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Opportunistic predation upon dragonflies by *Pseudis limellum* and *Pseudis paradoxa* (Anura: Hylidae) in the Gran Chaco region, Argentina

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To understand natural history of species, community food web interaction, and energy flows through ecosystems, analyses of feeding habits and strategies for resources exploitation are of high relevance. The cogeneric species *Pseudis paradoxa* (Linnaeus, 1758) and *Pseudis limellum* (Cope, 1862) have strong aquatic habits and often co-occur in permanent and vegetated waterbodies of open flooded savannah areas in South America (Duré and Kehr, 2001; Lavilla et al., 2004; Angulo and Baldo, 2008; authors pers. obs.). Both species occur largely sympatric in the Argentinean provinces of Formosa, Chaco, Corrientes, Entre Ríos and Santa Fe (24° S to 33° S; and 56° W to 62° W; Cei, 1980; Gallardo, 1987). These anurans have been characterized as active foragers with a generalist diet, which use floating vegetation as substrate for foraging (Duré and Kehr, 2001; Peltzer and Lajmanovich, 2002; Seib and Lajmanovich, 2003-2004; López, 2009). Trophic segregation was described when *P. paradoxa* and *P. limellum* occur in syntopy (Duré and Kehr, 2001). Here, we analyze the diet of syntopic *P. limellum* and *P. paradoxa* populations, which inhabit in a marshland covered with macrophytes (Fig. 1) located in the southern Gran Chaco region (Department of San Javier, Province of Santa Fe, Argentine; 29.901694 S; 59.856778 W). Additionally, we discuss their foraging strategy.

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Figure 1. The study area covered with macrophytes, located near the town of Alejandra, Province of Santa Fe, Argentina.

On January the 7th, 2010 we manually captured 19 postmetamorphic *P. paradoxa* individuals (mean snout-vent length= 46.12 ± 2.46 mm) and 14 *P. limellum* individuals (mean snout-vent length = 18.06 ± 1.54 mm). All individuals were euthanized *in situ* and subsequently deposited in the herpetological reference collection of the National Institute of Limnology (INALI: CONICET-UNL). After dissection, the entire content of the gastrointestinal tract of each individual was analyzed under a microscope. To describe the diet, we calculated the hierarchic index of relative prey importance (IRI%), that combines prey numerosity (N), volume (V) and frequency of occurrence (FO) to obtain a general expression of the importance of each prey item (George and Hadley, 1979): IRI% = 100*AL/ ΣAL, where AL = FO%*(N% + V%). Diet similarity between species was calculated as % overlap (Krebs, 1994): $Pjk = [\Sigma ni=1(\text{minimum } pij, pik]*100$; where *Pjk* is percentage overlap between species *j* and species *k*; *pij* and *pik* are the proportions of prey *i* in the diet of each of the two species.

Eighty-nine percent of the *P. paradoxa* (hereafter Pp) individuals and 79% of the *P. limellum* (hereafter Pl)

individuals contained dietary remains. We identified 78 prey items (Pp = 41, Pl = 37) classified in 17 categories (Table 1). Odonata was the most important prey in both species. Diet similarity between species was high (Pjk=75.98%). However, post-hoc analysis revealed that odonates consumed by *P. paradoxa* were significantly larger than those consumed by *P. limellum* (Odonata length: unpaired t test, t13 = 5.12, p = 0.0002; Odonata width: unpaired t test, t13 = 10.284, p < 0.0001; Odonata volume: unpaired t test with Welch correction, Welch's approximate t7 = 7.471, p = 0.0001).

Table 1. Index of relative prey importance values (IRI%) for *Pseudis limellum* and *Pseudis paradoxa*.

	P. limellum	*P. paradoxa*
INSECTA		
Odonata	74.68	77.90
Collembola	0.76	-
Heteroptera	-	0.59
Notonectidae	3.64	-
Mesovellidae	3.57	-
Corixidae	2.51	-
Lepidoptera (larvae)	9.36	-
Coleoptera	0.51	-
Coleoptera (larvae)	-	0.14
Hydrophilidae	-	3.68
Curculionidae	-	0.28
Hymenoptera	0.43	0.45
Diptera	2.82	0.14
Orthoptera	0.90	-
Acrididae	-	15.77
Gryllidae	-	0.32
ARACHNIDA		
Araneae	0.82	0.73

In a study that compared trophic resource exploitation of the same two Pseudis species analyzed here, Duré and Kehr (2001) found Diptera to be the principal prey item in the diet of *P. limellum*. Similar results were found by Seib and Lajmanovich (2003-2004) and López (2009). Other prey items reported in literature are spiders, hemipterans, lepidopterans and homopterans (Peltzer and Lajmanovich, 2002; Seib and Lajmanovich, 2003-2004; López, 2009). In contrast, odonates are represented in far lesser quantities than the above mentioned dietary items in these studies. Regarding *P. paradoxa*, Duré and Kehr (2001) reported Coleoptera and Diptera to be the more frequent dietary items. However, amphibians, hymenopterans and lepidopterans comprised a high proportion of the diet volume, despite their lower frequency and abundance within the diet (Duré and Kehr, 2001). As a result, Duré and Kehr (2001) observed significant differences in diet composition between *P. limellum* and *P. paradoxa*, reflected by differences in the proportion and size of consumed items. Consequently, these authors proposed that dietary differences would favor the coexistence of both species.

The high dietary overlap found in our study could potentially be attributed to a high temporary abundance of odonates during the sampling date (authors pers. obs.). Odonates are vulnerable to predation by anurans during oviposition, when reproducing individuals are in direct contact with the water surface, and during emergence, when larvae shed their skin (exuvia) as part of their metamorphosis to the adult stage (Rehfeldt, 1992; Worthen, 2010). The possibility of *P. limellum* and *P. paradoxa* to co-occur with an elevated diet overlap could therefore be facilitated by the temporary abundance of this food resource (i.e. summer dragonfly oviposition and emergence), variation in mean prey item size (larger frogs consumed larger dragonflies, probably a larger proportion of Anisoptera *versus* Zygoptera), and the high productivity of these wetlands (Seib and Lajmanovich, 2003-2004). For this reason, we proposed that, as *P. paradoxa* and *P. limellum* are generalist predators, they tend to opportunistically exploit temporary abundant prey - such as dragonflies during oviposition or emergence - which causes a temporary rise in 'taxonomic' diet overlap but likely results in minor food competition.

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