

Ecology in South America: present state and future prospects

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Abstract

South American ecological science has grown immensely in the past few decades, with flourishing graduate courses across the continent dedicated to the topic and an increasing number of researchers focused on understanding many aspects of the continent's immense biodiversity. Here, we present the special Issue "Ecology in South America: present state and future prospects" aiming at highlighting South American Ecological Research internationally and to promote South American research published in *Austral Ecology* beyond the English-speaking scientific community.

Key words: *Austral Ecology*, bilingual, Ecology, South America, Southern Hemisphere

Main text

South American ecological science has grown immensely in the past few decades, with flourishing graduate courses across the continent dedicated to the topic and an increasing number of researchers focused on understanding many aspects of the continent's immense biodiversity. In Brazil, for instance, the number of graduate-level ecology courses almost doubled between 2008 and 2019, jumping from 35 to 68 graduate courses in Ecology. South American Ecologists are conducting world-class research, often with international collaborations, and are continuously looking for international venues to publish their studies. When looking for journals to publish their work, South American Ecologists often consider access of the public for their published work, existence of article processing charges, and fit of the research to the journals' aims and scopes. In our experience as researchers, professors, reviewers, and editors, we came to understand that many studies being done in South America extend beyond local or national relevance and are important contributions to ecological knowledge in the Southern Hemisphere. *Austral Ecology* and Ecological Society of Australia, with their aim to publish innovative research to encourage the sharing of information and experiences that enrich the understanding of the ecology of the Southern Hemisphere, are an ideal venue for South American researchers looking to publish their work beyond the regional borders of South America. With that in mind, the goals of the special Issue "Ecology in South America: present state and future prospects" are to highlight South American Ecological Research internationally and to provide options to promote South American research published in *Austral Ecology* beyond the English-speaking scientific community.

All articles included in the special issue are bilingual, with a published version in English and in the most relevant language for the region where the study was conducted (Portuguese or Spanish). Also, most articles have embedded video abstracts in Portuguese or Spanish with English subtitles to promote inclusion and accessibility to scientific knowledge. Authors recorded video abstracts in their first language and highlight the great diversity of Ecologists conducting important ecological research in South America. Below is a brief description of the research selected for this special issue.

The study by Rago et al. (2024a; 2024b) explores the far-reaching impact of changing fire regimes on post-fire succession in Andean-Patagonian forests. Assessing understory vegetation response after mid to high-severity fires, their research provides valuable insights for restoration guidelines. Comparisons of plant community structures, fire severity-forest type interactions, and plant composition reveal an early recovery of lower stratum vegetation, primarily in moderately

severe areas. Authors observed limited regeneration in the upper stratum across severity levels. Despite reduced presence in burned plots, native species remain dominant. Consistent fire effects on shrubs and trees were highlighted, while plant community composition varies based on severity-forest type categories. Challenges include soil exposure, loss of the upper vegetation stratum, and limited natural recovery of certain tree species. These findings emphasize the need for tailored restoration actions, considering fire severity and forest type, to foster resilient ecosystems amidst changing fire regimes.

Azevedo et al. (2024a; 2024b) assessed the germination potential, treatments to overcome seed dormancy and seed dispersal (endozoochory) of forage native species by cattle. Three experiments were conducted to assess the germination responses of 21 native seeds collected from natural grasslands. Overall, they found that cattle ingestion and dispersal of seeds via faeces breaks seed dormancy and enables seed dispersal within natural grasslands. These native species can then be used as an alternative to commercial species when restoring native grasslands.

Tavares-Brancher et al. (2024a, 2024b) evaluated bees and their floral food availability along an urbanization gradient across six Brazilian cities. One hundred and thirty-two bee species were collected, and they found that the total abundance of bees was related to plant (both native and exotic) abundance. However, specialist bee richness and abundance were positively influenced by the proportion of native plants. Additionally, more grass cover positively influenced total abundance, solitary bees and below-ground nesting bees. Key findings from this paper identify that the inclusion of native plants should be a critical factor in developing landscaping options within urban areas to promote bee conservation.

Santoro et al. (2024a; 2024b) explore the utilitarian redundancy model to assess the resilience of local populations' plant knowledge systems. By analyzing plant species used by three traditional communities in the Patagonian steppe for various purposes, the researchers aim to understand the uniqueness and use pressure of native and exotic species. The findings indicate that the plant knowledge systems of the communities exhibit similar adaptive capacities through utilitarian redundancy, compensating for the loss of certain elements. Native species are observed to be more unique, and face higher use pressure compared to exotic species. These results underscore the

importance of conserving the native environment of the Patagonian steppe for the survival of traditional populations and inform conservation priorities for botanical species in the region.

The research conducted by Spirito et al. (2024a; 2024b) investigates gender stereotypes in the region by analyzing authorship and research themes in the field of ecology in Argentina. One of the key findings of the study highlights a notable disparity in the progression of ecological themes explored. It reveals that men gravitate towards areas associated with decision-making, while women engage with themes closely aligned with conservation and environmental processes. The gender disparity in leadership positions within the public sphere, occupied by men, is mirrored in the unequal representation of genders within the ecological themes studied in the region.

In Mestre et al. (2024a; 2024b) authors show a restoration project for five years after sapling plantation. The sub-Antarctic forests in Tierra del Fuego mountains are considered one of the few remaining wilderness areas on the planet; however, human disturbances like wildfires, exotic species, and so forth exacerbate their degradation. Two years after a wildfire, a reforestation project began to restore the natural canopy layer. Saplings of the native *Nothofagus* trees were obtained through the bare root method from undisturbed areas, which they evaluated the influence of (1) macro- (considering natural topography and vegetation physiognomy) and micro-environments (topography, canopy cover, substrate, and understory cover) affected by fire; and (2) the extraction size of the saplings (initial size), on survival and growth of planted saplings, over 5 years. At a macro-environment level, tree saplings showed higher success in well-drained zones, meanwhile at the micro-environment level saplings performed better in those that contribute to retain soil moisture and avoiding evapotranspiration. The authors conclude that environmental features influence differentially depending on the scale of analysis. To restore burnt temperate forests applying the bare root method, they recommended using *Nothofagus* saplings <40 cm tall for better results. To gain a more successful plantation, it is necessary to identify the best “refugees” as macro- and micro-environments that favor sapling development, understood as higher survival and growth over time.

Ligo et al. (2024a; 2024b) compiled 48 bat-fruit mutualistic networks and show how human impact and precipitation are major forces structuring these mutualistic networks along a latitudinal gradient in the Neotropics. This study also highlights how the undersampling of many tropical biomes reduces our ability to generalize and reach wide-

ranging conclusions on the structure of mutualistic networks. This paper is an important contribution towards our knowledge of latitudinal gradients in species richness and interaction diversity, a long sought after goal in global ecology.

Dalinger et al. (2024a; 2024b) evaluated the application of biotic indices on an anthropic and longitudinal gradient of rivers during the dry period. They show that biological indices are important tools for evaluating the quality of environments and their monitor. However, they are not universal tools, requiring the development of local biotic indices South America ecosystems, their unique characteristics, and their enormous biodiversity.

Sotomayor & Morales (2024a, 2024b) conducted a systematic review to identify research gaps and future directions for biodiversity research in Peru. Their results suggest research has been focusing on a limited number of regions and there is a need to increase the geographical coverage of ecosystems, especially in the Andes and the coast where habitat degradation and susceptibility to global change impacts are greater.

In another literature review, Cerqueira et al. (2024a; 2024b) have looked at trends and gaps in the literature on native palms of the Brazilian Atlantic Forest. They found surprisingly little research published on this important group of plants (research was found for only 60% of the palm species). Their review demonstrated the existence of geographical and knowledge biases in native palms of the Atlantic Forest.

Gonçalves et al. (2024a, 2024b) performed a systematic review on the diets of Neotropical tadpoles. They found out that most studies are descriptive and temporally restricted, failing to consider seasonal or ontogenetic variations and prey availability. To illustrate that, they report on the diet of tadpoles of *Scinax curicica* for two seasons and multiple ontogenetic stages. They found that the diet varied between dry and wet seasons, but throughout ontogeny. This paper calls for a more realistic evaluation of tadpole diets, considering environmental and life-history contexts.

Brazil-Sousa et al. (2024a; 2024b) analyzed how trophic niche position influences niche width in 32 freshwater fish species, considering intraspecific variation. Their hypothesis is that omnivorous species would have higher levels of individual specialization. They found that omnivores did not affect individual specialization. Instead, niche breadth positively affected individual specialization,

regardless of its trophic position. The innovation of this paper is that it creatively applied a tool to analyze individual specialization to a community of Neotropical fish, in which previous studies only took a mean field approach.

In their study, Melián et al. (2024a; 2024b) combine the functional and structural insights of existing models focused on trade-offs among wood traits and their implications for drought tolerance while further expanding the analytic domain to consider intraspecific trait variability and phenotypic plasticity. They apply this framework to analyze three widespread woody species in arid and semi-arid ecosystems in South America across a rainfall gradient. The results show noticeable differences in both the mean and variance of the ecological strategies across species: traits of *Neltuma flexuosa* (a phreatophyte) did not respond to rainfall suggesting drought avoidance, *Larrea divaricata* consistently showed overall high drought-tolerance traits, while *Bulnesia retama*'s traits shifted towards drought-tolerance values as aridity increased. This work serves as a compelling illustration of the valuable insights that can be gained through trait-based approaches on vegetation responses to changing climatic conditions, ultimately providing a mechanistic guidance for managing and conserving plant species in the face of climate change.

Martins et al. (2024a; 2024b) examined the association between vertebrates' roadkill and land cover and land use in a fragmented Brazilian savanna area. The researchers analyzed roadkill data obtained from weekly surveys conducted over a two-year period on a road located in the center-western region of Brazil. The study aimed to investigate the spatial distribution of vertebrate road mortality, including mortality records of endangered species. The findings revealed the presence of roadkill hotspots and a higher likelihood of roadkill occurrence in proximity to riparian forests and more distant from urban areas. The authors highlight the importance of considering the spatial patterns of mortality when identifying priority locations for mitigation efforts. They also recommend implementing mitigation measures near riparian forests to reduce wildlife mortality on roads.

Ribeiro et al. (2023) propose an analytical framework that combines predictive modelling of road mortality data with spatial prioritization criteria to identify road sections for mitigating wildlife-vehicle collisions in Brazil. They modelled the likelihood of collisions for three species of large mammals, two of them endangered, using the maximum entropy algorithm and land use and land cover classes. Subsequently, they rank road segments using a spatial prioritization approach. The study yielded consistent results when using two different criteria to weigh species: the degree of

threat to humans in wildlife-vehicle collisions and the conservation status of the species. The authors suggest that predictive models, like the one presented in this study, can be utilized to aid decision-making regarding roadkill mitigation in areas lacking data.

Dantas et al. (2022; 2024) describe how a pioneer palm species acts as an ecosystem engineer, such that its proliferation under disturbance has important consequences for secondary succession in Brazilian Atlantic Forest. Dense mounds of leaf litter form at the bases of the palms, limiting recruitment by shade-tolerant forest trees. The authors show that the mounds support a taxonomically and functionally depauperate ant fauna due to low beta diversity. The proliferation of palms following disturbance therefore engineers an important secondary impact of disturbance on biodiversity.

Vilches-Piñones et al. (2024a; 2024b) emphasize the importance of conserving bat species considered to be beneficial to agriculture and highlight how little is known about how different landscape types can affect the activity patterns of various bat species. The researchers studied how the activity of seven insectivorous species of bats south of Chile is affected by landscape type (homogenous and heterogenous agricultural landscapes), vegetation cover types (native, mixed, plantation), and the density of isolated trees. The heterogeneous landscape was dominated by *Tadarida brasiliensis*. *Lasiurus varius*, *L. villosissimus*, and *Myotis chiloensis* had higher activity levels in native and mixed forests, and *L. varius* and *L. villosissimus* had reduced activity around plantations. The homogeneous landscape was dominated by *L. varius* and *L. villosissimus*, and the activity levels of *T. brasiliensis*, *L. varius* and *L. villosissimus* decreased with a lower density of isolated trees. The researchers show the importance of considering forest elements in agroforestry landscapes to improve the efficacy of bat conservation programs.

Ballarin et al. (2024a; 2024b) conducted a thorough systematic review, focusing on studies examining the effects of fire on plant-animal interactions in Brazil, a country teeming with diverse fire-prone and fire-sensitive ecosystems harboring numerous plant and animal species. Through a comprehensive analysis, they synthesized the main goals, methodologies, and taxonomic groups employed in these studies, while also pinpointing shortcomings to be avoided and gaps to be addressed in future research endeavors. Their review unveils an existing geographic and taxonomic bias, as well as methodological limitations within studies. Considering these findings, the authors stressed the need for more comprehensive research, including a broader range of interactions and

consideration of key fire parameters, to improve our understanding of the complex relationship between fire, plants, and animals in Brazil.

Arruda et al. (2024a; 2024b) modelled the responses of different vegetational formation of Brazil to future changes in atmospheric CO₂ levels. They have simulated the environmental suitability of these vegetational formations under a future scenario (2070) of steady increases in CO₂ levels and assessed how Brazilian protected areas would be affected by changes in the environmental suitability. The authors found that an area over the size of the Central America and Mexico would be affected in Brazil by 2070 with large replacements of rainforests by dryer vegetation, especially in the Amazon Forest. Around 40% of the coverage of protected areas would also be affected, with greater impacts on Indigenous lands. The authors highlight that the predictions could even be underestimated as deforestation and degradation were not considered in their models.

Mendes-Silva et al. (2024a; 2024b) investigated the impacts that a florivorous beetle species could cause on the reproductive success of two sympatric *Banisteriopsis* (Malpighiaceae) species. The authors performed experiments where they manipulated the presence of extrafloral nectaries visiting ants, which protect the plants against herbivores, to test the effectiveness of ant-extrafloral nectaries mutualism on fruit production). The authors showed that ants failed in protecting the plants against florivory and hence, the *Anthonomus* beetles had a negative impact on fruit production. However, the results were context dependent, as the number of flowers and fruits per plant differed from one plant species to another. The study highlights how complex multitrophic systems are and that isolating the components of such systems can help to understand the ecological interaction involved.

López-Bedoya et al. (2024a; 2024b) performed a systematic review to assess the current knowledge about beetles in the Tropical Andes. The authors focused on three main groups of beetles: ground, rove, and dung beetles. The aim of this review was to understand the degree of knowledge and what knowledge gaps persist in terms of types of disturbance, topics, metrics and countries evaluated in existing literature. The authors found that dung beetles were the most represented group, especially in studies regarding forest conversion. In addition, most studies of all three groups of beetles focused on the metrics of species richness and abundance and were conducted in Colombia. The main knowledge gaps are the lack of information about ground and rove beetles and regions in countries like Bolivia and Venezuela. The paper also highlights the importance

of considering functional-related metrics to better understand human impacts on tropical Andean beetle communities.

Hidasi-neto et al. (2024; 2022) combined climate niche modelling (ENM) with a future climate scenario of greenhouse gases emissions to study the future changes in alpha and beta diversity of birds of the Brazilian Cerrado biome. Their analyses included more than 1000 bird species and revealed that biotic homogenization will likely increase due to mammal local extinctions and birds' local invasions.

Finally, Morales-Torres et al. (2024a; 2024b) describe their study of kleptoparasitism occurrence by the Brown-Hooded Gull (*Chroicocephalus maculipennis*) on Whimbrels (*Numenius phaeopus hudsonicus*) preying on intertidal Mole Crabs (*Emerita analoga*). They report that kleptoparasitism probability was positively related to prey handling time and size, and increased with the number of kleptoparasites present. However, the effect of prey handling time on kleptoparasitism occurrence did not increase with prey size.

Taken altogether, the articles published in the present special issue illustrates the breath of research in South America, including question-driven studies, noteworthy case studies of understudied ecological systems, linkages between people and nature, discussions of inclusion and diversity in science, and literature reviews. South America is one of the most biodiversity corners of the globe, thus potential to contribute with ecological knowledge is beyond doubt. However historical, social, and political hurdles still limit south American ecologists' capacity to fully realize that potential. South American ecological science is rich, vibrant, and diverse, offering important insights of our understanding of nature and its connections with people and society, so it is a great pleasure to open the pages of *Austral Ecology* to South American ecologists.

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