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"Gourmet" predation of *Liolaemus* lizards in the Puna Region of northwestern Argentina

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Birds are frequent predators on lizards (Figueroa-Rojas and Corales Stappung, 2004; Bianchini, 2014; Santoyo-Brito et al., 2014; Valladares Faúndez et al., 2015; Troncoso-Palacios et al., 2020) and some leave explicit, unconsumed leftovers in tree branches and bushes (e.g., the head; Young et al., 2004). Here we document the profligate consumption by a bird species of the internal organs and tails of *Liolaemus* lizards by analyzing desiccated remains of individuals found in the branches of shrubs.

There are very few records of bird predation on any species of the South American lizard family Liolaemidae, and most of those came from pellet content analysis. For example, Pérez and Ávila (2005), Troncoso-Palacios et al. (2020), and Ramírez-Álvarez and Cox (2023) described the consumption of two *Liolaemus* species and a *Phymaturus* species by shrike-tyrants of the genus *Agriornis*. The behaviour was similar in all cases, with the bird holding the lizard in its beak and hitting it against the rocky ground until the lizard remained immobile. In one case the bird flew away with a *Liolaemus* in its beak, and in the other two cases the bird, likely disturbed by the presence of observers, flew away leaving the prey behind. Marín (2021) described the same behaviour for *Agriornis* of hitting lizard prey against the ground or against branches. A similar behaviour was described for a miner, genus *Geositta*, whose prey was a *Liolaemus* hatchling (Santoyo-Brito et al., 2014). Although the specific behaviour was not recorded, a lizard was observed in the beak of another passerine, a meadowlark of the genus *Sturnella* (Bianchini, 2014). Further reports of lizard predation by passerine birds come from pellet studies of raptors in the genera *Falco* and *Geranoaetus* (Simonetti et al., 1982; Mella Avila, 2002; Figueroa-Rojas and Corales Stappung, 2004; Valladares Faúndez et al., 2015). In all cases, the authors mention the consumption of lizards without indicating if it was total or partial. Shrikes belonging to the genus *Lanius* have been documented to consume specific parts of lizards from the genera *Phrynosoma* and *Zootoca* selectively (Young et al., 2004; Antczak et al., 2019). However, such selective consumption has not been observed before for *Liolaemus* lizards.

During an ecology study of the *Liolaemus* assemblage near the San Antonio de los Cobres Village in the Puna Region of Salta Province, northwestern Argentina (24.0144°S, 66.2378°W, elevation 3478 m) the first author noticed unusual items along her transects (Fig. 1A). No fewer than 18 desiccated and partly consumed lizards of three species of *Liolaemus* were found on branches at the top of bushes in an area no larger than 4 km². The lizards were adults of *L. irregularis* Laurent, 1986, *L. multicolor* Koslowsky, 1989, and L. yanalcu Martínez Oliver & Lobo, 2002, and all were found "hanging" on branches amongst the shrubs (mainly of the genera *Parastrephia*, *Baccharis*, and *Nicotiana*), at an average height of 65 cm above the ground in the tallest of the plants found in the area (Fig. 1B). The lizards all exhibited a perforation in the chest or in the side of the neck region, approximately constant in diameter, and the tails and internal organs had been taken (Fig. 1C). Tails were severed at the level of the first caudal vertebra, taking the entire tail including its proximal part where more muscles and rich fat deposits are found (Paz, 2017). According to typical morphological characteristics of the species and sexes, such as the precloacal pores and size of the scales in the cloacal region (Valdecantos and Lobo, 2007), eight of the eleven dead *L. irregularis* were females, five of the six *L. multicolor* were males, and the only specimen of *L. yanalcu* was a male (Fig. 2 A).

Since these lizard species are terrestrial, the respective predator must have captured them on the ground and moved them to a bush where they were partially and surgically

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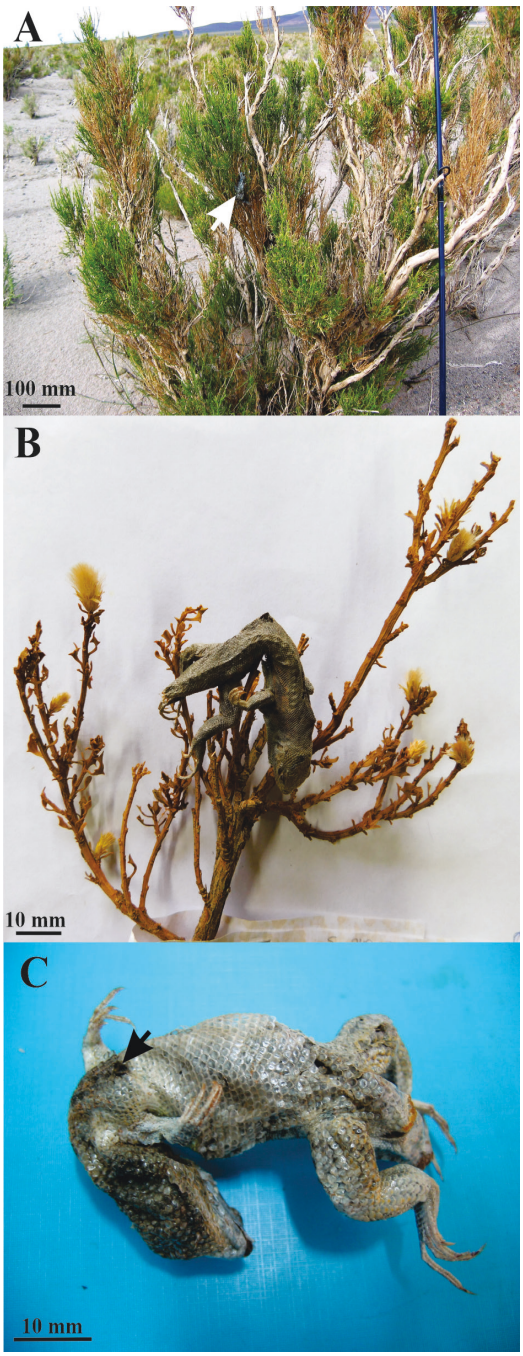

Figure 1. Desiccated individuals of *Liolaemus* found on shrub branches in the Puna Region, Salta Province, northwestern Argentina. (A) Longflower Tobacco, *Nicotiana* aff. *longibracteata*, with an *L. multicolor* male indicated by a white arrow. (B) Detail of how an *L. multicolor* female was positioned in a bush. (C) A male *L. multicolor* showing a hole in the chest indicated by a black arrow. Photos by S. Valdecantos and F. Lobo.

consumed. Although the actual predation events were never observed, bird community observations at the site and interviews with local residents showed that the bird species in the area that include lizards in their diets, though not specifically Liolaemidae, include *Agriornis montanus* or *A. micropterus* (Black-billed and Grey-bellied Shrike-tyrant), *Falco sparverius* (American Kestrel), *Geositta punensis* (Puna Miner), *Geranoaetus polyosoma* (Variable Hawk), and *Athene cunicularia* (Burrowing Owl). These last two species were observed perching on the tall bushes. However, due to earlier documented behaviour used to kill the prey, the most likely bird group for the type of feeding we here report is *Agriornis*. In addition to their general behaviour, the partial consumption of only medium-sized lizards and not the largest ones at the study site, support this contention. Furthermore, the beak morphology of *Agriornis* is appropriate for tearing out the viscera from a small orifice. *Agriornis* are 40% larger than *G. punensis*, and therefore they are more likely to be responsible for transporting lizards into the bushes and skilfully manipulating them for partial consumption. Miners does not perch in bushes, and hawks, kestrels, and owls would likely swallow the small prey whole.

In the literature, there are two reports for partial consumption of lizards by birds. One is an anecdotal observation of a California Scrub-Jay, *Aphelocoma californica*, that hammered a lizard against a wooden block and then penetrated its abdomen with its beak to ingest a considerable portion of the viscera in the abdominal and thoracic cavities (Yancey, 2018). The other outlined the behaviour of shrikes in the genus *Lanius* as they catch their prey. These birds are known to impale their prey on sharp objects such as branches, thorns, or barbed wire and pull the soft tissue out, leaving the skulls hanging from trees and shrubs. This is the case of *Lanius ludovicianus* in North America, which preys on a species of *Phrynosoma*, and *L. excubitor* and *L. meridionalis* in Poland and Israel, which prey on *Zootoca* and *Acanthodactylus* species (Young et al., 2004; Hawlena et al., 2010; Antczak et al., 2019).

Regarding the lizard species consumed, *L. irregularis* is the most abundant followed by *L. multicolor* (Valdecantos, 2011). Although nothing specific is known about the abundance of *L. yanalcu* based on specimen collection in the area for other studies, its abundance seems to be similar to that of *L. multicolor*. With respect to the morphology, while adult *L. multicolor* males are very colourful (Valdecantos and Lobo, 2007) this species was not the most abundant prey (Fig. 2A).

Thus, colour might not make lizards more attractive to predators such as *Agriornis*. In addition, the more frequent prey items were *L. irregularis* females (Fig. 2A), which are light brown and have a substrate-like colour as well as a similar adult size to *L. multicolor* (Fig. 2B; Valdecantos and Lobo, 2007). Evidently, colour is not the main characteristic for a bird to spot a lizard, but perhaps body shape and movement are more relevant. Size could also be a limiting factor to prevent shrike-tyrants from holding the largest specimens, given that males of *L. irregularis* were the least encountered prey (Fig. 2A, B).

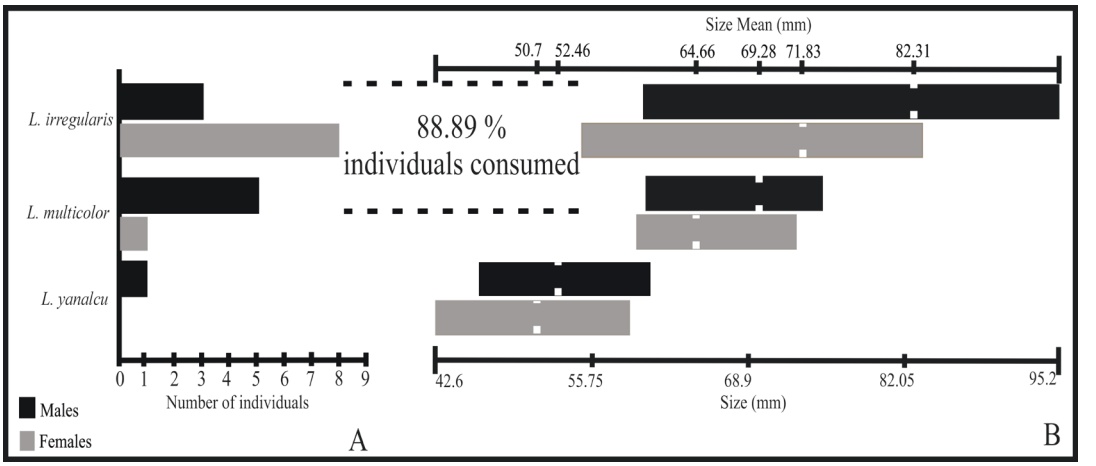

Figure 2. Number, sex, and sizes of the consumed *Liolaemus* species. (A) Number and sex of lizards found on shrubs of each species. (B) Adult sizes of each sex and lizard species. The bars include the minimum size (left limit) and maximum size (right limit) of each sex and species on the lower axis. On the upper axis, the average size of each sex and species is indicated by white, dotted lines on each bar. Between horizontal black lines, the percentage of individuals most consumed by number (A) and size (B) is indicated.

For a raptor like *Falco* or *Geranoaetus*, the size and weight of an *L. irregularis* male would not be limiting, since these predators can consume even larger rodents. It is not clear why only one female *L. multicolor* was found, but perhaps some particular, unknown behaviour of this species makes it less conspicuous to predators. Regarding *L. yanalcu*, its microhabitat use hidden by foliage and loose dry branches at the base of the shrubs may render them difficult to seen from a bird's perspective, which could potentially account for the low number found (Valdecantos, 2011).

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