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## COMMUNICATION

### FORAGING BEHAVIOR AND ASSOCIATION WITH MIXED FLOCKS BY THE CRITICALLY ENDANGERED ALAGOAS TYRANNULET *PHYLLOSCARTES CECILIAE* (AVES: PASSERIFORMES: TYRANNIDAE)

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## INTRODUCTION

Alagoas Tyrannulet *Phylloscartes ceciliae* (Image 1) is a globally threatened species (Critically Endangered; BirdLife International 2020) with a restricted distribution to the Pernambuco Endemism Center (Roda et al. 2011). This bird is found in 13 municipalities in the states of Alagoas and Pernambuco, however within only five protected areas (Roda et al. 2003; BirdLife International 2020; GBIF 2020; WikiAves 2020). Data on this species biology are still scarce. There is only sparse information about the species (e.g., Teixeira 1987; Collar et al. 1992; Roda et al. 2011). Here, we provide the first detailed information about the foraging behavior of *P. ceciliae* and new information about association with mixed flocks.

## MATERIALS AND METHODS

**Study area.** We collected field data mainly in 2009 in Frei Caneca, and Pedra D'Antas Private Reserves (RPPNs) which encompass 1,066ha of protected area, both located

at Serra do Urubu Mountains (-8.717S, -35.840W), in Jaqueira and Lagoa dos Gatos municipalities, Pernambuco, northeastern Brazil. The Serra do Urubu Forest Complex is one of the largest remaining areas of montane forest in the state of Pernambuco. Located in a region known as Pernambuco Endemism Center, Serra do Urubu is classified by the Brazilian Ministry of Environment as an area of extreme biological importance and identified by BirdLife International and SAVE Brasil as an Important Bird and Biodiversity Area (IBA) of high priority action. The predominant vegetation is montane dense ombrophilous forest based on the types of vegetation proposed by Veloso (1992) and the altitude varies from 600 to 750 m. We also recorded some information about associations of *P. ceciliae* with mixed flocks between 2010 and 2015. This study is part of the bird monitoring program of Serra do Urubu, conducted annually since 2005.

We actively searched for individuals of *P. ceciliae* from 18–27 November 2009, mainly during 05.00–08.00 h and 16.00–18.00 h, to collect information about the species' foraging behavior. We used the focal-animal method (Altmann 1974; Martin & Bateson 1986)

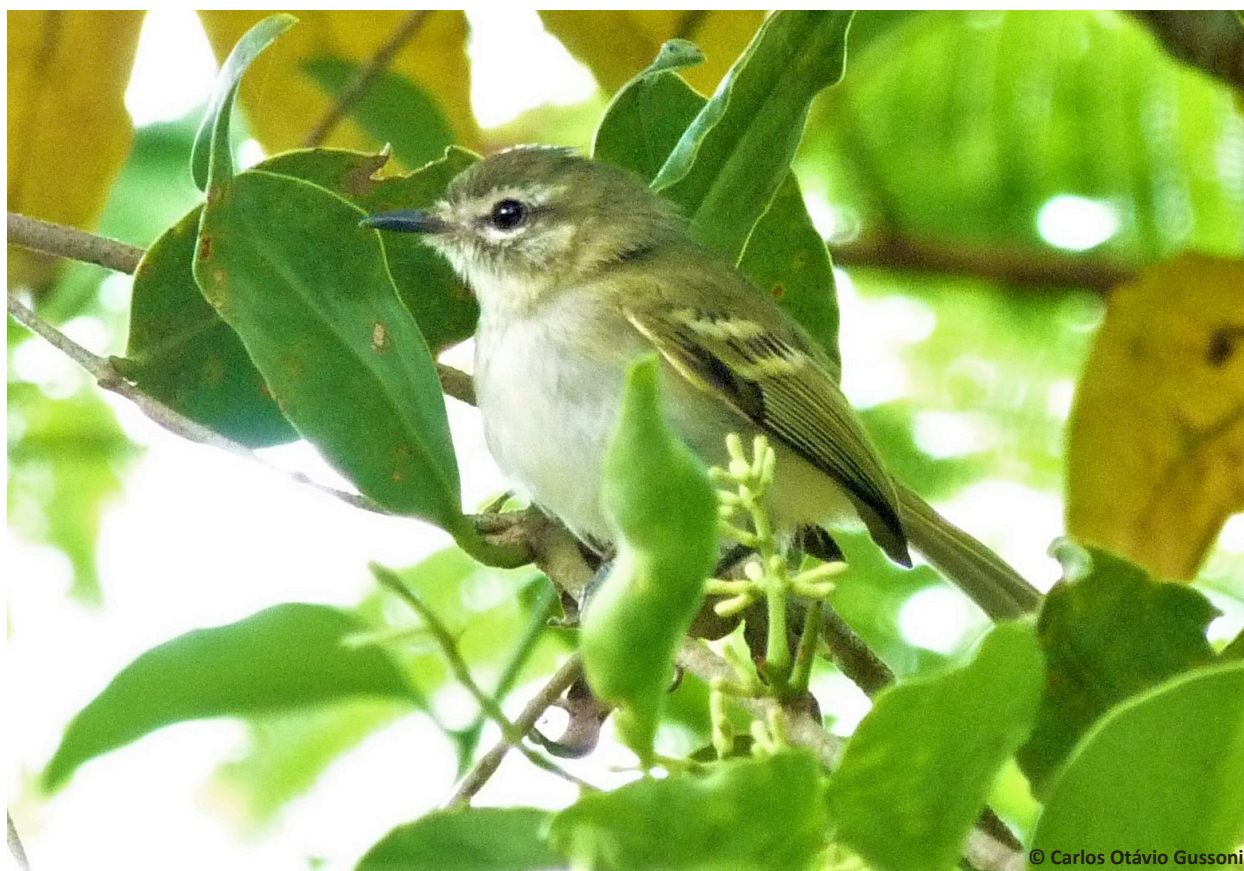


Image 1. The Alagoas Tyrannulet *Phylloscartes ceciliae*.



following individuals as long as possible and observing their foraging strategies with 10x binoculars. The interval between each observation was five minutes long so that they could be considered as independent samples (according to Alves & Duarte 1996). Any attempt of capture was treated as a sample of foraging behavior, either it was a successful attempt or not, as proposed by Fitzpatrick (1980). We classified the maneuvers according to Remsen & Robinson (1990). Also, we recorded the following parameters for each capture: substrate type (tree, shrub, or herbaceous), substrate characteristics (the presence and type, simple or pinnate, of the green leaves, dry leaves and/or twigs), substrate height, bird position on the substrate (inside/outside the canopy), the site where capture began (features: branches with green/dry leaves or twigs; height; and slope: horizontal = any angle between 0 and 15°, tilt = between 16° and 70°, vertical = between 71° and 90°), the site where capture ended (features: branches with green/dry leaves or twigs; height, and slope), the substrate where the prey was captured (air, green foliage, dry foliage, branch, stem, inflorescence; height), the distance between the start and the return perches, the distance from the bird to the prey, the distance from the prey to the new resting place (estimated visually), the height of the site where the prey lay, prey identity (when possible), whether the bird returned or not to the perch of departure, and the maneuver performed to capture. In addition, for aerial maneuvers, we recorded flight slope and direction. Other information on the biology of the species was collected ad libitum (Altmann 1974). The total dataset consisted of 61 foraging samples.

## RESULTS

### Foraging behavior

The Alagoas Tyrannulet seems to specialize in using the sally-strike maneuver (68.85%;  $n = 61$ ) to catch prey ( $n = 61$ ) on green foliage (50.82%) and in the air (34.42%). *P. ceciliae* used mainly branches with green leaves as both starting (68.86%) and return perches (70.49%). The other maneuvers used to catch prey were: reach-up (4.92%), reach-out (13.11%), lunge (4.92%), sally-hover (6.56%), and glean (1.64%). Individuals also captured prey on dry leaves (6.56%), dry branches (4.92%), inflorescences (1.64%), and trunks (1.64%). Among the prey capture substrates, *P. ceciliae* preferred small pinnate leaves, which accounted for 32.72% of the catch substrates, while simple leaves corresponded to 24.59%. The main prey manipulation ( $n = 61$ ) performed was

engulfing (93.44%), followed by gulping (3.28%), beating prey against dry branches (1.64%), and deliverance to another individual (1.64%).

The species also foraged either alone or in pairs, mainly in trees with green leaves (81.97%) 18.10 ± 6.03m high (median= 18m; min.= 8m; max.= 30m), with most capture events occurring inside tree canopies (98.36%). Individuals preferentially used tilted branches as perches of departure (75.41%) and return (70.49%), with the perches of departure being 12 ± 5.36 m high (median= 13.95m; min.= 5m; max.= 25m) and return perches were at 12 ± 5.21 m above ground (median= 13.86m; min.= 5m; max.= 25m). Most flights were also slanted (58.33%), with 64.41% out of them being slanted up while 16.95% were slanted down. On the other hand, 16.95% of flights were horizontal flights, and 1.69% were vertical-up ones. In none of the aerial maneuvers observed did the birds return to the perch after catching the prey. The distance from the initial perch to the return one ranged from 0 to 3.3 m (median= 54.32cm; mean= 50 ± 54.39cm), the distance from the bird to the prey ranged from 2cm to 1m (median= 29.61cm; mean= 30 ± 20.53cm) and the distance from the prey to the new perch ranged from 0 to 3 m (median= 35.68cm; mean= 30 ± 45.09cm).

*Phylloscartes ceciliae*'s successful catch rate was 2.93 catches/minute. In two capture events, it was possible to identify the prey: two caterpillars of approximately 5mm long each. One of them was captured by one individual and delivered to another one on the return perch (25 November 2009). In November 2009, we observed three individuals foraging together, possibly a family group.

### Association with mixed flocks

We observed four events in which individuals of Alagoas Tyrannulet accompanied mixed flocks in July ( $n = 1$ ), November ( $n = 2$ ), and December ( $n = 1$ ). The mixed flocks were composed of the following species (the number of flocks in which they are present are in brackets): *Myrmotherula axillaris* ( $n = 3$ ), *Terenura sicki* ( $n = 2$ ), *Dysithamnus mentalis* ( $n = 1$ ), *Herpsilochmus atricapillus* ( $n = 1$ ), *Ceratopipra rubrocapilla* ( $n = 1$ ), *Tolmomyias flaviventris* ( $n = 1$ ), *Cyclarhis gujanensis* ( $n = 1$ ), *Basileuterus culicivorus* ( $n = 1$ ), *Coereba flaveola* ( $n = 1$ ), *Saltator maximus* ( $n = 1$ ), *Tachyphonus rufus* ( $n = 1$ ), *Tangara cayana* ( $n = 1$ ), *Dacnis cayana* ( $n = 1$ ), *Hemithraupis guira* ( $n = 2$ ), and *Euphonia violacea* ( $n = 1$ ). In November 2009, contacts with the other species in mixed flocks corresponded to only 4.54% of the sightings of *P. ceciliae* ( $n = 44$ ), indicating that this species is not a



frequent follower of these flocks.

## DISCUSSION

### Foraging behavior

The data obtained added new information about the foraging activity of *P. ceciliae*, allowing a more detailed description of the strategies used by this species to catch prey. According to Teixeira (1987), *P. ceciliae* forage on the surface of leaves and branches, where it catches small insects. Collar et al. (1992) reported that this species feeds 6–15 m above ground level, capturing its prey with rapid movements directed to the axial and abaxial leaf surfaces.

The foraging height we observed in the current study agrees with other reports for species in the genus *Phylloscartes*, which forage from the lower stratum to the forest canopy where they inhabit (Narosky & Yzurieta 1987; Parker III 1992; Ridgely & Tudor 1994; Willis & Oniki 2003; Fitzpatrick et al. 2004; Sigrist 2005; Maldonado-Coelho 2009). As reported herein, several other species of the genus forage alone, in pairs or small groups, including family groups (Collar et al. 1992; Ridgely & Tudor 1994; Fitzpatrick et al. 2004; Birdlife International 2009). Many species of *Phylloscartes* often catch prey on leaves and/or in the air (see Fitzpatrick et al. 2004). Moreover, the Alagoas Tyrannulet seems to have a preference for capturing prey from small pinnate leaves, as reported by Maldonado-Coelho (2009) for *P. roquettei*.

Collar et al. (1992) recorded the capture of a tettigoniid (Orthoptera) by an individual of *P. ceciliae*, and Teixeira (1987) reports that this bird feeds on small insects. In this study, we report a new food item on *P. ceciliae*'s diet: caterpillars. This item is also present in the diet of other species such as *P. kronei* (Gussoni & Santos 2011), *P. ventralis* (Smith & Betuel 2006), *P. eximius* (Belton 1994), and *P. oustaleti* (Gonzaga et al. 2016). The catch rate is similar to that found for *P. kronei* that catches, on average, 2.12 prey/min (Gussoni & Santos 2011).

### Association with mixed flocks

According to Fitzpatrick et al. (2004), all species of the genus *Phylloscartes* accompany mixed bird flocks, however, it is not clear which bird species are associated with *Phylloscartes* species in these groups. Literature reports the presence of species from at least 12 families within mixed flocks with *Phylloscartes* (Teixeira 1987; Collar et al. 1992; Parker III 1992; Gonzaga & Pacheco

1995; O'Neill et al. 2000; Willis & Oniki 2003; Fitzpatrick et al. 2004; Venturini et al. 2005; Bodrati & Cockle 2006; O'Shea et al. 2007; Santos et al. 2009). Teixeira (1987) and Roda et al. (2003) found 19 species in mixed bird flocks with *P. ceciliae*. The current study included 12 new species to the list, totaling 31 species recorded in flocks with the species. As described for *P. kronei* by Gussoni (2010), *P. ceciliae* is not a frequent follower of mixed bird flocks. Other species of *Phylloscartes*, however, may follow such aggregations more often. *P. ventralis*, for example, is regularly found among mixed bird flocks, being recorded in 13% of the flocks studied by Ghizoni-Jr. (2009) in Santa Catarina.

The natural history data presented here is valuable to support conservation efforts and possible management actions for this species. It is well known that other species are locally extinct in our study area and two of them are probably extinct in the wild, the Alagoas Foliage-gleaner *Philydor novaesi* and the Cryptic Treehunter *Cichlocolaptes mazarbarnetti*, and others are on the brink of extinction such as the Alagoas Antwren (*Myrmotherula snowi*; known mainly for one site, Murici Ecological Station, nowadays). Unfortunately, the Alagoas Tyrannulet is one of the next candidates to require a recovery plan and our findings are useful for the conservation practitioners to design the best management strategies. Also, our results show that the majority of the prey capture events by Alagoas Tyrannulet occurred inside tree canopies, thus we can infer that this species needs a more advanced stage of forest succession, with higher trees, emphasizing the urgency for restoration programs in the region. Fortunately, there are some actions led by the NGO SAVE Brasil to recover the habitat and bring some hope for these birds on the brink of extinction at Serra do Urubu.

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## Communications

**First record of Wroughton's Small Spiny Mouse *Mus phillipsi* Wroughton, 1912 (Rodentia: Muridae) from Odisha, India with notes on diversity and distribution of other rodents**

– Pratyush P. Mohapatra, S.S. Talmale, V. Sarkar & S.K. Dutta, Pp. 17611–17618

**Small mammals in the human-dominated landscape in the northern Western Ghats of India**

– Sameer Bajar, Amol R. Kulavmode & Ranjit Manakadan, Pp. 17619–17629

**Faunal diversity of an insular crepuscular cave of Goa, India**

– Pratiksha Sail, Manoj Ramakant Borkar, Ismat Shaikh & Archana Pal, Pp. 17630–17638

**Potential remote drug delivery failures due to temperature-dependent viscosity and drug-loss of aqueous and emulsion-based fluids**

– Derek Andrew Rosenfield, Alfredo Acosta, Denise Trigilio Tavares & Cristiane Schilbach Pizzutto, Pp. 17639–17645

**Foraging behavior and association with mixed flocks by the Critically Endangered Alagoas Tyrannulet *Phylloscartes ceciliae* (Aves: Passeriformes: Tyrannidae)**

– Carlos Otávio Araujo Gussoni & Tatiana Pongiluppi, Pp. 17646–17650

**Ichthyofaunal diversity in the upper-catchment of Kabini River in Wayanad part of Western Ghats, India**

– Dencin Rons Thampy, M.R. Sethu, M. Bibin Paul & C.P. Shaji, Pp. 17651–17669

**Herpetofaunal inventory of Van Province, eastern Anatolia, Turkey**

– Mehmet Zülfi Yildiz, Naşit İçci & Bahadır Akman, Pp. 17670–17683

**Herpetofauna assemblage in two watershed areas of Kumoan Himalaya, Uttarakhand, India**

– Kaleem Ahmed & Jamal A. Khan, Pp. 17684–17692

**A checklist of earthworms (Annelida: Oligochaeta) in southeastern Vietnam**

– Dang Hai Lam, Nam Quoc Nguyen, Anh Duc Nguyen & Tung Thanh Nguyen, Pp. 17693–17711

**Some biological aspects of the central Indian endemic scorpion *Hottentotta jabaipurensis* Kovařík, 2007 (Scorpiones: Buthidae)**

– Pragya Pandey, Pratyush P. Mohapatra & D.B. Bastawade, Pp. 17712–17721

**First record of the early immature stages of the White Four-ring *Ypthima ceylonica* (Insecta: Lepidoptera: Nymphalidae), and a note on a new host plant from India**

– Hari Theivaprakasham, Hari Ramanasaran & Appavu Pavendhan, Pp. 17722–17730

**New additions to the larval food plants of Sri Lankan butterflies (Insecta: Lepidoptera: Papilionoidea)**

– Himesh Dilruwan Jayasinghe, Sarath Sanjeeva Rajapakshe & Tharindu Ranasinghe, Pp. 17731–17740

**An insight into the butterfly (Lepidoptera) diversity of an urban landscape: Guwahati, Assam, India**

– Sanath Chandra Bohra & Jayaditya Purkayastha, Pp. 17741–17752

**A report on the moth (Lepidoptera: Heterocera) diversity of Kappai River basin in Kerala, India**

– Chembakassery Jose Alex, Koladyparambil Chinnann Soumya & Thavalathadathil Velayudhan Sajeev, Pp. 17753–17779

**Observations on the flowering plant diversity of Madayippara, a southern Indian lateritic plateau from Kerala, India**

– C. Pramod & A.K. Pradeep, Pp. 17780–17806

**Malacofaunal inventory in Chintamani Kar Bird Sanctuary, West Bengal, India**

– S.K. Sajan, Swati Das, Basudev Tripathy & Tulika Biswas, Pp. 17807–17826

## Short Communications

**Food habits of the Dusky-striped Squirrel *Funambulus sublineatus* (Mammalia: Rodentia: Sciuridae)**

– Palassery Suresh Aravind, George Joe, Ponnu Dhanesh & Rajamani Nandini, Pp. 17827–17831

## Notes

**High altitude wetland migratory birds in the Sikkim Himalaya: a future conservation perspective**

– Prem K. Chhetri, Kusal Gurung, Thinlay Namgyal Lepcha & Bijoy Chhetri, Pp. 17832–17836

**Tawny Fish-owl *Ketupa flavipes* Hodgson, 1836 (Aves: Strigiformes: Strigidae): recent record from Arunachal Pradesh, India**

– Malyasri Bhattacharya, Bhupendra S. Adhikari & G.V. Gopi, Pp. 17837–17840

**First report of *Lipotriches (Rhopalomelissa) parca* (Kohl, 1906) (Halictidae: Nomiinae) from India**

– Bhaswati Majumder, Anandhan Rameshkumar & Sarfrazul Islam Kazmi, Pp. 17841–17842

**Addition of four species to the flora of Andaman Islands, India**

– Mudavath Chennakesavulu Naik, Lal Ji Singh, Gautam Anuj Ekka & C.P. Vivek, Pp. 17843–17846

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