

Birds of Vale das Taquaras region, Nova Friburgo, Rio de Janeiro state, Brazil: checklist with historical and trophic approach

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Uma listagem anotada de 349 espécies da avifauna da região do Vale das Taquaras, município de Nova Friburgo, na Serra do Mar do estado do Rio de Janeiro é aqui apresentada. Esta região está inteiramente contida na Área de Proteção Ambiental (APA) estadual de Macaé de Cima e consiste na parcela atualmente mais florestada do município de Nova Friburgo. É apresentada uma síntese histórica da exploração ornitológica regional, mas sobretudo uma especial abordagem trófica da avifauna florestal montana ocorrente. Das espécies assinaladas, 96% tem sua presença corroborada por espécime, fotografia ou gravação de áudio. O presente esforço de inventário e organização dos dados representou um acréscimo de 175 novas ocorrências à lista previamente disponível e permitiu a constatação de 22 ocorrências identificadas como colonização recente da área.

Vale das Taquaras Lodge (VT), near the Pico da Caledônia, nowadays is among the most regularly visited localities by birdwatchers in the environs of Nova Friburgo, in the mountains of Rio de Janeiro state. It is sited in the heart of the best-preserved forest in the municipality of Nova Friburgo (Fig. 1), protected under the auspices of the Área de Proteção Ambiental (APA) Macaé de Cima.

VT appears likely to become established among birdwatchers as one of the best areas in which to search for specialties of the mountains of Rio de Janeiro state that are either rare or especially localised in the Serra dos Órgãos, e.g. White-bearded Antshrike *Biatas nigropectus*, Slaty Bristlefront *Merulaxis ater* and Blue-bellied Parrot *Triclaria malachitea*, or whose habitats within the APA can be easily accessed by vehicle, including Bertoni's Antbird *Drymophila rubricollis*, Serra do Mar Tyrant-Manakin *Neopelma chrysolophum*, Black-and-gold Cotinga *Tijuca atra*, Plovercrest *Stephanoxis lalandi* and Chestnut-headed Tanager *Pyrhocomma ruficeps*, among others found at higher altitudes in the Serra do Mar requiring either more time or physical effort to reach via the Pedra do Sino trail, in the high part of the Serra dos Órgãos National Park.

Two well-known lists of the birds of the Nova Friburgo region pertain to localities situated either within or on the periphery of the APA Macaé de Cima, namely the Serra da Sibéria¹¹⁶ and Parque Estadual dos Três Picos⁴⁸. The present paper aims to augment and bring up to date Weinberg¹²⁷, based on work in 1980–86 within the VT region.

To aid our understanding of the avifauna of this part of the Serra do Mar, a brief history of ornithological activity since the early 19th century is presented, with the aim of demonstrating that much of the accumulated literature referring to the 'mountains of Nova Friburgo' is in fact better

associated with the unusual avifauna of the Paraíba do Sul Valley and the north of the municipality.

The avifauna of the VT and therefore the APA Macaé de Cima is equivalent to that of the districts of Murú, São Pedro da Serra and Lumiar, which is quite distinct from the northern part of the municipality of Nova Friburgo, in the districts



Figure 1. Location of the APA Macaé de Cima relative to the municipality of Nova Friburgo and the state of Rio de Janeiro.

of Campo do Coelho, Riograndina, Conselheiro Paulino, Amparo and the municipal capital. These latter districts form the north slope of the mountains and originally supported semideciduous forest similar to that in the Paraíba do Sul Valley, but are now largely deforested being replaced by fields and natural marshes. In contrast, the three southernmost districts of Nova Friburgo (and foci of this work) still support humid forest with many epiphytes on the seaward (southern) slope of the Serra do Mar.

In the centre of this region, the Vale das Taquaras, as well as Macaé de Cima and Lumiar, harbours the largest remaining patches of ombrophilous forest in the Nova Friburgo region, for which we present a complete bird list and detailed trophic analysis.

Study area

Vale das Taquaras Lodge lies within the APA Macaé de Cima, created by state decree 29.213, on 14 September 2001, which partially covers the district of Mury, all of Lumiar and São Pedro da Serra, and occupies 35,000 ha or 40% of the municipality of Nova Friburgo⁵⁴.

Sited at the base of the final stretch of the escarpment of the Serra do Mar in Rio de Janeiro, the APA Macaé de Cima lies within the Unidade Geomorfológica Escarpas da Serra de Macaé, Macabu e Imbé, in the headwaters of the rio Macacu, close to Nova Friburgo, with the neighbouring Unidade Geomorfológica Escarpas das Serras do

Couto e dos Órgãos, to the west. These two areas form an escarpment, at c.1,000–2,000 m altitude, that extends uninterrupted to the environs of Tinguá, separated from other parallel ranges by the principal valleys traversing the region, including that of the rio Macaé, which flows into the lower rio Paraíba do Sul. These two geomorphological units (Serra de Macaé and Serra dos Órgãos) experience very similar climatic and physiographic conditions, are very similar phytophysiognomy, including their endemic floral elements^{6,55} and their very similar avifaunal composition⁴⁹.

Collectively, these two units comprise part of the Mosaico Central Fluminense, which numbers some of the best-preserved conservation units in the central part of Rio de Janeiro state, among them the Parque Nacional da Serra dos Órgãos and the APA Guapimirim, and support environments as diverse as cloud forest atop the Serra do Mar to mangroves in the Baixada Fluminense^{14,41}.

The vegetation of the Macaé de Cima region is, in large part, Montane Atlantic Rainforest, while the region is traversed by the rio Macaé and its tributaries, which flow through this still-rich humid forest³⁹. Climate is constantly humid with mean annual rainfall varying between 1,500 mm and 2,000 mm. Mean temperature is c.17°C, with January and February the warmest months and July the coolest and driest³⁹.

The forest understorey is dominated by various herbs and shrubs of the families Araceae (genera *Anthurium*, *Philodendron* and *Monstera*),

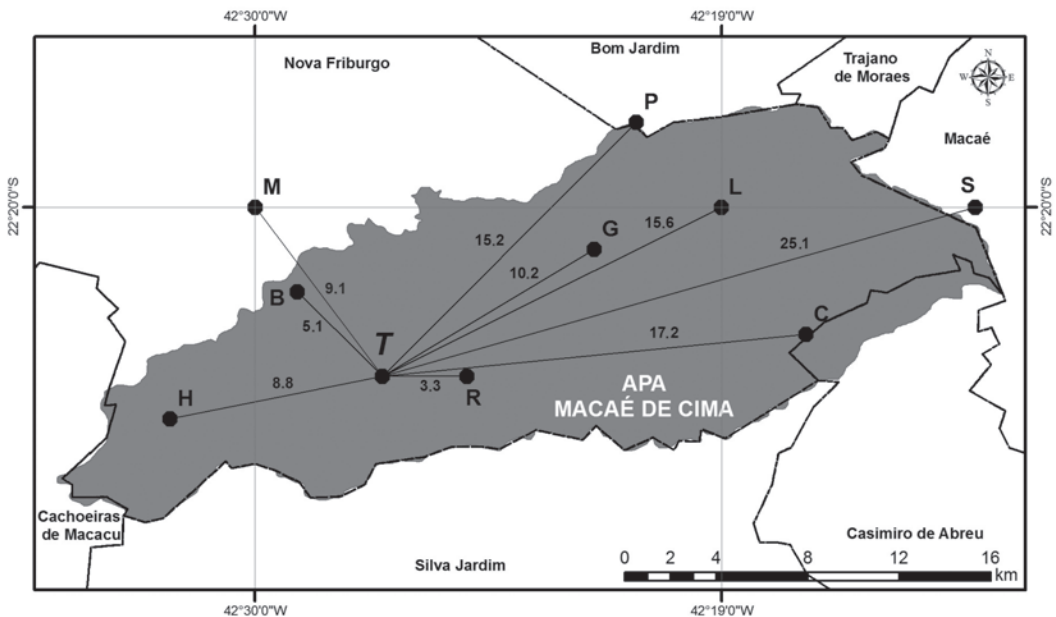


Figure 2. Location of Vale das Taquaras Lodge (T) within the APA Macaé de Cima, municipality of Nova Friburgo and the ten localities in which field work was conducted with their straight-line distance from the lodge in km.

Begoniaceae (*Begonia*), Piperaceae (*Piper* and *Peperomia*), small trees of Melastomataceae (*Miconia* and *Leandra*) and Rubiaceae (*Psychotria*), among others, as well as young palms of the genera *Euterpe* and *Attalea*, ferns, tree ferns (Cyatheaaceae) and bamboos (*Guadua*, *Chusquea* and *Merostachys*)³⁹. Epiphytic plants adorn the trunks and branches of trees, in particular, innumerable bromeliads (Bromeliaceae), orchids (Orchidaceae), begonias (Begoniaceae), small ferns (Pteridophyta), mistletoes (Loranthaceae), cacti (Cactaceae), mosses and lichens. Attractive vines and creepers, e.g., *Fuchsia regia* (Onagraceae) and wild passion fruits of the genus *Passiflora* (Passifloraceae), also compete for light in the understorey. One special group of plants are the hemi-parasites, which strangle their hosts over a period of time, among which we should mention those of the genera *Clusia* (Clusiaceae), *Coussapoa* (Cecropiaceae) and *Ficus* (Moraceae). Among those trees that comprise the bulk of the forest are species of Meliaceae (genera *Cabralea*, *Cedrela*), Myrtaceae (*Myrcia*, *Myrceugenia*, *Eugenia* and others), Vochysiaceae (*Vochysia*), Moraceae (*Ficus*), Lauraceae (*Nectandra*, *Ocotea* and others), Melastomataceae (*Miconia*, *Tibouchina*), Euphorbiaceae (*Alchornea*, *Croton* and *Sapium*), Araliaceae (*Schefflera*), Leguminosae (*Inga*, *Ormosia*, *Erythrina* and others) and Cecropiaceae (*Cecropia* and *Coussapoa*)³⁹. At edges, also notable are the presence of *Trema micrantha* (Ulmaceae), *Acnistus arborescens* (Solanaceae), cecropias (*Cecropia* spp.) and trees of the genus *Tibouchina* (Melastomataceae), among others.

Broadly speaking, the flora of the Macaé de Cima region mainly comprises tree species (51%), followed by herb-shrubs (31%) and vines and creepers (18%). Phanerogamous plants are responsible for the high diversity of the local flora, especially among the Melastomataceae, Leguminosae, Myrtaceae, Lauraceae, Rubiaceae and Bromeliaceae, which support particularly large numbers of such species³⁹.

The Macaé de Cima region also includes anthropogenically modified areas such as small rural properties, second homes and subsistence agricultural. There are also natural gaps, albeit perhaps enlarged by human actions, in the valleys, where small wetlands of cattails (*Typha* sp., Typhaceae) and narrow rivers meander through the forest.

Methods

Twelve bird surveys were conducted between April 2008 and September 2011, covering eight different months (February, April–June and August–November). The following 11 localities were visited in the APA Macaé de Cima (Fig. 2) from Vale das Taquaras Lodge (T = 22°24'S 42°27'W; 900

m), the base for our work. (R) Rio Bonito de Cima and environs (4 km east; 22°24'S 42°25'W; 800 m); (B) RPPN Bacchus (4.6 km north-west; 22°22'S 42°29'W; 1,400 m); (H) Macaé de Cima headquarters (7.2 km south-west; 22°25'S 42°32'W; 1,100 m); (M) Mury (9 km north-west; 22°20'S 42°30'W; 990 m); (G) Galdinópolis (10 km east; 22°21'S 42°22'W; 770 m); (L) Lumiar (16 km east; 22°20'S 42°19'W; 630 m); (C) Conde Redondo (18 km east; 22°23'S 42°17'W; 550 m); (S) São Romão (25 km east; 22°20'S 42°13'W; 300 m). A few records were made at another locality (P, São Pedro da Serra, 15 km north-east; 22°18'S 42°21'W; 850 m) during excursions between 1979 and 2004. Records made in 2008–11 form the base bird list for VT and its environs (Table 4), while records from the period 1979–2004 are also listed, but clearly marked.

We follow the English names, scientific nomenclature and taxonomic sequence of SACC (South American Classification Committee)¹⁰⁹, while species new to the region compared to Weinberg¹²⁷ are clearly denoted. Provenance within the APA, from site T (the epicentre) to site S (São Romão), the furthest away, is indicated. Based on the authors' experience in this region, occurrence is linked to one or more of six different habitats. Special attention is given to significant biogeographical association, with the Serra do Mar (for montane species) or the Atlantic Forest as a whole^{118,122,129}. Documentation, linked to the municipality of Nova Friburgo as a whole, is based on the available literature and specimens mentioned therein (see History of ornithological work), sound archives (Universidade Federal do Rio de Janeiro) or websites: www.xeno-canto.com, www.wikiaves.com. Sound-recordings and photographs have been taken since 2008 and largely derive from the work of the authors as well as the photographers Luis Florit, João Quental and Ivan Mendes.

Characterisation of trophic guilds is based on our field observation and various references^{15,56,107,112,114,118,124,128}, while floral identification to species level relied on material at the Carlos Toledo Rizzini herbarium (Parque Nacional da Serra dos Órgãos) and specialist references^{6,39,42,44}. Data on foraging are based on field work by JFP & RP in the Serra dos Órgãos since the 1990s, which has led to several articles in Brazilian ornithological journals wherein our methodology for data collection is fully elucidated^{71–91}.

History of ornithological work

The history of the human occupation of the Macaé de Cima is indivisible from the colonisation of Morro Queimado, which locality was subsequently named Neu Freiburg or Nova Friburgo⁶⁸. Formalised by a royal decree of 16 May 1818, it was planned to settle 260 families from the Swiss canton of Fribourg at Fazenda Morro Queimado, then part

of the district of Cantagalo. Accordingly, Nova Friburgo became the first non-Lusitanian colony to be founded in Brazil in an official capacity.

This explains why, from this early period, Nova Friburgo became a centre for exporting natural history material, as collecting was to some extent traditional among Central Europeans³⁰ as opposed to Iberian cultures. An English traveller recounted that in September 1821 a member of the colony killed various toucans, parrots, woodpeckers and other birds with the aim of stuffing them⁵².

The best example of such a person is that of the resident German naturalist Carl Henrich Bescke (1798–1851), who arrived in Nova Friburgo in the early 1830s, and sent material to European museums until his death⁶⁹. Bescke (also written Beske) collected the types of, for example, Long-trained Nightjar *Macropsalis forcipata* and Black-legged Dacnis *Dacnis nigripes*^{68,93}.

Prior to the work of Hermann Burmeister, the German naturalist who explored the environs of Nova Friburgo between 24 December 1850 and 4 April 1851^{5–10}, and also acquired material directly from Bescke, the region was completely unknown to the ornithological community. The first bird to be mentioned in the literature for Nova Friburgo was Swallow-tailed Kite *Elanoides forficatus*⁸, but it also served as the type locality for Rufous-backed Antvireo *Dysithamnus xanthopterus*¹⁰.

Edouard Ménétriés, French naturalist and participant in the celebrated Langsdorff expedition, and whose pioneering activities are the centre of various older and more recent controversies^{53,63,104,105}, visited Nova Friburgo on 30 September–1 October 1822 and in January and June 1823³³. It is certain that Ménétriés collected birds there, but the species concerned are unknown.

The Danish naturalist and celebrated palaeontologist, Peter Wilhelm Lund, collected 113 species at [Fazenda] Rosário (22°06'S 42°25'W) and 28 at Morro Queimado³⁴. He resided in Rosário for 16 months (8 February 1827–late June 1828) and from there visited Morro Queimado, the future centre of Nova Friburgo³⁴. Nowadays, Rosário lies close to the boundary between the municipalities of Bom Jardim and Duas Barras, c.22 km north-east of Nova Friburgo, but was treated in Reinhardt's monograph 'when pertaining to species that also occur in the 'campos' of Minas Gerais' as 'Neu Freiburg'^{34,106}.

The link between Nova Friburgo and Cantagalo, two traditional ornithological localities in Rio de Janeiro, has historical reasons. Although Nova Friburgo had been elevated to the status of town in 1820, shortly after the Swiss colony was founded, their emancipation from the jurisdiction of Cantagalo, coffee hub in the 19th century, occurred only in 1890^{13,16}. The relatively small distance between Nova Friburgo and Cantagalo (<40 km)

and their political / historical links explain why their avifaunas have been treated as identical, characterised as the mountainous 'Districto de Cantagallo', by Euler, Cabanis and Ihering^{12,21,31}. The Swiss naturalist and coffee-grower, Carl Hieronymus Euler, studied the breeding biology of birds at his Fazenda Bom Valle, Cantagalo, in 1862–66. In the inaugural article in his series, Euler¹⁹ stated that his fazenda and, therefore, his study area was 'the north slope of the Serra de Nova Friburgo'.

Euler also mentioned that, in the 1830s to 1860s, Jean de Roure maintained a collection of birds, and that he sold material to European institutions, mentioning in particular the Basel museum, in Switzerland^{20,62}. Roure's activities centred on the mountains of Nova Friburgo, specifically 'Macaé-Flusse', which corresponds to the region nowadays known as Macaé de Cima, i.e. in the headwaters of the rio Macaé^{20,62}. Roure is generally accepted to have been the original collector of the enigmatic Cherry-throated Tanager *Nemosia rourei*^{5,11,62}.

A few mentions of Nova Friburgo, together with biological notes, appear in two famous pictorial works^{17,25}. A collaborator of Gould, Thomas Reeves was Director-General of the Correios de S. M. Britânica in Rio de Janeiro, from 1844, specialised in collecting hummingbirds^{25,40}, a contemporary of the French naturalist Jean Théodore Descourtilz and editor of the latter's most important work⁵⁷.

Still in the 19th century, we must mention two collections made around Nova Friburgo, assembled by Youds and Schaufuss³¹. Those specimens purchased by Youds were mentioned in the multiple volumes of the *Catalogue of birds in the British Museum*¹²³ and, possibly, relate to the merchant J. Youds, owner of a shop of natural history objects in the city of Rio de Janeiro³⁵. Nothing is known of the person who sent a batch of 50 species to the entomologist L. W. Schaufuss, of Dresden, but among them were the first adult male Temminck's Seedeater *Sporophila falcirostris* to be described and the first Rufous-tailed Antbird *Drymophila genei* with a specific locality attached³⁴. During the 1880s, a small number of records were made by Emílio Goeldi, author of the first monograph on Brazilian birds in Portuguese²⁴, of which the most interesting was his observation of Solitary Tinamou *Tinamus solitarius* in the 'Serra de Macaé', hence Macaé de Cima.

The compilation of bird records from Nova Friburgo and / or Cantagalo at the end of the 19th century represented a milestone³¹, with some reservations. Some of the records of Burmeister and Youds from Nova Friburgo were considered doubtful in the following century⁶⁶ and two hummingbirds obtained by Reeves are perhaps hybrids²⁷. Several species are mentioned for Cantagalo that are absent from previous lists and whose inclusion

is unexplained. Do these mistakes originate with Ihering⁶⁶ or were they based on other records communicated to him by Euler? Some published records of Goeldi and important records by Roure, for example Great Horned Owl *Bubo virginianus* and Sickle-winged Nightjar *Eleothreptus anomalus*^{20,61} were not listed. Justifiably, the material obtained by Lund in 1827–28 has only recently become widely known^{34,100}. Consequently, the total of 368 species listed for Nova Friburgo and Cantagalo until 1900³¹ lacks a degree of context.

The first initiative of the 20th century was that of the French coleopterologist Edmond Gounelle, who in March–May 1903 collected six species of hummingbirds at Nova Friburgo²⁶. In September–November 1909, Ernst Garbe, on behalf of the Museu Paulista (now the Museu de Zoologia da Universidade de São Paulo), collected birds around Nova Friburgo⁹⁹, the first to be retained in Brazil. His material is detailed in the *Catálogos de aves do Brasil*^{97,98} from which it is clear that Garbe covered the region upon which the present work focuses, referred to therein as the ‘Serra de Macaé’, i.e. Macaé de Cima.

Garbe’s work marked the end of ornithological exploration in this region based solely on specimen collection. During the three subsequent decades, practically no ornithological initiatives focused on the region covered by this study. Between the late 1940s and 1990, Helmut Sick—the father of modern Brazilian ornithology—made several brief visits to Nova Friburgo, notably to the districts of Mury and Riograndina. On these occasions, Sick made natural history observations, new records and collected some specimens deposited in the Museu Nacional do Rio de Janeiro^{113,114,117,118}. However, the results of Sick’s work are scarcely known.

Over the last three decades, our brief history of ornithological work in the APA Macaé de Cima and / or the Nova Friburgo region, and the work of the senior author in this area overlap. JFP’s first visit was in July 1979 to Lumiar and Amparo (Nova Friburgo), as well as to the neighbouring municipalities of Bom Jardim and Duas Barras⁶⁷.

Between 1980 and 1982, L. Ferrez made regular two-day visits to observe birds in the Vale das Taquaras and its environs, with additional, more irregular, visits to the region in 1984–86¹²⁷. The total of 189 species recorded during the 1980s (only at APA Macaé de Cima) represents 66% of the historical total ($n = 285$, throughout Nova Friburgo) mentioned in the same paper¹²⁷.

From 8 December 1981 until 3 January 1982, M. Brooke, A. Hutson & D. Scott recorded 163 bird species in the Serra da Sibéria, a fragment of montane forest of c.1,200 ha, at 800–1,500 m¹¹⁶, while surveying for some of the threatened birds of south-east Brazil *sensu* King³² with a special focus on rediscovering the then lost Black-

hooded Antwren *Formicivora erythronotos* and Kinglet *Calyptura calyptura cristata*, whose most recent records were believed to be from Nova Friburgo^{59,116,125}.

In the latter half of the 1980s, Giovannini Luigi da Silva made several visits to Nova Friburgo, collecting specimens on behalf of the Museu Nacional, especially at Campestre, Três Picos and Campo do Coelho, all of which lie outside the APA Macaé de Cima. His complete species list is unavailable, but he is known to have made c.30 new records for the municipality of Nova Friburgo^{44,45}.

For academic purposes, a quantitative survey of birds over three years (1990–92) in the ‘cloud forests’ of the Reserva Ecológica Municipal de Macaé de Cima produced 213 species⁹⁶. A list of 374 taxa was presented in the same work, but this includes observations from 1988–97, at elevations of 200–1,700 m in the municipalities of Nova Friburgo, Silva Jardim and Cachoeiras de Macacu⁹⁶.

The most recent ornithological survey, in November 2005–August 2006, which covered a broad elevational range (15–2,219 m) and 35 localities in the Parque Estadual dos Três Picos recorded 321 species⁴⁸. This survey found 144 species in the area overlapping that of the state park and the APA Macaé de Cima (localities 1–6) and 189 species at localities within the municipality of Nova Friburgo (localities 1–6, 14–19)⁴⁸.

Results and Discussion

Diversity and composition.—A total of 349 species of birds is known in the study area (Table 4) of which c.20% were not recorded during post-2005 field work (Table 4). None of these are necessarily regionally extinct, as some of these perform local movement or are otherwise rare or locally distributed. Some 254 species were recorded in the immediate environs of VT, or 72.7% of all species in the APA Macaé de Cima.

Just 21 (6%) of the 349 species recorded in the study area can be considered uncorroborated (i.e. lacking documentation). Exactly 270 species (77%) have been photographed, 244 species (70%) are known by specimens mentioned in the literature and 100 species (28%) by sound-recordings (Table 4).

Of the total number of birds recorded in the study area, 54% are strongly linked to either the Serra do Mar in particular or the Atlantic Forest in general. The remainder can be categorised, biogeographically, as widespread species. In this latter category, two groups stand out: migrants ($n = 28$) and recent colonists of this part of the Serra do Mar in Rio de Janeiro (Table 1). The 22 recent colonists have reached the area during the last 25 years having expanded their ranges via the Paraíba do Sul Valley.

Table 1. Birds of open and semi-open habitats that have recently colonised the Vale das Taquaras region, with year of first record and estimated arrival in the state of Rio de Janeiro. Those species present in Rio de Janeiro for at least two centuries are marked —.

English name	RJ	VT
Cattle Egret <i>Bubulcus ibis</i>	1970	2000
Whistling Heron <i>Syrigma sibilatrix</i>	1950	2005
Savanna Hawk <i>Buteogallus meridionalis</i>	—	1999
Crowned Eagle <i>Harpyhaliaetus coronatus</i>	1980	2009
Zone-tailed Hawk <i>Buteo albonotatus</i>	1980	2010
Southern Lapwing <i>Vanellus chilensis</i>	—	1999
Picazuro Pigeon <i>Patagioenas picazuro</i>	1980	2005
Burrowing Owl <i>Athene cucularia</i>	1900	2005
White-eared Puffbird <i>Nystalus chacuru</i>	1900	1999
White Woodpecker <i>Melanerpes candidus</i>	—	2005
Laughing Falcon <i>Herpetotheres cachinnans</i>	1940	2009
Blue-winged Macaw <i>Primolius maracana</i>	—	2005
Wing-banded Hornero <i>Furnarius figulus</i>	1970	1996
Rufous-fronted Thornbird <i>Phacellodomus rufifrons</i>	1970	2008
Firewood-gatherer <i>Anumbius anumbi</i>	1940	2008
White-rumped Monjita <i>Xolmis velatus</i>	1900	1987
Masked Water Tyrant <i>Fluvicola nengeta</i>	1950	1987
Cattle Tyrant <i>Machetornis rixosa</i>	1960	1987
Grey-eyed Greenlet <i>Hylophilus amaurocephalus</i>	1990	2008
Brown-chested Martin <i>Progne tapera</i>	1900	1995
White-rumped Swallow <i>Tachycineta leucorrhoa</i>	1900	1995
Chopi Blackbird <i>Gnorimopsar chopi</i>	—	1987
Screaming Cowbird <i>Molothrus rufoaxillaris</i>	1950	2008
Common Waxbill <i>Estrilda astrild</i>	1900	1987
House Sparrow <i>Passer domesticus</i>	1900	1987

Six species from open and semi-open habitats that have colonised the state of Rio de Janeiro within the last 100 years⁶⁰, mainly from the Cerrado and Caatinga biomes, were already recorded in the region at the time of the first list²⁷: White-tailed Hawk *Buteo albicaudatus*, Red-legged Seriema *Cariama cristata*, Planalto Hermit *Phaethornis pretrei*, Chalk-browed Mockingbird *Mimus saturninus*, Burnished-buff Tanager *Tangara cayana* and Hepatic Tanager *Piranga flava*.

Roughly 50% of these colonists⁶⁰ reached disturbed areas of the highlands and the relatively well-forested region of VT. None is really common in the state's lowlands, but Picazuro Pigeon *Patagioenas picazuro*, White Woodpecker *Melanerpes candidus* and Masked Water Tyrant *Fluvicola nengeta* are all reasonably conspicuous and widespread at VT, while Southern Lapwing *Vanellus chilensis* and Cattle Tyrant *Machetornis rixosus* occupy small pastures. Some of these elements are still very localised or confined to the easternmost part of the APA (e.g., Cattle Egret *Bubulcus ibis*, Whistling Heron *Syrigma sibilatrix*, Burrowing Owl *Athene cucularia*). The appearance of some invasive species can be regarded

as episodic and only time will prove if these species will become resident in the region: Crowned Eagle *Harpyhaliaetus coronatus*, Zone-tailed Hawk *Buteo albonotatus* and Screaming Cowbird *Molothrus rufoaxillaris*.

Five species listed as colonists at VT have inhabited open-country zones in the state for at least two centuries (Table 1), but their appearance in the highlands appears to be recent. A particularly interesting case is that of Blue-winged Macaw *Primolius maracana*, which following decades of decline since the 1960s, currently appears to be experiencing a population boom within the state of Rio de Janeiro⁶⁵.

Given that distributions are dynamic, we should remark that at least three recent arrivals in the state have been already recorded on the periphery of the APA: Toco Toucan *Ramphastos toco*, Curl-crested Jay *Cyanocorax cristatellus* and Hooded Tanager *Nemostia pileata*. We postulate that their discovery within the study area is just a matter of time and due diligence.

Of biogeographical relevance¹²⁹ is that, of the overall total, 108 species are endemic to the Atlantic Forest, of which 65 are exclusively montane, while 51 others are represented by endemic subspecies, 19 of them restricted to the Serra do Mar (Table 4).

The total of 349 species found at VT cannot strictly be compared with those inventories published for other areas just to the west, namely the 458 species recorded in the Serra dos Órgãos⁴⁹ and 450 at Reserva Ecológica de Guapiaçu (REGUA)⁹⁵, because these surveys covered a more complete elevational transect of the Serra do Mar: Órgãos (100–2,263 m) and REGUA (30–2,200 m). Although elevations of 300–700 m were surveyed during the present inventory, most field work was conducted at 800–1,400 m. Nevertheless, the overall total number of species recorded in the APA represents an increase of 175 on that previously available¹²⁷.

Scrutiny of historical sources has revealed records of 51 species whose presence in the VT or Nova Friburgo has not been noted for 60 years (Table 2). We suppose that perhaps c.15% of these might still be present in very small numbers.

Taking the overall list (Table 4) in combination with those that have apparently been extirpated in the region (Table 2), i.e. 400 species, this total includes 39 species threatened with extinction at one or more of three levels: global, national and state (Table 3).

At global level⁷, 21 species are threatened. Three are Critically Endangered (Purple-winged Ground Dove *Claravis geoffroyi*, Kinglet Calyptura, Cherry-throated Tanager) and none has been recorded in the region during the last 60 years (Table 2), but all are associated with montane regions. Of the seven that are Endangered, three

Table 2. Bird species not recorded in the last 60 years at Vale das Taquaras (VT) or in the Nova Friburgo region (NF), with the collector's name or most recent data. * = possibly only north of Nova Friburgo; ** = possibly from outside the present limits of Nova Friburgo; ^ expected to be present around VT, given recent records the coastal slope, e.g. at Reserva Ecológica Guapiaçu⁹⁵.

English name	Species	Area	Last report from
Black-fronted Piping Guan	<i>Pipile jacutinga</i>	VT	Report by elderly local
Black-collared Hawk	<i>Busarellus nigricollis</i>	NF *	Burmeister
Long-winged Harrier	<i>Circus buffoni</i>	NF *	Lund
Grey Hawk	<i>Buteo nitidus</i>	NF *	Burmeister
Purple-winged Ground Dove	<i>Claravis geoffroyi</i>	NF	Burmeister
Pheasant Cuckoo	<i>Dromococcyx phasianellus</i>	VT	Mury, April 1952, H. Sick (<i>in litt.</i>)
Great Horned Owl	<i>Bubo virginianus</i>	VT	Macaé de Cima, Roure
Great Potoo	<i>Nyctibius grandis</i>	NF	Burmeister
Sickle-winged Nightjar	<i>Eleothreptus anomalus</i>	VT	Macaé de Cima, Roure
Minute Hermit	<i>Phaethornis idaliae</i>	NF **	Bescke
Black-eared Fairy	<i>Heliostyria auritus</i>	NF ^	Burmeister
Black-bellied Thornail	<i>Discosura langsdorffi</i>	NF	Bescke
Fork-tailed Woodnymph	<i>Thalurania furcata</i>	NF *	Bescke
Rufous-throated Sapphire	<i>Hylocharis sapphirina</i>	NF **	Burmeister
Three-toed Jacamar	<i>Jacamaralcyon tridactyla</i>	NF *	Burmeister
Buff-bellied Puffbird	<i>Notharchus swainsoni</i>	NF ^	Lund
Crescent-chested Puffbird	<i>Malacoptila striata</i>	NF ^	Lund
Rusty-breasted Nunlet	<i>Nonnula rubecula</i>	NF *	Lund
Black-necked Aracari	<i>Pteroglossus aracari</i>	NF ^	Bescke
Yellow-fronted Woodpecker	<i>Melanerpes flavifrons</i>	VT	Lund
Red-and-green Macaw	<i>Ara chloropterus</i>	NF	Descourtiz
Ochre-marked Parakeet	<i>Pyrrhura cruentata</i>	NF **	Burmeister
Maroon-faced Parakeet	<i>Pyrrhura leucotis</i>	NF **	Burmeister
Salvadori's Antwren	<i>Myrmotherula minor</i>	NF ^	Lund
Black-hooded Antwren	<i>Formicivora erythronotos</i>	NF	Burmeister
Scaled Antbird	<i>Drymophila squamata</i>	NF ^	Schaufuss
Fork-tailed Tody-Tyrant	<i>Hemitriccus furcatus</i>	NF	Bescke
Royal Flycatcher	<i>Onychorhynchus coronatus</i>	NF	Burmeister
Sulphur-rumped Flycatcher	<i>Myiobius barbatus</i>	NF ^	Schaufuss
Black-headed Berryeater	<i>Carpornis melanocephala</i>	NF **	Burmeister
Red-ruffed Fruitcrow	<i>Pyroderus scutatus</i>	NF	Lund
Banded Cotinga	<i>Cotinga maculata</i>	NF **	Burmeister
White-winged Cotinga	<i>Xipholena atropurpurea</i>	NF **	Burmeister
Striped Manakin	<i>Machaeropterus regulus</i>	NF ^	Burmeister
White-crowned Manakin	<i>Pipra pipra</i>	NF **	Bescke
Red-headed Manakin	<i>Pipra rubrocapilla</i>	NF **	Bescke
Black-tailed Tityra	<i>Tityra cayana</i>	NF ^	Burmeister
Black-capped Piprites	<i>Piprites pileata</i>	NF	? Bescke
Kinglet Calyptura	<i>Calyptura cristata</i>	NF	Lund
White-winged Swallow	<i>Tachycineta albiventer</i>	NF *	? Bescke
Black-capped Donacobius	<i>Donacobius atricapilla</i>	NF *	Burmeister
Yellowish Pipit	<i>Anthus lutescens</i>	NF *	Burmeister
Cherry-throated Tanager	<i>Nemosia rourei</i>	VT	Roure
Flame-crested Tanager	<i>Tachyphonus cristatus</i>	NF ^	Lund
Turquoise Tanager	<i>Tangara mexicana</i>	NF **	Burmeister
Red-necked Tanager	<i>Tangara cyanocephala</i>	VT	Lund
Copper Seedeater	<i>Sporophila bouvreuil</i>	NF *	Burmeister
Yellow-green Grosbeak	<i>Caryothraustes canadensis</i>	NF **	Burmeister
Riverbank Warbler	<i>Phaetholypis rivularis</i>	NF	Burmeister
Variable Oriole	<i>Icterus pyrrhopterus</i>	NF *	Burmeister
Orange-bellied Euphonia	<i>Euphonia xanthogaster</i>	NF **	Youds

Table 3. Extinct or threatened birds recorded in the VT study region at global¹, national⁴⁶ and state levels². # = no records in the last 60 years. CR = Critically Endangered; EX = Possibly Extinct; EN = Endangered; VU = Vulnerable; NT = Near Threatened; DD = Data Deficient.

English name	Global	National	State
Solitary Tinamou <i>Tinamus solitarius</i>	NT	NT	EN
Black-fronted Piping Guan <i>Pipile jacutinga</i> #	EN	EN	EX
Black-and-white Hawk-Eagle <i>Spizaetus melanoleucus</i>	—	—	VU
Black-collared Hawk <i>Busarellus nigricollis</i> #	—	—	VU
Grey-bellied Hawk <i>Accipiter poliogaster</i>	NT	DD	VU
Crowned Eagle <i>Harpyhaliaetus coronatus</i>	EN	VU	DD
Purple-winged Ground Dove <i>Claravis geoffroyi</i> #	CR	CR	EN
Great Potoo <i>Nyctibius grandis</i> #	—	—	VU
Black-bellied Thorntail <i>Discosura langsdorffii</i> #	—	VU	DD
Three-toed Jacamar <i>Jacamaroclyn tridactylus</i> #	VU	NT	VU
Black-necked Aracari <i>Pteroglossus aracari</i> #	—	—	VU
Red-and-green Macaw <i>Ara chloropterus</i> #	—	—	EX
Ochre-marked Parakeet <i>Pyrrhura cruentata</i> #	VU	VU	EN
Maroon-faced Parakeet <i>Pyrrhura leucotis</i> #	NT	VU	VU
Brown-backed Parrotlet <i>Touit melanonotus</i>	EN	VU	VU
Golden-tailed Parrotlet <i>Touit surdus</i>	VU	NT	VU
Vinaceous-breasted Parrot <i>Amazona vinacea</i>	EN	VU	VU
Blue-bellied Parrot <i>Tridaria malachitea</i>	NT	NT	VU
White-bearded Antshrike <i>Biatus nigropectus</i>	VU	VU	NT
Salvadori's Antwren <i>Myrmotherula minor</i> #	VU	VU	VU
Black-hooded Antwren <i>Formicivora erythronotus</i> #	EN	EN	VU
Oustalet's Tyrannulet <i>Phylloscartes oustaleti</i>	NT	—	VU
Fork-tailed Tody Tyrant <i>Hemitriccus furcatus</i> #	VU	NT	NT
(Atlantic) Royal Flycatcher <i>Onychorhynchus coronatus</i> #	VU	DD	VU
Black-headed Berryeater <i>Carpornis melanocephala</i> #	VU	VU	VU
Red-ruffed Fruitcrow <i>Pyroderus scutatus</i> #	—	NT	VU
Banded Cotinga <i>Cotinga maculata</i> #	EN	EN	EX
Bare-throated Bellbird <i>Procnias nudicollis</i>	VU	—	NT
White-winged Cotinga <i>Xipholena atropurpurea</i> #	EN	EN	EN
White-crowned Manakin <i>Pipra pipra</i> (subspecies <i>cephaleucos</i>) #	—	NT	VU
Red-headed Manakin <i>Pipra rubrocapilla</i> #	—	—	VU
Black-capped Piprites <i>Piprites pileata</i> #	VU	VU	VU
Kinglet <i>Calyptura calyptura cristata</i> #	CR	CR	NT
Cherry-throated Tanager <i>Nemosia rourei</i> #	CR	CR	—
Turquoise Tanager <i>Tangara mexicana</i> (subspecies <i>brasiliensis</i>) #	—	NT	VU
Green Honeycreeper <i>Chlorophanes spiza</i>	—	—	VU
Buffy-fronted Seedeater <i>Sporophila frontalis</i>	VU	VU	EN
Temminck's Seedeater <i>Sporophila falcirostris</i>	VU	VU	EN
Ultramarine Grosbeak <i>Cyanocompsa brissonii</i>	—	NT	VU

of them (Crowned Eagle, Brown-backed Parrotlet *Touit melanonotus*, Vinaceous-breasted Parrot *Amazona vinacea*) have been recorded recently in tiny numbers, but the others (Black-fronted Piping Guan *Pipile jacutinga*, Black-hooded Antwren, Banded Cotinga *Cotinga maculata*, White-winged

Cotinga *Xipholena atropurpurea*) are regionally extinct (Table 2) and the guan and Banded Cotinga have possibly been lost from the entire state^{2,64,95}. Banded and White-winged Cotingas are both lowland birds, while Black-hooded Antwren—from what we know now—must have occurred in successional habitats in the rio Bengalas Valley, exactly that area now occupied by urban Nova Friburgo. Of the 12 considered Vulnerable, five have occurred recently (Golden-tailed Parrotlet *Touit surdus*, White-bearded Antshrike *Biatus nigropectus*, Bare-throated Bellbird *Procnias nudicollis*, and Buffy-fronted *Sporophila frontalis* and Temminck's Seedeaters *S. falcirostris*). VT is possibly the state's stronghold for *P. nudicollis*. During part of 2009–10 both *Sporophila* were recorded in very large numbers during a mass seeding of bamboo, a phenomenon that since 2005 has occurred in waves across montane regions of Rio de Janeiro and neighbouring states. Subsequently, they reverted to their usual status, being scarcely encountered. The other seven Endangered species have not been recorded in the region for 60 years. The Atlantic Forest subspecies of Royal Flycatcher *Onychorhynchus coronatus swainsonii* (sometimes treated specifically) and Black-capped Piprites *Piprites pileatus* have been lost from the central Serra do Mar, but residual Three-toed Jacamar populations persist in the nearby Vale do Paraiba. Ochre-marked Parakeet *Pyrrhura cruentata*, Salvadori's Antwren *Myrmotherula minor*, Fork-tailed Tody-Tyrant *Hemitriccus furcatus* and Black-headed Berryeater *Carpornis melanocephala* still regularly occur in adjacent forests closer to the littoral^{2,64,95}.

At national level⁴⁶ 19 species are considered threatened in some category, many of them (73%) also treated as threatened globally. The Brazilian list considers Black-bellied Thorntail *Discosura langsdorffii* and Maroon-faced Parakeet *Pyrrhura leucotis* threatened, but not Three-toed Jacamar, Golden-tailed Parrotlet, Fork-tailed Tody-Tyrant and Royal Flycatcher. Crowned Eagle and Brown-backed Parrotlet are also regarded as threatened nationally, but at the lowest level.

At state level² 29 species are threatened, three of them being extinct (Black-fronted Piping Guan, Red-and-green Macaw *Ara chloropterus*, Banded Cotinga). The last two named species have possibly been extinct in the state for c.100 years. Fifteen of the 29 species considered threatened at state level are similarly listed nationally, although only Brown-backed and Golden-tailed Parrotlets, Vinaceous-breasted Parrot, and the bamboo specialists Buffy-fronted and Temminck's Seedeaters have occurred recently in the region. Thirteen species are considered threatened at the state level and still occur in our study area, namely Solitary Tinamou (which according to local people

has reappeared within the last five years, following a long period without records), Black-and-white Hawk-Eagle *Spizaetus melanoleucus*, Grey-bellied Hawk *Accipiter poliogaster*, Blue-bellied Parrot and Oustalet's Tyrannulet *Phylloscartes oustaleti*.

Considered Vulnerable at global and national levels, Grey-winged Cotinga *Tijuca condita* was described as recently as 1980 and is wholly restricted to the highest mountains in this region of Rio de Janeiro, having been recorded close to the westernmost extremity of the VT study region, on the Pico da Caledônia³. Within the study area, its vocalisation was heard (but not confirmed) by JFP on 6 September 2009 in a tract of cloud forest (1,500 m) at c.22°22'S 42°29'W.

The avifauna of Vale das Taquaras is essentially forest-based (see Table 4). Approximately 70% of the bird species recorded in the study area is forest-based, inhabiting the interior, border or airspace above it. For this reason, the following sections describe the trophic community of montane forest birds in this part of the Serra do Mar¹⁴.

Forest birds are most clearly represented by members of the Accipitridae, Columbidae, Psittacidae, Strigidae, Trochilidae, Trogonidae, Ramphastidae, Picidae, Thamnophilidae, Conopophagidae, Rhinocryptidae, Formicariidae, Dendrocolaptidae, Furnariidae, Tyrannidae, Cotingidae, Pipridae, Tityridae, Vireonidae, Turdidae, Thraupidae, Parulidae, among others (Table 4).

Among non-forest birds, we highlight the presence of several families / species (e.g. Phalacrocoracidae, Ardeidae, Rallidae, Alcedinidae) confined to swamps and small streams, and others from anthropogenic environments or fields with grasses and shrubs (e.g. Cariamidae, Cuculidae, Tytonidae, Bucconidae, Mimidae, Emberizidae, Estrildidae, Passeridae) (Table 4).

Trophic guilds.—Taking only forest species, six trophic guilds are recognised: insectivores, frugivores, granivores, nectarivores, omnivores and carnivores. Insectivores represent the most numerous guild totalling c.39% of all species recorded in the region and c.40% of forest species. From this guild, we highlight the various forest Caprimulgidae, Picidae, Thamnophilidae, Conopophagidae, Grallariidae, Rhinocryptidae, Formicariidae, Dendrocolaptidae, Furnariidae, Tyrannidae and Parulidae¹⁸. Omnivores, mainly from the Trogonidae, Tyrannidae, Thraupidae, Tityridae, Vireonidae and Turdidae, comprise the second most numerous trophic guild (26.5%), followed by frugivores (11.5%), carnivores (10.5%), nectarivores (6%) and granivores (4.5%).

Based on our work in the VT and the Serra dos Órgãos, we present a summary of interactions between these guilds and their food resources, with emphasis on foraging behaviour and the

genera or species exploited. We commence with the insectivores, which deserve special attention, both because they represent the most numerous guild in the Macaé de Cima and entire Serra dos Órgãos, by virtue of their ability to exploit diverse microhabitats and include a large number of Atlantic Forest endemics.

Insectivores.—Following Snow¹²⁰, the extreme diversity of insects allied to the numerous adaptations different groups possess to escape predation are factors that have provided a considerable boost to the diversity of Neotropical insectivores. Thus, various foraging techniques have evolved among insectivorous birds, which have specialised in taking certain groups of insects and / or utilising different microhabitats or specific substrates. Fruits, in contrast, 'want' to be eaten and, for this reason, do not offer many opportunities for specialisation, thereby explaining the greater diversity of insectivorous birds in Neotropical forests.

It should be borne in mind that the separation into subguilds which follows is an effort to group species according to their principal microhabitats and feeding niches, based on the literature and our own field work. Although consistent and useful in most cases, some insectivores appear in two or more subguilds, revealing the dynamic flexibility of these species with respect to their different niches and substrates.

Ground insectivores: Among the mainly terrestrial birds are White-bibbed Antbird *Myrmeciza loricata*, Variegated Antpitta *Grallaria varia*, Rufous-capped Antthrush *Formicarius colma*, Short-tailed Antthrush *Chamaeza campanisona*, Such's Antthrush *C. meruloides*, Brazilian Antthrush *C. ruficauda*, Rufous-breasted Leaf-tosser *Sclerurus scansor* and Sharp-tailed Streamcreeper *Lochmias nematura*. This group captures most prey in the dense leaf litter on the forest floor, interspersed by shrubs, bamboos, fallen logs and dead fern and palm fronds. *Lochmias nematura* is especially fond of streams in forest. The forest floor covered with dense leaf litter below *Guadua* and *Merostachys* bamboos is frequented by *Myrmeciza loricata*, *Sclerurus scansor* and the three species of *Chamaeza*, all of which turn over leaves in search of prey. *M. loricata* makes short sally-strikes to take prey on the underside of green leaves, and prefers natural gaps with dense accumulations of twigs and fallen logs. The three *Chamaeza* walk on bamboo and fallen logs, singing from perches higher on trees or in bamboo.

A second group is formed by semi-terrestrial birds that also frequently feed on the ground, e.g. Star-throated Antwren *Myrmotherula gularis*, the tapaculos (Slaty Bristlefront *Merulaxis ater*, Mouse-coloured Tapaculo *Scytalopus speluncae* and White-breasted Tapaculo *Eleoscytalopus*

indigoticus), species of *Conopophaga* and *Synallaxis*, and White-browed Warbler *Basileuterus leucoblepharus*. These species are common at edges with dense tangles of dead fern fronds and palms mixed with bamboo (*Guadua*, *Merostachys* and *Chusquea*). *Myrmotherula gularis* occurs in small groups, often around creeks, perching on narrow, vertical stems, investigating litter trapped above ground, but also descending to the floor. Prey is obtained on the ground, in foliage (dead or live) and on dead fronds of palms and ferns, among other substrates. Tapaculos when descending to the ground also use, like *M. gularis*, vertical branches as perches.

Antswarm followers like White-shouldered Fire-eye *Pyriglena leucoptera* and Thrush-like Woodcreeper *Dendrocincla turdina* also take prey on the forest floor, mainly arthropods disturbed by the ants passage^{51,130}, peering from perches in the understorey, then jumping or flying down to capture grasshoppers (Orthoptera) and beetles (Coleoptera), among other prey, on the forest floor, on trunks and fallen branches. *Dendrocincla turdina* also follows coatimundis *Nasua nasua* and monkeys (*Cebus nigritus*) in search of prey displaced by these mammals.

Trunk and branch insectivores: Woodpeckers (Picidae), woodcreepers (Dendrocolaptidae) and a small group of Furnariidae (genera *Xenops* and *Heliobletus*) comprise another subguild that forage on trunks and branches. Although members of this subguild always climb trees and at first glance there is no significant diversification of feeding niches, this impression is illusory. Firstly, Scaled Woodcreeper *Lepidocolaptes squamatus* and Sharp-billed Treehunter *Heliobletus contaminatus* are specialised foragers on epiphytes. Our published studies in the Atlantic Forest of south-east Brazil demonstrated that these two species use their bills to manipulate, remove or displace mosses and lichens to capture prey^{71,75,86}. Approximately 70–75% of these two species' foraging activities are directed at these substrates.

The genus *Xenops* specialises in a particular type of 'garbage' forest, exploring mainly narrow twigs and dead branches (up to 3 cm in diameter). As our observations⁸⁸ of Streaked *Xenops X. rutilans* in the Serra dos Órgãos and Itatiaia National Park demonstrate, this species preferentially investigates holes and cracks in dead twigs (without foliage) still attached to trees or shrubs (62.7%) or suspended within the vegetation (24.4%).

Among woodcreepers there is a high degree of microhabitat selection and allocation of resources, from Scaled Woodcreeper that forages in mosses and lichens, to White-throated Woodcreeper *Xiphocolaptes albicollis* which is a specialist in bromeliads^{91,110,119}.

Such diversity of feeding niches among woodcreepers is accompanied by a varied repertoire of foraging behaviours employed by the different species. Lesser Woodcreeper *Xiphorhynchus fuscus* explores dead plant matter in the Atlantic Forest, including dead leaves within bromeliads, fragments of arboreal ferns (Cyatheaceae) and dead palm fronds⁷³. Olivaceous Woodcreeper *Sittasomus griseicapillus* uses various substrates to capture prey on main trunks, live foliage, the air and other substrates. This species regularly performs aerial sallies to take mosquitos and small flies (Diptera) in the air or on live foliage, behaviour rare for most woodcreepers in the Serra dos Órgãos⁷⁸. Planalto Woodcreeper *Dendrocolaptes platyrostris*, which takes prey on main trunks, also frequents blooms in the forest canopy, such as *Schefflera* sp. (Araliaceae) and the palm *Euterpe edulis*, in search of bees (Hymenoptera) and other winged insects.

Among Picidae, White-browed Woodpecker *Piculus aurulentus* has a predilection for trunks and dead branches, partially damaged by the action of epiphytes such as mosses, lichens and Piperaceae. Others, e.g., Yellow-eared *Veniliornis maculifrons* and Green-barred Woodpeckers *Colaptes melanochloros*, use their bills to chisel into bamboo (*Guadua tagoara*) stems. The tiny White-barred Piculet *Picumnus cirratus* explores slender vines and bamboos, hanging on petioles of dead *Cecropia hololeuca* leaves and using its short, stout bill to 'attack' bare branches. Like *Xenops*, *P. cirratus* also visits dead twigs suspended above ground in the forest. Blond-crested Woodpecker *Celeus flavescens* explores rotting tree branches, as well as consuming fruits (e.g. *Myrsine* sp., Myrsinaceae, and *Talauma ovata*, Magnoliaceae).

Live-foliage insectivores: This subguild includes several species of Thamnophilidae, Furnariidae, Tyrannidae, Tityridae, Vireonidae, Parulidae and Thraupidae, among others, which feed primarily, sometimes exclusively, on arthropods on live leaves. We include here some omnivores, especially vireos and tanagers, which regularly feed on live foliage. This group of insectivores use various foraging methods, capturing prey either while perched, in flight or hanging from branches, and, although the same species may employ more than one or even all three methods, usually one is favoured.

The three species of *Dysithamnus* antvireos typically forage on live foliage, investigating the small leaves of understorey trees by hopping on branches or making short sallies to surprise prey. Caterpillars are among their principal diet, but also small beetles (Coleoptera) and stick insects (Orthoptera, Phasmidae), as well other arthropods. Streak-capped Antwren *Terenura maculata* frequents the upper strata, exploring the interior of dense vine tangles and the well-foliated ends of

branches, moving rapidly, surprising prey on leaves and hanging from limbs and petioles¹³⁰.

Among furnariids, Buff-fronted Foliage-gleaner *Philydor rufum* is an 'acrobat' that, in addition to live foliage, to a lesser extent also explores dead leaves. Employing various acrobatic manoeuvres, often hanging upside-down on leaves and twigs, it investigates the foliage at the tips of branches, palm fronds and arboreal ferns or clusters of flowers and fruits for prey. *P. rufum* pulls open rolled-up leaves to find spiders or caterpillars, using its legs or bill, and tears at leaves to extract arthropods⁸⁰.

Tyrant flycatchers (Tyrannidae) include many diverse species of insectivores that principally forage on live foliage. Forest species regularly use aerial manoeuvres, sallying to take prey on limbs of trees, but the specific techniques used vary quite widely²². The first group of species (e.g. Sepia-capped Flycatcher *Leptopogon amaurocephalus*, Eared Pygmy Tyrant *Myiornis auricularis* and Grey-hooded Flycatcher *Mionectes rufiventris*) employ the 'sit and wait' technique, in which the bird perches quietly, periodically making short flights, usually upwards, to seize prey on the underside of limbs or leaves. *L. amaurocephalus* and *M. auricularis* flutter immediately prior to striking at their prey (sally-hover), with large fronds of *Euterpe edulis* palms and arboreal ferns (Cyatheaceae) favoured hunting substrates. Perching on their branches, these species scan for the presence of small arthropods above them. *L. amaurocephalus* and *M. rufiventris* follow mixed-species flocks, perching in the understorey, waiting for prey to be dislodged by the feeding birds higher up. Caterpillars and grasshoppers (Orthoptera) form part of the diet of *L. amaurocephalus*, whereas *M. rufiventris* hovers to take arthropods on leaves and in spiderwebs, as well as regularly taking fruit (e.g. *Alchornea triplinervia*, *Struthanthus* sp., *Siparuna* sp., *Clusia* sp.). White-throated Spadebill *Platyrinchus mystaceus* hunts in the understorey, remaining motionless while perched on a relatively open site, making rapid, usually horizontal, sallies (without hovering) to small leaves of shrubs, small trees and bamboo.

In contrast to the 'sit and wait' technique, Grey-capped Tyrannulet *Phyllomyias griseocapilla* and Mottle-cheeked Tyrannulet *Phylloscartes ventralis* move actively through the trees, making short sallies to take prey on foliage. Species of *Phyllomyias* also take fruits, especially *Struthanthus* (Loranthaceae), while Yellow Tyrannulet *Capstempis flaveola* and Black-tailed Flycatcher *Myiobius atricaudus* prefer to hunt in *Guadua tagoara* bamboo. *M. atricaudus* employs a peculiar foraging method, keeping the wings and tail open while making aerial sallies to catch prey in the foliage or the airspace between the bamboo stems, and is extremely restless. The

species of *Pachyramphus* take caterpillars and diverse arthropods from live foliage, and even consume fruits. Prey is taken both while perched and via short flights.

Rufous-crowned Greenlet *Hylophilus poicilotis* has a peculiar foraging method, flying (or jumping) to cling briefly to live leaves to take caterpillars, spiders, beetles and other arthropods. Parrini *et al.*⁸⁵ described in detail its foraging behaviour in the Atlantic Forest of south-east Brazil, finding that foliage-dwelling arthropods represent c.60% of the species' diet, supplemented by fruits, especially *Struthanthus* spp. (Loranthaceae). Rufous-browed Peppershrike *Cyclarhis gujanensis*, like the greenlet, hangs from leaves to take caterpillars, rips apart large dead leaves, e.g. *Cecropia*, using its bill, and uses the feet to secure prey (e.g. caterpillars and beetles) on branches, which behaviour is frequent among vireos.

Tropical Parula *Parula pitiayumi* and Golden-crowned Warbler *Basileuterus culicivorus* are among the most active foragers in live foliage, with the latter species one of the most frequent participants in mixed-species flocks in the Serra dos Órgãos. These two species are constantly active, taking advantage of the intense movement of the foliage to displace small arthropods. *B. culicivorus* bounces on large fern fronds (Cyatheaceae), making reaching movements to glean prey on leaflets, bamboo (*Guadua tagoara*) foliage or saplings, for example those of the genera *Psychotria* (Rubiaceae), *Miconia* (Melastomataceae) and *Solanum* (Solanaceae).

Tanagers, in contrast to the majority of species from the previously mentioned families, more regularly include fruit in their diets. The various species of *Tangara*, e.g. Brassy-breasted Tanager *T. desmaresti*⁸², explore live foliage in the upper forest strata in search of prey. Green-headed Tanager *T. seledon*, like Brassy-breasted Tanager, moves in monospecific flocks of up to 16 birds, but differs from other congeners in taking prey on branches, rather than leaves. Fawn-breasted Tanager *Pipraeidea melanonota* searches for caterpillars, while the two species of *Hemithraupis* investigate the ends of branches in the canopy, inspecting the underside of leaves by peering and craning movements, rather than perching upside-down. Black-goggled Tanager *Trichothraupis melanops*, unlike the previously mentioned species, joins mixed-species understorey flocks led by Red-crowned Ant Tanager *Habia rubica*, which regularly follow army antswarms. *T. melanops* regularly employs aerial manoeuvres to seize prey from the leaves of small trees or in the airspace of the understorey. Blue Dacnis *Dacnis cayana* uses its bill to lever apart (gaping) leaves attached by webs or gelatinous substances in search of small prey.

Dead-leaf insectivores: Dead leaves are searched with varying frequency by diverse bird species. Some authors^{108,111} have determined that species spending >75% of their time foraging on this substrate should be considered 'specialists' and those that spend 25–75% of their time 'regular users'. In the Serra dos Órgãos, most of the specialists or regular users are *Thamnophilidae*, *Dendrocolaptidae*, *Furnariidae*, *Tyrannidae* and *Vireonidae*. Examples of regular users are Pallid Spinetail *Cranioleuca pallida*, Buff-fronted Foliage-gleaner, Grey-hooded Flycatcher and Rufous-crowned Greenlet^{72,80,85}.

Recent work in the Atlantic Forest of south-east Brazil, based in large part on field work in the Serra dos Órgãos, has described in detail the feeding behaviour of several species specialised in feeding in dead leaves, for example White-browed Foliage-gleaner *Anabacerthia amaurotis*, Black-capped Foliage-gleaner *Philydor atricapillus* and Lesser Woodcreeper^{47,73,77,83}. These studies revealed that the dead foliage of certain plants, especially palms, tree ferns (*Cyatheaceae*), bromeliads and bamboo are among the most exploited substrates by these birds. The acrobatic furnariids (*Anabacerthia amaurotis*, *Philydor atricapillus* and White-eyed Foliage-gleaner *Automolus leucophthalmus*) manipulate twigs and dead leaves in palm fronds and ferns, or dead leaves of bromeliads, to extract their prey. White-eyed Foliage-gleaner has a predilection for dense clumps of dead leaves suspended above ground. Lesser Woodcreeper searches the litter accumulated on ferns and bromeliads.

White-throated Woodcreeper and Pale-browed Treehunter *Cichlocolaptes leucophrus* specialise in foraging on bromeliads, especially dead plant matter lodged inside them, which these two species systematically remove. The woodcreeper destroys bromeliads, spending long periods using its bill to remove dead leaves from the lower part of these plants⁹¹. In the Atlantic Forest, *C. leucophrus* is the insectivore that concentrates most (c.90%) of its foraging on these plants⁸⁷.

Other examples of dead-leaf specialist insectivores are Ochre-rumped Antbird *Drymophila ochropyga* and White-collared Foliage-gleaner *Anabazenops fuscus*, which are strictly associated with extensive bamboo in the Serra dos Órgãos (see below).

Bamboo insectivores: Bamboos (*Poaceae*: *Bambusoideae*) occupy large parts of the Vale das Taquaras and a diverse group of birds utilise these plants. Although many species utilise bamboo to some extent (see above), here we include only insectivore 'specialists', especially several *Thamnophilidae*, *Furnariidae* and *Tyrannidae*. Such specialisation in various cases (see above) was a 'parallel' specialisation in dead foliage⁸⁷.

Three species of *Drymophila* (Ferruginous Antbird *D. ferruginea*, *D. rubricollis* and *D. ochropyga*) illustrate a singular case of microhabitat selection and resource-partitioning between morphologically similar species^{36,37,103}. All three capture prey both while perched, extracting it from leaves, and by employing acrobatic manoeuvres, hanging down or sideways on slender bamboo stems. *D. ochropyga* differs by using a high proportion of dead bamboos, particularly *Guadua tagoara*. This species moves through the base of the bamboo, where dead vegetable matter, particularly dead leaves, accumulates. Unlike *D. ochropyga*, Ferruginous and Bertoni's Antbirds prefer live foliage, foraging in the upper strata of bamboo. Bertoni's Antbird has a special affiliation for *Merostachys* bamboos, at higher altitudes than the previous two species in Macaé de Cima and elsewhere in the Serra dos Órgãos, for example in the national park.

White-bearded Antshrike *Biatas nigropectus* is restricted to bamboo, especially *Guadua tagoara*, foraging in both the foliage and thorns. White-collared Foliage-gleaner explores the various parts of *G. tagoara*, pecking at stems, removing their leaves, inserting the bill into nodes and thorns, or destroying dead leaves in search of prey⁸⁴. Drab-breasted Bamboo Tyrant *Hemitriccus diops* and Large-headed Flatbill *Ramphotrigon megacephalum* forage in live bamboo, mainly using flights (70%) to catch prey in *Guadua tagoara* (pers. obs.). *H. diops* capture prey in shrubs adjacent to bamboo.

Aerial insectivores: This subguild basically comprises two families, swifts (*Apodidae*) and swallows (*Hirundinidae*)¹¹⁸. Some tyrannids (e.g. Tropical Pewee *Contopus cinereus*, Shear-tailed Grey Tyrant *Muscipira vetula* and Long-tailed Tyrant *Colonia colonus*) and nightjars (*Caprimulgidae*) also mainly use aerial manoeuvres to capture prey. While swifts and swallows permanently seek prey in flight, tyrant flycatchers and nightjars 'sit and wait', perched at the forest edge or on the ground.

Frugivory.—Frugivory is prevalent among diverse families in the Macaé de Cima and other parts of the Serra dos Órgãos. The following is an overview of trophic interactions between omnivorous / frugivorous / granivorous birds and the fruiting of certain families / genera / species of plants in the Serra dos Órgãos. The basic difference between frugivores and omnivores birds is that the latter feed on both insects and fruits, while frugivores feed primarily, and in some cases exclusively, on fruits^{101,102,118,121}. Behavioural patterns noted in frugivores and omnivores basically revolve around methods of foraging on fruits, associated with the number of individuals that usually visit plants, among other factors^{38,115,118}.

Regarding foraging methods, Trogonidae, Tyrannidae, Cotingidae and Pipridae take fruits in flight, whereas Psittacidae (e.g. Plain Parakeet *Brotogeris tirica*, Maroon-bellied Parakeet *Pyrhura frontalis*), Vireonidae (*Hylophilus poicilotis*) and Sharpbill *Oxyruncus cristatus* hang upside-down to feed. Several species of Cracidae, Columbidae, Psittacidae and Ramphastidae perch on nearby branches and crane forward to feed, while tanagers lean down from above to take species such as *Miconia* spp., and thrushes take fruits both while perched and in flight. After seizing a fruit, parrots, tanagers and euphonias typically chew them, whereas other families, for example, Trogonidae, Cotingidae, Pipridae and Turdidae rarely do so^{115,118}. Those species that visit fruiting trees in flocks include Psittacidae (e.g. Maroon-bellied Parakeet, Plain Parakeet, Blue-winged Parrotlet *Forpus xanthopterygius*, Scaly-headed Parrot *Pionus maximiliani*), Thraupidae (e.g. *Tangara desmaresti*, *T. seledon*, Golden-chevroned Tanager *Thraupis ornata*) and Icteridae (e.g. Red-rumped Cacique *Cacicus haemorrhous*).

Association between frugivores / granivores and fruiting bamboo: The montane forests of south-east Brazil are generally dominated by extensive areas of bamboo of the genera *Guadua*, *Chusquea* and *Merostachys*^{103,122}. Between 500 and 1,200 m, *Guadua tagoara* (Poaceae: Bambuseae) is prominent in the Vale das Taquaras, being one of the most abundant forest species. Popularly known as 'Taquaruçu' this bamboo is native to the Atlantic Forest, occurring mainly in the Brazilian coastal mountains between Bahia and Santa Catarina¹. Fruiting events by this and other bamboo species are rare, with many years between them. A massive fruiting of *G. tagoara* was noted in 2004–08 in the Macaé de Cima and elsewhere in the Serra dos Órgãos. Seed production was accompanied by the death of large areas of bamboo, which is usually true in several species of bamboos. Careful observation revealed extensive brownish gaps amid the forest landscape, corresponding to areas previously dominated by *G. tagoara*.

No fewer than seven species (Maroon-bellied Parakeet, Green-winged Saltator *Saltator similis*, Ruby-crowned Tanager *Tachyphonus coronatus*, Uniform Finch *Haplospiza unicolor*, Buffy-fronted and Temminck's Seedeaters, and Sooty Grassquit *Tiaris fuliginosus*) are regularly observed feeding on the seeds of *G. tagoara*. Such massive fruiting, synchronous across the Serra dos Órgãos, attracted huge numbers of two granivores, *Sporophila frontalis* and *S. falcirostris*. Both species are poorly known around Macaé de Cima and considered rare in the Serra dos Órgãos⁴⁹. Notably, from 2005, the songs of hundreds or thousands of these two *Sporophila* became part of the landscape over large areas of the Serra dos Órgãos. Sick¹¹⁸ highlighted

the phenomenon of fruiting bamboos as a resource capable of attracting thousands of *Sporophila frontalis*, plus other granivorous birds such as Temminck's Seedeater and Sooty Grassquit in the montane forests of south-east Brazil.

During the fruiting event, insectivores such as Green-barred and Yellow-eared Woodpeckers exploited the senescent stems of *G. tagoara* in search of prey. Others, such as Pallid Spinetail, Eared Pygmy Tyrant and Yellow-olive Flycatcher *Tolmomyias sulphureus* sought arthropods in the spiderwebs that proliferated in the dead bamboo.

Melastomataceae, a key resource for birds in the Vale das Taquaras and Serra dos Órgãos: Several studies have reported the importance of the Melastomataceae for birds in the Atlantic Forest of south-east Brazil^{23,28,50,76,81}. The genus *Miconia* is notable for the large number of species used by birds around Macaé de Cima and elsewhere in the Serra dos Órgãos. This genus includes small trees and saplings that generally occur at edges or in natural clearings. Parrini & Pacheco⁷⁶ observed 47 species of birds consuming fruit of six different species of *Miconia* on an altitudinal gradient (520–1,830 m) in Serra dos Órgãos National Park. According to these authors, the different species of *Miconia* largely fruit at different times of year, with greatest overlap in winter, making them particularly key resources for birds during the dry season.

The different species of *Tangara* are among the principal consumers of succulent *Miconia* fruits^{76,81}. Visiting these plants in monospecific flocks, *Tangara* species disperse large numbers of seeds, although their habit of chewing the berries, common among tanagers, causes a certain amount of 'waste' of seeds around their parent plants^{50,76}. Species of *Miconia* are also taken by other omnivores (Tyrannidae) as well as specialist frugivores (Pipridae and Cotingidae). Pin-tailed *Ilicura militaris* and Swallow-tailed Manakins *Chiroxiphia caudata* visit these plants alone, using aerial manoeuvres to take fruits without chewing them. Black-and-gold Cotinga *Tijuca atra* and Bare-throated Bellbird perch beside bunches of *Miconia chartacea* feeding calmly.

Small saplings of the genus *Leandra* (Melastomataceae), abundant components at the forest edge, also provide important food for birds, their fruits being consumed by tanagers (e.g. Black-goggled Tanager, Ruby-crowned Tanager *Tachyphonus coronatus* and Brassy-breasted Tanager), manakins (*Chiroxiphia caudata*) and thrushes.

Psychotria (Rubiaceae), abundant fruits in the understory: The shrubby genus *Psychotria* (Rubiaceae) is very obvious along trails and roads around Macaé de Cima and the Serra dos Órgãos in general. The fruits of several species are bluish, grouped in small clusters, contrasting with their

whitish or yellow flowers. In submontane and montane forests, *Psychotria nuda* is one of the genus' commonest representatives and is visited by birds such as Black-goggled Tanager, Swallow-tailed Manakin and Red-crowned Ant Tanager. Flocks of Brassy-breasted and Azure-shouldered Tanagers *Thraupis cyanoptera* are observed at the forest edge frequenting *Psychotria constricta* and *P. velloziana*⁸². Tanagers chew fruit, dropping parts below the parent plants. Some specialist frugivores such as Hooded Berryeater *Carpornis cucullata* visit the understorey to feed on *Psychotria*. Like the Melastomataceae, it is common to observe several *Psychotria* together at certain locations at the forest edge, attracting monospecific flocks of tanagers.

Cecropiaceae as a resource for avian frugivores / omnivores at different seasons: Two species of the genus *Cecropia*, *C. hololeuca* and *C. glaziovii*, are among the most conspicuous forest elements in the Serra dos Órgãos⁷⁰. These trees are pioneers, appearing in deforested sites, forest edges, old secondary forests and natural clearings. The long catkins are food for a diverse guild of birds, from parakeets and trogons to thrushes and tanagers. Surucua Trogon *Trogon surrucura* tears off pieces of *C. glaziovii* fruits in flight, while flocks of Maroon-bellied Parakeet, Blue-winged Parrotlet and Plain Parakeet hang on the catkins of *C. hololeuca* to feed. Species of *Tangara* and *Thraupis* do the same on *C. glaziovii*, removing pieces from the tip of the catkins. Rufous-bellied *Turdus rufiventris* and Pale-breasted Thrushes *T. leucomelas* feed on both species of *Cecropia* while perched.

A third species of this family, *Coussapoa microcarpa*, is known for 'strangling' other trees while growing, like trees of the fig family Moraceae. A large tree, typical of the forests of south-east Brazil, *C. microcarpa* occurs in various parts of the Serra dos Órgãos. According to a study in the last-named region⁷⁴, tanagers, especially species of *Tangara* and *Thraupis*, thrushes (Yellow-legged Thrush *Turdus flavipes*, Rufous-bellied Thrush), euphonias (Chestnut-bellied Euphonia *Euphonia pectoralis*, Blue-naped Chlorophonia *Chlorophonia cyanea*) and Plain Parakeet are the principal consumers of its fruits. This fig also attracts larger frugivores such as Plumbeous Pigeon *Patagioenas plumbea* and Surucua Trogon. The inflorescences, consisting of masses of many fleshy fruits, possess tiny seeds that are chewed and swallowed by tanagers and euphonias.

The two species of *Cecropia* fruit at different seasons—*C. hololeuca* in winter (June–August) and *C. glaziovii* in summer (January–February)—while *Coussapoa microcarpa* fruits between November and April, and is particularly visited by family groups of birds during the post-breeding period⁷⁴.

Association between birds and the palm Euterpe edulis: *E. edulis* (Arecaceae) is one of

the most abundant trees in the Atlantic Forest of south-east Brazil⁷⁰. This palm fruits throughout autumn and winter (April–September) in the Serra dos Órgãos and is frequently visited by guans, parakeets, toucans, thrushes and some cotingas. While some species / families of birds consume the entire fruit, swallowing it quickly after collection, others take the pulp (arils) and discard the seeds without ingesting them. Dusky-legged Guan *Penelope obscura*, Spot-billed Toucanet *Selenidera maculirostris*, Saffron Toucanet *Pteroglossus bailloni*, Rufous-bellied Thrush, Yellow-legged Thrush, Pale-bellied Thrush and Hooded Berryeater use the first method, whereas Scaly-headed Parrot and Maroon-bellied Parakeet feed only on arils. The blooms of this palm also attract many insects, in particular small Hymenoptera, which are taken by woodcreepers, for example Planalto and Olivaceous Woodcreepers⁷⁸.

Relationship between tree species of the genus Alchornea (Euphorbiaceae) and migrant omnivores: Many species (e.g. Tyrannidae, Pipridae, Tityridae, Turdidae and Thraupidae) consume the fruits of two species of *Alchornea* that occur at forest edges and clearings in the Serra dos Órgãos⁷⁹. However, some migrant birds that depart south-east Brazil in late summer to winter further north, are frequently found in association with fruiting *Alchornea triplinervia* in the months prior to their departure (in January–April)⁷⁹. Among these we should mention several, primarily insectivores or omnivores, which are common in Macaé de Cima during spring and summer: Streaked Flycatcher *Myiodynastes maculatus*, Variegated Flycatcher *Empidonomus varius*, Swainson's Flycatcher *Myiarchus swainsoni* and White-winged Becard *Pachyramphus polychopterus*. *Alchornea glandulosa* fruits from late August until October, in spring when, coincidentally, the same species of birds return south. The fruits are consumed by members of the Tyrannidae and Tityridae, both in the period before leaving (*Alchornea triplinervia*) and on returning (*A. glandulosa*).

Such differences in fruiting periods may suggest that this is a strategy used by two morphologically very similar species, in terms of their fruits, to reduce competition with regard to their principal dispersers and to benefit from the presence of migrants at different seasons. It is thus also relevant that other insectivores / omnivores, for example Euler's Flycatcher *Lathrotriccus euleri*, Tropical Kingbird *Tyrannus melancholicus* and Yellow-legged Thrush, all of which partially vacate the Serra dos Órgãos during winter¹⁶, consume the fruits of these two *Alchornea*⁷⁹.

Another factor responsible for fluctuations in the overall avian population in the Serra dos Órgãos is associated with the local breeding period. In particular, *Alchornea triplinervia* also benefits from

family groups of birds, which occur in the Serra dos Órgãos in January–April (the post-breeding period here)^{16,79}, as was earlier noted for *Coussapoa microcarpa*. Juvenile and adult Black-goggled, Brassy-breasted, Golden-chevroned and Azure-shouldered Tanagers, as well as thrushes, are regularly observed feeding on *Alchornea* at this season. In south-east Brazil various authors have demonstrated that fruits of these species are frequently consumed by Tyrannidae, Thaupidae and others^{79,90,92,126}.

Forest canopy fruits: Among tall trees that produce fruits attractive to birds we should mention the giant figs (e.g. *Ficus organensis*, Moraceae), certain species of the genera *Schefflera* (Araliaceae), *Ocotea* and *Nectandra* (Lauraceae), *Cupania oblongifolia*, and *Coussapoa microcarpa*, among others. The meaty fruits of *Ficus organensis*, which mature throughout summer and autumn, are exploited mainly by tanagers (Brassy-breasted, Azure-shouldered and Palm Tanagers *Thraupis palmarum*), euphonias (Chestnut-bellied Euphonia, Blue-naped Chlorophonia), parakeets (Maroon-bellied Parakeet and Plain Parakeet) and thrushes (*Turdus rufiventris*). With exception of thrushes, the other species chew the fruit, before ingesting them.

Schefflera spp. are visited by toucans (*Selenidera maculirostris*), thrushes (*Turdus flavipes*), elaenias (Highland Elaenia *Elaenia obscura*), cotingas (Hooded Berryeater, Swallow-tailed Cotinga *Phibalura flavirostris*), among others. Unlike those birds that visit large figs, this group of species consumes the whole fruit including the tough skin, behaviour also exhibited by Rufous-bellied Thrush, Black-and-gold Cotinga, and others, that consume fruits of the genera *Ocotea* and *Nectandra*.

The fruits of *Cupania oblongifolia* start to appear in late spring (November), and their large seed cases are visible throughout the summer. Such seeds are too large to be taken by small birds, e.g. tanagers and euphonias, but instead are exploited by tyrant flycatchers (Tropical Kingbird, Great Kiskadee *Pitangus sulphuratus*, Streaked Flycatcher), thrushes (Pale-breasted, White-necked *Turdus albicollis*, Rufous-bellied, Creamy-bellied *T. amaurochalinus* and Yellow-legged Thrushes), Crested Becard *Pachyramphus validus*, among other species able to swallow the seeds whole. Nevertheless, Brassy-breasted Tanagers and Golden-chevroned Tanagers do make brief visits to remove pieces of the orange-coloured arils.

The hard fruits of a *Vochysia* sp. (Vochysiaceae), trees that comprise much of the forest canopy in the Serra dos Órgãos, are consumed by Scaly-headed Parrot, which grinds them open with its bill.

Fruits of the forest edge and clearings: Shrubs and small trees of the genera *Trema* (Ulmaceae), *Schinus* (Anacardiaceae), *Solanum*, *Acnistus*

(Solanaceae), *Myrsine* (Myrsinaceae) and *Ureca* (Urticaceae), as well as the previously mentioned Melastomataceae (genera *Leandra* and *Miconia*) and cecropias are among those plants that produce fruits most favoured by birds at forest edges around Macaé de Cima and the Serra dos Órgãos as a whole.

The tiny drupes of *Trema micrantha* attract small omnivores such as diverse thraupids (Buff-throated Saltator *Saltator maximus*, Brassy-breasted Tanager, Blue Dacnis, Yellow-backed Tanager *Hemithraupis flavicollis* and Ruby-crowned Tanager) and other birds including Bananaquit *Coereba flaveola*, Red-eyed Vireo *Vireo olivaceus*, Chestnut-crowned Becard *Pachyramphus castaneus*, and Social *Myiozetetes similis*, Variegated and Streaked Flycatchers. The long fruiting season of *T. micrantha* is a well-known reproductive strategy of plants in secondary environments⁴.

Rufous-bellied and Creamy-bellied Thrushes and other generalists, like Great Kiskadee and Sayaca Tanager *Thraupis sayaca* visit *Schinus terebinthifolius* in small farms in the region. *Acnistus arborescens* and several small trees of the genus *Solanum* (Solanaceae) are frequented by Brassy-breasted and Azure-shouldered Tanagers and by Pileated Parrot *Pionopsitta pileata*, which chew the fruits prior to ingestion, while Swallow-tailed Manakin swallows them quickly without chewing. *Thraupis cyanoptera* also consumes the flowers and leaves of *Acnistus arborescens* and *Solanum* sp. Folivory is an unusual aspect of the diet *T. cyanoptera*, which in the Serra dos Órgãos has been observed feeding on the leaves of other plants, including vines of the genus *Sechium* (Cucurbitaceae).

Saplings of the genus *Myrsine* produce large quantities of fruit eaten by frugivores like Swallow-tailed Manakin and Swallow-tailed Cotinga, as well as by omnivores such as Grey-hooded Attila *Attila rufus*, Grey-hooded Flycatcher, Rufous-crowned Greenlet, Red-eyed Vireo and Brassy-breasted Tanager. Grey-hooded Attila has a varied diet comprising fruits, insects (e.g. butterflies) and small frogs captured at the edge of forest streams. In summer and autumn, the succulent berries of *Ureca baccifera* are eaten by Swallow-tailed Manakin and the genus *Euphonia*.

Interactions between birds and Loranthaceae: The Loranthaceae are hemiparasites that suck the sap of other plants. Its fruits are dispersed by birds after they defecate or regurgitate their seeds, which attach themselves to branches or trunks of other plants by means of their sticky exteriors^{29,118,121}. Birds are important both to transfer the seeds to new areas and, by removing the peel, enabling the mistletoe to affix itself to a host plant. In the Vale das Taquaras, *Struthanthus* and *Psittacanthus*

Table 4. List of species recorded in Vale das Taquaras region, Nova Friburgo, Rio de Janeiro, Brazil, with indication of occurrence, association with forested or open habits, trophic guilds, biogeographical category and documentation.

English name	Species	APA	F/O	TG	Biog	Evid
TINAMIDAE						
Solitary Tinamou	<i>Tinamus solitarius</i>	H	F	Fr	AFe	S,T
Brown Tinamou	<i>Crypturellus obsoletus</i>	T	F	Fr	SMt	S,T,P
Tataupa Tinamou	<i>Crypturellus tataupa</i>	T	Fw	Fr	AD	S
CRACIDAE						
Rusty-margined Guan	<i>Penelope superciliaris</i> *	C	F	Fr	AD	S
Dusky-legged Guan	<i>Penelope obscura</i>	T	F	Fr	SMt	P,T
ODONTOPHORIDAE						
Spot-winged Wood Quail	<i>Odontophorus capueira</i>	T	F	Fr	AFe	S,T,P
PHALACROCORACIDAE						
Neotropic Cormorant	<i>Phalacrocorax brasilianus</i> *	M	Oa	Pi	AD	P
ARDEIDAE						
Black-crowned Night Heron	<i>Nycticorax nycticorax</i> *	M	Oa	On	AD	P
Striated Heron	<i>Butorides striata</i> *	M	Oa	On	AD	P
Cattle Egret	<i>Bubulcus ibis</i> *	S	O	On	AD +	P
Great Egret	<i>Ardea alba</i> *	R	Oa	On	AD	P
Whistling Heron	<i>Syrigma sibilatrix</i> *	S	O	On	AD +	P
Snowy Egret	<i>Egretta thula</i> *	M	Oa	On	AD	S,P
THRESKIORNITHIDAE						
Green Ibis	<i>Mesembrinibis cayennensis</i> *	T	Oa	On	AD	–
CATHARTIDAE						
Turkey Vulture	<i>Cathartes aura</i>	T	Fw	De	AD	P
Lesser Yellow-headed Vulture	<i>Cathartes burrovianus</i> *	S	O	De	AD	–
Black Vulture	<i>Coragyps atratus</i>	T	O	De	AD	P
ACCIPITRIDAE						
Grey-headed Kite	<i>Leptodon cayanensis</i> *	G	F	Ca	AD	P
Swallow-tailed Kite	<i>Elanoides forficatus</i> *	T #	F	Ca	AD m	S
Black Hawk-Eagle	<i>Spizaetus tyrannus</i>	T	F	Ca	AFc	S,T,P
Black-and-white Hawk-Eagle	<i>Spizaetus melanoleucus</i>	H	F	Ca	AD	P
Rufous-thighed Kite	<i>Harpagus diodon</i> *	T	F	Ca	AD m	P
Plumbeous Kite	<i>Ictinia plumbea</i> *	G	F	Ca	AD m	S
Grey-bellied Hawk	<i>Accipiter poliogaster</i> *	T	F	Ca	AD m	P
Tiny Hawk	<i>Accipiter superciliosus</i> *	P #	F	Ca	AD	–
Sharp-shinned Hawk	<i>Accipiter striatus</i> *	T	Fw	Ca	AD	S,P
Crane Hawk	<i>Geranoospiza caerulescens</i> *	H	F	Ca	AD	S
Savanna Hawk	<i>Buteogallus meridionalis</i> *	T	O	Ca	AD +	P
Crowned Eagle	<i>Buteogallus coronatus</i> *	T	O	Ca	AD +	S,P
Roadside Hawk	<i>Rupornis magnirostris</i>	T	O	Ca	AD	P
White-rumped Hawk	<i>Parabuteo leucorrhous</i>	T	F	Ca	SMp	T,P
White-tailed Hawk	<i>Geranoaetus albicaudatus</i>	T	O	Ca	AD	P
Black-chested Buzzard-Eagle	<i>Geranoaetus melanoleucus</i>	T#	O	Ca	SMp	P
Mantled Hawk	<i>Pseudastur polionotus</i>	T	F	Ca	Afe	P
Short-tailed Hawk	<i>Buteo brachyurus</i> *	T	Fw	Ca	AD	T,P
Zone-tailed Hawk	<i>Buteo albonotatus</i> *	G	Fw	Ca	AD +	P
RALLIDAE						
Slaty-breasted Wood Rail	<i>Aramides saracura</i>	T	F	On	AFe	S,T,P
Blackish Rail	<i>Pardirallus nigricans</i>	T	Oa	On	AD	S,T,P

English name	Species	APA	F/O	TG	Biog	Evid
CHARADRIIDAE						
Southern Lapwing	<i>Vanellus chilensis</i> *	T	O	On	AD +	P
COLUMBIDAE						
Ruddy Ground Dove	<i>Columbina talpacoti</i> *	R	O	Gr	AD	S,P
Blue Ground Dove	<i>Claravis pretiosa</i> *	H #	F	Fr	AD m	S
Rock Pigeon	<i>Columba livia</i> *	M	Ou	Gr	AD	P
Picazuro Pigeon	<i>Patagioenas picazuro</i> *	T	O	Fr	AD +	P
Pale-vented Pigeon	<i>Patagioenas cayennensis</i> *	T	Fw	Fr	AD	–
Plumbeous Pigeon	<i>Patagioenas plumbea</i>	T	F	Fr	SMt	S,T
White-tipped Dove	<i>Leptotila verreauxi</i>	T	Fw	Fr	AD	S,P
Grey-fronted Dove	<i>Leptotila rufaxilla</i> *	T	F	Fr	AD	P
Ruddy Quail-Dove	<i>Geotrygon montana</i> *	H #	F	Fr	AD m	S,P
CUCULIDAE						
Squirrel Cuckoo	<i>Piaya cayana</i>	T	Fw	In	AD	S,P
Smooth-billed Ani	<i>Crotophaga ani</i>	T	O	In	AD	S,P
Guira Cuckoo	<i>Guira guira</i> *	S	O	In	AD	S,P
Striped Cuckoo	<i>Tapera naevia</i>	R	O	In	AD	S
TYTONIDAE						
Barn Owl	<i>Tyto alba</i> *	T	O	Ca	AD	S
STRIGIDAE						
Tropical Screech Owl	<i>Megascops choliba</i>	T	Fw	Ca	AD	S,P
Black-capped Screech Owl	<i>Megascops atricapilla</i> *	T	F	Ca	AFe	S
Tawny-browed Owl	<i>Pulsatrix koeniswaldiana</i> *	T	F	Ca	AFe	S
Rusty-barred Owl	<i>Strix hylophila</i> *	T	F	Ca	SMe	S,T
Mottled Owl	<i>Ciccaba virgata</i> *	T	F	Ca	AFt	T,P
Least Pygmy Owl	<i>Glaucidium minutissimum</i> *	B	F	Ca	AFe	S
Ferruginous Pygmy Owl	<i>Glaucidium brasilianum</i> *	L #	Fw	Ca	AD	S,T,P
Burrowing Owl	<i>Athene cucularia</i> *	S	O	Ca	AD +	P
Striped Owl	<i>Pseudoscops clamator</i>	T #	Fw	Ca	AD	S
Stygian Owl	<i>Asio stygius</i> *	T	Fw	Ca	AD	T,P
NYCTIBIIDAE						
Common Potoo	<i>Nyctibius griseus</i>	T	F	In	AD	S,P
CAPRIMULGIDAE						
Short-tailed Nighthawk	<i>Lurocalis semitorquatus</i>	T	F	In	AD m	S
Common Pauraque	<i>Nyctidromus albicollis</i>	T	F	In	AD	P
Ocellated Poorwill	<i>Nyctiphrynus ocellatus</i>	P	F	In	AD	–
Rufous Nightjar	<i>Antrostomus rufus</i>	T	F	In	AD m	S
Scissor-tailed Nightjar	<i>Hydropsalis torquata</i>	T #	O	In	AD	–
Long-trained Nightjar	<i>Macropsalis forcipata</i>	T	Hb	In	SMe	S,P
APODIDAE						
Sooty Swift	<i>Cypseloides fumigatus</i> *	T	Fw	In	AD m	–
White-collared Swift	<i>Streptoprocne zonaris</i>	T	O	In	AD m	S,P
Biscutate Swift	<i>Streptoprocne biscutate</i> *	T	O	In	AD m	T,P
Grey-rumped Swift	<i>Chaetura cinereiventris</i> *	T	F	In	AFt	–
Sick's Swift	<i>Chaetura meridionalis</i>	T	O	In	AD m	S
TROCHILIDAE						
Black Jacobin	<i>Florisuga fusca</i>	T	F	Ne	AFe	S,P
Saw-billed Hermit	<i>Ramphodon naevius</i> *	C	F	Ne	AFe	S,P
Rufous-breasted Hermit	<i>Glaucis hirsutus</i> *	T	F	Ne	AD	S,P

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Dusky-throated Hermit	<i>Phaethornis squalidus</i> *	T	F	Ne	SMe	S
Reddish Hermit	<i>Phaethornis ruber</i>	T	F	Ne	AD	S,P
Planalto Hermit	<i>Phaethornis pretrei</i>	T	O	Ne	AD	T,P
Scale-throated Hermit	<i>Phaethornis eurynome</i>	T	F	Ne	SMe	S,P
White-vented Violetear	<i>Colibri serrirostris</i> *	P	Hb	Ne	SMp	–
Black-throated Mango	<i>Anthracothorax nigricollis</i> *	T #	Fw	Ne	AD m	S
Frilled Coquette	<i>Lophornis magnificus</i>	T	F	Ne	AD	S,P
Brazilian Ruby	<i>Clytaeama rubricauda</i>	T	F	Ne	SMe	S,P
Amethyst Woodstar	<i>Calliphlox amethystina</i>	T	Fw	Ne	AD	S,P
Glittering-bellied Emerald	<i>Chlorostilbon lucidus</i>	T	Fw	Ne	AD	P
Plovercrest	<i>Stephanoxis lalandi</i>	T	Hb	Ne	SMe	S,P
Swallow-tailed Hummingbird	<i>Eupetomena macroura</i>	T	O	Ne	AD	P
Violet-capped Woodnymph	<i>Thalaurania glaucopsis</i>	T	F	Ne	AFe	S,P
Sombre Hummingbird	<i>Aphantochroa cirrochloris</i> *	T	Fw	Ne	SMp	S,P
White-throated Hummingbird	<i>Leucochloris albicollis</i>	T	Fw	Ne	SMp	S,T,P
Versicoloured Emerald	<i>Amazilia versicolor</i> *	T	F	Ne	AD	S,P
Sapphire-spangled Emerald	<i>Amazilia lactea</i> *	P	Fw	Ne	AFe	P
White-chinned Sapphire	<i>Hylocharis cyanus</i>	S	F	Ne	AFt	S
TROGONIDAE						
Green-backed Trogon	<i>Trogon viridis</i> *	C	F	On	AFt	S
Surucua Trogon	<i>Trogon surrucura</i>	T	F	On	SMt	S,T,P
Black-throated Trogon	<i>Trogon rufus</i>	T	F	On	AFt	S,T,P
ALCEDINIDAE						
Ringed Kingfisher	<i>Megaceryle torquata</i>	T	Oa	Pi	AD	S,P
Amazon Kingfisher	<i>Chloroceryle amazona</i> *	R	Oa	Pi	AD	S,P
Green Kingfisher	<i>Chloroceryle americana</i>	R	Oa	Pi	AD	S,P
MOMOTIDAE						
Rufous-capped Motmot	<i>Baryphthengus ruficapillus</i> *	T	F	On	AFe	S,P
GALBULIDAE						
Rufous-tailed Jacamar	<i>Galbula ruficauda</i> *	S	F	In	AD	S,P
BUCCONIDAE						
White-eared Puffbird	<i>Nystalus chacuru</i> *	G	O	In	AD +	S,P
RAMPHASTIDAE						
Channel-billed Toucan	<i>Ramphastos vitellinus</i> *	T	F	On	AD	S,T,P
Red-breasted Toucan	<i>Ramphastos dicolorus</i> *	H	F	On	Sme	S,P
Spot-billed Toucanet	<i>Selenidera maculirostris</i> *	T	F	Fr	AFe	S,P
Saffron Toucanet	<i>Pteroglossus bailloni</i> *	T	F	Fr	Sme	S,P
PICIDAE						
White-barred Piculet	<i>Picumnus cirratus</i>	T	F	In	AFt	S,P
White Woodpecker	<i>Melanerpes candidus</i> *	T	O	In	AD +	S,P
Yellow-eared Woodpecker	<i>Veniliornis maculifrons</i>	T	F	In	AFe	S,P
White-browed Woodpecker	<i>Piculus aurulentus</i> *	T	F	In	SMe	S,P
Green-barred Woodpecker	<i>Colaptes melanochloros</i> *	T	F	In	AD	S,P
Campo Flicker	<i>Colaptes campestris</i>	T	O	In	AD	P
Blond-crested Woodpecker	<i>Ceelus flavescens</i> *	T	F	In	AD	S,P
Lineated Woodpecker	<i>Dryocopus lineatus</i>	T	F	In	AFt	S,P
Robust Woodpecker	<i>Campephilus robustus</i> *	T	F	In	AFe	S
CARIAMIDAE						
Red-legged Seriema	<i>Cariama cristata</i>	C	O	On	AD	P

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FALCONIDAE						
Laughing Falcon	<i>Herpetotheres cachinnans</i> *	T	Fw	Ca	AD +	–
Barred Forest Falcon	<i>Micrastur ruficollis</i>	T	F	Ca	AD	S,T
Collared Forest Falcon	<i>Micrastur semitorquatus</i> *	T	F	Ca	AD	S
Southern Caracara	<i>Caracara plancus</i>	T	O	Ca	AD	S,P
Yellow-headed Caracara	<i>Milvago chimachima</i>	T	O	Ca	AD	T,P
American Kestrel	<i>Falco sparverius</i>	R	O	Ca	AD	S
Plomado Falcon	<i>Falco femoralis</i> *	T	O	Ca	AD	P
PSITTACIDAE						
Blue-winged Macaw	<i>Primolius maracana</i> *	T	Fw	Fr	AD +	S,P
White-eyed Parakeet	<i>Aratinga leucophthalma</i> *	T	O	Fr	AD	S,P
Maroon-bellied Parakeet	<i>Pyrrhura frontalis</i>	T	F	Fr	AFe	P
Blue-winged Parrotlet	<i>Forpus xanthopterygius</i> *	G	Fw	Fr	AD	S
Plain Parakeet	<i>Brotogeris tirica</i> *	T	F	Fr	AFe	S,P
Brown-backed Parrotlet	<i>Touit melanotus</i> *	T	F	Fr	SMe	S
Golden-tailed Parrotlet	<i>Touit surdus</i> *	T	F	Fr	AFe	S,T
Red-capped Parrot	<i>Pionopsitta pileata</i> *	T	F	Fr	SMe	S,P
Scaly-headed Parrot	<i>Pionus maximiliani</i>	T	F	Fr	AFt	S,P
Vinaceous-breasted Parrot	<i>Amazona vinacea</i> *	T	F	Fr	AFe	S
Blue-bellied Parrot	<i>Triclaria malachitacea</i>	T	F	Fr	SMe	S,T
THAMNOPHILIDAE						
Giant Antshrike	<i>Batara cinerea</i>	T	F	In	SMt	S,T,P
Large-tailed Antshrike	<i>Mackenziaena leachii</i>	T	Hb	In	SMe	S,P
Tufted Antshrike	<i>Mackenziaena severa</i>	T	F	In	SMe	S,P
White-bearded Antshrike	<i>Biatas nigropectus</i> *	T	F	In	SMe	S,T,P
Rufous-capped Antshrike	<i>Thamnophilus ruficapillus</i>	T	Hb	In	SMt	S,P
Variable Antshrike	<i>Thamnophilus caeruleus</i>	T	F	In	SMt	S,T,P
Spot-breasted Antvireo	<i>Dysithamnus stictothorax</i> *	T	F	In	SMe	P
Plain Antvireo	<i>Dysithamnus mentalis</i>	T	F	In	SMt	S,T,P
Rufous-backed Antvireo	<i>Dysithamnus xanthopterus</i> *	T	F	In	SMe	S,T,P
Star-throated Antwren	<i>Myrmotherula gularis</i> *	T	F	In	SMe	S,T
Ferruginous Antbird	<i>Drymophila ferruginea</i>	T	F	In	SMe	S,T,P
Bertoni's Antbird	<i>Drymophila rubricollis</i> *	T	F	In	SMe	S,T,P
Rufous-tailed Antbird	<i>Drymophila genei</i> *	B	F	In	SMe	S,T,P
Ochre-rumped Antbird	<i>Drymophila ochropyga</i>	T	F	In	SMe	S,T,P
Dusky-tailed Antbird	<i>Drymophila malura</i>	T	Hb	In	SMe	S,T,P
Streak-capped Antwren	<i>Terenura maculata</i> *	B	F	In	AFe	S
White-shouldered Fire-eye	<i>Pyriglena leucoptera</i>	T	F	In	AFe	S,T,P
White-bibbed Antbird	<i>Myrmeciza loricata</i>	T	F	In	SMe	S,T
CONOPOPHAGIDAE						
Rufous Gnateater	<i>Conopophaga lineata</i>	T	F	In	SMt	S,T,P
Black-cheeked Gnateater	<i>Conopophaga melanops</i>	T	F	In	AFe	T,P
GRALLARIIDAE						
Variagated Antpitta	<i>Grallaria varia</i>	T	F	In	AFt	S,T
RHINOCRYPTIDAE						
Spotted Bamboo-wren	<i>Psilorhamphus guttatus</i> *	T	F	In	SMe	P
Slaty Bristlefront	<i>Merulaxis ater</i> *	B	F	In	SMe	S,P
White-breasted Tapaculo	<i>Eleoscytalopus indigoticus</i> *	G	F	In	SMe	S
Mouse-coloured Tapaculo	<i>Scytalopus speluncae</i> *	T	F	In	SMe	S,T,P
FORMICARIIDAE						
Rufous-capped Antthrush	<i>Formicarius colma</i> *	H	F	In	AFt	S

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Short-tailed Antthrush	<i>Chamaeza campanisona</i>	T #	F	In	SMt	S
Such's Antthrush	<i>Chamaeza meruloides</i> *	T	F	In	SMe	S,T,P
Rufous-tailed Antthrush	<i>Chamaeza ruficauda</i> *	T	F	In	SMe	S,T,P
FURNARIIDAE						
Rufous-breasted Leafcreeper	<i>Sclerurus scansor</i>	T	F	In	AFe	S,P
Olivaceous Woodcreeper	<i>Sittasomus griseicapillus</i>	T	F	In	AFt	S,P
Plain-winged Woodcreeper	<i>Dendrocincla turdina</i>	H	F	In	AFe	S
Planalto Woodcreeper	<i>Dendrocolaptes platyrostris</i>	T	F	In	AFt	S,T,P
White-throated Woodcreeper	<i>Xiphocolaptes albicollis</i>	T	F	In	AFe	S,P
Lesser Woodcreeper	<i>Xiphorhynchus fuscus</i>	T	F	In	AFe	S,P
Black-billed Scythebill	<i>Campylorhamphus falcularius</i> *	T	F	In	AFe	S,P
Scaled Woodcreeper	<i>Lepidocolaptes squamatus</i>	T	F	In	AFe	S,P
Plain Xenops	<i>Xenops minutus</i> *	T	F	In	AFt	S,T
Streaked Xenops	<i>Xenops rutilans</i>	T	F	In	AFt	S,P
Wing-banded Hornero	<i>Furnarius figulus</i> *	G	O	In	AD +	P
Rufous Hornero	<i>Furnarius rufus</i>	R	O	In	AD	P
Sharp-tailed Streamcreeper	<i>Lochmias nematura</i>	T	Hb	In	SMp	S,T,P
White-collared Foliage-gleaner	<i>Anabazenops fuscus</i>	T	F	In	SMe	S,T,P
Pale-browed Treehunter	<i>Cichlocolaptes leucophrus</i> *	T	F	In	AFe	T
Sharp-billed Treehunter	<i>Heliobletus contaminatus</i>	B	F	In	SMe	S,P
Ochre-breasted Foliage-gleaner	<i>Philydor lichtensteini</i> *	T	F	In	SMe	S
Black-capped Foliage-gleaner	<i>Philydor atricapillus</i> *	H	F	In	AFe	–
Buff-fronted Foliage-gleaner	<i>Philydor rufum</i>	T	F	In	SMt	S,T,P
White-browed Foliage-gleaner	<i>Anabacerthia amaurotis</i>	T	F	In	SMe	S,T
Buff-browed Foliage-gleaner	<i>Syndactyla rufosuperciliata</i> *	T	F	In	SMt	S,P
White-eyed Foliage-gleaner	<i>Automolus leucophthalmus</i> *	R	F	In	AFp	–
Rufous-fronted Thornbird	<i>Phacelodomus rufifrons</i> *	T	O	In	AD +	P
Orange-eyed Thornbird	<i>Phacelodomus erythrophthalmus</i>	T	F	In	AFe	S,T,P
Firewood-gatherer	<i>Anumbius annumbi</i> *	G	O	In	AD +	–
Pallid Spinetail	<i>Cranioleuca pallida</i> *	T	F	In	SMe	S,T,P
Yellow-chinned Spinetail	<i>Certhiaxis cinnamomeus</i> *	S	Oa	In	AD	S,P
Rufous-capped Spinetail	<i>Synallaxis ruficapilla</i>	T	F	In	SMe	S,T,P
Grey-bellied Spinetail	<i>Synallaxis cinerascens</i> *	T	F	In	SMp	S,T,P
Spix's Spinetail	<i>Synallaxis spixi</i>	T	O	In	AD	S,P
TYRANNIDAE						
Rough-legged Tyrannulet	<i>Phyllomyias burmeisteri</i>	T	F	On	SMp	S,T,P
Greenish Tyrannulet	<i>Phyllomyias virescens</i> *	B	F	On	SMe	S,P
Planalto Tyrannulet	<i>Phyllomyias fasciatus</i>	T	F	On	AFt	S,P
Grey-capped Tyrannulet	<i>Phyllomyias griseocapilla</i> *	T	F	On	SMe	S,P
Grey Elaenia	<i>Myiopagis caniceps</i> *	M	F	In	AD	S
Yellow-bellied Elaenia	<i>Elaenia flavogaster</i>	T	O	On	AD	P
White-crested Elaenia	<i>Elaenia albiceps</i> *	T	F	On	AD m	–
Olivaceous Elaenia	<i>Elaenia mesoleuca</i>	T	F	On	SMp	S,P
Highland Elaenia	<i>Elaenia obscura</i> *	B	Hb	On	AFp m	S,T,P
Southern Beardless Tyrannulet	<i>Campptostoma obsoletum</i>	T	Fw	In	AD	S,T,P
Sooty Tyrannulet	<i>Serpophaga nigricans</i> *	R	Hb	In	SMp	S,P
White-crested Tyrannulet	<i>Serpophaga subcristata</i>	T	Fw	In	AD	S,T,P
Yellow Tyrannulet	<i>Capsiempis flaveola</i> *	T	F	In	AD	S,P
Mottle-cheeked Tyrannulet	<i>Phylloscartes ventralis</i>	T	F	In	SMp	S,T,P
Oustalet's Tyrannulet	<i>Phylloscartes oustaleti</i>	T #	F	In	SMe	T
Serra do Mar Tyrannulet	<i>Phylloscartes difficilis</i> *	B	F	In	SMe	T,P
Grey-hooded Flycatcher	<i>Mionectes rufiventris</i>	T	F	On	SMe	S,P

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Sepia-capped Flycatcher	<i>Leptopogon amaurocephalus</i> *	T	F	In	AD	S,P
Eared Pygmy Tyrant	<i>Myiornis auricularis</i> *	T	F	In	AFe	S,T
Drab-breasted Pygmy Tyrant	<i>Hemitriccus diops</i> *	T	F	In	SMe	S,T,P
Hangnest Tody-Tyrant	<i>Hemitriccus nidipendulus</i> *	C	Hb	In	AFe	P
Ochre-faced Tody-Flycatcher	<i>Poecilatriccus plumbeiceps</i>	T	Fw	In	SMp	S,P
Grey-headed Tody-Flycatcher	<i>Todirostrum poliocephalum</i>	R	F	In	AFe	S,P
Yellow-olive Flycatcher	<i>Tolmomyias sulphurescens</i>	T	F	In	AFt	S,P
White-throated Spadebill	<i>Platyrinchus mystaceus</i>	T	F	In	SMp	S,P
Bran-coloured Flycatcher	<i>Myiophobus fasciatus</i>	T	O	In	AD	S,P
Black-tailed Flycatcher	<i>Myiobius atricaudus</i> *	T	F	In	SMt	S,P
Cliff Flycatcher	<i>Hirundinea ferruginea</i> *	T	O	In	AD	S,P
Euler's Flycatcher	<i>Lathrotricus euleri</i>	T	F	In	AD	S,T,P
Tropical Pewee	<i>Contopus cinereus</i> *	R	F	In	AFt	S,P
Blue-billed Black Tyrant	<i>Knipolegus cyanirostris</i>	T	F	On	SMp	S,P
Crested Black Tyrant	<i>Knipolegus lophotes</i>	R	O	On	SMp	P
Velvety Black Tyrant	<i>Knipolegus nigerrimus</i>	T	Hb	On	SMt	S,P
Yellow-browed Tyrant	<i>Satrapa icterophrys</i> *	G	O	In	AD m	S,P
Grey Monjita	<i>Xolmis cinereus</i> *	M	O	In	AD m	P
White-rumped Monjita	<i>Xolmis velatus</i> *	G	O	In	AD m	P
Shear-tailed Grey Tyrant	<i>Muscipipra vetula</i> *	T	F	In	SMe	S,P
Masked Water Tyrant	<i>Fluvicola nengeta</i> *	T	Oa	In	AD +	P
Long-tailed Tyrant	<i>Colonia colonus</i> *	T	F	In	AD	S,P
Cattle Tyrant	<i>Machetornis rixosa</i> *	T	O	In	AD +	P
Piratic Flycatcher	<i>Legatus leucophaeus</i> *	G	Fw	On	AD m	P
Rusty-margined Flycatcher	<i>Myiozetetes cayanensis</i> *	T	Fw	On	AFt	T,P
Social Flycatcher	<i>Myiozetetes similis</i>	T	O	On	AD	S,P
Great Kiskadee	<i>Pitangus sulphuratus</i>	T	O	On	AD	T,P
Streaked Flycatcher	<i>Myiodynastes maculatus</i>	T	F	On	AD m	S,P
Boat-billed Flycatcher	<i>Megarynchus pitangua</i> *	T	Fw	On	AD	S,T,P
Variiegated Flycatcher	<i>Empidonomus varius</i>	T	F	In	AD m	S,T,P
Tropical Kingbird	<i>Tyrannus melancholicus</i>	T	F	On	AD m	S,P
Fork-tailed Flycatcher	<i>Tyrannus savana</i> *	G	O	In	AD m	P
Greyish Mourner	<i>Rhytipterna simplex</i> *	H #	F	In	AFt	P
Sirystes	<i>Sirystes sibilator</i>	T	F	In	AFt	S,P
Swainson's Flycatcher	<i>Myiarchus swainsoni</i> *	T	F	On	SMp m	S,T,P
Short-crested Flycatcher	<i>Myiarchus ferox</i>	T	Fw	On	AD m	P
Large-headed Flatbill	<i>Ramphotrigon megocephalum</i> *	T	F	In	SMt	T,P
Rufous-tailed Attila	<i>Attila phoenicurus</i> *	H	F	On	SMp m	T
Grey-hooded Attila	<i>Attila rufus</i>	T	F	On	AFe	S,T,P
OXYRUNCIDAE						
Sharpbill	<i>Oxyruncus cristatus</i>	T	F	On	AFt	S,P
COTINGIDAE						
Hooded Berryeater	<i>Carpornis cucullata</i> *	T	F	Fr	SMe	S,P
Black-and-gold Cotinga	<i>Tijuca atra</i>	T	F	Fr	SMe	S,T,P
Bare-throated Bellbird	<i>Procnias nudicollis</i>	T	F	Fr	AFe	S,T,P
PIPRIDAE						
Serra do Mar Tyrant-Manakin	<i>Neopelma chrysolophum</i> *	T	F	On	SMe	S,T,P
Pin-tailed Manakin	<i>Illicura militaris</i>	T	F	Fr	SMe	S,P
White-bearded Manakin	<i>Manacus manacus</i>	R	F	Fr	AFt	S
Swallow-tailed Manakin	<i>Chiroxiphia caudata</i>	T	F	Fr	SMe	S,T,P
TITYRIDAE						
Greenish Schiffornis	<i>Schiffornis virescens</i>	T	F	On	SMe	S,T,P

English name	Species	APA	F/O	TG	Biog	Evid
Buff-throated Purpletuft	<i>Iodopleura pipra</i> *	T #	F	On	SMe	S
Shrike-like Cotinga	<i>Laniisma elegans</i>	T #	F	Fr	SMt	S
Green-backed Becard	<i>Pachyrampus viridis</i>	T	Fw	In	AD	S,T,P
Chestnut-crowned Becard	<i>Pachyrampus castaneus</i>	T	F	In	AFt	S,T,P
White-winged Becard	<i>Pachyrampus polychopterus</i>	T	Fw	In	AD	T,P
Crested Becard	<i>Pachyrampus validus</i> *	T	F	In	AD	T,P
INCERTAE SEDIS						
Swallow-tailed Cotinga	<i>Phibalura flavirostris</i>	T	F	Fr	SMt	S,P
VIREONIDAE						
Rufous-browed Peppershrike	<i>Cyclarhis gujanensis</i>	T	F	In	AD	S,T,P
Red-eyed Vireo	<i>Vireo olivaceus</i>	T	F	On	AD m	P
Rufous-crowned Greenlet	<i>Hylophilus poicilotis</i>	T	F	On	SMe	S,T,P
Grey-eyed Greenlet	<i>Hylophilus amaurocephalus</i> *	T	Fw	On	AD +	S,P
HIRUNDINIDAE						
Blue-and-white Swallow	<i>Pygochelidon cyanoleuca</i>	T	O	In	AD	S,T,P
Southern Rough-winged Swallow	<i>Stelgidopteryx ruficollis</i>	T	O	In	AD	P
Brown-chested Martin	<i>Progne tapera</i> *	G	O	In	AD m	–
Grey-breasted Martin	<i>Progne chalybea</i> *	S	O	In	AD	S,P
White-rumped Swallow	<i>Tachycineta leucorrohoa</i> *	P #	O	In	AD	–
TROGLODYTIDAE						
House Wren	<i>Troglodytes aedon</i>	T	O	In	AD	S,P
Long-billed Wren	<i>Cantorchilus longirostris</i> *	C	F	In	AFt	S
TURDIDAE						
Yellow-legged Thrush	<i>Turdus flavipes</i>	T	F	On	AFe	S,T,P
Pale-breasted Thrush	<i>Turdus leucomelas</i>	T	Fw	On	AD	S,P
Rufous-bellied Thrush	<i>Turdus rufiventris</i>	T	Fw	On	AD	S,T,P
Creamy-bellied Thrush	<i>Turdus amaurochalinus</i>	T	O	On	AD	S,P
White-necked Thrush	<i>Turdus albicollis</i>	T	F	On	AFt	P
MIMIDAE						
Chalk-browed Mockingbird	<i>Mimus saturninus</i>	T	O	On	AD	P
THRAUPIDAE						
Brown Tanager	<i>Orchesticus abeillei</i>	T	F	On	SMe	S
Cinnamon Tanager	<i>Schistochlamys ruficapillus</i>	R	O	On	AD	P
Magpie Tanager	<i>Cissopis leverianus</i> *	H	F	On	AFt	S,P
Olive-green Tanager	<i>Orthogonys chloricterus</i>	T #	F	On	SMe	S
Orange-headed Tanager	<i>Thlypopsis sordida</i>	R #	Fw	On	AD	P
Chestnut-headed Tanager	<i>Pyrrhocomma ruficeps</i> *	M #	F	On	SMe	S,T,P
Black-goggled Tanager	<i>Trichothraupis melanops</i>	T	F	On	SMp	S,T,P
Ruby-crowned Tanager	<i>Tachyphonus coronatus</i>	T	Fw	On	AFe	S,P
Brazilian Tanager	<i>Ramphocelus bresilius</i>	T	F	On	AFe	S,P
Sayaca Tanager	<i>Thraupis sayaca</i>	T	O	On	AD	P
Azure-shouldered Tanager	<i>Thraupis cyanoptera</i>	T	F	On	SMe	S,T,P
Golden-chevroned Tanager	<i>Thraupis ornata</i>	T	F	On	SMe	S,P
Palm Tanager	<i>Thraupis palmarum</i>	T	Fw	On	AD	P
Diadem Tanager	<i>Stephanophorus diadematus</i> *	P #	Hb	On	SMp	S,T,P
Fawn-breasted Tanager	<i>Pipraeidea melanonota</i>	T	F	On	SMp	S,P
Burnished-buff Tanager	<i>Tangara cayana</i>	T	O	On	AD	S,P
Green-headed Tanager	<i>Tangara seledon</i> *	S	F	On	AFe	S,P
Brassy-breasted Tanager	<i>Tangara desmaresti</i>	T	F	On	SMe	S,T,P
Gilt-edged Tanager	<i>Tangara cyanoventris</i>	M	F	On	SMe	S,P
Swallow Tanager	<i>Tersina viridis</i>	T	Fw	Fr	AD m	S,P

English name	Species	APA	F/O	TG	Biog	Evid
Black-legged Dacnis	<i>Dacnis nigripes</i> *	T #	F	On	SMe	S
Blue Dacnis	<i>Dacnis cayana</i>	T	O	On	AD	S,P
Green Honeycreeper	<i>Chlorophanes spiza</i> *	R	F	On	AFt	P
Rufous-headed Tanager	<i>Hemithraupis ruficapilla</i>	T	F	On	AFe	S,P
Yellow-backed Tanager	<i>Hemithraupis flavicollis</i> *	S	F	On	AFt	S
Chestnut-vented Conebill	<i>Conirostrum speciosum</i> *	M	Fw	In	AD	S,P
Uniform Finch	<i>Haplospiza unicolor</i> *	T	F	Gr	SMe	S,T,P
Bay-chested Warbling Finch	<i>Poospiza thoracica</i> *	B	Hb	On	SMe	S,T,P
Saffron Finch	<i>Sicalis flaveola</i>	T	O	Gr	AD	S,P
Blue-black Grassquit	<i>Volatinia jacarina</i>	T	O	Gr	AD	S,P
Buffy-fronted Seedeater	<i>Sporophila frontalis</i> *	T	F	Gr	SMe	S,T,P
Temminck's Seedeater	<i>Sporophila falcirostris</i> *	T	F	Gr	SMe	S,T,P
Dubois's Seedeater	<i>Sporophila ardesiaca</i> *	M	O	Gr	AD	P
Double-collared Seedeater	<i>Sporophila caerulescens</i>	T	O	Gr	AD	S,P
Bananaquit	<i>Coereba flaveola</i> *	T	O	On	AD	S,P
Sooty Grassquit	<i>Tiaris fuliginosus</i> *	T	Fw	Gr	AD	S,P
INCERTAE SEDIS						
Black-throated Grosbeak	<i>Saltator fuliginosus</i>	T #	F	On	AFe	S
Buff-throated Saltator	<i>Saltator maximus</i> *	S	F	On	AFp	S
Green-winged Saltator	<i>Saltator similis</i>	T	F	On	SMp	S,T,P
Thick-billed Saltator	<i>Saltator maxillosus</i> *	M #	F	On	SMe	–
EMBERIZIDAE						
Rufous-collared Sparrow	<i>Zonotrichia capensis</i>	T	O	Gr	AD	S,T,P
Grassland Sparrow	<i>Ammodramus humeralis</i> *	G	O	Gr	AD	S
Half-collared Sparrow	<i>Arremon semitorquatus</i>	T	F	On	SMe	S,P
CARDINALIDAE						
Hepatic Tanager	<i>Piranga flava</i>	T	O	On	AD	P
Red-crowned Ant Tanager	<i>Habia rubica</i>	T	F	On	AFt	S,P
Ultramarine Grosbeak	<i>Cyanocompsa brissonii</i> *	L #	O	Gr	AD	S,P
PARULIDAE						
Tropical Parula	<i>Parula pitiauyumi</i>	T	F	In	AD	P
Masked Yellowthroat	<i>Geothlypis aequinoctialis</i>	T	O	In	AD	S,T,P
Golden-crowned Warbler	<i>Basileuterus culicivorus</i>	T	F	In	SMp	S,T,P
White-browed Warbler	<i>Basileuterus leucoblepharus</i>	T	F	In	SMp	S,T,P
ICTERIDAE						
Crested Oropendola	<i>Psarocolius decumanus</i>	T	F	On	AD	P
Red-rumped Cacique	<i>Cacicus haemorrhous</i> *	S	F	On	AFt	–
Chopi Blackbird	<i>Gnorimopsa chopi</i> *	T	O	On	AD +	–
Screaming Cowbird	<i>Molothrus rufoaxillaris</i> *	G	O	On	AD +	–
Giant Cowbird	<i>Molothrus oryzivorus</i> *	T	O	On	AD m	–
Shiny Cowbird	<i>Molothrus bonariensis</i>	T	O	On	AD	S,P
FRINGILLIDAE						
Hooded Siskin	<i>Sporagra magellanica</i> *	R	O	Gr	SMt	P
Purple-throated Euphonia	<i>Euphonia chlorotica</i> *	M #	O	Fr	AD	P
Violaceous Euphonia	<i>Euphonia violacea</i> *	T	F	Fr	AFt	P
Golden-rumped Euphonia	<i>Euphonia cyanocephala</i>	T #	Fw	Fr	SMp m	P
Chestnut-bellied Euphonia	<i>Euphonia pectoralis</i>	T	F	Fr	AFe	S,P
Blue-naped Chlorophonia	<i>Chlorophonia cyanea</i> *	T	F	Fr	SMt	S,P
ESTRILDIDAE						
Common Waxbill	<i>Estrilda astrild</i> *	S	O	Gr	AD +	P

English name	Species	APA	F/O	TG	Biog	Evid
PASSERIDAE						
House Sparrow	<i>Passer domesticus</i> *	L	O	On	AD +	P

Legend: **APA**—T (VT, Vale das Taquaras, epicentre); R (Rio Bonito de Cima 4 km east); B (RPPN Bacchus 4.6 km north-west); H (Macaé de Cima headquarters 7.2 km south-west); M (Mury 9 km north-west); G (Galdinópolis 10 km north-east); P (São Pedro da Serra, 15 km north-east); L (Lumiar 16 km north-east); C (Conde Redondo 18 km east); S (São Romão 25 km east); # (Recorded only pre-2005). **F/O** (Forest or open habitats)—F (Forest); Fw (Forest, but weak association); Hb (Specific open or semi-open montane habitat); O (open); Oa (Open, aquatic); Ou (Open, urban). **TG** (Trophic guild)—Ca (Carnivores), De (Detritivores), Fr (Frugivores), In (Insectivores), Gr (Granivores), Ne (Nectarivores), On (Omnivores), Pi (Piscivores). **Biog** (Biogeography)—AFe (Atlantic Forest endemic, both montane and lowland); AFt (Atlantic Forest endemic subspecies); SMe (Serra do Mar endemic); SMt (Serra do Mar, mainly montane endemic subspecies); SMp (Regional population privative of Serra do Mar, i.e. montane); AD (Ample distribution); + (Recent coloniser, during last 15 years); m (migratory). **Evid** (Documentary evidence)—S (Specimen); T (Tape-recorded); P (Photographed). * Not recorded by Weinberg¹²⁷. English names and scientific nomenclature follow Remsen *et al.*¹⁰⁹.

mistletoes are commonly found on branches of various tree species both ornamental and native. Among the various birds that consume mistletoes, we highlight flycatchers of the genera *Phyllomyia* and *Mionectes*, *Hylophilus* greenlets, Serra do Mar Tyrant-Manakin *Neopelma chrysolophum*, Sharpbill, Brown Tanager *Orchesticus abeillei*, Blue-naped Chlorophonia and species of *Euphonia*.

The fruits of mistletoes, especially those of the genus *Struthanthus*, are important dietary supplements primarily for insectivores, e.g. Grey-hooded Flycatcher, Grey-capped Tyrannulet, Planalto Tyrannulet *Phyllomyia fasciatus* and Rufous-crowned Greenlet^{29,85,118}. Grey-capped Tyrannulet feeds on the fruits of *Struthanthus* year-round, making it one of the principal dispersal agents of these plants in the Serra dos Órgãos.

The fruits of mistletoes can be ingested in large quantities in short periods, the different species using different behaviours. Grey-hooded Flycatcher can ingest up to nine *Struthanthus* sp. fruits in c.40–55 seconds, or makes sallies to pluck them and eat them one by one, without chewing. The two *Phyllomyia* take the fruits both when perched and during aerial sallies.

Sharpbill hangs below the branches of *Psittacanthus* sp., ingesting its fruits directly. Euphonias and Blue-naped Chlorophonia consume the succulent fruits of *Phoradendron* sp., chewing them prior to ingestion.

Chestnut-bellied Euphonia, Violaceous Euphonia *E. violacea* and Blue-naped Chlorophonia also feed on the fruits of the morphologically similar *Rhipsalis cacti* (e.g. *R. elliptica*).

Nectarivores.—Hummingbirds, of which there are 17 forest-based species at Macaé de Cima, principally feed on nectar¹¹⁸. Saw-billed Hermit *Ramphodon naevius* has a special preference for inflorescences of *Heliconia* spp. (Musaceae) and tubular bromeliads such as *Vriesea philippocoburgii*. Several species of *Psychotria* are frequented by *R. naevius* and others such as Scale-throated Hermit *Phaethornis eurynome*, which also inhabits shady understorey. *P. eurynome* takes insects as well as visiting flowers of small orchids, wild passion

fruit (*Passiflora* sp., Passifloraceae) and lianas like *Fuchsia regia* (Onagraceae).

Fuchsia regia is common in the montane forests of Macaé de Cima and the Serra dos Órgãos, and is also visited by Plovercrest *Stephanoxis lalandi*, White-throated Hummingbird *Leucochloris albicollis* and Brazilian Ruby *Clytolaema rubricauda*. Plovercrest inhabits higher elevations (>1,000 m) in the Serra dos Órgãos and Macaé de Cima, where the males lek in clearings and forest edges, especially where there are many flowers of *Lantana* (Verbenaceae). *Clytolaema rubricauda*, which also occurs in the highlands of south-east Brazil, searches for nectar at a variety of sources, among them trees of the genera *Inga*, *Erythrina* (Leguminosae) and *Pseudobombax* (Bombacaceae), bromeliads (*Vriesea billbergioides*), lianas (*Fuchsia regia*) and vines of the genus *Marcgravia* (Marcgraviaceae).

Violet-capped Woodnymph *Thalurania glaucopis* has one of the broadest altitudinal ranges of any hummingbird in the Serra dos Órgãos, occurring from sea level to high montane regions (above 1,500 m), and is also found in all strata of the forest. It is highly versatile in resource utilisations, visiting flowers of shrubs (*Psychotria nuda*, *Acnistus arborescens*), vines (*Fuchsia regia*), mistletoes of the genus *Psittacanthus* (Loranthaceae), bromeliads (*Vriesea philippocoburgii*) and tall trees such as *Erythrina falcata*, *Spirotheca passifloroides* (Bombacaceae) and *Vochysia* sp. (Vochysiaceae). Black Jacobin *Florisuga fusca*, the most abundant species in spring and summer, searches for nectar at flowers of *Jacaratia spinosa* (Caricaceae), *Hortia* sp. (Rutaceae), *Eriotheca* sp. (Bombacaceae) and *Inga sessilis* (Leguminosae), among others.

Trees that flower in winter, for example, *Erythrina falcata*, are key resources for several hummingbirds (e.g., *Thalurania glaucopis*, *Leucochloris albicollis*, Versicoloured Emerald *Amazilia versicolor*, *Clytolaema rubricauda*) as well as for birds (e.g., Maroon-bellied Parakeet, Blue Dacnis, Bananaquit and Red-rumped Cacique) that occasionally include nectar in their diets⁸⁹. These trees lose all of their foliage and, soon thereafter,

produce many red flowers that attract a diverse range of birds and insects during the dry season in the Serra dos Órgãos.

With the exception of hummingbirds, Bananaquit and Blue Dacnis are among those birds that most regularly feed on nectar. Using their bill, Bananaquits open holes in the base of the corolla of tubular flowers of *Psittacanthus* sp., vines of the genus *Thunbergia* (Acanthaceae), *Erythrina falcata* and various other plants. Both species visit *Eucalyptus* sp. flowers, together with some hummingbirds (*Thalurania glaucopis*, *Leucochloris albicollis*) in winter.

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