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The social spider *Parawixia bistriata* (Rengger, 1836) (Araneidae) as a potentially significant source of avian mortality in the Paraguayan Chaco

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Abstract

Five cases of bird entrapment in the social webs of *Parawixia bistriata* (Araneidae: Araneinae: Araneini) are reported from the Paraguayan Chaco. These are the first reports of avian entrapment for this species, and add one new family (Thraupidae) and four new species to the global biological inventory of bird species caught in spider webs. The wing chord and masses of the largest two species, *Tyrannus melancholicus* (Tyrannidae) and *Columbina picui* (Columbidae) greatly exceed the maximum reported for other Neotropical species. It is argued that possibility of mortality from entrapment is not merely a matter of morphology as has been previously suggested, but includes other factors such as spider species, silk type, and area of entanglement. A possible temporal relationship between the growth and life history of this spider and the potential for entrapment is postulated. It is proposed that increased deforestation in the Paraguayan Chaco could lead to an increase in avian entrapment in this webs of this species.

Keywords: birds • *Columbina picui* • *Coryphospingus cucullatus* • entrapment • *Saltatricula multicolor* • *Troglodytes aedon* • *Tyrannus melancholicus*

Introduction

The ñandutí spider *Parawixia bistriata* (Rengger, 1836) (Araneidae: Araneinae: Araneini) is a large and conspicuous social spider that is widespread in drier areas of Paraguay and abundant in the Chaco, west of the Paraguay River (Levi 1992). Though its social behaviour was reported as early as Azara (1809), and much commented on during the 19th Century (Rengger 1836; Masterman 1869, 1891; Darwin 1845; Goeldi 1892; Holmberg 1874a,b), it was widely questioned by prominent arachnologists of the time (Pickard-Cambridge 1870; McCook 1890) until the observations were confirmed by Simon (1891). The extensive colonial orb webs built by the species are of cultural signifi-

cance in Paraguay, probably inspiring the local artisanal ñandutí lace (Fowler & Diehl 1978).

Colony structure comprises two parts: a silky, diurnal retreat (bivouac) located 2–5 m above ground (typically in a tree or lamp post) in which the black mass of spiders is clearly visible, and a nocturnal capture web, composed of a scaffold of thick support threads radiating out from the nest for 10–30 m and upon which the individual orbs are woven at night (Gobbi, Zucchi & Sakagami 1979). The construction of the orb of each individual spider may take as long as an hour (Gobbi, Zucchi & Sakagami 1979). Webs are typically located at the forest edge, or along hedgerows, but not in closed canopy forest, and a single colony may contain over 300 individuals. The orbs are consumed each morning before the retreat to the bivouac, but the scaffold of support threads remains in place. The breeding system is univoltine, with spiderlings hatching in May and the last adults disappearing in March (Fowler & Diehl 1978). This synchronicity in senescence (and hence body size) is essential to the evolution of the colonial system employed.

Prey consumption is a function of body size, with larger spiders building larger webs. Orbs may even be designed specifically to catch certain types of seasonally abundant prey, maximising the efficiency of silk usage (Sandoval 1994). Unlike most colonial orb-weaving spiders, this species exhibits facultative, communal prey capture and feeding. Small prey items are consumed only by the orb resident, but small groups of neighbours may share prey that is significantly larger than themselves (Fowler & Diehl 1978; Gobbi, Zucchi & Sakagami 1979; Sandoval 1987; Fowler & Gobbi 1988; Fernández-Campon 2007). Prey that is too large to be consumed is able and permitted to free itself from the orbs, but damages it in the process (Fowler & Gobbi 1988; Fernández-Campon 2007).

Brooks (2012) provided a review of records of birds caught in spider webs, listing 68 cases, representing 54 species in 23 families, with additional data for Asian birds provided by Walther (2016), meaning a total of 84 bird species documented. Although the cause of entrapment of birds in spider webs is not always clear, it has been hypothesized to occur by three basic means: 1) foraging for insects trapped in the web; 2) gathering material for nest building; 3) accidentally flying into an unseen web (Peloso & de Sousa 2007). It is uncommon for spiders to actually predate birds (Levy 1987; Peloso & de Sousa 2007), but entrapment is nonetheless a significant source of mortality for some bird families (Graham 1997), and without human assistance as many as 73% of cases of entrapment ultimately result in death (Brooks 2012). The venom of *P. bistriata* is potent enough to subdue small vertebrates, but there is no evidence that vertebrates are consumed by this species (Araujo-Rodrigues *et al.* 2001, 2004).

In this paper we provide information on five Paraguayan cases of bird entrapment in the web of *P. bistriata*, a species not listed by Brooks (2012) as previously associated with bird entrapment, adding one new family (Thraupidae) and four new species to the biological inventory of bird species.



Fig. 1: Dead Picui Ground Dove *Columbina picui* tangled in a web at Laguna Capitán, Presidente Hayes department. © A. J. Lesterhuis.

Picui Ground Dove *Columbina picui* (Columbidae)

An individual in a state of decomposition (Fig. 1) was found tangled in a web at Laguna Capitán, Presidente Hayes department, $-22.540278^{\circ}\text{S}$ $-59.676389^{\circ}\text{W}$, by AJL and Rob Clay on 05 July 2018. Given the poor state of preservation, it was assumed to have been trapped for a considerable time.

Mean wing chord of four specimens of *Columbina picui* from the Paraguayan Humid Chaco were 87.71 mm (± 1.69) and mean mass 44.75 g (± 1.52) (Smith, Betuel & Batjes 2008).

Tropical Kingbird *Tyrannus melancholicus* (Tyrannidae)

An individual of this species was found dead at Puerto Barbero, Presidente Hayes department, $-24.914173^{\circ}\text{S}$ $-57.304178^{\circ}\text{W}$, by OR on 05 January 2009 suspended by one wing and one leg from the spider silk.

Mean wing chord of four specimens of *Tyrannus melancholicus* from the Paraguayan Humid Chaco was 112.00 mm (± 1.30) and mean mass 46.00 g (± 2.00) (Peris 1990).

Many-coloured Chaco Finch *Saltatricula multicolor* (Thraupidae)

A freshly deceased adult was found by OR suspended by the left wing (Fig. 2) on 01 February 2018 at approximately 15 km SE of Teniente Manuel Irala Fernández, on the Ruta Trans Chaco at Estancia Millón, Boquerón department, $-22.904094^{\circ}\text{S}$ $-59.480793^{\circ}\text{W}$.

Mean wing chord of 22 specimens of *Saltatricula multicolor* from the Paraguayan Dry Chaco was 68.18 mm (± 1.78) and mean mass 22 g (± 1.53) (Smith, Betuel & Batjes 2008).



Fig. 2: A freshly deceased Many-coloured Chaco Finch *Saltatricula multicolor* found at approximately 15 km SE of Teniente Manuel Irala Fernández, on the Ruta Trans Chaco. © O. Rodríguez.

Red-crested Finch *Coryphospingus cucullatus fargoii* (Thraupidae)

On 14 February 2018 an adult male caught by the left wing in a support line of a *P. bistriata* web was found by AJL, Hugo Cabral and Mateo Lesterhuis close to Loma Plata, Boquerón department, approximately -22.38°S -59.79°W . The bird (Fig. 3) was hanging just under an electric cable at a height of approximately 15–20 m. The individual, at first believed to be dead, was suspended by its left wing and tried unsuccessfully to escape on several occasions. Just above the tip of the left wing a thick noose could be observed, indicating the bird had been struggling for some time. It was considered that the bird would be unlikely to survive.

Mean wing chord of 19 male specimens of *Coryphospingus cucullatus fargoii* from the Paraguayan Dry Chaco was 62.61 mm (± 1.66) and mean mass 13.75 g (± 0.80) (Smith, Betuel & Batjes 2008).



Fig. 3: A living adult male Red-crested Finch *Coryphospingus cucullatus fargoii* caught in a support line of a *P. bistriata* web close to Loma Plata, Boquerón department. © A. J. Lesterhuis.



Fig. 4: A deceased adult Southern House Wren *Troglodytes aedon* found in a spider web at Fortín Toledo, Boquerón department. © P. Smith.

Southern House Wren *Troglodytes aedon musculus* (Troglodytidae)

On 30 January 2018 a deceased adult Southern House Wren *Troglodytes aedon musculus* (Fig. 4) was found by PS entangled in a spider web at Fortín Toledo, -22.333333°S -60.350000°W, Boquerón department, Paraguayan Chaco. The web was partly entwined within a *Stetsonia* cactus and at least partially continuous with the support lines of a social web of the spider *P. bistriata*. The bird was somewhat decomposed, suggesting it had been trapped for some time, and was bound tightly with spider silk around the feet, tail and more loosely around one wing. There were no signs of spider predation.

Mean wing chord of 13 specimens of *Troglodytes aedon musculus* from Paraguay was 50.23 mm (range = 47–56; P. Smith unpublished data) and the mean mass of the species from across its range varies from 10.4–11.6 g (Dunning 2008). There have been previous reports of House Wren entrapment in spider webs (Gosling 1984; Hallbeck 2007; Brooks 2012).

Discussion

Brooks (2012) stated that the mean mass of birds that died in spider webs was 9 g and mean wing chord was 53 mm, whilst those that were able to free themselves had a mean mass of 11 g and mean wing chord of 66 mm. Though

these differences were not statistically significant, the values for some of the deceased birds published here are much greater than the mean masses and wing chord values proposed as potential limits. In the cases of *Tyrannus melancholicus* and *Columbina picui* (the two largest species in our sample), it is over four times the proposed mass and, in the case of *T. melancholicus*, almost double the wing chord length, the greatest yet documented for any Neotropical species. Walther (2016) provided data for several Asian species that surpassed even these numbers. It would seem reasonable to assume therefore that the factors affecting a bird's ability to free itself would be more complex than simple morphometrics, and might additionally include factors such as the species of spider (and type and tensile strength of its silk), the area of the body that is ensnared, and the condition of the bird. A bird ensnared by an extremity may be expected to tire quickly, something that would rapidly be lethal in the Chaco where day time summer temperatures regularly surpass 40°C (Fariña Sanchez 1973).

Given the complex, strengthened structure of the colonial webs of *P. bistriata*, we hypothesize that even heavier birds than those recorded here might struggle to free themselves if bound by the thickened support lines. We performed a simple test of the tensile strength of these lines by hanging a weighted bag from a collected piece of support line. It was found that a single strand could comfortably hold 300 g without breaking. Whilst a dead weight exerts less force than a moving weight, it should be noted that a bound bird is often entangled by more than a single strand, and, depending on how heavily and by what part of the body it is bound, it may have to exert an even greater force than that measured here in order to free itself. This suggests that potentially far bigger birds than those recorded here could feasibly become entangled in the webs of *P. bistriata*.

The construction of orbs is a time-consuming and energetically costly undertaking (Gobbi, Zucchi & Sakagami 1979; Sandoval 1994; Blackledge & Wenzel 1999), and some spiders build structures (stabilimenta) into their webs to increase visibility. These have been proposed as a protective device against web destruction by birds, thereby saving time and energy for the spiders (Eisner & Nowicki 1983; Blackledge & Wenzel 1999). Despite the costs of rebuilding broken webs, the orbs of *P. bistriata* do not figure stabilimenta (Sandoval 1994).

With the individual orbs being consumed each morning, the only part of the structure remaining by day is the much thicker scaffold of support lines. These are present in high density, and their location in prime hunting areas for insects might be considered to put them at risk of frequent collision by birds. Support lines are the product of several individual spiders spinning their silk together to make thicker threads (Masterman 1869) and, given their permanence, it may be assumed that the overall cost to each individual spider in the colony is lower for a broken support line than it is for a broken orb web. This fact, coupled with the extreme tensile strength of these lines, suggests that natural breakage by birds, as opposed to entrapment or rebounding, is likely to be a relatively rare event, and that such events may be toler-

ated. Indeed the presence of the decomposing Picui Ground Dove and House Wren still hanging from the web indicates that the spiders take no measures to remove entrapped birds, and that the function of the support line is unaffected by the extra weight.

P. bistrata is an exceptionally abundant spider in the Paraguayan Chaco (Fowler & Diehl 1978), and with increasing deforestation levels (Yanosky 2013) creating ever more of the forest edge habitats that the species favours, it would seem that its populations are likely to increase. However, this reduction in forest cover, coupled with increased edge effect and possibly greater numbers of spiders, also threatens to bring birds and spiders into increased contact, potentially making these colonial webs an significant source of mortality for bird species in the region.

Bearing in mind that four of the five cases of entrapment occurred during the months of January and February (when adult spiders are at their largest and fieldworkers are rarely in the field because of the extreme heat), it is perhaps worthy of further study whether the risk of avian entrapment increases temporally, proportional to the growth of the spiders and hence the possible increased strength of their webs.

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