Herpetology Notes, volume 9: 105-108 (2016) (published online on 28 April 2016)

A case of *Podarcis carbonelli* intake by *Podarcis virescens*

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Podarcis virescens (*P. hispanica* type 2) and *P. carbonelli* are two of the evolutionary lineages that constitute the *Podarcis hispanica* species complex (Kaliontzopoulou et al. 2011) and both are endemic to the Iberian Peninsula. *P. virescens* (*P. hispanica* type 2) is distributed in Central and Southern Iberian Peninsula, except for the most southern, southeastern and eastern extremes of Spain (Sá-Sousa et al. 2002, Kaliontzopoulou et al. 2011, Geniez et al. 2014). *P. carbonelli* has a very fragmented distribution, occupying the Northern-Central region of Portugal between Douro and Mondego rivers, the west Central System from Serra da Estrela to Sierra de Francia, the west Portuguese coast south to Douro river and an isolated population at Doñana National Park at southwestern coast of Spain (Sá-Sousa 2000, 2004, 2008, Kaliontzopoulou et al. 2011, Sillero and Carretero 2013).

As most small lacertids (see Arnold 1987, Diaz and Carrascal 1993) these two lizards mostly prey on small arthropods as *Coleoptera*, *Homoptera* and *Aranea* (Pérez-Mellado 1998a, 1998b). Among several biotic and abiotic factors determining feeding behaviour in lacertids (Arnold 1987, Carretero 2004), intraspecific predation, i.e. cannibalism, is frequently attributed to high densities and reduced resource availability characteristic of insular populations (e.g. Pérez-Mellado and Corti 1993). Usually, the cannibal predator is considerably larger than the prey (Polis 1981), which are most frequently juveniles. Intraspecific predation is a phenomenon widespread across several vertebrate groups as fishes (Smith and Reay 1991), amphibians, and reptiles (Polis and Myers 1985). Also predation events between closely related species, including congenerics, have been reported in fishes (e.g. *Onchorhynchus* spp. Taniguchi et al. 2002), amphibians (e.g. *Ambystoma* spp. Stenhouse et al. 1983, Cortwright 1988), and reptiles (e.g. *Anolis* spp. Stamps 1983; Gerber and Echternacht 2000). Furthermore, this type of predation frequently occurs between species with similar ecological requirements exploiting the same resources – a phenomenon termed intraguild predation – where individuals prey over direct competitors (Polis et al. 1989).

Several cases of intraspecific predation have been reported for insular populations of some species of the lizard genus *Podarcis*. For instance, adults of *P. atrata* from Columbretes Islands are known to predate on both conspecific eggs and juveniles, where males have been shown to have a higher propensity towards cannibalism than females (Castilla 1995, Castilla and Van Damme 1996). Similarly, some conspecific juveniles were found in the diet of both males and females of *P. filfolensis* from Linosa (Bombi et al. 2005) and Lampione (Carretero et al. 2010) islands in the Pelagian Archipelago, as well as of *P. gaigeae* from Skyros (Adamopoulou et al. 1999). Although less frequent, cannibalism has also been reported for continental populations of *Podarcis*, e.g. for *P. muralis* from Kabischki in east Bulgaria (Engelmann 1964 *in* Polis and Myers 1985) and from Vransko in central Slovenia, where this species is found in populations with high local densities (Žagar and Carretero 2012). Adult males of *P. sicula* have also been reported to pray over juveniles of their own species, e.g. in central (Rugiero 1994, Grano et al. 2011) and southern Italy (Capula and Aloise 2011) and in an introduced population in New York (Burke and Mercurio 2002). Interestingly, despite the fact that

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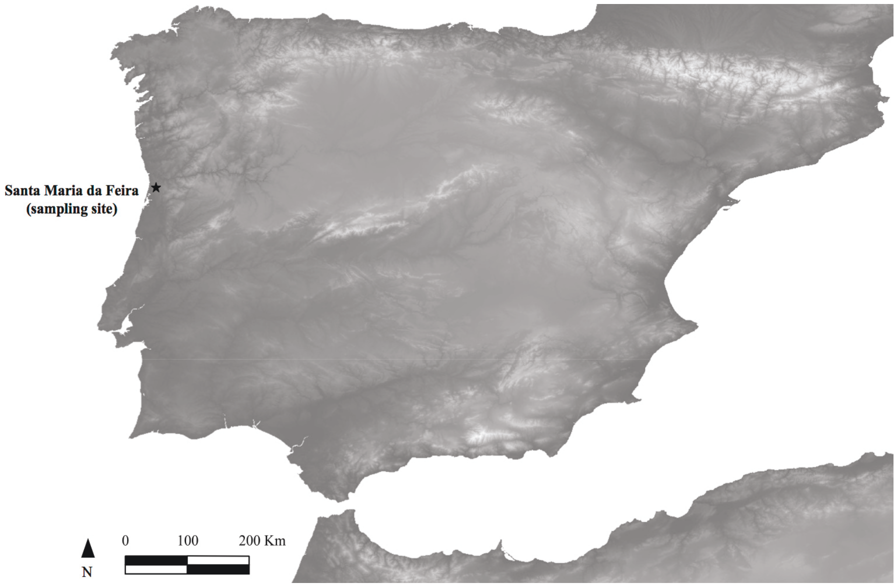

Figure 1. Iberian Peninsula map with the geographic location of the syntopyc *Podarcis virescens* and *P. carbonelli* populations from Santa Maria da Feira (Portugal).

various areas of distribution overlap and even strict syntopy among different *Podarcis* species exist (Gasc et al. 1997, Arnold and Ovenden 2002), only one case of interspecific predation attempt has been reported, to our knowledge. Remarkably, this single observation comes from an introduced population of an insular species, *P. pityusensis*, in Barcelona, where an adult was seen attacking, but not eating, an autochthonous *P. liolepis* male (Carretero and Llorente 2001).

While sampling in Santa Maria da Feira (40.92° N, 8.54° E, Datum WGS1984; Fig. 1), Aveiro, Portugal, we captured a *P. virescens* male that regurgitated a *Podarcis* tail, while being manipulated immediately after the capture. The sampling was carried out on July 9, 2013, in the medieval castle of Santa Maria da Feira where both species occur in strict syntopy. The captured lizard was 58 mm in snout vent length (SVL). The regurgitated tail was small, fresh, non-regenerated and with small segments indicating that it belonged to a newborn lizard. To confirm the morphological identification of the predator, and identify the species of the prey, we used genetic tools because the specific identification is impossible based on tail morphology only. Genomic DNA was extracted from alcohol-preserved tail muscle following the EasySpin® Genomic DNA Tissue Kit manufacturer's instructions. For both individuals we sequenced a 16S rRNA gene fragment (504 bp) with the primers 16sL1 and 16sH1 as described in Hedges and Bezy (1993) and a ND4-tRNA^{LEU} gene fragment (809 bp) with the primers ND4 and Leu as described in Arévalo et al. (1994). PCR products were sequenced with the same primers used for amplification of ND4-tRNA^{LEU} and with 16sL1 for 16S rRNA following the ABI PRISM BigDye Terminator Cycle Sequencing 3.1 (Applied Biosystems) standard protocol. These sequences were edited by hand with BioEdit version 7.2.5 (Hall 1999) then compared to sequences available in GenBank® using the BLAST® tool. Genetic analysis corroborates the morphological identification of the captured lizard as a *P. virescens* and also validates the regurgitated tail as belonging to a *P. carbonelli* individual. The 16s gene fragments match 99% with other 16s fragments from both *P. virescens* (accession numbers DQ081081 – DQ081084) and *P. carbonelli* (accession numbers DQ081081 – DQ081084). Similar results were obtained with the ND4 gene fragments that match 99% with other *P. carbonelli* fragments of the same gene (accession numbers EF081135 – EF081156 and DQ081154 – DQ081155) and 99% with *P. virescens* (accession numbers DQ081159, EU269563 and EU269567). Note that *P. virescens* and *P. carbonelli* sequences are different by 4.37% and 8.04% on average for the 16S and ND4 fragments analyzed here, meaning that the genetic identification is straightforward. Sequences are deposited in GenBank® under the accession numbers KP455498 and KP455500 for *P. virescens* and KP455499 and KP455501 for *P. carbonelli* respectively.

Because we could only recover the tail of the *P. carbonelli* juvenile, we cannot be sure if the captured lizard consumed the whole animal or just the autotomized tail. In any case, some characteristics of the observed event are worth noting. The case reported here consists of a single observation, and we cannot reach general conclusions on its frequency, but the marked difference in size between the predator *P. virescens* (mean SVL = 53.23; Kaliontzopoulou 2010) and prey *P. carbonelli* (mean SVL = 50.20; Kaliontzopoulou 2010) reported here fits previous observations, as several cases of cannibalism are known in *Podarcis* species, where large adults, mainly males, attack and/or prey over juveniles (Rugiero 1994, Castilla 1995, Castilla and Van Damme 1996, Burke and Mercurio 2002, Capula and Aloise 2011, Grano et al. 2011, Žagar and Carretero 2012). The time of the year at which the sampling was carried out coincides with the birth of new hatchlings, which seems to be the case of the *P. carbonelli*, and the differences in size between large adults and newborns are very marked. The consumed prey would certainly represent an important energy intake for the predator (Polis et al. 1989). In addition, elevated lizard density also seems to be a common factor associated to observations of cannibalism and predatory attacks towards co-specifics (Pérez-Mellado and Corti 1993), a case not restricted to insular populations (e.g. Žagar and Carretero 2012). In the case reported here, both species are strictly syntopic and relatively abundant at a local scale, increasing interspecific encounters and yielding antagonistic interactions more prone to occur. In cases of co-occurrence of closely related species, intraguild predation could act as a community structure regulator, where juveniles are particularly vulnerable (Polis et al. 1989, Polis and Holt 1992). Therefore it is not surprising that a large adult male would predate over a juvenile from a competitor species. Both necrofagia and the opportunistic consumption of the autotomized tail are events very unlikely to occur. Nevertheless as we cannot assess the attempt of predation, we cannot completely discard both hypotheses.

The lack of known interspecific predation events among *Podarcis* species may be associated to a low frequency of occurrence of such events in natural populations. Additionally, their incidence is expected to be higher in some temporal and spatial frames, as during the hatching period and in high density populations. Since this kind of biological interactions represent a high energy intake to the predator and could interfere in the community structure, they represent an intriguing field for future investigation to better understand its ecological importance among lizards.

Acknowledgments. GD was supported by a PhD grant (SFRH/BD/89750/2012), CL by a research grant (PTDC/BIA-BEC/102179/2008), and CP and AK by post-doctoral grants (SFRH/BPD//87204/2012 and SFRH/BPD/68493/2010 respectively), all under the Programa Operacional Potencial Humano – Quadro de Referência Estratégico Nacional funds from the European Social Fund and Portuguese Ministério da Educação e Ciência. Support was also provided by FCT project PTDC/BIA-BEC/102179/2008, under FEDER COMPETE funds (FCOMP-01-0124-FEDER-007062) and by the project "Biodiversity, Ecology and Global Change" cofinanced by North Portugal Regional Operational Programme 2007/2013 (ON.2 – O Novo Norte), under the National Strategic Reference Framework (NSRF), through the European Regional Development Fund (ERDF).

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Accepted by Spartak Litvinchuk