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Exotic and native parrots (Psittaciformes) in Brazilian households: a national survey from iNaturalist

Papagaios (Psittaciformes) exóticos e nativos em lares brasileiros: um levantamento nacional por meio do iNaturalist

Rafaela Mendes **SPALDING**[1, 4]; Matheus Moraes **DOS SANTOS**[2] & Enrico Ammirati Rodrigues **TOSTO**[3]

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ABSTRACT
Brazil harbors the world's richest Psittaciformes diversity. This phenomenon is reflected in the widespread culture of keeping birds as companion animals in the country. Comprehensive national data on which parrot species are kept as pets remain scarce, hindering conservation efforts and public policies. This study leverages citizen science data from iNaturalist to conduct a nationwide analysis of parrots kept in Brazilian households. We identified 998 eligible observations, comprising 60 species (37 native, 23 exotic). Results reveal a heterogeneous national pattern, heavily influenced by regional disparities. While exotic species overwhelmingly dominated the records from the Southeast and South, the Northern and Northeastern regions showed a contrasting pattern, with a greater prevalence of native species. The findings demonstrate the utility of citizen science for mapping human-animal interactions at a national scale, providing critical insights into regional trends of native and exotic species prevalence. This data is vital for informing targeted public policies on wildlife trade, conservation, and animal welfare.
Keywords: aviculture, citizen science, companion animals, pets.

RESUMO
O Brasil possui a mais rica diversidade de Psittaciformes do mundo. Esse fenômeno é refletido na cultura de manter essas aves como animais de companhia no país. Dados nacionais abrangentes sobre quais espécies de papagaios são mantidas como animal de companhia permanecem escassos, dificultando os esforços de conservação e políticas públicas. O presente estudo aproveita os dados de ciência cidadã do iNaturalist para conduzir uma análise em escala nacional dos papagaios mantidos em domicílios brasileiros. Foram identificadas 998 observações elegíveis, compreendendo 60 espécies (37 nativas, 23 exóticas). Os resultados revelam um padrão nacional heterogêneo e fortemente influenciado por disparidades regionais. Enquanto as espécies exóticas dominaram amplamente os registros das regiões Sudeste e Sul, as regiões Norte e Nordeste mostraram um padrão contrastante, com uma maior prevalência de espécies nativas. Os achados demonstram a utilidade da ciência cidadã para mapear interações homem-animal em escala nacional, fornecendo informações críticas sobre as tendências regionais da prevalência de espécies nativas e exóticas. Tais dados são vitais para informar políticas públicas direcionadas sobre o comércio de vida silvestre, conservação e bem-estar animal.
Palavras-chave: animais de companhia, avicultura, ciência cidadã, *pets*.

[1] Universidade Anhembi Morumbi (UAM), Rua Doutor Almeida Lima, 1134, Mooca – CEP 03101-001, São Paulo, SP, Brasil.

[2] Museu Biológico, Instituto Butantan, Butantã, São Paulo, SP, Brasil.

[3] Rede Brasileira de Naturalistas: https://redenaturalista.org.

[4] Corresponding autor: rafaela.spalding@gmail.com.

INTRODUCTION

Brazil is the widely recognized for its rich biodiversity, being the most biodiverse country in the world (MITTERMEIER *et al*., 1997; ABRANCHES, 2020). According to Sick *et al*. (1997), Brazil harbors the richest biodiversity of Psittaciformes in the world, with 87 registered species (PACHECO *et al*., 2021), all belonging to the family Psittacidae. That richness, besides its ecological and conservational importance, distributed among the country's many biodiversity hotspots (MITTERMEIER *et al*., 2011), also reflects itself on the human-animal interactions, especially on the context of companion animals originated from the wildlife trade (ROBINSON & REDFORD, 1991).

The culture of keeping and breeding birds is widespread in Brazil (ALVES *et al*., 2010). Data from the Brazilian Association of Pet Products Industry (ABINPET, 2024) points to approximately 160.9 million pets in Brazilian households, of which 42.8 million are birds. These numbers include both native and exotic species. The reason birds are kept as companion animals is varied. Some of the reasons listed by Tidemann & Gosler (2012) include the connection to nature and the countryside, companionship, creating a pleasant atmosphere and releasing stress. Birds are the most trafficked taxon in Brazil according to data published by the NGO Freeland (2023) and the National Report on Wildlife Trafficking, made by the National Wildlife Anti-Trafficking Network (RENCTAS, 2001). However, despite the magnitude of these practices, there is a notable scarcity of systematic data on which species comprise these numbers (ALVES *et al*., 2010). This gap hinders the understanding of the ecological and cultural dimensions of this phenomenon and the planning of public policies aimed at conservation and animal welfare (KUHNEN & KANAAN, 2014).

Studies have tried to address this information gap, typically focusing on specific regions or cities. For instance, Zardo *et al.* (2014) documented a higher prevalence of exotic species kept in the city of Santa Maria, in Rio Grande do Sul state, while Nascimento *et al.* (2023) reported that most pet birds in Rio Branco, the capital city of Acre, consisted of native wildlife species. Alves *et al.* (2010) noted the presence of both exotic and native Psittaciformes species in the rural city of Catolé do Rocha, Paraíba.

Despite the efforts, the lack of data from most regions or a nationwide survey hinders more comparative and comprehensive analysis for pattern identification (ALVES *et al*., 2013). Considering the logistical difficulties of doing nationwide searches and questionings, it is necessary to seek alternative data sources for the mapping of Psittaciformes kept as companion animals (SÁNCHEZ-MERCADO *et al*., 2021; HILL *et al*., 2025). A promising tool that collects biodiversity data is the citizen science platform iNaturalist (https//www.inaturalist.org), that harbors almost 250 million observation records of more than 500,000 identified species, made by over 3.5 million citizens and specialists worldwide. Through collective and georeferenced contributions, this database has been used multiple times in large data compilations (MESAGLIO *et al*., 2021; ROSA *et al*., 2022; FORTI & SZABO, 2023), offering a new perspective to understand distribution, frequency and origin (native or exotic) of species observed in different contexts (ARISTEIDOU *et al*., 2021), including domestic and non-wild environments (GROOM *et al*., 2021).

Given this context, the present study aims to conduct a nationwide data analysis of Psittaciformes kept as companion animals in Brazil, using available records from the iNaturalist platform. The main objectives are to identify regional trends, prevalence of exotic and native species, and to enhance understanding of avifauna under human care in the country, with the goal of providing actionable insight for conservation strategies, environmental education and the formulation of public policies.

MATERIAL AND METHODS

To gather the observations used in this study, searches were filtered by country (Brazil), order (Psittaciformes), and observations marked as "captive" through the iNaturalist platform. The data extracted covers observations submitted between the creation of the platform, in March 2008, and May 2025.

All sightings were then analyzed to exclude those from zoos and rehabilitation centers. The criteria for exclusion included: (a) a large and appropriately sized aviary, indicative of proper care, (b) if the poster specified the zoo or rehabilitation center in the caption of the observation and (c) the observation's location. If imprecise but within the range of a zoo or rehabilitation center, and matching the first criterion (a), the observation was excluded to avoid including zoo animals in the study, which would compromise the data, especially regarding species diversity. Additionally, escaped pets were excluded to avoid data bias. Since escaped pets of native species cannot be reliably distinguished from wild birds based solely on photographs, including them would skew the data toward exotic species. Any observation that raised doubts regarding these categories was also excluded (figure 1).

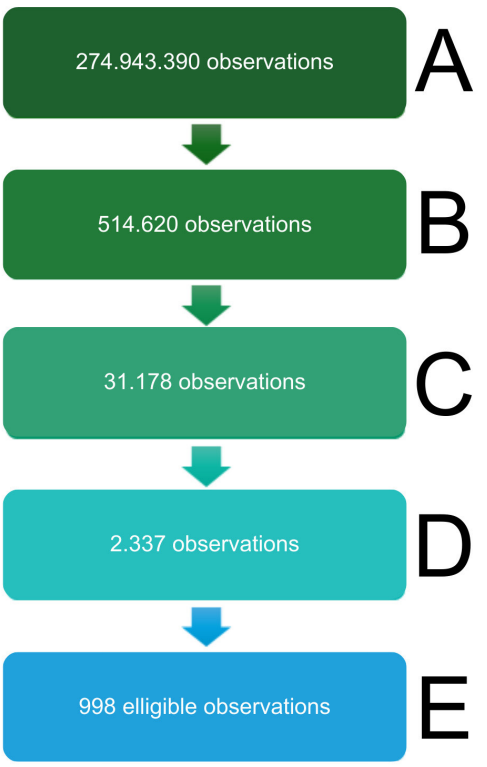

Figure 1 – Flowchart illustrating the sequential filtering of iNaturalist data. From an initial pool of total observations submitted to the platform from its creation to May 2025 (A), subsequent filters for taxonomic group (Psittaciformes, B), location (Brazil, C), and captive status (D) resulted in a final dataset of 998 eligible observations (E) through previously described criteria for analysis. Source: primary.

Species identifications were corrected (when necessary) and verified using the *Birds of the world* identification guide (BILLERMAN *et al*., 2025) and with assistance from the iNaturalist community. Birds that were difficult to identify due to poor photo quality or unusual appearances were classified only to the genus level. Some observations were also left at the genus level due to confirmed or suspected hybridization, including lovebirds (*Agapornis* spp.) and macaws (*Ara* spp.), whose hybrids were often identifiable from photographs, as well as eclectus parrots (*Eclectus* spp.). When hybrids could be confidently identified, they were specified as such, noting the species of origin. Otherwise, they remained categorized as *sp.*

All observations were compiled into a spreadsheet containing the following data: (1) genus, (2) species, (3) family, (4) IUCN conservation status, (5) year of observation, (6) political subdivision (North, Northeast, Center-West, Southeast, and South), (7) state, (8) whether the species is native to Brazil, (9) whether it is native to the observation region, (10) number of individuals in the photograph, (11) a link to the iNaturalist observation and (12) additional comments when necessary.

RESULTS AND DISCUSSION

In total, 998 observations met all the established criteria. 60 distinct species were identified, comprising 23 exotic and 37 native species. These species were divided into 3 families, Cacatuidae (n = 6), Psittaculidae (n = 14) and Psittacidae (n = 40), and 31 different genera (table 1). These account for three out of the four families belonging to the order Psittaciformes (CLEMMENTS *et al*., 2024). An analysis of conservation status of the species found in this study, according to IUCN Red List, found the majority were classified as Least Concern (n = 44). The remaining species were distributed amongst other categories, such as near threatened (n = 7), vulnerable (n = 5) and endangered (n = 4).

Table 1 – List of parrot species identified in the study, showing taxonomic family, scientific and common names, and the total number of observations *per* species.

Family	Species	English name	Portuguese name	Records
Cacatuidae	*Cacatua alba*	White Cockatoo	Cacatua-branca	1
	Cacatua galerita	Sulphur crested Cockatoo	Cacatua-de-crista-amarela	3
	Cacatua moluccensis	salmon-crested Cockatoo	Cacatua-de-poupa-encarnada	1
	Calyptorhynchus banksii	red-tailed black-cockatoo	Cacatua-de-cauda-vermelha	1
	Eolophus roseicapilla	Galah	Galah	3
	Nymphicus hollandicus	Cockatiel	Calopsita	306
Psittacidae	*Alipiopsitta xanthops*	Yellow-faced parrot	Papagaio-galego	2
	Amazona aestiva	Turquoise-fronted Amazon	Papagaio-verdadeiro	81
	Amazona amazonica	Orange-winged Amazon	Curica	36
	Amazona autumnalis	Red-lored Amazon	Papagaio-diadema	1
	Amazona brasiliensis	Red-tailed Amazon	Papagaio-de-cara-roxa	1
	Amazona farinosa	Mealy Amazon	Papagaio-moleiro	2
	Amazona festiva	Festive Amazon	Papagaio-da-várzea	9
	Amazona ochrocephala	Yellow-crowned Amazon	Papagaio-campeiro	8
	Amazona rhodocorytha	Red-browed Amazon	Chauá	8
	Amazona sp.	–	–	3
	Amazona vinacea	Vinaceous-breasted Amazon	Papagaio-de-peito-roxo	7

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Continuation of the table 1

Family	Species	English name	Portuguese name	Records
	Anodorhynchus hyacinthinus	Hyacinth Macaw	Arara-azul-grande	6
	Ara ararauna	Blue-and-gold Macaw	Arara-canindé	69
	Ara ararauna x chloropterus	Harlequin Macaw	–	5
	Ara ararauna x macao	Catalina Macaw	–	1
	Ara chloropterus	Red-and-green Macaw	Arara-vermelha	15
	Ara macao	Scarlet Macaw	Araracanga	14
	Ara severus	Chesnut-fronted Macaw	Maracanã-guaçu	4
	Ara sp. *(unidentified hybrid)*	–	–	2
	Aratinga auricapillus	Golden-capped Parakeet	Jandaia-de-testa-vermelha	5
	Aratinga jandaya	Jandaya Parakeet	Jandaia-verdadeira	4
	Aratinga weddellii	Dusky-headed Parakeet	Periquito-de-cara-suja	1
	Bolborhynchus lineola	Barred Parakeet	Periquito-catarina	1
	Brotogeris chiriri	Yellow-chevroned Parakeet	Periquito-de-encontro-amarelo	10
	Brotogeris cyanoptera	Cobalt-winged Parakeet	Periquito-de-asa-azul	2
	Brotogeris sanctithomae	Tui Parakeet	Periquito-testinha	3
	Brotogeris sp.	–	–	1
	Brotogeris tirica	Plain Parakeet	Periquito-rico	3
	Brotogeris versicolurus	White-winged Parakeet	Periquito-da-campina	3
	Diopsittaca nobilis	Red-shouldered Macaw	Maracanã-pequena	6
	Eupsittula aurea	Peach-fronted Parakeet	Periquito-rei	15
	Eupsittula cactorum	Cactus Parakeet	Periquito-da-caatinga	12
	Eupsittula sp.	–	–	1
	Forpus coelestis	Pacific Parrotlet	Tuim-peruano	1

to be continued...

Continuation of the table 1

Family	Species	English name	Portuguese name	Records
	Forpus xanthopterygius	Cobalt-rumped Parrotlet	Tuim	3
	Guaruba guarouba	Golden Parakeet	Ararajuba	6
	Myiopsitta monachus	Monk Parakeet	Caturrita	7
	Pionites leucogaster	White-bellied parrot	Marianinha-de-cabeça-amarela	1
	Pionus maximiliani	Scaly-headed parrot	Maitaca-verde	4
	Pionus menstruus	Blue-headed parrot	Maitaca-de-cabeça-azul	3
	Primolius maracana	Blue-winged Macaw	Maracanã	9
	Psittacara leucophthalmus	White-eyed Parakeet	Periquitão	27
	Psittacus erithacus	Gray parrot	Papagaio-cinzento	1
	Pyrrhura frontalis	Maroon-bellied Parakeet	Tiriba-de-testa-vermelha	8
	Pyrrhura molinae	Green-cheeked Parakeet	Cara-suja-do-pantanal	1
	Thectocercus acuticaudatus	Blue-crowned Parakeet	Aratinga-de-testa-azul	1
Psittaculidae	*Agapornis fischeri*	Fischer's lovebird	Inseparável-de-Fischer	24
	Agapornis fischeri x personatus	–	–	7
	Agapornis fischeri x roseicollis	–	–	1
	Agapornis personatus	Yellow-collared lovebird	Inseparável-mascarado	19
	Agapornis personatus x roseicollis	–	–	5
	Agapornis roseicollis	Rosy-faced lovebird	Inseparável-angolano	18
	Agapornis sp.	–	–	1
	Agapornis sp. (unidentified hybrid)	–	–	1
	Eclectus sp.	Eclectus	Papagaio-eclético	3
	Lorius chlorocercus	Yellow-bibed Lory	Lóri-de-colar-amarelo	1
	Lorius garrulus	Chattering Lory	Lóri-das-molucas-setentrionais	1

to be continued...

Continuation of the table 1

Family	Species	English name	Portuguese name	Records
	Lorius lory	Black-capped Lory	Lóri-de-barrete-preto	1
	Melopsittacus undulatus	Budgerigar	Periquito-australiano	144
	Platycercus eximius	Eastern Rosella	Roselha-do-leste	6
	Psephotus haematonotus	Red-rumped parrot	Periquito-de-uropígio-vermelho	6
	Psittacula cyanocephala	Plum-headed Parakeet	Periquito-de-cabeça-roxa	1
	Psittacula eupatria	Alexandrine Parakeet	Periquito-alexandrino	1
	Psittacula krameri	Rosy-ringed Parakeet	Periquito-de-colar	26
	Trichoglossus haematodus	Coconut Lorikeet	Lóri-do-coqueiral	1
	Trichoglossus moluccanus	Rainbow Lorikeet	Lóri-arco-íris	3

The southeast region was the area with the highest number of records (n = 505), driven primarily by the states of São Paulo (n = 223) and Minas Gerais (n = 149). It was followed by the South (n = 177), Northeast (n = 142), Center-West (n = 98) and North (n = 60) regions (figure 2). A few observations (n = 14) lacked a defined region because the user selected area in iNaturalist was too broad, encompassing multiple states. These records were excluded from the geographical analysis.

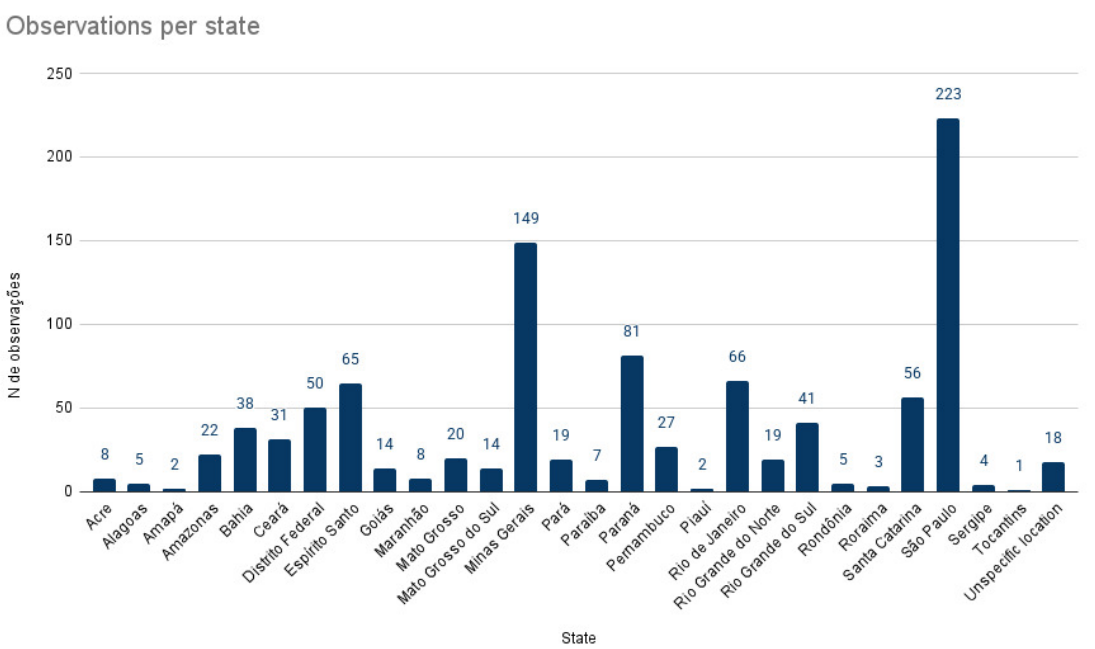

Figure 2 – Distribution of eligible observations through Brazilian states. The "Unspecific location" column comprises observations where the user-selected area was too broad to be assigned to a single state, but some could be attributed to a macroregion. Source: primary.

REGIONAL TRENDS

Brazil is divided into 5 macro regions: north, northeast, center-west, southeast and south (BRASIL, 1970), which vary significantly in climate, culture and avifauna. The distribution of records across these regions was heterogeneous: the southeast region was the most numerous (n = 505), followed by the south (n = 177), northeast (n = 142), center-West (n = 98) and north (n = 60). The disparity in observation density is expected for data sourced from citizen science platforms (GELDMAN *et al.*, 2016).

The distribution of native and exotic species, however, revealed significant trends (figure 3). A regional analysis shows that the north and northeast regions exhibited a greater proportion of native species being kept as companion animals. The center-west presented a near-even split, though with a slight prevalence of exotic species. In contrast, the south and southeast presented an overwhelming dominance of exotic species. While the national dataset showed a predominance of exotic species, this is likely biased by the overwhelming number of observations from the southeast. These trends highlight that the national pattern is not uniform and heavily influenced by regional disparities. The causes of such differences are unstudied but might be related to regional culture and local avifauna.

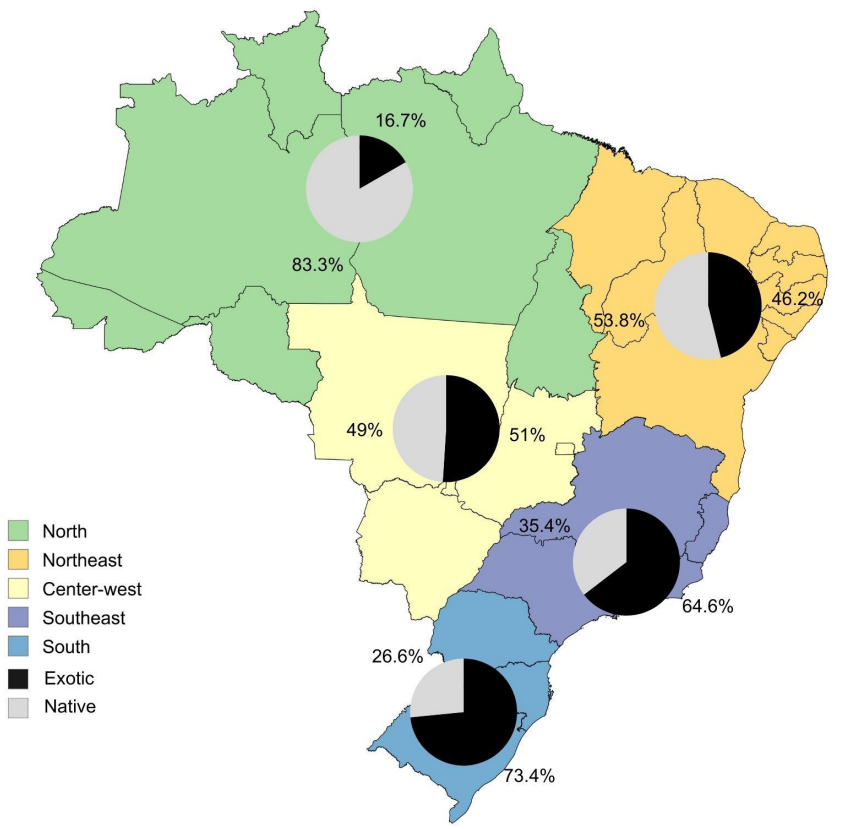

Figure 3 – Regional distribution of native and non-native species across Brazilian regions. Source: primary.

CITIZEN SCIENCE

Citizen science has been a strategic tool for the production of scientific knowledge in the field of biodiversity, principally through collaborative databases such as iNaturalist. The massive contribution of records creates unique opportunities for analysis at different scales, from local to global patterns trends (SILVERTOWN, 2009). However, the potential of these data directly depends on rigorous data processing and analysis, including filtering records and taxonomic validation (STEEN *et al.*, 2019; MATUTINI *et al.*, 2021). When properly processed, such information can complement

scientific information and fill in natural history gaps and even enhance the robustness of ecological inferences (BRADTER *et al*., 2018; CAPINHA *et al*., 2024; OZOLINA *et al*., 2025). Thus, platforms like iNaturalist become not only repositories of observations but dynamic data sources that, when subjected to careful analyses, can support highly relevant academic work.

SPECIES TRENDS

Cockatiels (*Nymphicus hollandicus,* n = 306) and budgerigars (*Melopsittacus undulatus*, n = 144) together represented almost half of all records. Their prevalence is likely explained by their status as domesticated species throughout Brazil (BRASIL, 2019), meaning the purchase, sale, and breeding of these birds does not require official documentation or government supervision.

Parrots from the genus *Amazona* spp. (n = 156), particularly the species *Amazona aestiva* (n = 81) and *Amazona amazonica* (n = 36), were also widespread throughout most states, both within and outside their native ranges. These species are commonly kept as pets throughout Brazil, as proven by Alves *et al.* (2010), Zardo *et al.* (2014) and Nascimento *et al.* (2023).

Most observations of native species (n = 284) occurred within their native ranges, with slightly more than a fourth of observations (n = 106) being recorded outside these regions. This trend had notable exceptions depending on the species. For instance, all observations of the endangered golden parakeet (*Guaruba guarouba*, n = 6) were found outside its native range. Similarly, the blue-and-gold macaw (*Ara ararauna*, n = 69) was primarily observed outside its native range, with 51 records beyond it, compared to 16 within and 2 of undetermined origin. Contrarily, highly prevalent species like the white-eyed parakeet (*Psittacara leucophthalmus*, n = 27), peach-fronted parakeet (*Eupsittula aurea*, n = 15), and yellow-chevroned parakeet (*Brotogeris chiriri*, n = 10) were recorded exclusively within their native ranges.

HYBRIDS AND COLOR MUTATIONS

The classification of some individuals warrants further discussion. Specimens identified as *Eclectus* sp. were maintained at the genus level due to a recent taxonomic split of the species (BRAUN *et al*., 2017), causing the captive populations to be made out of mostly hybrids (SWICEGOOD, 2003). Hybrids between macaw species *(Ara* spp.) and lovebird species (*Agapornis* spp.) were identified through comparison with descriptive references and visual confirmation (MCCARTHY, 2006; VAN DEN ABEELE, 2016). Additionally, some of the species analyzed had color mutations typical of captive breeding, including *Nymphicus hollandicus* (Cacatuidae); *Psittacula krameri*, *Platycercus eximius*, *Psephotus haematonotus*, *Melopsittacus undulatus*, *Agapornis roseicollis*, *Agapornis fischeri*, *Agapornis personatus* (Psittaculidae); *Bolborhynchus lineola*, *Forpus coelestis* and *Pyrrhura molinae* (Psittacidae). These were classified to species level based on comparisons to other relevant physical characteristics, aided by a guide to avian color mutations (MARTIN, 2002). Five instances were classified only to the genus level (*Amazona* sp., n = 3; *Eupsitulla* sp., n = 1; *Brotogeris* sp., n = 1) due to potential for hybridization, color aberrations that obscured species-level diagnostic features and/or poor photographic qualities.

CONCLUSION

This study demonstrates that the composition of parrots kept in Brazilian households is not homogeneous but defined by strong regional differences that divide in the prevalence of native and exotic species. The successful application of iNaturalist data shows the value of citizen science in mapping human-animal interactions on a national scale. These findings provide a critical evidence base for developing targeted public policies concerning wildlife trade, avian conservation, and animal welfare.

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