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Multidisciplinary approaches for conserving Southern isolates of Atlantic lizards in the Iberian Peninsula.

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Being excellent models in evolutionary ecology, lizard populations isolated by ecological reasons are also relevant for conservation because of their vulnerability to extinction. Both aspects are linked because the ecological and evolutionary traits need to be known for developing conservation strategies. Here we report two cases, the lacertids *Podarcis carbonelli* and *Lacerta schreiberi*, in which a combined methodology is being applied. Both species, endemic to the Iberian Peninsula and with Atlantic affinities, display a continuous distribution in the northwest which becomes fragmented southwards. Southern isolates are frequently small, surrounded by unsuitable Mediterranean environments and more than 100 kilometres apart from their main ranges. Two isolates, *P. carbonelli* in Doñana and *L. schreiberi* in Montes de Toledo, are currently being monitored.

Case 1: *Podarcis carbonelli* in Doñana.

The Carbonell's Lizard was described by Pérez-Mellado (1981) as a subspecies of the Bocage Lizard (*Podarcis bocagei*) for the Sierra de Gata and Serra da Estrela mountain ranges in Central Iberia on the basis of morphological traits. Later, it was reported for Doñana by Magraner (1986) but this citation remained

ignored during more than one decade due to the extremely distinct nature of the environment from the *type locality*. However, after extensive studies on distribution (Sá-Sousa, 2001a; Carretero *et al.*, 2002) and morphology (Sá-Sousa *et al.*, 2000; Sá-Sousa, 2001b, Kaliontzopoulou *et al.*, 2005), it has been raised to the species level (Sá-Sousa & Harris, 2002). Currently, the known range of the species covers not only the Western Central System but also other Northern mountains connecting this to the coast and then a narrow coastal stripe reaching the Western coast of Algarve. Such range becomes extremely fragmented south of Tejo River and more closely attached to the coast (Fig.1). These discoveries made more likely the presence of an isolated population in Doñana that, in fact, this was confirmed by both morphological (Sá-Sousa *et al.*, 2001) and genetic evidence (Harris *et al.*, 2002).

A phylogeographic study of the overall pattern of distribution of the species has been conducted very recently (Pinho *et al.*, 2007). Nevertheless, this peculiar scattered pattern awaits a proper biogeographic scenario which will be relevant for conservation strategies. In fact, *P. carbonelli* has recently been classified as *Vulnerable* in the Red Book of Vertebrates of Portugal (Cabral, 2005) mainly due to its fragmented range. A preliminary study on the environmental factors constraining the distribution of the species has been carried out in Doñana (Román, 2006) but it is based on limiting sampling and does not take into account all the ecological potentialities demonstrated in other areas. Moreover, genetic sampling in the area is limited and an adequate morphometrical analysis of the Andalusian populations is still lacking.

Case 2: *Lacerta schreiberi* in Montes de Toledo.

The Schreiber's Lizard is a large lacertid which is mainly distributed in the NW Iberian Peninsula (Marco, 2002). Whereas in the Northwest the area of occupation is continuous and populations are abundant, the Southern populations become rare and isolated, restricted to some Atlantic spots (from W to E Mochique, São Mamede, Guadalupe, Montes de Toledo and Sierra Morena) surrounded by Mediterranean, unsuitable environments (Marco, 2002; Brito *et al.*, 1996). Because these Southern populations harbour a considerable part of the genetic diversity of the species (Godinho, 2004; Paulo *et al.*, 2001, 2002) and are extremely vulnerable at mid-term (Brito *et al.*, 1999), determining their conservation status is priority. The isolate population of Montes de Toledo in Castilla-La Mancha, far apart from the closest isolate in this sense is paradigmatic.

In 2007, two parallel conservation projects were launched to clarify the status of the populations of both species in the two isolates areas following a three step procedure, namely:

- For *P. carbonelli*: 1a) to assess their taxonomical placement of this population among the Iberian *Podarcis* by estimating their phylogenetic affinities and

phylogeographic structure using genetic markers, as well as by characterising their morphological variation in comparison with other members of the *Podarcis hispanica* complex.

- For *L. schreiberi*: 1b) to assess the degree genetic diversity and differentiation of the populations as well as the number of Evolutionary Significant Units (ESUs) within the phylogeographic structure of the species.

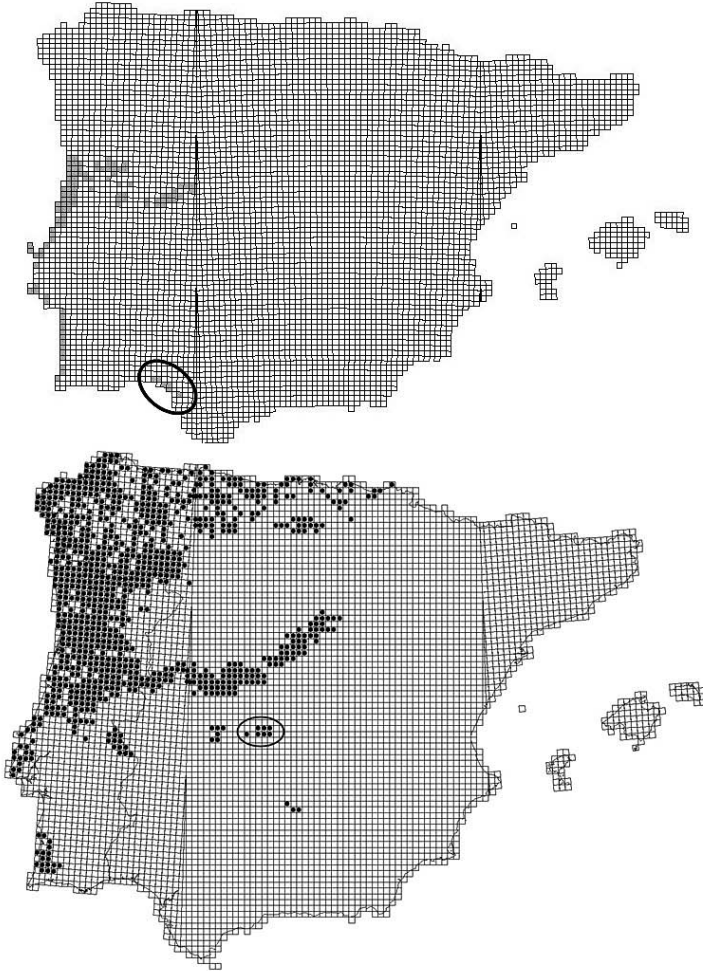


Figure 1. Current distributions of *Podarcis carbonelli* (above) and *Lacerta schreiberi* (below) represented on a 10 × 10 km UTM grid (after Marco 2002, Sá-Sousa 2003, Sillero 2006, and Herpetological Atlas of Portugal, unpubl.). The Circles indicate the Doñana and the Montes de Toledo isolates, respectively.

- For both: 2) to analyse the ecological and historical factors determining their distribution pattern at different scales (local and microhabitat) and 3) to determine the areas of occupancy and occurrence and estimates of relative abundance providing elements for attributing a conservation category.

Work plan

Both studies are multidisciplinary, combining censuses, GIS modelling, genetic markers and morphometrics. Transects and mark-recaptures are used to obtain demographic estimates. The areas of occupation and the ecological variables determining the presence of both species are analysed using models in MaxEnt (Elith *et al.*, 2006). Such models will be projected to the past for deducing the origin of the isolates and to the future for determining the extinction risk under the climate change scenarios. Mitochondrial and nuclear markers (Godinho, 2004) are analysed to estimate the phylogeographic structure and the genetic diversity whereas linear and geometric morphometrics are used for determining the degree of phenotypic divergence. All these results will provide the basis for determining the evolutionary relevance of the isolates, for pointing their main menaces and for attributing them an objective conservation category, as well as for designing future management measures.

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REFERENCES

- Brito J.C., Brito e Abreu F., Paulo O.S., Da Rosa H.D. & Crespo E.G., 1996. Distribution of Schreiber's green lizard (*Lacerta schreiberi*) in Portugal: a predictive model. *Herpetological Journal*, 6: 43- 47.
- Brito J.C., Luís C., Godinho M.R., Paulo O.S. & Crespo E.G., 1998. Bases para a Conservação do Lagarto-de-agua (*Lacerta schreiberi*). *Estudos de Biologia e Conservação da Natureza*. no 23. Instituto da Conservação da Natureza, Ministério do Ambiente, Lisboa.
- Brito J.C., Godinho R., Luis C., Paulo O.S. & Crespo E.G., 1999. Management strategies for conservation of the lizard *Lacerta schreiberi* in Portugal. *Biological Conservation*, 89: 311-319.
- Cabral M.J. (ed.), 2005. *Livro Vermelho dos Vertebrados de Portugal*. Instituto de Coservação da Natureza. Lisboa.
- Carretero M.A., Sá-Sousa P., Barbosa D., Harris D.J. & Pinho C., 2002. Sintopía estricta entre *Podarcis bocagei* y *P. carbonelli*. *Boletín de la Asociación Herpetológica Española*, 13(1-2): 20-24.
- Elith J., Graham C.H., Anderson R.P., Dudík M., Ferrier S., Guisan A., Hijmans R.J., Huettmann F., Leathwick J.R., Lehmann A., Li J., Lohmann L.G., Loiselle B.A., Manion G., Moritz C., Nakamura M., Nakazawa Y., Overton J.M., Peterson A.T., Phillips S.J., Richardson K.S., Scachetti-Pereira R., Schapire R.E., Soberón J., Williams S., Wisz M.S. & Zimmermann N.E., 2006. Novel methods improve prediction of species' distributions from occurrence data. *Ecography*, 29: 129-151.

- Godinho R., 2004. Historia Evolutiva do Lagarto-de-agua, *Lacerta schreiberi*. Thesis Doctoral. Univerdad de Lisboa.
- Harris D.J., Batista V., Carretero M.A., Pinho C. & Sá-Sousa P., 2002. Mitochondrial DNA sequence data confirms the presence of *Podarcis carbonelli*, Pérez-Mellado, 1981 in Southern Spain. *Herpetozoa*, 15(3/4): 188-190.
- Kaliontzopoulou A., Carretero M.A. & Llorente G.A., 2005. Differences in the pholidotic patterns of *Podarcis bocagei* and *P. carbonelli* and implications for species determination. *Revista Española de Herpetología*, 19: 71-86.
- Magraner J., 1986. Nouvelle donée sur la répartition de *Podarcis bocagei carbonelli* (V. Pérez-Mellado, 1981), (Sauria, Lacertidae), dans la Péninsule ibérique et observations sur son écologie à Doñana (Andalousie, Espagne). *Bulletin Societé Herpétologique de France*, 38: 6-12.
- Marco A., 2002. *Lacerta schreiberi* Bedriaga, 1878. Lagarto verdinegro (pp. 233-235). In: Pleguezuelos J.M., Marquez R. & Lizana M. (eds), *Atlas y Libro Rojo de los Anfibios y Reptiles de Espana*. Segunda impresion. Direccion General de Conservacion de la Naturaleza-Asociacion Herpetologica Espanola, Madrid.
- Paulo O.S., Dias C., Bruford M.W., Jordan W.C. & Nichols R.A., 2001. The persistence of Pliocene populations through the Pleistocene climatic cycles: evidence from the phylogeography of an Iberian lizard. *Proceeding of the Royal Society London B*, 268: 1625-1630.
- Paulo O.S., Jordan W.C., Bruford M.W. & Nichols R.A., 2002. Using nested clade analysis to assess the history of colonization and the persistence of populations of an Iberian lizard. *Molecular Ecology*, 11: 809-819.
- Pérez-Mellado V., 1981. Nuevos datos sobre la sistemática y distribución de *Podarcis bocagei* (Seoane, 1884) (Sauria, Lacertidae) en la Península Iberica. *Amphibia-Reptilia*, 2: 259-265.
- Pinho C., Harris D.J. & Ferrand N., 2007. Contrasting patterns of population subdivision and historical demography in three western Mediterranean lizard species inferred from mitochondrial DNA variation. *Molecular Ecology*, 16: 1191-1205.
- Pinho C., Ferrand N. & Harris D.J., 2006. Reexamination of the Iberian and North African *Podarcis* (Squamata: Lacertidae) phylogeny based on increased mitochondrial DNA sequencing. *Molecular Phylogenetics and Evolution*, 38: 266-273.
- Román J., Ruiz G., Delibes M. & Revilla E., 2006. Factores ambientales condicionantes de la presencia de la lagartija de Carbonell *Podarcis carbonelli* (Pérez-Mellado, 1981) en la comarca de Doñana. *Animal Biodiversity and Conservation*, 29: 73-82.
- Sá-Sousa P., 2001a. A controversa sistemática das lagartixas do género *Podarcis* Wagler, 1830 (sauria, Lacertidae) em Portugal. PhD Thesis. University of Lisbon. Lisbon.
- Sá-Sousa P., 2001b. Comparative chorology between *Podarcis bocagei* and *P. carbonelli* (Sauria: Lacertidae) in Portugal. *Revista Española de Herpetología*, 15: 85-97.
- Sá-Sousa P., Almeida A.P., Rosa H.D., Vicente L. & Crespo E.G., 2000. Genetic and morphological relationships of the Berlenga wall lizard (*Podarcis bocagei berlenguensis*: Lacertidae). *Journal of Zoological Systematics And Evolutionary Research*, 38: 95-102.
- Sá-Sousa P., Vicente L. & Crespo E.G., 2002. Morphological variability of *Podarcis hispanica* (Sauria: Lacertidae) in Portugal. *Amphibia-Reptilia*, 23: 55-69.
- Sá-Sousa P. & Harris D.J., 2002. *Podarcis carbonelli* Pérez-Mellado, 1981 is a distinct species. *Amphibia-Reptilia*, 23: 459-468.
- Sá-Sousa P., González de la Vega J.P. & Barnestein J.A.M., 2001. Presencia de la lagartija *Podarcis carbonelli* en Andalucía. *Boletín de la Asociación Herpetológica Española*, 12: 77-79.
- Sillero N., 2006. Application of Remote Sensing and Geographical Information Systems in the Biogeography of Iberian Amphibians and Reptiles. PhD Thesis. University of León. León.