects on soil properties and nutrient stocks. Forest Ecology and Management 566: e122050. https://doi.org/10.1016/j.foreco.2024.122050

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Artificial Intelligence (AI) use

The authors accept full responsibility for the content of the manuscript, including the disclosure of any use of AI.
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Author contributions

Conceptualization: LS. Data curation: SD, PC. Funding acquisition: PC, LS. Investigation: SD. Methodology: SD, LS, JP. Supervision: LS. Visualization: SD, PC, JP. Writing – original draft: SD. Writing – review & editing: LS, JP, PC.

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Data availability

All of the data that support the findings of this study are available in the main text.