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Spot-billed toucanet *Selenidera maculirostris* (Aves: Ramphastidae): importance of citizen science and scientific data in investigating its occurrence in modified environments around the largest urban area in South America

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Toucans and toucanets are widely distributed in the Neotropical Region. Some species perform regional movements in search of food resources, but little is known about this behavior and the use of modified habitats. The spot-billed toucanet *Selenidera maculirostris* is endemic to the Atlantic Forest of Brazil, Paraguay, and Argentina. The species is threatened with extinction in the state of São Paulo (Brazil) due to deforestation. We compiled historical and current data on the occurrence of the species in the São Paulo Metropolitan Region (SPMR), the largest urban area in South America, to investigate the hypothesis that this species performs seasonal regional movements between preserved forests and modified areas during the autumn and winter. Data from the literature, online platforms, and a 17-year field study produced a total of 200 records since 1889, for 45 locations, indicating that the species has a wide occurrence in the SPMR, being common to the Serra do Mar. It occurs in the preserved forests of the southern portion of the SPMR throughout the year and is more common in the altered and fragmented forests near the Serra do Mar in autumn–winter. These possible seasonal movements between more preserved areas and altered areas are probably in search of food, a behavior that needs further study since the forests of the SPMR have been rapidly destroyed in recent years.

KEYWORDS

Brazil, São Paulo, Serra do Mar, birds, threatened species, endemic species

Introduction

The family Ramphastidae includes five different genera and 36 species of toucans and toucanets that are spread widely throughout the Neotropical Region. They occupy a variety of habitats, with some species performing seasonal, regional, and altitudinal movements in search of food resources. Representatives of different genera that carry out such regional movements include the white-throated toucan *Ramphastos tucanus*, chestnut-eared aracari *Pteroglossus castanotis*, and yellow-eared toucanet *Selenidera spectabilis*, the behaviors of which remain poorly understood (Winkler et al., 2020).

The genus *Selenidera* includes six species, five of which are found in Brazil (Pacheco et al., 2021). The spot-billed toucanet *Selenidera maculirostris* is the sole representative of the genus in the Atlantic Forest, to which it is endemic (Vale et al., 2018). The species is discrete and somewhat elusive (It vocalizes little and at specific times of the day, generally at dawn and dusk, and does not have a very agitated movement behavior, actively moving between the trees), occurring in large, dense, humid forest patches. Juçara palm (*Euterpe edulis*) fruits are among the main food sources of this toucanet, which also feeds on other types of fruits, invertebrates, and small vertebrates. These birds usually occur alone or in male–female pairs in the mid strata of the forest, but often gather in small groups during the fruiting period of some plants, including palm trees (Goeldi, 1894; Sick, 1997; Sigrist, 2006; Short, 2021).

Originally with a wide geographical distribution in the state of São Paulo, in the southeastern part of Brazil, *Selenidera maculirostris* was extinguished from the forests of the interior of the state beginning in the 1970s due to extensive deforestation and forest fragmentation, leaving it restricted to forests of the eastern part, mainly in the Serra do Mar (Willis, 1979; Magalhães, 1999; Willis and Oniki, 2003). This habitat reduction and the low number of field records earned this species a classification as Vulnerable in the list of animals threatened with extinction in the state of São Paulo (São Paulo, 2018). The species has been regularly reported in the forests surrounding the São Paulo Metropolitan Region (SPMR), in the eastern part of the state, since 1889, including some individuals within the urban area (Almeida et al., 2003; Willis and Oniki, 2003). Pinto (1945) attributed the presence of a single individual at an urban site within the city of São Paulo in June 1943 to the relative proximity of large forest patches surrounding the city (Serra da Cantareira to the north and Serra do Mar to the south). Another hypothesis suggested by Pinto is that the individual was observed during the coldest period of the year (June) and was probably performing some sort of migratory movement from Serra do Mar. The same author noted the same pattern for other bird species at the same location, such as the Pileated Parrot *Pionopsitta pileata*.

As SPMR is the largest urban area in South America, with approximately 21.5 million inhabitants (IBGE, 2023), and a high current rate of deforestation and environmental degradation (Natalini, 2020), we organized available data (scientific and citizen science) and produced field data to better understand the current geographic distribution of *S. maculirostris* in this region of the state of São Paulo and the possible movements described by Pinto (1945), thus contributing to the natural history, ecology, and conservation of this Atlantic Forest endemic.

Materials and methods

Study area

The SPMR is in the eastern portion of the state of São Paulo in southeastern Brazil (Figure 1). It is the largest urban area in South America, with 39 municipalities and ca. 21.5 million people (IBGE, 2023). Mostly within the Atlantic Forest domain, SPMR is surrounded by areas with native vegetation forming a green belt recognized as an Atlantic Forest Biosphere Reserve (Costa, 1997). There are also numerous forest fragments of various sizes within SPMR that are partially protected, including Fontes do Ipiranga State Park (526 ha) (Figure 1). The considerably large forest fragments within SPMR contribute to its high biodiversity, with approximately 650 bird species (Willis and Oniki, 2003; Figueiredo, 2020). The existing vegetation cover of most of the SPMR is composed of fragments of native vegetation, including forests and open areas (São Paulo, 2002).

Three regions located in southern and northern SPMR deserve to be highlighted, namely, Núcleo Curucutu and Morro Grande Reserve in the south and Serra da Cantareira in the north, because those are large areas of forest in the SPMR (Figure 1). Núcleo Curucutu is one of 10 different administrative regions of Serra do Mar State Park (23°59′12.38″S, 46°44′07.70″W) and encompasses an area of 36,134 ha in southern SPMR. The altitudinal gradient ranges from 5 to 1,050 m and possesses a mosaic of habitats (Garcia and Pirani, 2003; Pessenda et al., 2009). According to Tarifa and Armani (2000), the climate of the region is tropical super humid on the reverse of the Atlantic Plateau and tropical oceanic super humid on the eastern facade. Temperatures vary between a low of 0°C (winter) and a high of 34°C (summer), with annual rainfall ranging from 3,497 to 4,435 mm, as measured between 2008 and 2011 (Malagoli, 2013). Morro Grande Reserve (23°44′5.38″S, 46°57′51.55″W; 966 m elevation) is located in southwestern SPMR and encompasses 10,000 ha of predominantly Dense Montane Ombrophilous Forest. The Cantareira region (23°23′04.98″S, 46°34′31.48″W; 1,039 m elevation) possesses four state parks: Cantareira (7,900 ha), Alberto Löfgren (187 ha), Itapetinga (10,193 ha), and Itaberaba (15,200 ha). The relief ranges from 750 to 1,250 m, and the vegetation is predominantly Dense Montane Ombrophilous Forest. To the north of the Cantareira region is Serra do Japi, a large natural area partially protected by the Serra do Japi Biological Reserve (2,071 ha). The climate is mesothermal and humid, with rainy summers and dry winters (CWA Köppen),

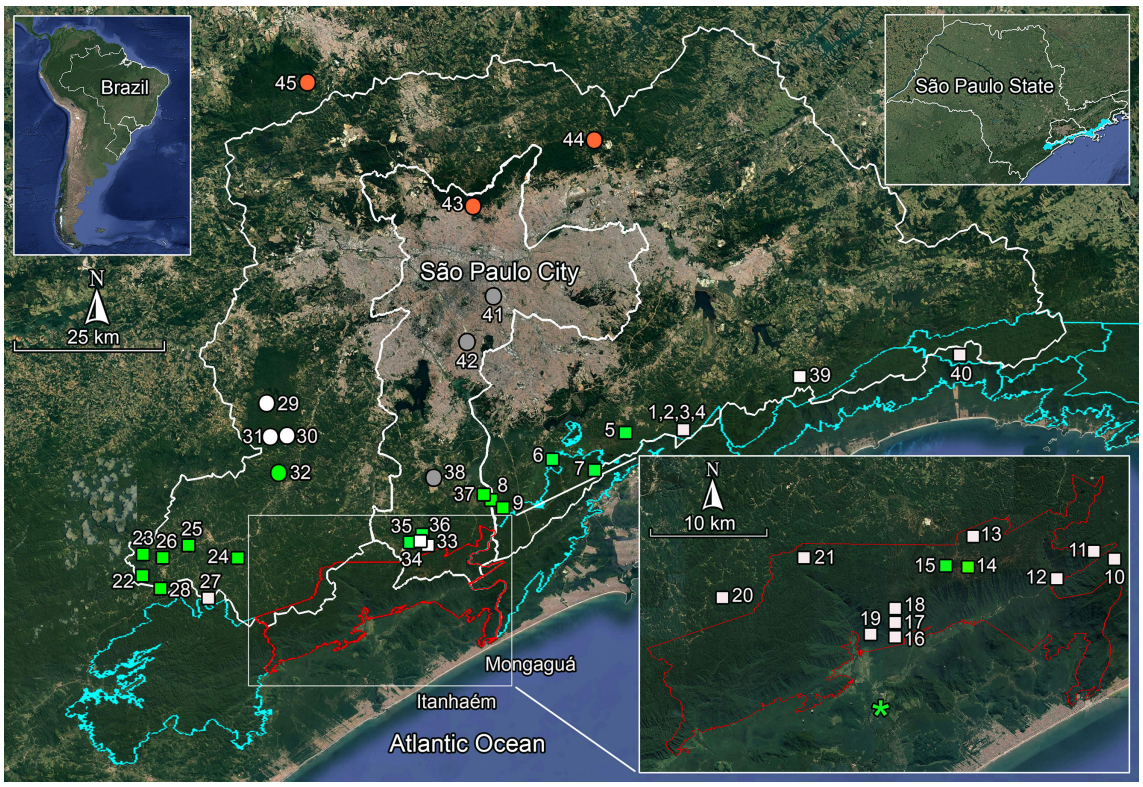

FIGURE 1
Records for *Selenidera maculirostris* in the São Paulo Metropolitan Region (SPMR). The larger and smaller white-bordered regions represent the SPMR and the municipality of São Paulo, respectively. The blue border represents the Serra do Mar State Park (PESM), with emphasis on the Núcleo Curucutu bordered by red. Geographic distribution: squares indicate records located in Serra do Mar (the region closer to the Atlantic slope), while circles indicate those located outside Serra do Mar (region farther from the Atlantic slope). Environment: white points indicate records in Southern native forest, green points in countryside/forest edge, orange in Northern forests, and gray in Urban environments (Supplementary Material 1). The asterisk indicates the location of "Estrada do Rio Mambú", in Itanhaém. Locality 20 is outside the limits of the Núcleo Curucutu, as it has not yet been officially included as part of the reserve. Source: Google Earth (Image Landsat/Copernicus 2023).

with annual temperature and rainfall averaging 20°C and 1,500 mm, respectively (Bencke et al., 2006) (Figure 1).

Ornithological data from the literature and online platforms

We gathered information from scientific journals and books and through searches on the web portals Web of Science, Scopus, and Google Scholar, using Boolean operators AND, OR, and NOT. We used scientific and popular (in English and Portuguese) names as keywords (Serra do Mar, Serra da Cantareira, Morro Grande, São Paulo, Mata Atlântica/Atlantic Forest, Região Metropolitana de São Paulo/Metropolitan Region of São Paulo) in the searches within the different web portals. Until 13 April 2024, we consulted the scientific collections of Museu de Zoologia da Universidade de São Paulo (MZUSP) and the online data platforms eBird (ML https://ebird.org - eBird Basic Dataset, 2021), WikiAves (WA—https://www.wikiaves.com.br), and Xeno-Canto (XC—https://www.xeno-canto.org). Repeated records (same locality and date) from the online platforms and/or the literature (i.e., duplicates) were not considered.

Field data

The authors FS and MAR, and auxiliary researchers, gathered information between 2007 and 2011 in 10 areas of Núcleo Curucutu during 18 different field trips. Each area was sampled four times per year (one campaign of 3 days in each season), with the simultaneous use of three different survey methods—point counts, mist nets, and visual observations—for a total of 306 days of survey work covering the main types of vegetation and different altitudes within the park. Thirteen additional summer trips were made in the month of March (average of 7 days each) of 2012 and 2024 in the "Campos" area of Núcleo Curucutu, using the same methods as used in the initial sampling, for a total of 97 days of survey work. During this period, another 25 days of additional visual observation were carried out in a variety of locations, including areas that were not sampled in the systematic study. The 10 areas selected for the systematic and standardized study were sampled by 5-point counts (in line), separated spatially by 100 m and temporally by 10 min (at dawn, for three consecutive days per expedition and the same points throughout the study period), which added 1,319 point counts (samples) for a total of 219.5 census-hours. Twenty mist nets (30

mm mesh; 12 m × 2 m, four bags) were distributed along 2 lines with 10 nets each and were left open all day for a total of 125,717 net-hours. Captured birds were marked with metal bands from CEMAVE/ICMBio (National Center for Research and Conservation of Wild Birds) and released after biometric measurements and ectoparasite evaluation. The visual observation method consists of observations made entirely during the field period, without a predetermined time or location such as with point counts.

The author MLSR obtained additional field data from occasional sightings approximately 3 km from Núcleo Curucutu, where he has resided and observed birds continuously since 2015.

Data organization and analysis

The records were organized into three data groups:

Group 1 refers to geographic location: "Serra do Mar", for locations in or near the main forest block of Serra do Mar, and "outside Serra do Mar", for locations outside this region. These definitions were based on satellite images from the platform Google Earth Pro (https://www.google.com.br/earth/) (Figure 1; Supplementary Material 1).

Group 2 refers to environment type: "Southern native forests" and "Southern altered forests" are forests located in the central-southern portion of SPMR, of which "native forests" are primary forests (not deforested) and "altered forests" are secondary forests, including small forest fragments (less than 100 ha) that have suffered some type of impact, such as partial logging, being forests of smaller size and more light, with more clarity inside the forest. "Northern forests" are forests in the northern region of SPMR, formed by Serra da Cantareira and Serra do Japi reserves, including primary and secondary forests. "Urban" includes urban areas of the city of São Paulo. Environment types were determined through field visits by the authors (Figure 1; Supplementary Material 1).

Group 2 (3) consists of the five locations in the southern region of SPMR that have a greater amount of field information on *S. maculirostris* than the others, because they are data from citizen science. Morro Grande, Espinheiro Negro, and Paranapiacaba are some of the most visited locations by bird watchers and photographers in SPMR, with hundreds of species lists and records available on online platforms (eBird, 2024; WikiAves, 2024). Núcleo Curucutu is the only location in SPMR that has long-term systematic and scientific field data on *S. maculirostris*, obtained between 2007 and 2024, including capture and recapture data from mist netting (Figure 1; Supplementary Material 1).

Data from both groups were presented in Microsoft Excel© graphs, subdivided by season, namely, autumn, winter, spring, and summer. Autumn and winter are colder and drier, while spring and summer are warmer and wetter, in southeastern Brazil. Each graph considered the number of records suitable for the respective use, hence the difference between the number of records used in each approach.

Results

We compiled a total of 200 records of *S. maculirostris* for SPMR between 1889 and 2024 for 45 localities and 15 of the 39 existing municipalities. Of this total, 91 were published by different traditional sources (e.g., scientific articles); 100 were available from online platforms (eBird, WikiAves, and Xeno-Canto); two were from third parties (people); and seven were unpublished field records made by the authors. One literature record (Almeida et al., 2003; locality 42) and one unpublished record (locality 38) refer to birds that were found inside homes in urban areas. Twenty-five of the 45 locations with records are in protected reserves, of which 21 are in eight public reserves and 4 are in two private reserves (Figure 1; Supplementary Material 1).

Field data for *S. maculirostris* include 71 records for Núcleo Curucutu, obtained between 2007 and 2021. The species was registered at least once during each of the first 18 fieldtrips (between 2007 and 2011), especially in Dense Ombrophilous Forest formations, with an atypical record in a region of natural fields (locality Campos) of a bird moving between cloud forests. The species was found at 7 out of 10 localities within the park during this first survey period. The altitudes of these records range from 15 to 820 m. Fifty-one of the 71 records made at Núcleo Curucutu were visual, auditory, or both, and on 20 occasions, a total of 15 individuals were netted among four localities (localities 14, 16, 17, and 18; Figure 1; Supplementary Material 1). On these occasions, the 15th individual was banded, four of which were recaptured at the original locality (one individual twice), but on different dates. The species was recorded at two other localities between 2012 and 2022: locality 34 in October and locality 10 in December, both in 2015 (Supplementary Material 1).

The author MLSR and his family made seven records (pairs or small groups) of *S. maculirostris* between 2020 and 2024, except 2022, in the months of March and April (autumn), on the farm where they reside on Boa Vista road, 3 km north of Núcleo Curucutu (Figure 1; Supplementary Material 1). The individuals were feeding on the fruits of Bangalow palm (*Archontophoenix cunninghamiana*) and of a type of persimmon (*Diospyros* spp.). Both the palm tree and the persimmon are non-native plants in Brazil. Although the area was full of Juçara palms, they did not possess any fruit when the toucanets were registered. MLSR continued to record *S. maculirostris* for consecutive days (e.g., five, six) until the end of fruiting. The birds were always observed feeding on the same plants during the 4 years of observation.

Two other records by third parties are worth mentioning. The first was in May 2018 at Ponte Seca road, a rural region with connectivity to the Serra do Mar forest matrix. This record was of a female feeding at a local bird feeder. The second record was of another adult female, which was rescued by environmental police in the Vargem Grande neighborhood, an urban area located just 8 km from the main urban area of the city of São Paulo (Figure 1; Supplementary Material 1).

Of the total number of records of *S. maculirostris* obtained for SPMR (200), 79% (n = 158) are for the geographic location of Serra

do Mar (proportional records for the four seasons of the year) and 21% (n = 42) for the geographic location of outside Serra do Mar (records for the four seasons of the year, because of the data from Morro Grande Reserve, but with a slightly greater concentration in autumn–winter) (Supplementary Material 1; Figure 2). When environment type within SPMR is also considered, the southern forests have 193 records with 67% (n = 129) for Southern native forests (Serra do Mar and Morro Grande, high and dense forests), with occurrence in the four seasons of the year, and 33% (n = 64) for Southern altered forests (including forest fragments and open and anthropic environments), with predominant occurrence in autumn–winter. Northern forests (Serra da Cantareira and Serra do Japi) had 2% (n = 4) of the records, with occurrence restricted to autumn, as did Urban sites (2%, n = 3, main urban and satellite region), with occurrence restricted to autumn–winter (Figure 3; Supplementary Material 1).

There were varied occurrences among the five locations in SPMR with the most records of *S. maculirostris*. Records for Núcleo Curucutu (Serra do Mar), the largest, most natural, and best-preserved forest area in SPMR (location with the most available data), are common and proportional throughout the four seasons of the year. Records for Morro Grande (an area far from the main block of the Serra do Mar), one of the largest and best-preserved forest fragments in SPMR, are more frequent in the winter and spring, but in smaller numbers during all seasons of the year. Records for Espinheiro Negro, also in the Serra do Mar but in a rural and partially fragmented area (approximately 1,500 m from the most preserved main area), are concentrated in winter and autumn, being less common in spring and especially in summer. Records for Paranapiacaba, also in Serra do Mar but in marginal environments and continuous with the more preserved area, are also concentrated in autumn and winter, with no detections in spring and few in summer. Lastly, records for Estrada da Bela Vista, also in Serra do Mar but in a rural and fragmented area, where the author MLSR lives, are practically exclusive to autumn, with the only summer record being made in the last 2 days of that season (March 18), when the climate is already more similar to the next season—autumn (Figures 1, 4; Supplementary Material 1).

Discussion

Selenidera maculirostris is widely distributed throughout the São Paulo Metropolitan Region, where it has been documented since the end of the 19th century. Most records of it, including quantitative and biological data, were obtained in the Serra do Mar region (region near the Atlantic slope) via ornithological field research, such as the long-term work developed at Núcleo Curucutu of Serra do Mar State Park (Schunck et al., 2019). However, bird watchers and photographers have been increasingly contributing to the generation of data on the occurrence of the species in SPMR over the last 10 years, including locations with unpublished records (eBird, 2024; WikiAves, 2024; Xeno-Canto, 2024).

The available data show that *S. maculirostris* is a typical and resident species of Serra do Mar, where most of its historical and current records are concentrated. This finding was expected, given the size and excellent conservation status of the forest in this area of the state of São Paulo. Additionally, 55.5% of the records were made in protected reserves, which is a good sign for an endangered species that occurs in a region with constant deforestation (Natalini, 2020). Nonetheless, the protected natural areas of SPMR need to be expanded to protect this and dozens of other threatened species of the state of São Paulo (Bressan et al., 2009; São Paulo, 2018).

The finding of only three records for Cantareira leads to three main explanations. The first is imperfect detection, as mentioned by Tonetti et al. (2017), of a species that has always been resident in the region. However, Cantareira is one of the most visited locations by researchers and bird watchers in southeastern Brazil, which reduces the chances of a resident species going unnoticed, even if it is elusive. The second explanation is that the population is small and not very dense and thus difficult to detect in the field. This scenario

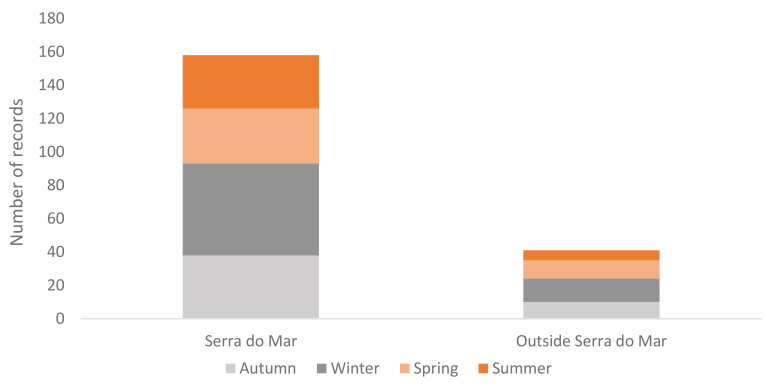

FIGURE 2
Number of *Selenidera maculirostris* records per season for group 1 data, which represents the geographic location. Autumn and winter are colder and drier, while spring and summer are warmer and wetter in southeastern Brazil. The number of records on the *y*-axis represents the total number of records obtained for this data category.

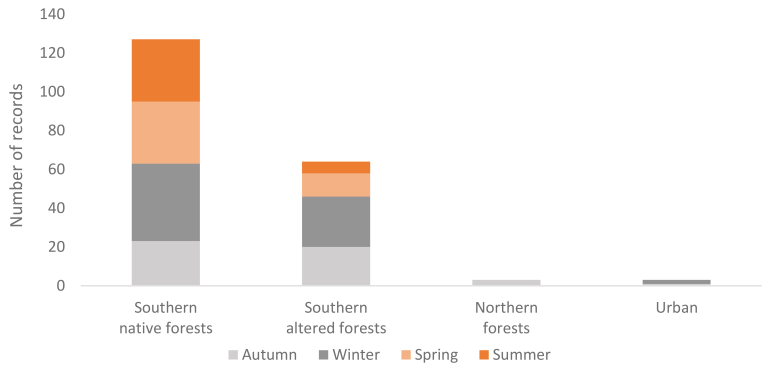

FIGURE 3
Number of *Selenidera maculirostris* records per season for group 2 data, representing habitat type. Autumn and winter are colder and drier, while spring and summer are warmer and wetter, in southeastern Brazil. The number of records on the *y*-axis represents the total number of records obtained for this data category.

is possible given that the Cantareira region has been deforested in the past (Tonetti et al., 2017). The third explanation is that its presence is due to the seasonal movement of birds from the Serra do Mar during the autumn–winter period of southeastern Brazil (between March 20 and September 23), as mentioned by Pinto (1945), and that the local population had gone extinct prior to the 1970s, when extinctions of this species are mentioned for forest fragments in the interior of the state of São Paulo (Willis, 1979; Magalhães, 1999; Willis and Oniki, 2003). This explanation is supported by the period of the year when the three available records were made. In 1965, six individuals were collected on two different days in early June (winter); individuals generally live alone or in pairs and usually gather in small groups such as this only when there is an abundant food source (Goeldi, 1894; Sigrist, 2006; Short, 2021). The 2010 record was made between 20 and 29 April, at the beginning of autumn, although there are no further details about the number of birds observed (DERSA, 2010; Tonetti et al., 2017). These three explanations also apply to the recent record made in Serra do Japi (May 2018), approximately 30 km north of Serra da Cantareira.

When present, *S. maculirostris* is relatively easy to detect. The species was recorded on all 18 trips to Núcleo Curucutu between 2007 and 2011, and 82% of the recorded individuals were either heard or seen, while 18% of the records were from mist nets. Although the species tends to vocalize little and more often low at dusk, its croaking vocalization is very characteristic and easily distinguished from other Atlantic Forest toucan and toucanet species (Sigrist, 2006; Short, 2021).

The Morro Grande Forest Reserve, located in a region intermediate between the southern and northern forests, also draws attention due to the occurrence of *S. maculirostris*. The species was not detected by the 2001–2003 field study conducted by Develey and Martensen (2006), who attributed its absence in the region to the poor quality of the environment (part of the region comprised secondary forests) and low food availability (fruits), mainly the low density and presence of young Juçara palm plants.

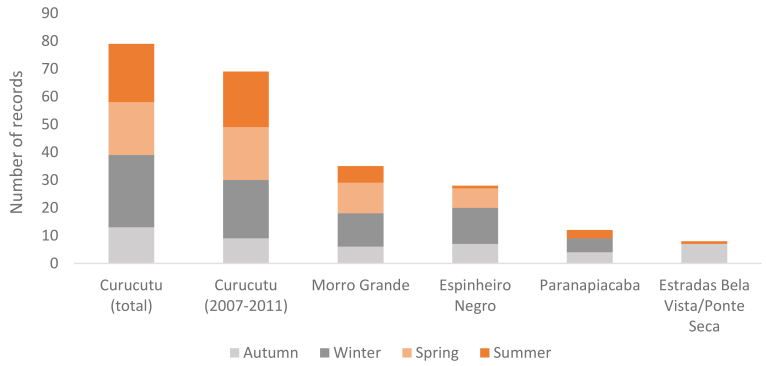

FIGURE 4
Number of *Selenidera maculirostris* records per season for group 3 data (the five locations with the most field records). Núcleo Curucutu is shown according to two different sets of data—one of total records and one for records obtained between 2007 and 2011. The number of records on the *y*-axis represents the total number of records obtained for this data category.

However, beginning in 2016, 13 years later, the species began to be detected continuously by bird watchers, which may indicate an improvement in the quality of the environment (more mature forests) and an increase in food availability, mainly adult Juçara palm plants, which are currently found in greater quantities. The available data indicate that *S. maculirostris* may be a resident species in the region, although the greater number of records in winter and autumn suggests some type of movement, perhaps the arrival of more individuals from other regions, something that needs further investigation.

The few occurrences in urban environments (3), including one detection in 1943 by Pinto (1945), lead us to believe that these were free-living birds moving outside their typical habitat of dense and humid forests, as this bird is not captured to serve as a pet.

The low number of records for the urban area of SPMR hinders rigorous testing of the hypothesis of the seasonal presence of *S. maculirostris* in urban areas during autumn and winter, which would characterize the possible seasonal movement proposed by Pinto (1945), even though all records were made in the autumn–winter period, indicating this possibility. The records for the SPMR indicate a proportional occurrence among the seasons of the year for both the Serra do Mar and the region outside the Serra do Mar, indicating that the species is resident in the SPMR. However, when only records from the southern forests of the SPMR are considered, a pattern of proportional occurrence during the seasons of the year is observed for well-preserved areas, but greater occurrence during the autumn–winter period in altered forests. This pattern is even clearer when considering the locations with the most records in Serra do Mar. In Núcleo Curucutu, the species is common in all four seasons of the year, but in adjacent continuous forests (surrounded by anthropized areas) and in forest fragments close to the main preserved matrix, there is a greater occurrence in autumn–winter. Isolated examples, such as Espinheiro Negro and Paranapiacaba, where most records occur during the autumn–winter period, indicate potential regional movement. Especially notable is Estrada da Bela Vista, where in recent years, birds have been appearing only in autumn, with one record in the last days of the season, likely in search of food resources (Figure 4; Supplementary Material 1).

Regional movement has been observed for different species of frugivorous birds, including ramphastids (Sick, 1997; Short, 2021; Winkler et al., 2020). There are fewer fruiting plants in autumn–winter in the Atlantic Forest of southeastern Brazil (Lorenzi, 2002a, b), which forces many frugivorous species to move regionally in search of resources (Sick, 1997). Exotic plants that bear fruits during autumn and winter in rural areas may favor regional movements of *S. maculirostris*, as well as other bird species, since these fruits are an extra food resource during the harshest period of the year for survival.

Considering the time of the year of records of *S. maculirostris* for SPMR made outside the tall, dark, and humid forests of Serra do Mar, its typical habitat, suggests seasonal movements. Together, the urban records made in autumn and winter, records for the northern region made in autumn, two records for Curucutu outside the preserved forest in an open and altered environment made in autumn and winter, and the records from Estrada da Bela Vista made in autumn, including a record of a roadkill bird on Estrada do Mambú (MZUSP 92445) near banana plantations approximately 7 km from the continuous forest of the lower portion of Núcleo Curucutu (Figure 1), reveal a certain frequency of birds moving through different environments in the driest and coldest period of the year in southeastern Brazil (when they are not reproducing), that is indicative of regional movements.

Although the records presented here indicate regular seasonal movements for *S. maculirostris* during the coldest months of the year, the low number of records outside Serra do Mar reveals that it may only be part of the population that moves. A similar observation was reported for the *S. spectabilis* in Central America (Short, 2020). All individuals of *S. maculirostris* recorded outside Serra do Mar were adults, which rules out the possibility that only young birds looking for new territories wander out of the main forest regions. Still, another issue that deserves future study is the types of displacements made by *S. maculirostris* between the Atlantic slope and the coastal plain of the state of São Paulo.

The movements carried out by some species of the family Ramphastidae are still little known and studied (Winkler et al., 2020). The increasing destruction of the last unprotected forest remnants in SPMR, which has more than 20 million human inhabitants, is the biggest issue regarding the *S. maculirostris* population therein. This scenario may further compromise the use of those last habitats as areas for food, rest, and even as "springboards" during their movements during the coldest periods of the year. This environmental issue may not only prevent future studies of *S. maculirostris* but also hinder the conservation of the rich biodiversity that exists and is already widely threatened in this region of the eastern part of the state of São Paulo (Malagoli et al., 2008; Bressan et al., 2009; Natalini, 2020).

Conclusions

Selenidera maculirostris has been known to be part of the avifauna of the São Paulo Metropolitan Region for 125 years. Therein, the species occurs between 15 and 1,250 m elevation and occupies mostly tall and dark forests but may also occasionally use different types of habitats, including cloud forests and rural and urban areas. The species can be found year-round along the forest matrix of Serra do Mar. At least part of the population from Serra do Mar performs seasonal regional movements during the autumn–winter period to small urban green areas in the plateau. Future research is needed to better understand aspects of the natural history of this toucanet and explore whether it performs seasonal movements in search of food or for climatic reasons. We recommend that this species be kept on the list of endangered animals of the state of São Paulo due to increasing deforestation in different regions of the São Paulo Metropolitan Region.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The requirement of ethical approval was waived for studies involving animals because the data used are from literature, field observations, and other research projects. The studies were conducted in accordance with the local legislation and institutional requirements.

Author contributions

FS: Conceptualization, Investigation, Data curation, Formal Analysis, Project administration, Writing – original draft, Writing – review & editing. MLSR: Investigation, Data curation, Writing – review & editing. MAR: Investigation, Data curation, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declare that no Generative AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fbirs.2025.1534188/full#supplementary-material

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Supplementary Material

Supplementary Material 1. Records for *Selenidera maculirostris* in the São Paulo Metropolitan Region. The "Nº" column corresponds to the localities in Figure 1. The "Locality" shows the names in Portuguese. The "Region" column indicates the geographic location and type of environment of the record: 1. Serra do Mar, 2. Outside Serra do Mar, 3. Southern forests, 4. Southern native forests, 5. Southern altered forests, 6. Northern forests and 7. Urban environments. The "Season" column indicates season of the year: spring, summer, winter, autumn. The "Documentation" column contains number(s) for available museum specimens (MZUSP), images (WA), vocalization recordings (XC), lists (S) and recordings by authors F.S., M.L.S.R. and M.A.R. The band numbers (M or N) for birds captured and marked in the Núcleo Curucutu are given with indication of capture (C) or recapture (R) in parentheses, and if there was visual and/or auditory observation (O) on the same date; Núcleo Curucutu records without these indications were only visual or auditory observations. Empty spaces in the "Source" column indicate the same source as the previous record (above) in the column.

N°	Locality	Coordinates Geographic	Alt a.s.l.	Municipality	Region	Season	Date (M/D/Y)	Documentation	Author/Collector	Source
1	Alto da Serra	23°46'37.16"S 46°19'53.53"W	770	Santo André	1,3,4	winter	08/09/1899	MZUSP314-315	João Lima and Adolph Hempel	Willis and Oniki 2003
					1,3,4	winter	July/1904	MZUSP4772	João Lima	Willis and Oniki 2003
	Estação Biológica de Alto da Serra de Paranapiacaba				1,3,4	winter	06/25/2015	S24059311	eBird list	eBird
2	Paranapiacaba	23°46'40.33"S 46°18'3.95"W	808	Santo André	1,3,4	summer	03/14–15/2009		Centro de Estudos Ornitológicos	CEO 2014
					1,3,4	autumn	04/14/2013	WA934623	Andreas Oberhuber	WikiAves
	Paranapiacaba - Vila				1,3,4	winter	06/23/2015	WA1740785	Jose Souza	WikiAves
3	Paranapiacaba - Parque Natural Municipal Nascentes de Paranapiacaba - Trilha do Mirante	23°47'10.30"S 46°18'6.02"W	1.009	Santo André	1,3,4	summer	03/15/2009	S33542298 WA12147	eBird list Emerson Kaseker	eBird Wikiaves
					1,3,4	winter	06/14/2015	WA1726252	Ivan M. Campos	WikiAves
					1,3,4	autumn	05/13/2018	WA2972154	João Dantas	WikiAves
					1,3,4	winter	06/21/2019	S57569234 XC482969	eBird list Marcelo Feliti	eBird
					1,3,4	winter	06/09/2021	S89944792	eBird list	eBird

4	Paranapiacaba - Estrada do Taquarussu	23°46'8.21"S 46°17'14.24"W	910	Santo André	1,3,4	autumn	04/14/2013	S98984456	eBird list	eBird
					1,3,4	autumn	05/25/2013	S98984487	eBird list	eBird
					1,3,4	winter	08/10/2017	S38656799	eBird list	eBird
					1,3,4	summer	02/29/2020	S67021023	eBird list	eBird
5	Rio Grande da Serra	23°46'36.34"S 46°24'12.40"W	781	Rio Grande da Serra	1,3,5,	summer	03/17/2018	S46825549	eBird list	eBird
6	Núcleo Itutinga-Pilões do PESM - Trilha da Barragem	23°49'10.81"S 46°31'19.44"W	734	São Bernardo do Campo	1,3,5	winter	07/30/2016	S30944735	eBird list	eBird
7	Núcleo Itutinga-Pilões do PESM - Estrada do Sangradouro	23°50'11.74"S 46°27'37.02"W	739	São Bernardo do Campo	1,3,5	winter	07/27/2019	S58524812	eBird list	eBird
					1,3,5	summer	03/16/2023	S131111787	eBird list	eBird
					1,3,5	autumn	04/21/2023	S134572179	eBird list	eBird
					1,3,5	autumn	05/12/2023	S137550603	eBird list	eBird
8	Curucutu (bairro na região do rio Curucutu)	23°53'S 46°37'W	747	São Bernardo do Campo	1,3,5	winter	August and September/1907		Steindachner	Willis and Oniki 2003, Schunck et al. 2019
9	Próximo da Estrada do Capivari	23°53'39.9"S 46°35'47.9"W	755	São Bernardo do Campo	1,3,5	summer	03/19/2022	S105217255	eBird list	eBird
10	Núcleo Itutinga-Pilões do PESM - Região dos túneis 18 e 19 da Estrada de Ferro Sorocabana (Mairink-Santos)	23°58'17.03"S 46°35'44.77"W	588	São Paulo/São Vicente	1,3,4	summer	12/03/2015		Fabio Schunck, Leo Malagoli, João Bosco	Schunck et al. 2019
11	Núcleos Curucutu e Itutinga-Pilões do PESM - Estação Ferroviária Engenheiro Ferraz (Estrada de Ferro Sorocabana/Mairink-Santos)	23°58'28.7"S 46°37'05.5"W	630	São Paulo/São Vicente	1,3,4	autumn	05/26/1964	MZUSP54858	A. M. Olalla	Willis and Oniki 2003, Schunck et al. 2019

					1,3,4	autumn	05/27/1964	MZUSP54859-54863	A. M. Olalla	
					1,3,4	autumn	05/31/1964	MZUSP54864	A. M. Olalla	
					1,3,4	autumn	06/06/1964	MZUSP54865	A. M. Olalla	
					1,3,4	winter	09/14/1964	MZUSP56595-56596	A. M. Olalla	
					1,3,4	winter	09/21/1964	MZUSP56597-56600	A. M. Olalla	
					1,3,4	winter	09/08/1965	MZUSP60598-60599	A. M. Olalla	
12	Núcleo Curucutu do PESM - Capivari	23°59'58.3"S 46°39'07.6"W	51-100	São Paulo	1,3,4	spring	10/21/2010		F. Schunck et al.	Schunck et al. 2019
					1,3,4	spring	10/22/2010			
					1,3,4	winter	09/17/2011			
					1,3,4	spring	10/21/2010			
13	Núcleo Curucutu do PESM - Rua sem nome	23°57'43.0"S 46°43'10.1"W	705-780	São Paulo	1,3,4	spring	11/13/2010		F. Schunck et al.	Schunck et al. 2019
					1,3,4	spring	11/15/2010			
14	Núcleo Curucutu do PESM - Campo	23°59'36.8"S 46°43'58.2"W	780-820	São Paulo	1,3,5	autumn	05/02/2010	N08768 (C)	F. Schunck et al.	Schunck et al. 2019
15	Núcleo Curucutu do PESM - Sede planalto	23°59'8.93"S 46°44'34.61"W	791	São Paulo	1,3,5	winter	06/25/2015	S24054168	eBird list	eBird, São Paulo 2018b
16	Núcleo Curucutu do PESM - Cota 30	24°02'27.2"S 46°46'35.6"W	15-78	Itanhaém	1,3,4	summer	12/02/2007	M00846 (C,O)	F. Schunck et al.	Schunck et al. 2019
					1,3,4	summer	12/03/2007	M00848 (C)		
					1,3,4	winter	09/18/2008			
					1,3,4	winter	09/19/2008			
					1,3,4	summer	12/28/2008			
					1,3,4	summer	12/29/2008			

					1,3,4	summer	12/30/2008	M00848 (R,O)		
					1,3,4	summer	02/19/2009			
					1,3,4	winter	09/07/2009			
					1,3,4	winter	09/09/2009			
					1,3,4	autumn	05/18/2010			
					1,3,4	spring	11/22/2010	M00848 (R,O)		
					1,3,4	spring	11/25/2010			
17	Núcleo Curucutu do PESM - Cota 200	24°01'57.7"S 46°46'40.1"W	143-352	Itanhaém	1,3,4	autumn	05/19/2008		F. Schunck et al.	Schunck et al. 2019
					1,3,4	autumn	05/20/2008			
					1,3,4	winter	09/17/2008			
					1,3,4	summer	01/03/2009	N08764 (C,O)		
					1,3,4	summer	01/05/2009	M00861 (C)		
					1,3,4	summer	02/18/2009	N08766 (C)		
					1,3,4	winter	09/04/2009			
					1,3,4	winter	09/05/2009			
					1,3,4	summer	12/15/2009	M00872 (C,O)		
					1,3,4	summer	12/16/2009	M00873 (C,O)		
					1,3,4	autumn	05/17/2010	N09359 (C)		
					1,3,4	spring	09/23/2010	M00872 (R)		
					1,3,4	spring	09/23/2010	M00875 (C,O)		
					1,3,4	spring	11/26/2010	N08764 (R)		
					1,3,4	spring	11/26/2010	N09362 (C)		
					1,3,4	summer	03/21/2010			
					1,3,4	autumn	03/22/2010			
					1,3,4	spring	09/24/2010			
					1,3,4	spring	11/26/2010			
					1,3,4	spring	11/27/2010			
					1,3,4	summer	02/24/2011			
					1,3,4	summer	03/04/2011	N09363 (C)		
					1,3,4	summer	03/04/2011	N09364 (C)		

					1,3,4	winter	06/06/2011			
					1,3,4	winter	09/11/2011			
					1,3,4	winter	09/12/2011			
18	Núcleo Curucutu do PESM - Cota 400	24°01'37.2"S 46°46' 48.0"W	447-620	Itanhaém	1,3,4	winter	06/08/2007		F. Schunck et al.	Schunck et al. 2019
					1,3,4	winter	07/13/2007			
					1,3,4	spring	11/29/2007	M00845 (C)		
					1,3,4	summer	03/06/2008			
					1,3,4	autumn	05/25/2008			
					1,3,4	autumn	05/26/2008			
					1,3,4	autumn	05/27/2008			
					1,3,4	winter	09/10/2008			
					1,3,4	winter	09/11/2008	M00859 (C, O)		
					1,3,4	summer	02/14/2009			
					1,3,4	summer	02/15/2009	M00859 (R)		
					1,3,4	winter	06/19/2009			
					1,3,4	winter	09/01/2009			
					1,3,4	spring	11/20/2009			
					1,3,4	spring	12/01/2009			
					1,3,4	summer	03/19/2010			
					1,3,4	summer	03/20/2010			
					1,3,4	winter	09/21/2010			
19	Núcleo Curucutu do PESM - Trilha do Mambu (travessia)	24°02'28.5"S 46°48'41.2"W	20-350	Itanhaém	1,3,4	spring	11/16/2007		F. Schunck et al.	Schunck et al. 2019
20	Núcleo Curucutu do PESM - Fazenda Stihl	24°00'24.1"S 46°56'03.9"W	718-730	Juquitiba	1,3,4	spring	12/09/2010		F. Schunck et al.	Schunck et al. 2019
					1,3,4	winter	06/22/2011			
					1,3,4	winter	09/21/2011			
					1,3,4	winter	06/22/2011			

21	PESM, Núcleo Curucutu - Trilha da Cachoeira do Funil	23° 59' 36.01"S 46° 51' 44.35"W	650	Juquitiba/Itanhaém	1,3,4	winter	09/14/2021	S94687775	Wesley P. Soares	eBird
22	Estrada Noboru Hanai	23°59'42.78"S 47°10'55.01"W	632	Juquitiba	1,3,5	autumn	05/27/2016	S32405639	eBird list	eBird
23	Estrada dos Caramirangas	23°58'10.08"S 47°10'51.83"W	689	Juquitiba	1,3,5	spring	10/11/2019	S60549947	eBird list	eBird
					1,3,5	autumn	04/05/2020	S66688697	eBird list	eBird
					1,3,5	winter	06/13/2021	S90143580	eBird list	eBird
					1,3,5	winter	07/23/2021	S92173025	eBird list	eBird
24	Fundação Lymington	23°57'51.90"S 47°00'51.60"W	723	Juquitiba	1,3,5	winter	08/21/2010	S6836545	eBird list	eBird
25	Não informado	23°57'01.6"S 47°06'43.0"W	730	Juquitiba	1,3,5	winter	06/17/2021	S90342505	eBird list	eBird
26	Fazenda Anambé	23°57'37.5"S 47°08'33.6"W	750	Juquitiba	1,3,5	spring	12/02/2021	S98383329	eBird list	eBird
					1,3,5	spring	12/06/2021	S98539829	eBird list	eBird
27	Instituto Terra Luminous	24°01'21.8"S 47°03'57.7"W	750	Juquitiba	1,3,4	summer	03/24/2022	WA4776447 S105892172	eBird list Anelisa Magalhães	eBird Wikiaves
28	Espinheiro Negro	24°00'59.7"S 47°09'09.5"W	670	Miracatu/Pedro de Toledo/Juquitiba	1,3,5	spring	10/20/2016	S32132103	eBird list	eBird
					1,3,5	winter	08/18/2017	S38701340		
					1,3,5	autumn	04/22/2018	S44858773		
					1,3,5	autumn	04/30/2018	S45111618		
					1,3,5	autumn	05/12/2018	S45665033		
					1,3,5	spring	12/12/2018	S49145916		
					1,3,5	winter	06/05/2019	S57133009		
					1,3,5	winter	06/08/2019	S57225247		
					1,3,5	winter	06/15/2019	S57406321		
					1,3,5	winter	06/16/2019	S57434352		

					1,3,5	summer	03/02/2021	S82843889		
					1,3,5	autumn	04/11/2021	S85644268		
					1,3,5	winter	07/23/2021	S92178335		
					1,3,5	winter	08/07/2021	S92907339		
					1,3,5	winter	08/21/2021	S105423318		
					1,3,5	autumn	04/17/2022	S107263915		
					1,3,5	winter	07/27/2022	S115872580		
					1,3,5	winter	08/08/2022	S130112150		
					1,3,5	winter	08/13/2022	S116866083		
					1,3,5	winter	09/10/2022	S118460289		
					1,3,5	autumn	05/13/2023	S137390520		
					1,3,5	autumn	06/05/2023	S140665145		
					1,3,5	winter	09/02/2023	S148807820		
					1,3,5	spring	10/03/2023	S151388626		
					1,3,5	spring	10/042023	S151430018		
					1,3,5	spring	10/08/2023	S152108473		
					1,3,5	spring	10/09/2023	S152462487		
					1,3,5	spring	10/13/2023	S152066709		
29	Reserva do Morro Grande	23°44'5.38"S 46°57'51.55"W	966	Cotia	2,3,4	summer	01/06/2016	WA1974309	Rodrigo Y Castro	WikiAves
					2,3,4	winter	07/09/2016	WA2239968	Rogerio Magalhaes	
					2,3,4	winter	09/22/2016	S31969386	eBird list	eBird
					2,3,4	spring	09/24/2016	WA2294756	Ronaldo R. de Moraes	WikiAves
					2,3,4	spring	11/25/2016	WA2380303	Rodrigo Y Castro	
					2,3,4	autumn	04/02/2017	WA2515622	Cristina Rappa	
					2,3,4	autumn	04/02/2017	WA2528715	Francisco Boiani	
					2,3,4	winter	09/09/2017	WA3059964	Emerson Kaseker	
					2,3,4	summer	01/14/2018	WA2853623	Rodrigo M. Ribeiro	

					2,3,4	autumn	05/12/2018	WA2981139	Rogerio Magalhaes	
					2,3,4	winter	07/07/2018	WA3026935 S47078770	Lista do eBird Gabriel Caram	WikiAves eBird
					2,3,4	winter	07/13/2018	WA3034031	Ruy C. de Almeida	WikiAves
					2,3,4	winter	07/20/2018	WA3044780	Carlos Moura	
					2,3,4	spring	10/12/2018	WA3152653 S74618621	eBird list Patrícia Hanate	WikiAves eBird
					2,3,4	spring	10/28/2018	S49522256	eBird list	eBird
					2,3,4	autumn	04/20/2019	WA3370477	Francisco Boiani	WikiAves
					2,3,4	winter	09/20/2020	WA3982273 S73936210	eBird list Rafaella Mata	WikiAves eBird
					2,3,4	spring	10/24/2020	WA4037741	Antonio Fáveri	WikiAves
					2,3,4	spring	11/28/2020	WA4099836	Rogério Magalhaes	
					2,3,4	summer	02/11/2021	WA4200413	Rogério Magalhaes	
					2,3,4	summer	02/19/2021	WA4210373	Fernando Pupo	
					2,3,4	autumn	05/03/2022	WA4824047	Anderson R. Silva	
					2,3,4	winter	09/22/2022	S31969386	Lista do eBird	eBird
30	Reserva do Morro Grande/Trilha Buraco do Camel	23°47'08.1"S 46°56'24.9"W	1015	Cotia/São Lourenço da Serr	2,3,4	spring	12/09/2020	S77319984	eBird list	eBird
					2,3,4	spring	10/09/2021	S95812765		
					2,3,4	summer	03/03/2022	S104100806		
31	Reserva do Morro Grande/São Lourenço da Serra	23°47'46.5"S 46°58'16.5"W	992	São Lourenço da Serra	2,3,4	spring	11/28/2021	S99250021	eBird list	eBird
32	Sítio Piraquara	23°50’33.5’’S 46°57’50.6’’W	755	São Lourenço da Serra	2,3,5	spring	10/20/2019	S60786811	eBird list	eBird
					2,3,5	autumn	04/24/2020	S67721430		
					2,3,5	winter	07/08/2020	S71263786		
					2,3,5	winter	09/08/2021	S94704427		

					2,3,5	summer	03/04/2023	S130153380		
					2,3,5	winter	09/05/2023	S149049613		
					2,3,5	winter	09/20/2023	S150666675		
					2,3,5	spring	11/05/2023	S153918376		
33	Sítio Maravilha, Cachoeira do Sagui, APA Capivari Monos	23°56'44.09"S 46°43'15.79"W	759	São Paulo	1,3,4	summer	01/25/2014	WA1227583	Dalva Vieira	WikiAves
					1,3,4	summer	02/23–25/2016		Kleber E. Rodrigues	Schunck et al. 2019
34	Estrada das Arapongas, APA Capivari Monos	23°56'12.54"S 46°43'40.80"W	792	São Paulo	1,3,4	spring	10/06/2015		Fabio Schunck and Leo Malagoli	Schunck et al. 2019
35	Estrada da Bela Vista, APA Capivari Monos	23°56'21.50"S 46°44'59.72"W	819	São Paulo	1,3,5	autumn	04/12/2020	S73760523	Maria L. da S. Rodrigues	eBird
					1,3,5	autumn	04/14/2020	S73760665	Maria L. da S. Rodrigues	
					1,3,5	autumn	04/10/2021	S106410864	Arlinda da S. Nascimento	
					1,3,5	autumn	04/24/2021	S106411014	Maria L. da S. Rodrigues	
					1,3,5	summer	03/18/2023	S168269632	José Hilton Nascimento da Silva	
					1,3,5	autumn	05/16/2023	image, S168269391	Maria L. da S. Rodrigues	
					1,3,5	autumn	03/24/2024	video, S168269791	Dárcio Aparecido Alves Rodrigues	
36	Estrada da Ponte Seca, APA Capivari Monos	23°54'14.10"S 46°43'37.96"W	765	São Paulo	1,3,5	autumn	05/17/2018	image	Leila Botelho e Geraldo	
37	Estrada do Curucutu, próximo ao Convento Servidoras do Senhor e da Virgem de Matará	23°52'34.28"S 46°37'40.66"	800	São Paulo	1,3,5	winter	08/02/2021	WA4423698	Edson Filho	WikiAves

38	Bairro Vargem Grande	23°51'36.09"S 46°42'35.67"W	758	São Paulo	2,7	winter	08/13/2020	image	não informado	Grupo Amigos das APAs
39	Parque das Neblinas	23°44'20.88"S 46°10'53.81"W	849	Mogi das Cruzes	1,3,4	autumn	05/21/2019	S56589420/S56894021	eBird list	eBird
					1,3,4	autumn	09/13/2023	S149780697		
40	Estação Biológica de Boracéia, Núcleo Padre Dória do PESM	23°38'58.74"S 45°53'49.09"W	843	Salesópolis	1,3,4	spring	12/15/1991	S38673702	eBird list	eBird
					1,3,4	autumn	04/05/2000	XC85413	Jeremy Minns	Xeno-Canto, Minns et al. 2009
					1,3,4	spring	November 2008 and 2009		Vagner Cavarzere et al.	Cavarzere et al. 2010
					1,3,4	spring	11/18/2017	WA2788550	Paulo R. Moura	WikiAves
41	Horto do Museu Paulista, Ipiranga	23°35'10.52"S 46°36'34.85"W	786	São Paulo	2,7	autumn	06/02/1943	MZUSP 29157	João Lima	Willis and Oniki 2003
42	Sacomã, Rodovia Anchieta (próximo do Parque Estadual das Fontes do Ipiranga - Parque do Estado)	23°38'17.46"S 46°36'22.76"W	786	São Paulo	2,7	winter	September 2001		DEPAVE-3	Almeida et al. 2003
43	Serra da Cantareira	23°26'16.42"S 46°39'33.53"W	970	São Paulo	2,6	autumn	06/03/1965	MZUSP60592-60595	A. M. Olalla	Willis and Oniki 2003, Tonetti et al. 2017
					2,6	autumn	06/09/1965	MZUSP60596-60597	A. M. Olalla	
44	Serra da Cantareira (locality A5)	23°21'58.89"S 46°27'11.37"W	955	Guarulhos	2,6		2009–2010		Marco A. Rego et al.	Tonetti et al. 2017
45	Serra do Japi - Trilha pingo de ouro	23°15'29.51"S 46°55'33.17"W	1.065	Jundiaí	2,6	autumn	05/01/2018	S45140173	Lista do eBird	eBird

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