
FRONTISPÍCIO. Macho adulto (abaixo) e fêmea (acima) de *Stymphalornis acutirostris*. Desenho de Rafael A. Dias.

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# Fruit eating by birds in a forest fragment in southeastern Brazil

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RESUMO. **Consumo de frutos por aves em um fragmento de mata no sudeste do Brasil.** Neste estudo registramos as espécies de frutos utilizadas como alimento por aves em um fragmento de mata semidecídua (250 ha) alterada e isolada, localizada no município de Campinas -SP. Registramos 32 espécies de aves alimentando-se dos frutos de 36 espécies de plantas. As espécies de aves mais comumente registradas foram pequenos passeriformes (*Tachyphonus coronatus, Chiroxiphia caudata, Trichothraupis melanops, Vireo olivaceus, Manacus manacus,* e *Saltator similis*) que caracteristicamente sobrevivem em áreas degradadas no sudeste do Brasil. Aves frugívoras de grande porte, por outro lado, foram raramente observadas, o que reflete o atual grau de empobrecimento da avifauna na área de estudo. Aves migrantes foram frequentemente observadas alimentando-se de frutos. Estas aves podem ter um papel importante como dispersoras de sementes na área estudada.
PALAVRAS-CHAVE: dispersão de sementes, floresta semidecídua, fragmentação de florestas, ornitocoria, sudeste brasileiro.

ABSTRACT. In this study we surveyed fruits eaten by birds in a 250 ha highly disturbed and isolated forest fragment in southeastern Brazil. We recorded 32 bird species eating the fruits of 36 plant species. The birds most frequently recorded eating fruits were small passerines (*Tachyphonus coronatus, Chiroxiphia caudata, Trichothraupis melanops, Vireo olivaceus, Manacus manacus,* and *Saltator similis*) that thrive in a variety of disturbed forests in southeastern Brazil. Large frugivorous birds were rarely recorded which reflect the impoverished avifauna of the area. Migrant birds were often observed eating fruits. These birds may play an important role as seed dispersers in such a disturbed habitat.
KEY WORDS: forest fragmentation, ornithochory, seed dispersal, semideciduous forest, southeastern Brazil.

Two broad subjects involving birds received special attention in tropical ecological studies during the last twenty years: the multiple effects of forest fragmentation on avian populations (Willis 1979, Bierregaard and Lovejoy 1989), and the interactions between avian frugivores and their food plants (McKey 1975, Howe and Estabrook 1977). Since both issues are of special interest for conservation and management (Terborgh and Winter 1980, Howe 1984) and given the present rate of tropical forest conversion (Myers 1984, 1989), they must figure as priorities for future studies (Terborgh 1992).

Forest fragments are exposed to long-term alterations in vegetation structure and floristic composition, mainly due to changes in abiotic conditions or human disturbance, which have immediate consequences for the animal community (Janzen 1983, Laurence 1990). Large frugivorous

birds, for example, may fail to subsist in fragmented areas where their food resources have diminished following unusual climatic conditions or logging (Willis 1979, Terborgh and Winter 1980), triggering a series of extinctions in a "domino effect" as predicted by Howe (1984).

In this study we surveyed fruits eaten by birds in a 250 ha forest fragment in southeastern Brazil. We were especially interested in identify which bird species inhabiting the fragment perform the bulk of seed dispersal in such a disturbed habitat.

## STUDY SITE AND METHODS

We studied the diet of frugivorous birds from April 1988 to December 1991 at Santa Genebra Reserve, a 250 ha forest fragment (22°49'S, 47°06'W, 640 m a.s.l.) located in Campinas, São Paulo State, southeastern Brazil. The reserve is surrounded by field crops and isolated by several kilometers from other forest tracts (see aerial photograph in Chiarello and Galetti 1994). Mean annual temperature is 20,6° C and mean annual rainfall around 1360 mm (Morellato 1991), with a rainy-hot season extending from November to February, and a dry-cold season from May to August.

Santa Genebra forest, classified as low subtropical moist forest (Holdridge 1967) or tropical semideciduous forest (Longman and Jenik 1987), is nowadays a mosaic of early and old secondary vegetation. The early secondary areas are dominated by species of Solanaceae, Cecropiaceae, and Piperaceae, by liana species (mostly Bignoniaceae and Malpighiaceae) (Morellato 1991), and also by *Celtis* shrubs (Ulmaceae) (Matthes 1992). The old secondary forest has trees 15-20 m high and is characterized by a discontinuous canopy with emergent trees, such as *Cariniana legalis* (Lecythidaceae) and *Hymenaea courbaril* (Caesalpiniaceae), reaching up 30 m. The most common families are Lauraceae, Rutaceae and Meliaceae. Logging in the past created large gaps in the forest interior and edges which were rapidly occupied by lianas and bamboo tickets.

According to Willis (1979), the forested area was reduced to its present size in 1969 by logging about 145 ha. After that, the area has suffered selective logging mainly along its edges and trail margins. The present avian species composition of Santa Genebra is quite different from that before isolation. One of the most striking changes is the disappearance of large frugivorous birds such as cotingas (Cotingidae), toucans (Ramphastidae) and trogons (Trogonidae) (Willis 1979, Aleixo and Vielliard 1995).

We recorded the diet of birds along the forest edges and trails by walking on one to three days a week along a 5 km transect. Transects were carried out mostly in the mornings between 06:00 and 13:00, when weather permitted. The field work was the same for both seasons. Whenever we found a bird species (one bird or a flock) eating fruits we recorded one feeding bout irrespective of the length of time it fed. If the bird (or flock) moved to another fruit source, a new bout was recorded. The use of transects to survey the fruits eaten by birds may favor the most common bird and plant species (Wheelwright *et al.* 1984). Since our general goal was to detect the most important potential seed dispersers (in terms of number of fruit species eaten and visitation rates to fruiting plants), this method of data gathering seems to be adequate. It is important to notice that the data presented here is neither a complete measure of fruit diet breadth of the species of concern nor a measure of their impact on plant species fitness through seed dispersal.

In order to cover massive crops of some individual plants or fruiting of uncommon and rare species, we watched seven plant species (*Chamissoa altissima* - Amaranthaceae, *Dendropanax cuneatum* - Araliaceae, *Protium heptaphylum* - Burseraceae, *Cabralea canjerana* and *Trichilia clauseni* - Meliaceae, *Ixora venulosa* - Rubiaceae, and *Trema micrantha* - Ulmaceae) during observation sessions conducted between 06:00 and 13:00 totalling 36 h of observation (table 1). During each observation session, that lasted from 15 to 110 min, we recorded the identity of bird species visiting the plants and the number of visits made by them. Observations were made from an unobstructed viewing point aproximately 8-15 m from the focal plant. *Trichilia clauseni* is the most abundant tree occurring in the forest interior, while *T. micrantha* is one of the most common species of the forest edges. *Chamissoa altissima* is one of the few fleshy-fruited species to produce fruits during the winter period (pers. obs.).

We did not consider Emberizinae in our analysis because they usually feed on weed seeds at the edge of the forest. We also did not consider the two psittacid species occurring at Santa Genebra (*Pionus maximiliani* and *Forpus xanthopterygius*) because they usually act as seed predators instead of seed dispersers (Galetti and Rodrigues 1992). Bird nomenclature used here follows Ridgely and Tudor (1989, 1994). Plant taxonomy follows Cronquist (1981).

## RESULTS

We recorded 399 feeding bouts of 29 bird species (9 families) eating 36 plant species (26 families) along the transects at Santa Genebra (table 2). The diaspores of these plants varied from 1.9 to 15.0 mm in diameter. However, plants with small diaspores (diameter < 10 mm) predominated in our sample (75%; 27 out of 36 plant species), including *T. micrantha*, *C. altissima*, *C. pachystachia*, and *P. glabrata*, consumed by the largest bird assemblages (table 2). The group of plants with small diaspores included very common species (*T. micrantha* and *C. pachystachia*), rare species (*P. glabrata* with only two individuals in our transect), and also species with prolonged fruiting seasons (*T. micrantha* fruits from October to June, and *C. pachystachia* from October to April), and those that bear mature fruits during a relatively short period (*C. altissima* fruits in June and July, and *P. glabrata* in November and December). Plants with large diaspores

Table 1. Number of visits made by birds recorded during focal observations on fruiting plants at Santa Genebra Reserve, southeastern Brazil. Plant families and species are arranged in alphabetical order.

| Plant species | Observation time (h) | No. plants observed | Bird species[a] (migrating species indicated by an asterisk) | | | | | | | | | | | | | | | | | | Total number of visits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3* | 4* | 5* | 6* | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14* | 15 | 16 | 17 | 18 | |
| AMARANTHACEAE | | | | | | | | | | | | | | | | | | | | | |
| *Chamissoa altissima* | 1,7 | 1 | 3 | 1 | | | | | | | | | | | | | | 1 | 5 | | 10 |
| ARALIACEAE | | | | | | | | | | | | | | | | | | | | | |
| *Dendropanax cuneatum* | 1,7 | 1 | | 2 | | | | | | | 1 | | | | | | | | | 3 | 6 |
| BURSERACEAE | | | | | | | | | | | | | | | | | | | | | |
| *Protium heptaphyllum* | 2,5 | 1 | 1 | 6 | | | | | | | | 2 | | | | | | 1 | | 6 | 16 |
| MELIACEAE | | | | | | | | | | | | | | | | | | | | | |
| *Cabralea canjerana* | 14,5 | 1 | 4 | 1 | 2 | 1 | 1 | 12 | 9 | 1 | | | 8 | | | 11 | 1 | | | | 51 |
| *Trichilia clauseni* | 3,6 | 2 | 2 | | | | | | | | | | | | 1 | 10 | | 3 | 1 | 2 | 19 |
| RUBIACEAE | | | | | | | | | | | | | | | | | | | | | |
| *Ixora venulosa* | 1,7 | 1 | 2 | 3 | | | | | | | | | | 1 | | | | | | 1 | 7 |
| ULMACEAE | | | | | | | | | | | | | | | | | | | | | |
| *Trema micrantha* | 10,3 | 5 | 14 | 13 | | | | | | | | | | | | 2 | | 7 | | 5 | 41 |
| Total | 36,0 | 12 | 26 | 26 | 2 | 1 | 1 | 12 | 9 | 1 | 1 | 2 | 8 | 1 | 1 | 23 | 1 | 12 | 6 | 17 | 150 |

[a] - 1. *Chiroxiphia caudata*, 2. *Manacus manacus*, 3. *Tyrannus savanna*, 4. *T. melancholicus*, 5. *Empidonomus varius*, 6. *Myiodynastes maculatus*, 7. *Pitangus sulphuratus*, 8. *Myiarchus ferox*, 9. *Myiophobus fasciatus*, 10. *Turdus rufiventris*, 11. *T. leucomelas*, 12. *T. amaurochalinus*, 13. *Cyclarhis gujanensis*, 14. *Vireo olivaceus*, 15. *Dacnis cayana*, 16. *Tachyphonus coronatus*, 17. *Trichothraupis melanops*, 18. *Saltator similis*.

(diameter ≥ 10 mm; e.g., *Pereskia aculeata, Copaifera langsdorffii, Ocotea* spp.) invariably were consumed by a small bird assemblage (one to five species).

The number of bird species observed eating the fruits of a given plant species in the transect varied from one to 16. The birds most commonly observed eating fruits were *Tachyphonus coronatus* (61 feeding bouts, 14 fruit species), *Chiroxiphia caudata* (44, 18), *Trichothraupis melanops* (38, 9), *Vireo olivaceus* (38, 6), *Manacus manacus* (32, 15), and *Saltator similis* (32, 10). These six species combined were responsible for 61.4% of the feeding bouts recorded. Large frugivores such as *Ramphastos toco* and *Penelope superciliaris* were rarely observed (two feeding bouts each) (table 2). A total of 150 visits were recorded during direct observations to fruiting plants, and the most frequent visiting birds recorded were also the six species previously mentioned (73% of the visits recorded) (table 1). A considerable proportion of the feeding bouts (16.2%, N = 399), and visits (26.0%, N = 150) recorded respectively during transects and focal observations were made by migrant bird species.

## DISCUSSION

Second-growth habitats in tropical areas generally have a great abundance of fleshy fruits (Martin 1985, Martin and Karr 1986, Levey 1988), mainly due to the presence of colonizing plant species whose small-seeded fruits attract a great variety of small passerines (Wheelwright *et al.* 1984). Not surprisingly the plant species that attracted the larger number of bird species at Santa Genebra were either colonizer species (e.g., *T. micrantha* and *C. pachystachia*) or species typical of old-secondary forests (e.g., *C. canjerana*). These species present some features which might have contributed to their attractiveness to birds. *Trema micrantha* and *C. pachystachia* are both abundant species with prolonged fruiting seasons which gave the plants the opportunity to be exploited by resident, migrant, as well as vagrant (i.e., those species that occurr irregularly at Santa Genebra; see Aleixo and Vielliard 1995) bird species. *Chamissoa altissima* is one of the few species to bear fleshy fruits during the dry season, a period of general fleshy fruit scarcity at Santa Genebra (Morellato 1991). *Cabralea canjerana* and *P. glabrata* produce seeds covered with lipid-rich arils that are in general highly prefered by birds (Stiles 1993, Pizo 1994).

Summing data from transects and focal observations, we recorded 32 bird species eating fruits at Santa Genebra, which represent 24% of the 133 bird species recently recorded in the reserve (Aleixo and Vielliard 1995). However, only six species (see above) were in conjunction responsible for the most part of the feeding bouts and visits recorded. As number of visits made by a particular bird species to fruiting plants is often positively correlated with the number of seeds dispersed (Schupp 1993), we can thus assert that the above species performed much of the potential seed dispersal events recorded during this study. These species are among the most abundant at Santa Genebra (Aleixo and Vielliard 1995), and thrive in a variety of disturbed forests in southeastern Brazil (Willis 1979, Willis and Oniki 1981). Furthermore, these species are relatively narrow gaped ones (the most robust of them - *Saltator similis* - has a mean gape width of 11.4 mm, N = 10), which should set limits to the fruit diameter they can swallow whole (Wheelwright 1985). Possibly as a consequence, plant species with large diaspores (diameter ≥ 10 mm) invariably had a small feeding assemblage (one to five bird species). Particularly instructive is the case of the "Copaíba" (*Copaifera langsdorffii* - Caesalpiniaceae, mean diameter of the diaspores 10 mm, N = 10) which have a typical ornithochoric fruit with the conspicuous yellow aril contrasting with the black seed. In a large non-fragmented forest and in cerrado vegetation in southeastern Brazil their fruits are eaten by a large bird assemblage (Motta and Lombardi 1990, pers. obs.). At Santa Genebra, however, we recorded only two bird species eating the fruits of *C. langsdorffii* along transects. Additionally, Pedroni (1993) observed only seven bird species doing so during 87 h of direct observation on five *C. langsdorffii* trees. Of these seven species, only three (*Ramphastos toco, Pitangus sulphuratus*, and *Turdus rufiventris*) were able to swallow the diaspores whole and thus could be regarded as potential seed dispersers. The other species are either seed predators (*Pionus maximiliani*), or seed "wasters", i.e., ate only the aril discarding the seeds beneath parent trees (*Tyrannus melancholicus, Dacnis cayana and Thraupis sayaca*). Paradoxically, the most efficient seed disperser of *C. langsdorffii* seeds at Santa Genebra seems to be the howler monkey (*Alouatta fusca*) (Pedroni 1993, Galetti *et al.* 1994).

Howe (1984) suggested that plants with large seeds dispersed by large birds (e.g., toucans, guans, cotingas) are the first to loose their seed dispersers in depauperate habitats, and consequently become more vulnerable to extinction. The above example of *C. langsdorffii* may be illustrative of this process, but future studies are needed to monitor the long-term consequences of a reduced seed-disperser assemblage to the population structure of *C. langsdorffii* (see Keeler-Wolf 1988).

Second-growth habitats in the neotropics are important to house migrant birds during migration and often have a great abundance of these birds (Leck 1972, see papers included in Hagan and Johnston 1992). At Santa Genebra migrant species represent 14% of the avifauna (Aleixo and Vielliard 1995). Most of them are summer migrants that stay in the reserve from September to March. Their presence coincides with the fruit maturation period of most flesh-fruited species occurring at Santa Genebra (Morellato 1991). Thus, the frequent record of migrant birds eating fruits was not entirely surprisingly. Although migrant birds are opportunist frugivores (Poulin and Lefebvre 1996), they can also play an important role as seed dispersers as well (Howe and de Steven 1979, Blake and Loiselle 1992). *Vireo olivaceus*, for example, arrives at the studied area in

Table 2. Number of feeding bouts involving birds and fruits recorded at Santa Genebra Reserve, southeastern Brazil. Plant families and species are arranged in alphabetical order.

| Plant species | Bird species[a] (migrating species indicated by an asterisk) | | | | | | | | | | | | | | | | | | | | | | | | | | | Total number of bird species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3* | 4 | 5 | 6* | 7* | 8* | 9* | 10 | 11 | 12 | 13 | 14 | 15* | 16 | 17* | 18 | 19 | 20 | 21* | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | |
| AMARANTHACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Chamissoa altissima* | | | | 2 | 2 | | | | | | | 2 | | | | | | | 1 | 1 | | 2 | 1 | | 1 | 5 | 11 | | 2 | 11 |
| ANNONACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Xylopia brasiliensis* | | | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | 2 |
| ARALIACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dendropanax cuneatum* | | | | 2 | 5 | | | | | | 4 | | | 1 | | | 4 | | | | | | | | | | | | 8 | 6 |
| BORAGINACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cordia* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| BURSERACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Protium heptaphyllum* | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| CACTACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pereskia aculeata* | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | 3 |
| *Rhipsalis* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| CAESALPINIACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Copaifera langsdorffii* | 1 | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | 2 |
| CECROPIACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cecropia pachystachia* | | | | 1 | 2 | | | | | 1 | | 1 | | 1 | | | | 2 | 3 | | | | 5 | 2 | | 16 | 2 | | | 11 |
| CELASTRACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Maytenus aquifolium* | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| CUCURBITACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Momordica charantia* | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | | | 1 | 4 |
| EUPHORBIACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Pera glabrata* | | | | 1 | 2 | 1 | | | | | 1 | | | | | | 3 | | 3 | | | | 1 | | | 7 | 1 | | 2 | 10 |

Table 2. (continued)

| Plant species | Bird species* (migrating species indicated by an asterisk) | | | | | | | | | | | | | | | | | | | | | | | | | | | Total number of bird species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3* | 4 | 5 | 6* | 7* | 8* | 9* | 10 | 11 | 12 | 13 | 14 | 15* | 16 | 17* | 18 | 19 | 20 | 21* | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | |
| LAURACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ocotea corimbosa* | 2 | | | | | | | 1 | | 2 | | | | | | | | | | | | | | | | | 1 | | | 4 |
| *Ocotea* cf. *macropoda* | | | | 4 | 2 | | | | | 1 | | | | | 1 | | | | | | | | | | | | 1 | | | 5 |
| *Ocotea* sp. | | 1 | 1 | 1 | | | | | 1 | | | | | | | | | | | | | | | | | | | | | 4 |
| *Persia* cf. *major* | | | | | | | | 2 | | 1 | | | | | | | | | | | | | | | | | | | | 2 |
| MAGNOLIACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Talauma ovata* | | | | | 1 | | | 1 | | 3 | | 6 | | | 1 | | | | 2 | | | | | 2 | | | | | | 7 |
| MELASTOMATACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Miconia elegans* | | | | 2 | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 2 |
| *Miconia discolor* | | | | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Miconia* sp. | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| MELIACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cabralea canjerana* | | | | 1 | | | | 2 | 4 | 6 | | | | | | | 8 | | 3 | | | | | | | | | | | 6 |
| *Trichilia clauseni* | | | | 1 | | | | | | | | | | | | 3 | 7 | | | | | | | | 1 | 3 | 2 | 3 | 2 | 8 |
| MORACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Chlorophora tinctoria* | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 |
| *Ficus luschnatiana* | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| MYRTACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Gomidesia affinis* | | | | 6 | 1 | | | | | | | 6 | | | | | | | 1 | | | | | | | 1 | | | | 5 |
| PIPERACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Piper* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| ROSACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Rubus* sp. | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | 1 | | | | | 3 |
| RUBIACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Palicourea* sp. | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 2 |

Table 2. (continued)

| Plant species | Bird species[a] (migrating species indicated by an asterisk) | | | | | | | | | | | | | | | | | | | | | | | | | | | | Total number of bird species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3* | 4 | 5 | 6* | 7* | 8* | 9* | 10 | 11 | 12 | 13 | 14 | 15* | 16 | 17* | 18 | 19 | 20 | 21* | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | |
| RUTACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Zanthoxylum hyemale* | | | | | | | | | | | | | | • | | 1 | 9 | | 5 | | | 1 | | | | | | 1 | | 5 |
| SAPINDACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Paullinia rhomboidea* | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Paullinia* sp. | | | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | 2 |
| SOLANACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cestrum* sp. | | | | | | | | | | | | | | | | | | 1 | | | | | | | | 1 | | | 2 | 3 |
| ULMACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Trema micrantha* | | | | 5 | 5 | | 2 | 1 | 1 | | | 2 | | | | | 7 | | 6 | | | 2 | 3 | 1 | 1 | 10 | 12 | 2 | 12 | 16 |
| URTICACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Urera baccifera* | | | | | 4 | | | | | | | | | | | | | 1 | | | 1 | | | 2 | 6 | 12 | 7 | | | 7 |
| VERBENACEAE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Citharexylum mirianthum* | | | | 6 | 1 | | | | 4 | | | | | 8 | | | | | | | | | | 1 | | | | | 1 | 6 |
| *Lantana* sp. | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| Total | 2 | 2 | 1 | 44 | 32 | 1 | 2 | 9 | 11 | 15 | 5 | 17 | 1 | 10 | 2 | 4 | 38 | 4 | 24 | 1 | 1 | 5 | 12 | 9 | 10 | 61 | 38 | 6 | 31 | |

[a] 1. *Penelope superciliaris*, 2. *Ramphastos toco*, 3. *Tityra cayana*, 4. *Chiroxiphia caudata*, 5. *Manacus manacus*, 6. *Sirystes sibilator*, 7. *Tyrannus savanna*, 8. *T. melancholicus*, 9. *Myiodynastes maculatus*, 10. *Pitangus sulphuratus*, 11. *Myiophobus fasciatus*, 12. *Elaenia flavogaster*, 13. *Cyanocorax cristatellus*, 14. *Turdus rufiventris*, 15. *T. amaurochalinus*, 16. *Cyclarhis gujanensis*, 17. *Vireo olivaceus*, 18. *Coereba flaveola*, 19. *Dacnis cayana*, 20. *Conirostrum speciosum*, 21. *Pipraeidea melanonota*, 22. *Tangara cayana*, 23. *Thraupis sayaca*, 24. *Ramphocelus carbo*, 25. *Habia rubica*, 26. *Tachyphonus coronatus*, 27. *Trichothraupis melanops*, 28. *Thlypopsis sordida*, 29. *Saltator similis*.

September, then becoming one of the most abundant bird species there. This species is among the most frequent fruit-eating birds recorded during this study, and is the most important seed disperser of *C. canjerana* at Santa Genebra (Pizo in press).

Populations of migrant birds may be influenced by climatic and habitat changes occurring along their migratory routes which can affect the number of birds arriving at a given stopover site (Martin and Karr 1986, Hagan and Johnston 1992). Variation in the population of migrant birds in turn is likely to alter the number of seeds these birds can disperse (Malmborg and Willson 1988). Thus, a special attention should be paid to migrant birds at Santa Genebra, not only due to their general importance as seed dispersers but also due to the possible impact that inter-annual variation in their populations can have on seed dispersal spectra of plants.

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