

FORAGING BEHAVIOR OF PLAIN-MANTLED TIT-SPINETAIL (*LEPTASTHENURA AEGITHALOIDES*) IN SEMIARID MATORRAL, NORTH-CENTRAL CHILE

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Resumen. – Comportamiento de forrajeo del tijeral (*Leptasthenura aegithaloides*) en matorral semiárido, centro-norte de Chile. – Hemos estudiado el comportamiento de forrajeo del tijeral (*Leptasthenura aegithaloides*) en el matorral del centro-norte de Chile. Se trata de una especie de la familia Furnariidae que es insectívora recolectora desde perchas. Frecuenta los arbustos más dominantes y busca presas y alimentos principalmente en el follaje, grupos de flores, pequeñas ramas y masas de líquenes. Los arbustos preferidos incluyen a *Porlieria* y *Baccharis*. Se alimentan desde alturas cercanas al suelo hasta arbustos superiores a dos metros de altura. Se los encuentra más frecuentemente en parejas o en grupos pequeños, posiblemente familias, de tres a cinco aves. Las densidades promedio en el matorral (1,49 - 1,69 aves por hectárea) son mayores que las reportadas para otros lugares. Los tijerales en el matorral forman grupos de especies mixtas con facilidad, especialmente en el invierno Austral. Su estrategia de forrajeo y su comportamiento son similares a las del Mito sastrecillo de América del Norte (*Psaltiriparus minimus*) y del Mito común (*Aegithalos caudatus*), ambos de la familia Aegithalidae, sugiriendo estrategias ecológicas convergentes en ambientes estructuralmente similares.

Abstract. – We studied foraging behavior of Plain-mantled Tit-spinetail (*Leptasthenura aegithaloides*) in matorral (scrubland) habitat of north-central Chile. Our findings show this species is an insectivorous, perch-gleaning specialist. It frequents most dominant shrubs and searches for prey and food primarily in foliage, flower clusters, small twigs and lichen masses. Preferred shrubs include *Porlieria* and *Baccharis*. They forage from near the ground to shrubs exceeding two meters in height. They are most often encountered in pairs or in small, presumably family groups, of three to five birds. Mean densities in matorral habitats (1.49–1.69 birds per hectare) are higher than reported elsewhere. Tit-spinetails readily form mixed-species assemblages in matorral scrub, particularly in the Austral winter. Its foraging strategy and behavior are similar to North American Bushtit (*Psaltiriparus minimus*) and Long-tailed Tit (*Aegithalos caudatus*), both of the family Aegithalidae, suggesting convergent ecological strategies in structurally similar environments. *Accepted 18 April 2011.*

Key words: Furnariidae, Plain-mantled Tit-spinetail, *Leptasthenura aegithaloides*, Chile, matorral, foraging behavior, prey capture.

INTRODUCTION

The tit-spinetails (genus *Leptasthenura*) are long-tailed furnariids represented by ten described species distributed from Venezuela to Argentina and Chile. In general, they occur

in Andean scrublands and lowland scrub of the southern cone of South America. Tit-spinetails are closely related to Des Murs' Wiretail (*Sylviortborhynchus desmursii*) and Thorn-tailed Rayadito (*Aphrastura spinicauda*) occupying a basal position within Synallaxinae

(Gonzalez & Wink 2008). Their foraging behavior has been compared with holarctic parids, hanging acrobatically from foliage tips (Ridgley & Tudor 1994, Jaramillo 2003). They are characterized by a very short, parid-like bill and long, highly graduated tail. The Plain-mantled Tit-spinetail (*L. aegithaloides*) is distributed from southern Peru to southern Argentina. Within Chile are three well-described forms which may represent more than one species (Ridgley & Tudor 1994, Jaramillo 2003). The central Chilean forms are birds of lowland matorral and desert scrub and are represented by two very similar subspecies, *L. a. aegathiloides* and *L. a. griescens*, which form a continuous distribution that is allopatric from other subspecies. While Plain-mantled Tit-spinetails are insectivorous and favor scrub and shrubby habitats, other facets of their life history and ecology are very poorly understood. Our objectives were to assess: (1) abundance, (2) foraging behavior, (3) prey-capture methods, and (4) plant associations of Plain-mantled Tit-spinetail in semiarid matorral in north-central Chile.

STUDY AREA AND METHODS

We conducted our studies in the Quebrada de las Vacas, a coastal valley in Parque Nacional Bosque de Fray Jorge ("Fray Jorge hereafter"). Fray Jorge comprises 9959 ha on the coast of Chile's IV Region, 400 km north of Santiago and 100 km south of La Serena (30°41'S, 71°40'W) (Fig. 1). The habitat is coastal steppe matorral (Gajardo 1993), characterized by dense (50–60%) ground cover of drought-resistant shrubs (Gutiérrez *et al.* 1993). We focused our efforts in and around a long-term research station established to monitor ecological responses to abiotic influences (Gutiérrez *et al.* 2010, Meserve *et al.* 2003, 2009). Avian inventories began with initial surveys in 2002 followed by quantitative

studies of avian populations beginning in 2004. While population surveys have been conducted three times per year, detailed foraging observations were made by both authors during visits on 20–28 February 2002, 21–28 February 2004, and 28 July–10 August 2006.

We quantified the behavior of actively foraging adult Plain-mantled Tit-spinetail and not those resting, primarily singing, or involved in other activities that might affect foraging behavior. Observations were conducted from 07:00 to 11:00 h under conditions of negligible wind. We regularly and repeatedly traversed the study site at a slow pace. Once a bird was found, we recorded sequential behaviors with a hand-held stopwatch. We tracked the bird as long as we could record behavior. If the bird was lost (usually due to dense scrub), we stopped the timer until the bird was relocated, when we would start again. The sequence of observations recorded was considered a single foraging bout. We recorded the species of shrub used (multiple plant species could be recorded per bout) as well as all foraging behaviors during the course of each bout. We used behavioral categories outlined by Fitzpatrick (1980); specifically, flycatching, hover gleaning, and perch gleaning. We noted the substrate used by birds when foraging; this included foliage, flowers, exposed twigs, bark, lichen, galls and ground. We also noted whether birds were alone, in pairs, or family groups, and if they joined mixed-species foraging flocks. These data were used to describe foraging behavior, supplementing quantifiable data. Most foraging records were written in field books, but some were documented using a hand-held cassette recorder and later transcribed.

We measured population density using data from 32 point count stations on eight transects spanning ~ 7 km (north-south) in

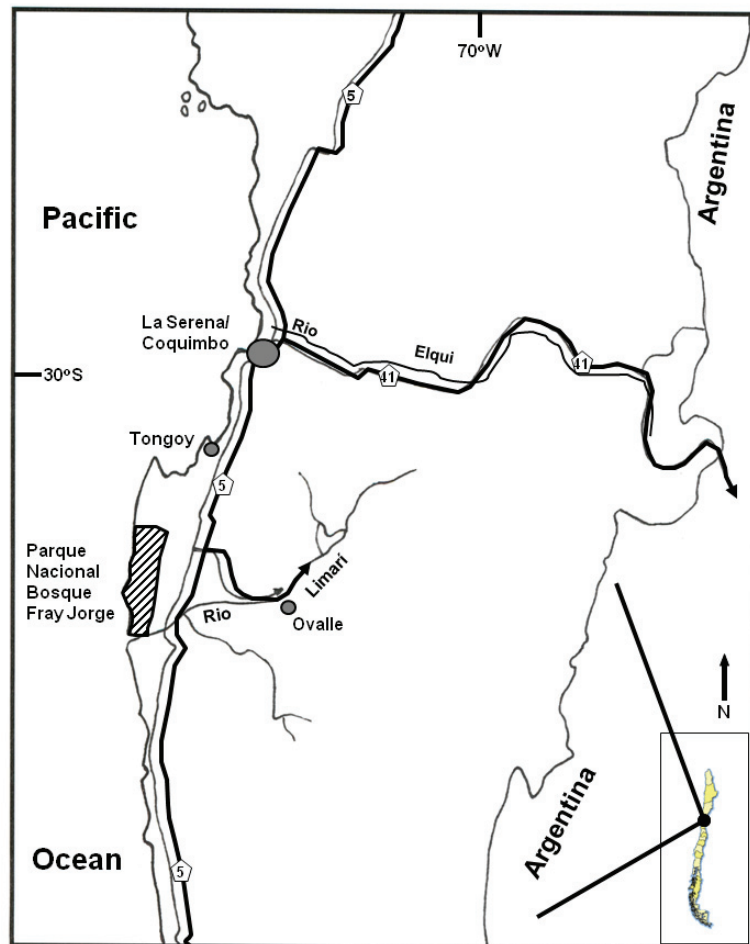


FIG. 1. Parque Nacional Bosque de Fray Jorge (study sites) along the coast of north-central Chile.

the Quebrada de las Vacas. Estimates were based on 8-min variable-distance estimation following Bibby *et al.* (2000). These data were gathered from transects counted three times a year (August, October, and July) from 2004 through 2010. Transects were surveyed twice each sampling period. All surveys were conducted in the morning (before ~ 10:00 h) and were limited to days with low wind (Beaufort scale < 2). We estimated detection functions and quantified density with program DISTANCE 6.0, Release 2 (Thomas *et al.* 2006).

We characterized the habitat using paired 5-m line-intercept transects at each avian point count station (32 sampling points). This method is most suited for shrub communities where cover and structure are goals of the assessment (Bauer 1943, Mueller-Dombois & Ellenberg 1974). We recorded the species, length of transect intercepted by the plant, and the maximum width of the plant perpendicular to the transect line for each individual plant overlapping the transect, and estimated ground cover following Cox (1996).

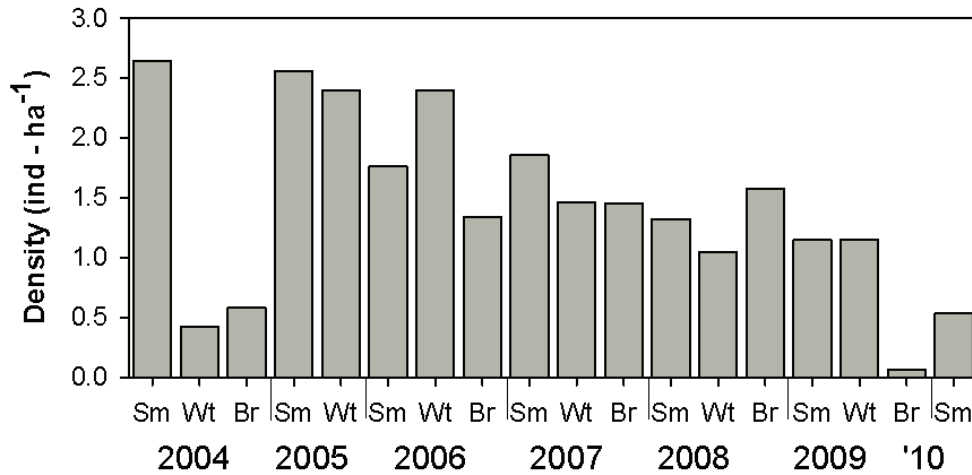


FIG. 2. Seasonal density (birds/ha) of Plain-mantled Tit-spinetail at Parque Nacional Bosque de Fray Jorge, Chile, 2004–2010 (Sm=Summer, Wt = Winter, Br = Breeding).

RESULTS

Density and social tendencies. Population densities varied from approximately 1 bird in 17 ha (< 0.06 birds/ha; breeding season 2009) to over 2 birds per ha (summer 2005 and 2005, winter 2005 and 2006), but no clear seasonal patterns were evident (Fig. 2). Summer densities were not significantly higher than those in winter (\bar{x} = 1.69 (SD \pm 0.76) vs. 1.48 (SD \pm 0.79) birds/ha; t = 0.49, df = 11, p > 0.60). In spite of variable numbers, Plain-mantled Tit-spinetail was ubiquitous on all transects and recorded at nearly every point count station at least once annually. Birds were evenly distributed among the matorral and generally were observed in small family groups (presumably) or pairs. We only recorded three observations of singletons.

Plain-mantled Tit-spinetails were social in their foraging associations. Observations were of birds in small “parties” averaging four individuals (range 2–7 birds). Small groups of tit-spinetails were often associated with other birds as core species within mixed-species

foraging flocks. Interspecific associations included: Striped Woodpecker (*Picoides lignarius*), Southern House Wren (*Troglodytes aedon chilensis*), and Dusky-tailed Canastero (*Pseudasthenes humicola*). Tit-spinetails moved in small flocks by flying from shrub to shrub, generally foraging in outer branches, rarely the interior. They maintained constant contact visually and with buzzy and chattering calls.

Shrub selection by Plain-mantled Tit-spinetail. Plain-mantled Tit-spinetails used shrubs largely in proportion to their availability (based on cover; linear regression; F = 57.71, df = 4, P = 0.0047; Fig. 3, Table 1). While the number of foraging events was not strongly associated with the availability of shrubs (r^2 = 0.31), the time spent foraging was a direct function of availability of species and cover (r^2 = 0.95; Fig. 3). Nonetheless, foraging observations in *Porlieria* and *Baccharis* accounted for 86% of foraging observations although these comprised only 42% of shrub cover. *Porlieria* and *Baccharis* were the focus of 48 and 38% of foraging activity, respectively, but comprised

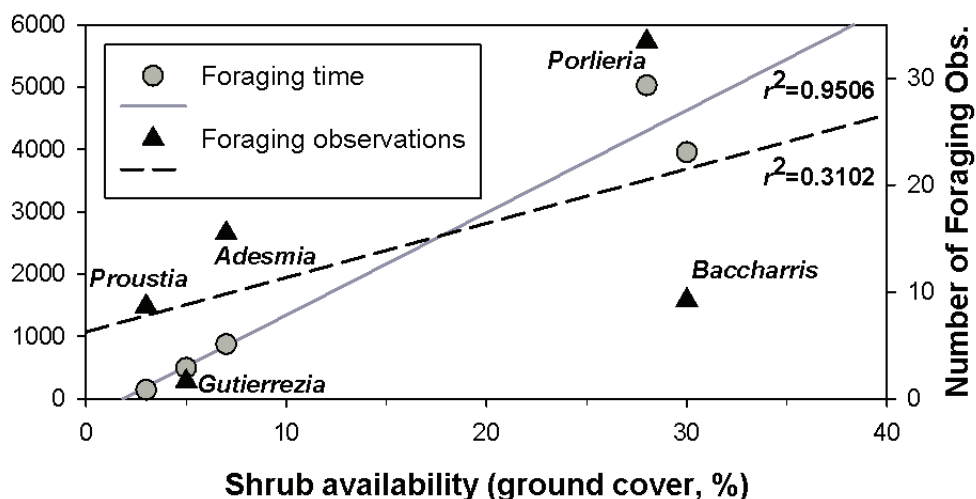


FIG. 3. Number of foraging observations and foraging time by Plain-mantled Tit-spinetail as a function of aerial cover of focal plant species (> 1 plant is generally visited/foraging bout, recorded as separate observations); once a bird is foraging in the plant, plant species used largely in proportion to availability (linear regression; $F = 57.71$, $df = 4$, $p = 0.0047$).

only 33 and 9% of shrub cover. A third shrub, *Adesmia*, was moderately abundant (15% of shrub cover) but received 8% of foraging visits (Table 1).

Although we lacked sufficient observations in winter to test for seasonal differences, available data suggested seasonality in foraging. Whereas summer foraging emphasized *Baccharis* (46% of observations) and *Porlieria* (43%), efforts in winter were strongly directed towards *Porlieria* (73%) and *Adesmia* (20%). Indeed, *Baccharis* was used only in summer, as were a number of low growing, semi-open, flowering plants (Fig. 4). In contrast, while never a major recipient of foraging activity by Plain-mantled Tit-spinetails, *Proustia* was visited only in winter.

Method of prey capture. We recorded 73 individual foraging sessions, comprising 10,525 s (175.4 min) of observations. Observations on individual birds averaged 284 s (range = 13–880 s). Plain-mantled Tit-spinetails are foli-

age-gleaning specialists; this behavior accounted for 100% of the observations and time foraging (Fig. 5). Foraging was primarily focused in foliage (35% of time observed), lichen masses (24%) and on external branches and bark (23%, Fig. 5). Birds flew from shrub to shrub, usually within two meters of the ground, accessing the shrub from lower branches and systematically moving upward. They foraged in the outer branches and foliage tips and exhibited a creeping-crawling behavior through foliage and along branches, working in a corkscrew fashion around dense structures, actively probing and picking for prey items. They often hung upside-down to inspect the underside of foliage, with their tail pointing down or at a right angle to the body. Stomach contents of three individuals recently collected by us outside the park contained insect matter.

Foraging within shrubs appeared to be directed towards the densest and most complex structures and the substrate used varied

TABLE 1. Dominant plant composition of the matorral habitat in the Quebrada de las Vacas, Parque Nacional Fray Jorge, Chile. Aerial coverage is summed across line transects conducted at 32 point-count stations.

Scientific name	Chilean name	Coverage (m ²)	% Cover
<i>Porlieria chilensis</i>	Guayacán	190,525	33.4
<i>Adesmia bedwelli</i>	Adesmia	88,181	15.5
<i>Chenopodium petiolare</i>	Chenopodium	61,703	10.8
<i>Proustia pungens</i>	Proustia	49,201	8.6
<i>Baccharis linearis</i>	Romerillo	52,469	9.2
<i>Bahia ambrosioides</i>	Bahia	32,253	5.7
<i>Fluorencia thurifera</i>	Incienso	17,469	3.1
<i>Heliotropium</i> spp.	Helitropo	13,179	2.3
<i>Anisomeria littoralis</i>	Pircún	11,088	1.9
<i>Senna cummingii</i>	Alcaparra	9,853	1.7
Others (19 taxa)		53,134	9.3

across shrub species. Foraging in *Baccharis* was focused primarily on foliage (53%) and flower clusters (26%), whereas in *Porlieria* this was greatest in lichen (47%). In *Adesmia*, tit-spinetails spent equal time on thin branches and flower clusters (44 and 46% respectively). Flower clusters were visited in winter survey periods only.

DISCUSSION

Our data characterize Plain-mantled Tit-spinetails as perch-gleaning specialists. In Argentina, this species gleans insects from the outer branches of shrubs, often dangling, tit-like, from vegetation (Cueto *et al.* 1997). Other species of spinetails also are foliage-gleaners (Blendinger 2005, Lloyd 2008). Fly-catching has been reported from Tawny Tit-spinetail (*L. yanacensis*; Mazar Barnett *et al.* 1998) but we did not observe this behavior in *L. aegithaloides*. Three species of spinetails (White-browed Tit-spinetail, *L. xenothorax*; Andean Tit-spinetail, *L. andicola*; and Tawny Tit-spinetail) are bark-foliage gleaners in *Polylepsis* woodlands, partitioning resources by foraging at different levels of the woodland (Lloyd 2008).

Plain-mantled Tit-spinetail foraging behavior and strategies are similar to those characterized for North American Bushtit (*Psaltriparus minimus*) and Eurasian Long-tailed Tit (*Aegithalos caudatus*) (Franzreb & Franzreb 1984, Franzreb 1984, Hertz *et al.* 1976, Morse 1978, Sloane 2001). Both Holarctic species are also characterized as perch-gleaning specialists and, like the Plain-mantled Tit-spinetail, use their long tails as a counterbalance for acrobatic foliage gleaning. Adaptations of pedal morphology, plumage, and bill structure as well as foraging behavior appear convergent between the furnariid studied here and these Northern Hemisphere aegothalid tits.

One interesting foraging stratum used by spinetails in Fray Jorge matorral habitat was lichen masses in *Porlieria*. This lichen (*Usnea rubicund*) is a foliose species, and is widespread in Chile. In arid habitats, it is known from the fog belt of coastal hills where it grows almost exclusively on *Porlieria* (Redon *et al.* 1975, Muñoz-Schick *et al.* 2001). In Fray Jorge, this lichen can completely cover outer branches of *Porlieria* (Redon *et al.* 1975, Engilis & Kelt pers. observ.). While in *Porlieria*, spinetails spend a high proportion of time probing

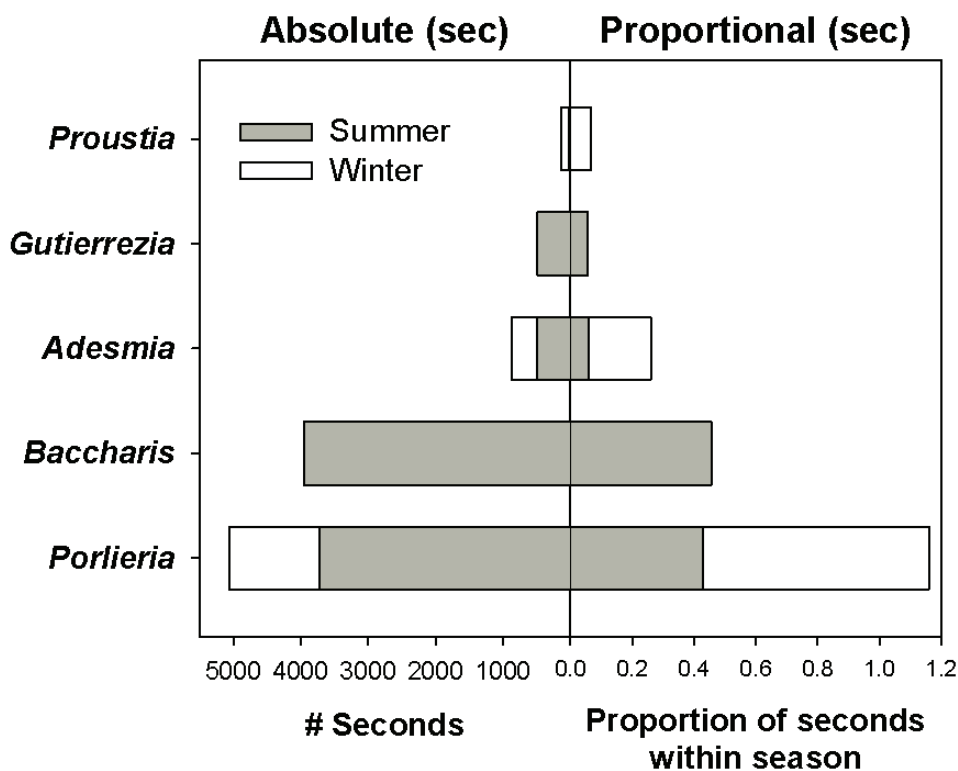


FIG. 4. Plain-mantled Tit-spinetail distribution of foraging time in plant species and season.

these lichen masses, presumably for arthropods, including scale insects. We noted two other species using these lichens, Dusky-tailed Canastero and Southern House Wren, but did not gather any quantitative data to assess if it was a preferred foraging substrate for either species. In *Polylepis* woodlands, barks and branches are also densely covered by lichens and mosses, which forms a substrate used by spinetails; this use has not been quantified relative to foliage and exposed branches (Lloyd 2008).

Plain-mantled Tit-spinetails have a large geographic range, within which they occur in a variety of scrub and forested habitats, suggesting generalist foraging habits. Our data support this categorization in two ways. First,

foraging was highly associated with the spatial availability of shrub species in Fray Jorge. Second, the species shifted foraging preferences based on flowering and vegetative phenology (e.g., summer preference for *Baccharis*). This shift in response to flowering phenology occurs in other species of spinetails and other insectivores in semiarid scrubland in Argentina (Blendinger 2005, Engilis & Kelt 2009). Spinetails forage in summer extensively amongst *Baccharis*, which grows densely in washes where water remains close to the surface. These dense thickets are visible from great distances and are preferred foraging sites for many insectivorous birds (Engilis & Kelt 2009). *L. aegithaloides* forages in small groups which seems typical of other species

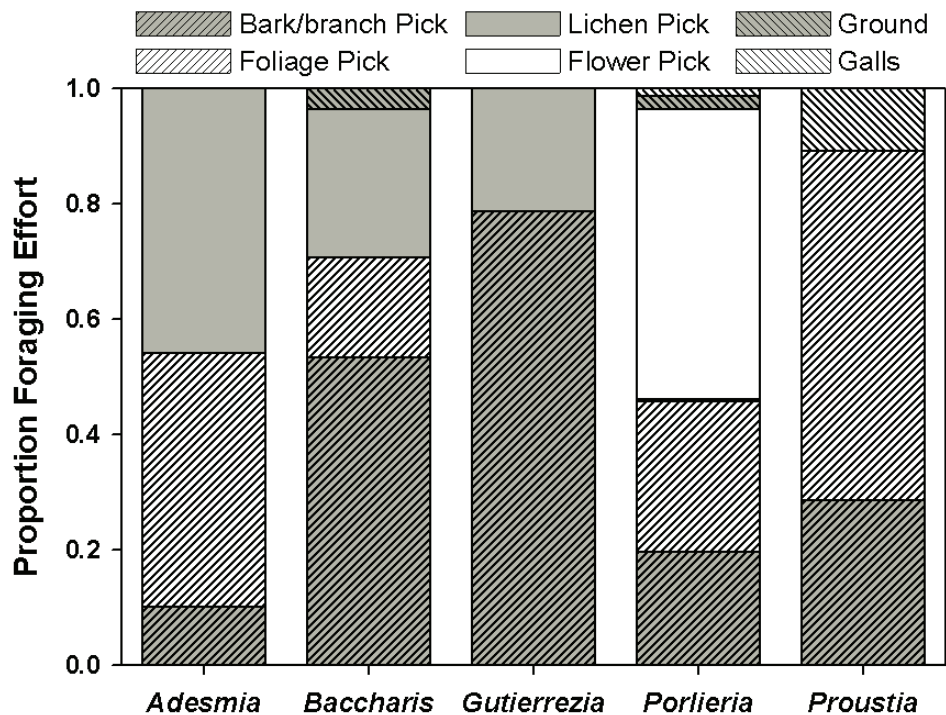


FIG. 5. Proportion of foraging effort (seconds in plant) in Plain-mantled Tit-Spinetail by strata visited.

of the genus (Cabanne *et al.* 2007, Lloyd 2008, Ridgley & Tudor 1994).

Population densities at our site were higher than reported elsewhere in Chile. Vergara & Simonetti (2004) recorded average densities of 0.03 birds/ha in fragmented forests in the Cordillera de la Costa (36°S). Gonzales-Gomez *et al.* (2006) reported densities in fragmented Valdivian forests of southern Chile ranging from 0.01 to 0.02 birds/ha, and Estades (1997) reported 0.37–0.46 birds/ha in semideciduous scrub and ñirre (*Nothofagus antarctica*) scrub. The latter two study sites were above 40°S latitude in a cooler and wetter climate, and densities reported were from a single breeding season and did not account for annual variation. All three studies were in forested or forest fragmented habitat, which may not be optimal for spinetails.

Plain-mantled Tit-spinetails are small and easily overlooked in dense matorral habitat, but the species is well suited for further attention in ecological studies. Further observations should strive to clarify seasonal shifts in plant use, foraging in relation to flowering phenology, and effects of climate (e.g., El Niño Southern Oscillation) on demography and, in turn, on their influence on arthropod communities.

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