



Associations Between Golden-Headed Lion Tamarins and the Bird Community in the Atlantic Forest of Southern Bahia

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We examined the presence of birds accompanying and foraging in proximity to golden-headed lion tamarins at Una Biological Reserve, Bahia, Brazil. We followed 3 groups of golden-headed lion tamarins over 3 yr. We noted all birds ≤ 5 m of a lion tamarin during 20-min observation periods. We found 11 different bird species in the presence of the lion tamarins. We most often found insectivores, such as woodcreepers and nunbirds, in association with them, eating prey the tamarins flushed. Associations were most frequent in mature and shade-cocoa forests. The group that spent most of its time in mature and shade-cocoa forest was also the group that foraging birds followed most frequently. Differences in resource availability among forest types, such as the abundance of microforaging environments, may affect the frequency and diversity of birds seen in association with golden-headed lion tamarins.

KEY WORDS: *Leontopithecus chrysomelas*; Lion tamarins; Mixed-species associations.

INTRODUCTION

Birds have often been reported in association with species that flush animal prey while foraging or moving through the forest (Rodrigues *et al.*, 1994; Terborgh, 1983; Willis and Oniki, 1978). Researchers have

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observed capuchins, squirrel monkeys, and tamarins associating with birds (Boinski and Scott, 1988; Fontaine, 1980; Heymann, 1992; Passos, 1997; Rodrigues *et al.*, 1994). For birds, potential advantages of the associations include improved access to food and increased protection from predators (Moynihan, 1976; Passos, 1997; Rodrigues *et al.*, 1994; Siegel *et al.*, 1989). Associations may benefit insectivorous birds by allowing them to catch prey flushed by foraging primates (Boinski and Scott, 1988; Egler, 1991; Passos, 1997; Rodrigues *et al.*, 1994). Rodrigues *et al.* (1994) noted that tanagers associated more with various taxa that flush insects, including ants, primates and other bird species, in times of low fruit and insect availability, indicating benefits to the tanagers.

Many researchers have studied trends in the temporal frequency of bird-primate associations throughout the day or across seasons. Ferrari (1990) found a diurnal pattern, with kites most frequently in the presence of buffy-headed marmosets in the morning. Other researchers have found no diurnal pattern of association (Boinski and Scott, 1988; Egler, 1991; Fontaine, 1980). Associations between marmosets and kites (Ferrari, 1990) and between squirrel monkeys and kites, tanagers, and woodcreepers (Boinski and Scott, 1988) show seasonal patterns, though Fontaine (1980) did not identify any in his study of capuchins and kites. Rodrigues *et al.* (1994) found a seasonal pattern in associations between tanagers and insect flushers at 1 field site but not at a 2nd, and Rodrigues *et al.* (1994) suggested seasonality in rainfall may have been a factor.

We examined the presence of birds accompanying and foraging in proximity to 3 groups of golden-headed lion tamarins at Una Biological Reserve, Bahia, Brazil. We explored diurnal and seasonal patterns of associations. Given the lack of seasonal variation in rainfall at Una (Rylands, 1989), we expected that the association frequency would remain relatively constant across months of the year. We also examined the effect of habitat characteristics on the frequency of associations between birds and lion tamarins. Lion tamarins spend much of their time foraging in epiphytic bromeliads (Raboy and Dietz, 2004; Rylands, 1989), which are more abundant in mature and shade-cocoa forest (Raboy *et al.*, 2004). Assuming that the birds accompany the lion tamarins to catch prey the lion tamarins flushed, we tested the hypothesis that associations will be more frequent when the lion tamarins are foraging in mature and shade-cocoa forest.

METHODS

Three groups of golden-headed lion tamarins were observed from 1998 to 2000 at Una Biological Reserve in southern Bahia, Brazil. The groups

had a similar number of individuals throughout the course of the study (Raboy and Dietz, 2004). We followed the tamarins for 2 complete days, from emergence from the sleeping site until retirement in the evening, and 2 partial days each week. We included a total of 477 d of observation—202 complete days and 275 partial days. We considered all birds ≤ 5 m of a lion tamarin in the focal group during each 20-min observation period to be in association with the lion tamarins. We identified several of the birds in association with lion tamarins to the specific level. However, we found it difficult to distinguish among woodcreepers (Dendrocolaptidae), a family with numerous species in Southern Bahia (Sick, 1993), and therefore categorized them as 1 group for the analyses. We also recorded the habitat type (mature, shade-cocoa, or secondary forest). B. E. Raboy and 2 field assistants collected all data.

The 3 groups of lion tamarins differed in the time they spent in each habitat type (Raboy *et al.*, 2004). Groups Piaçava, Onça, and Entulho spent 80.7%, 52.4%, and 4.7% of their time in mature and shade-cocoa forest, respectively, and 8.4%, 32.3%, and 93.0% in secondary forest (Raboy *et al.*, 2004). We combined mature and shade-cocoa forest in our analyses because of similarities in the abundance of lion tamarin foraging substrates in these habitats (Raboy *et al.*, 2004).

Statistical Methods

We analyzed the impact of habitat type on bird presence via 2×2 χ^2 tests (SAS Institute, Cary, USA). We evaluated effects across groups via Cochran-Mantel-Haenszel statistics (Hollander and Wolfe, 1999). We used $\alpha = 0.05$ to determine significance.

RESULTS

The 3 groups differed markedly in the percentage of observation periods that included a bird species ≤ 5 m: 52% for Piaçava, 39.4% for Onça, and 11.7% for Entulho. We observed 5 species of woodcreepers and 6 other species of birds in association with them (Table I). We most often observed woodcreepers and white-fronted nunbirds (*Monasa morphoes*) with them. They followed the lion tamarin groups closely and took insects in flight as the lion tamarins foraged in bromeliads. The number of observation periods in which we recorded each bird species (or bird group for Dendrocolaptidae) in association with lion tamarins is in Table II. Together woodcreepers and nunbirds accounted for 92.7% of all observations. On 1250 occasions

Table I. Scientific classification and common name for all birds observed in association with the lion tamarins

| Family | Scientific name | Common Name |
|------------------|---------------------------------------|---------------------------|
| Dendrocolaptidae | <i>Sittasomus griseicapillus</i> | Olivaceous woodcreeper |
| | <i>Dendrocincla turdina</i> | Plain-winged woodcreeper |
| | <i>Xiphorhynchus guttatus</i> | Buff-throated woodcreeper |
| | <i>Lepidocolaptes fuscus</i> | Lesser woodcreeper |
| | <i>Campyloramphus trochilirostris</i> | Red-billed scythebill |
| Bucconidae | <i>Monasa morphoes</i> | White-fronted nunbird |
| Trogonidae | <i>Trogon viridis</i> | White-tailed trogon |
| Cuculidae | <i>Piaya cayana</i> | Squirrel cuckoo |
| Icteridae | <i>Cacicus haemorrhous</i> | Red-rumped cacique |
| Accipitridae | <i>Harpagus bidentatus</i> | Double-toothed kite |
| Cotingidae | <i>Lipaugus vociferans</i> | Screaming piha |

>1 species or group of birds were with them during a 20-min period (Table III); 94.7% of those observations occurred in mature or shade-cocoa forest.

Associations were less frequent immediately after the emergence of the lion tamarins from their sleeping sites and immediately before their retirement in the evening; however, sample sizes were smaller then. Otherwise, we did not see any discernible pattern of diurnal associations (Fig. 1). We did not observe any clear pattern of monthly fluctuations in bird associations for any of the 3 groups (Fig. 2). We saw greater variation within than between months of the year.

Birds were significantly more likely to be found in association with lion tamarins in mature and shade-cocoa forest than in secondary forest for all of the three groups [Piaçava, $\chi^2(1) = 8.81$, $p = 0.003$; Onça, $\chi^2(1) = 79.93$,

Table II. Number of 20-min periods in which we observed each bird species or bird group (for Dendrocolaptidae) for each golden-headed lion tamarin group

| Bird identification | Piaçava | Onça | Entulho | Total |
|-----------------------|---------|------|---------|-------|
| Woodcreepers | 2167 | 1367 | 293 | 3827 |
| White-fronted nunbird | 971 | 522 | 12 | 1505 |
| White-tailed trogon | 72 | 32 | 15 | 119 |
| Squirrel cuckoo | 75 | 23 | 9 | 107 |
| Red-rumped cacique | 51 | 44 | 7 | 102 |
| Double-toothed kite | 54 | 4 | 1 | 59 |
| Screaming piha | 29 | 6 | 0 | 35 |

Table III. Frequency of multiple species observed in the same observation period for each group of golden-headed lion tamarins

| Number of bird species or bird groups visible | Piaçava | Onça | Entulho |
|---|---------|------|---------|
| 0 | 1734 | 1965 | 2185 |
| 1 | 1681 | 1082 | 313 |
| 2 | 711 | 373 | 13 |
| 3 | 90 | 15 | 0 |
| 4 | 12 | 5 | 0 |
| Total | 4228 | 3476 | 2509 |

$p < 0.0001$; Entulho, $\chi^2(1) = 9.78$, $p = 0.0018$]. The pattern of association was significant across groups (QMH = 91.88, $p < 0.0001$).

DISCUSSION

We observed golden-headed lion tamarins in association with 11 species of birds, the majority of which were woodcreepers and white-fronted nunbirds. Though other researchers observed birds following

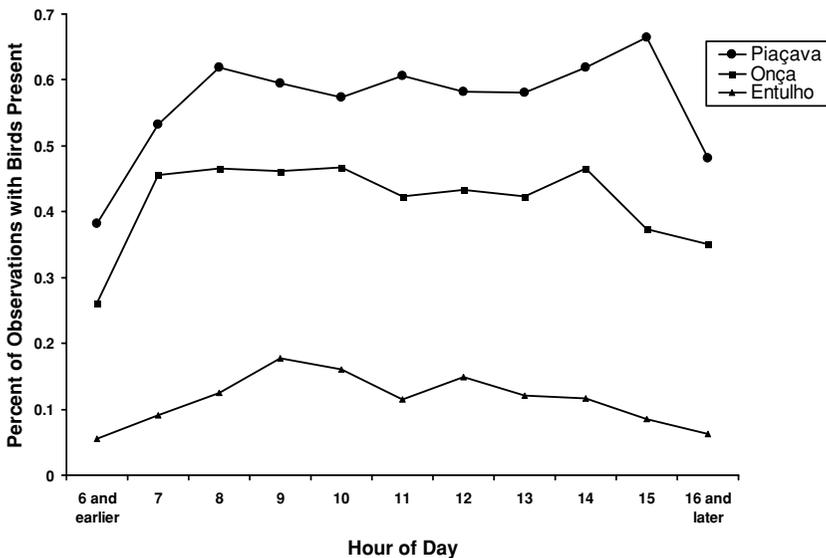


Fig. 1. Percentage of observation periods in which at least 1 bird was ≤ 5 m of a golden-headed lion tamarin for 3 groups across all hours of the day.

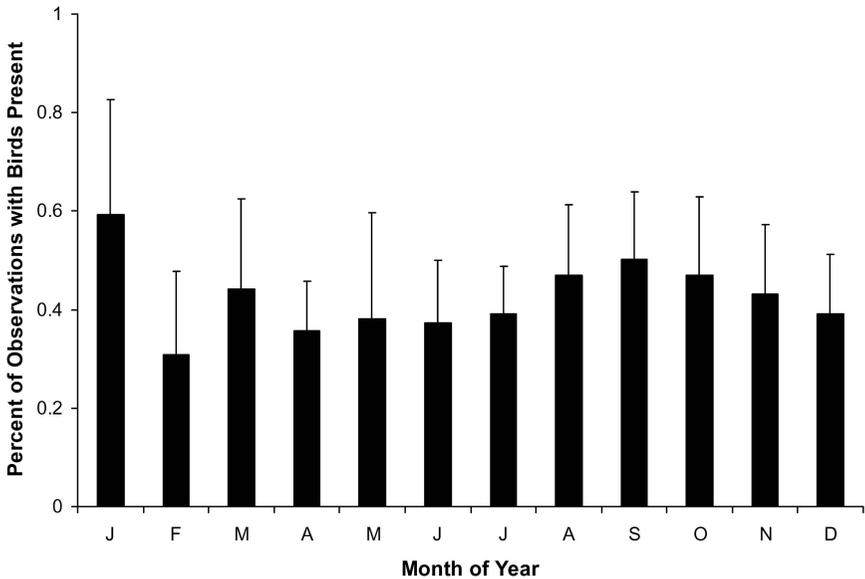


Fig. 2. Percentage of observation periods in which at least 1 bird was seen ≤ 5 m of a golden-headed lion tamarin across months of the year, averaged across all groups. Error bars represent the standard error across groups for each month.

primate groups and eating discarded fruit (cuckoos following *Saguinus*, Siegel *et al.*, 1989), associations between golden-headed lion tamarins and most of the bird species appeared to center on gaining access to insects. Woodcreepers and nunbirds followed closely behind the lion tamarins as they moved from bromeliad to bromeliad. The birds frequently captured insects that foraging monkeys flushed. The high rainfall and lack of seasonality in the region (Rylands, 1989) may indicate a relative abundance and lack of seasonality in insect prey, and, as such, a constant rate of associations across months of the year. Our results support the interpretation, as no seasonal trend in the frequency of associations was apparent. Likewise, given that golden-headed lion tamarins forage for insects throughout the day (Raboy and Dietz, 2004), we would not expect birds associating primarily to gain access to insect prey to display diurnal variation in rate of association.

The unequal proportions of time spent in habitat types for each of the 3 lion tamarin groups may explain the difference in frequencies of interspecific associations. Birds were least often with Entulho, the group that spent the least amount of time in mature and shade-cocoa forest (11.7% of observation periods in association with birds), and most often with Piaçava, the

group that spent the greatest amount of time in mature and shade-cocoa forest (52.0% in association).

We consider two explanations for the relationship between habitat type and frequency of association. First, the birds likely to associate with lion tamarins may be tall forest specialists and, thus, more abundant in mature and shade-cocoa forest than in secondary forest. However, the birds most frequently associating with the tamarins (woodcreepers and white-fronted nunbirds) are considered flexible in the habitats they occupy (del Hoyo, 2003; Hilty, 2003; Kricher, 1997; Ridgely, 1976; Stiles and Skutch, 1989). Woodcreepers are frequently in mature forest as well as secondary and edge habitats (Kricher, 1997). The 5 woodcreeper species we recorded following golden-headed lion tamarins are frequently found along forest edges, with some reports even placing olivaceous woodcreepers and the red-billed scythebill in semi-open areas (del Hoyo, 2003; Hilty, 2003; Ridgely, 1976; Stiles and Skutch, 1989). White-fronted nunbirds are also in forest clearings and river edges, as well as mature forest (Hilty, 2003; Stiles and Skutch, 1989). Moreover, we often observed the birds in association with the lion tamarins following groups from one habitat type to another during an association.

Second, birds may associate with greater frequency in mature and shade-cocoa forests because these habitats have a greater abundance of foraging substrates for the lion tamarins (Raboy *et al.*, 2004), and may, as such, yield a greater abundance of flushed insect prey for the birds. In a study in another region of the Atlantic Forest, bromeliads sampled in taller tree stands contained more insects than those in forest with lower canopies (Domingues *et al.*, 1989). In our study, association frequency was greater in habitats with high bromeliad concentrations. In addition, the number of observation periods in which we noted multiple bird species or bird groups in association with tamarins was greater in shade-cocoa and mature forest. Given the rapid conversion of mature and shade-cocoa forests to cattle ranching throughout Southern Bahia (Saatchi *et al.*, 2001), the relationship between insect prey abundance and the foraging patterns of species that depend on those trophic resources bears further study.

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