

Contribution to the knowledge on the reptile fauna of Jebel Sirwa (Morocco), with some insights into the conservation status of *Vipera latastei-monticola*

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RESUMEN: El Jebel Sirwa es un macizo montañoso de origen volcánico localizado entre las cordilleras del Alto Atlas y Anti-Atlas en Marruecos, y representa el límite sur del piso bioclimático oromediterráneo en la cuenca del Mediterráneo. En esta nota se detallan las observaciones de 10 especies de reptiles mediterráneos para la zona norte del macizo, haciendo hincapié en su variación altitudinal. Se cita por primera vez en el macizo la serpiente *Hemorrhois hippocrepis* y se hace una serie de consideraciones sobre el estado de conservación de *Vipera latastei-monticola* en el mismo.

The Mediterranean Basin, one of the World's richest region in the number of endemic fauna and flora rates (Myers *et al.*, 2000), reaches its south-western limit in Morocco, where aridity increases giving pass to the Saharan region (Olson *et al.*, 2001). Limits between these two regions have extraordinarily shifted in latitude along time (e.g., during Pleistocene climatic oscillations), promoting the expansion and isolation of Mediterranean elements in southern mountain ranges (Huseman *et al.*, 2014). Furthermore, the current variation in climatic conditions, both along latitude and altitude, resulted in the existence and succession of different bioclimatic stages within the Mediterranean Region (Blondel, 2010). Accordingly, some high mountain ranges in Morocco favour the southern extend for montane bioclimatic stages, and this is the case for the volca-

nic Jebel Sirwa. This mountain range is located between the High Atlas and Anti-Atlas Mountains (Figure 1), with maximum altitude of 3305 masl, and represents the southernmost limit for the Oromediterranean bioclimatic stage (Benabid, 1982; Quézel & Médail, 2003).

Reptiles are among the most diverse groups of vertebrates in Morocco (Cox *et al.*, 2006). As ectotherms, their activities depend on environmental conditions, and thus, their distributional ranges are frequently linked to climatic gradients (e.g., Martínez-Freiría *et al.*, 2013). When species ranges and ecological requirements are considered, three general groups can be differentiated for the Mediterranean reptiles within Morocco (Bons & Geniez, 1996; Husemann *et al.*, 2014): (1) humid species, frequently of European origin, which are mostly restricted to northern regions and moderate-high

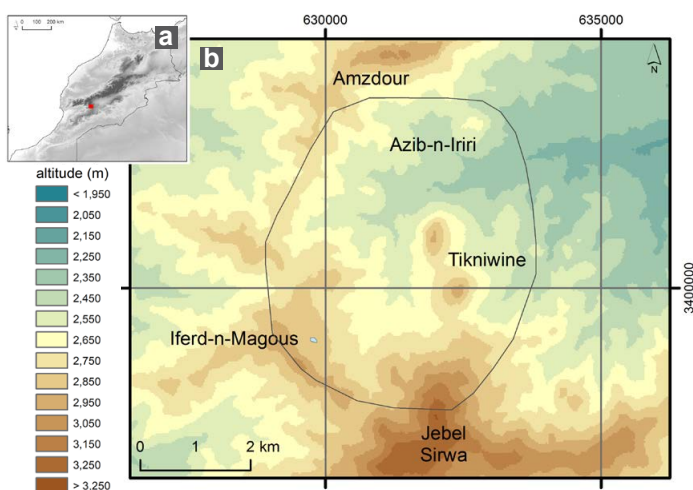
altitudinal ranges with Mediterranean sub-humid and humid climates (e.g., *Podarcis vaucheri*, *Coronella girondica*, *Natrix astreptophora*, *Vipera latastei*); (2) mesic species, ranging everywhere in the Mediterranean Region, although generally absent from humid and montane climate areas (e.g., *Mauremys leprosa*, *Psammotromus algirus*, *Hemorrhois hippocrepis*, *Malpolon monspessulanus*, *Natrix maura*); and (3) endemic species, restricted to particular areas (e.g., *Chalcides minutus*, *Chalcides manueli*), or to specific mountain ranges with montane climate (e.g., *Chalcides montanus*, *Quedenfeldtia trachyblepharus*, *Atlantolacerta andreanskyi*, *Vipera monticola*). According

to particular environmental requirements, we expect that representatives of these three groups might segregate along a climatic gradient, such as the altitudinal range of Jebel Sirwa.

In this note, we report distributional and altitudinal records for 10 reptile species collected on the northern slopes of Jebel Sirwa (Figure 1; UTM 29R 3398 – 3403 N, 0629 - 0634 W; WGS 1984) during four fieldwork campaigns in August 2011, April and June 2014, and April 2016. The main objective of this fieldwork was sampling the Atlas Dwarf Viper *V. monticola*, to coherently delimitate evolutionary and conservation units within the *V. latastei*-*monti-*

Figure 1: a) Location of the Jebel Sirwa Mountain in Morocco. b) Zoom into the Jebel Sirwa region, depicting the altitudinal variation and the approximate delimitation of the sampled area. c) View of the landscape taken northwards from the way to Jebel Sirwa summit.

Figura 1: a) Localización del Jebel Sirwa en Marruecos. b) Aproximación a la región del Jebel Sirwa, mostrando la variación altitudinal y la delimitación aproximada de la zona muestreada. c) Vista del paisaje tomada desde el acceso norte de la cima del Jebel Sirwa.



cola complex (see Velo-Antón *et al.*, 2012). Average number of people involved in fieldwork was four (ranging from two to eight), and total number of days spent in the field was nine. Altitudinal range covered during fieldwork goes from 2300 (Azib-n-Iriri) to 3050 masl (north access to Jebel Sirwa; Figure 1). This area represents the transition from Supramediterranean to Oromediterranean bioclimatic stages, and it is composed of scrublands with *Cytisus balansae*, *Astragalus ibrahimianus*, *Hormathophylla spinosa* and *Bupleurum spinosum* (Benabid, 1982; Slimani *et al.*, 1996), grasslands and abundant rocky outcrops (Figure 1). Records were expressed in UTM 1x1 km squares (WGS 1984 datum).

In total, we provide 29 records for 10 species (Table 1). Summing up our records and those previously published (Bons & Geniez, 1996; Slimani *et al.*, 1996; Harris *et al.*, 2010), the number of reptile species recorded for the northern slopes of Jebel Sirwa increases to 13 (*Scelarcis perspicillata*, *Mesalina olivieri* and *Malpolon monspessulanus* were not detected in our sampling). Among the 10 species recorded, three were humid, three were

mesic and four were montane endemic (Table 1). When altitudinal data are compared among groups of species, a trend for altitudinal segregation can be noticed, with montane endemics reaching higher altitude than humid and mesic species (Table 2). This trend is more evident for lizards (e.g., the pair *P. vaucheri* – *A. andreanskyi*; Table 2), as the number of records is higher than for snakes. Nevertheless, our records provide a slightly increase (ca. 50 m) in the altitudinal range reported in Morocco for the two mesic snakes *H. hippocrepis* and *N. maura* (see Bons & Geniez, 1996).

In accordance to the literature (e.g., Bons & Geniez, 1996), some species were linked to particular micro-habitat features. For example, the diurnal gecko *Q. trachyblepharus* and the lizard *Timon tangitanus* were linked to big rocks, the snake *C. girondica* (Figure 2c) to flat rocks, or the lizard *A. andreanskyi* and the viper *V. monticola* (Figure 2d) to thorny bushes.

The only species never reported on the northern slope of Jebel Sirwa was the mesic *H. hippocrepis* (Figure 2b), previously recor-

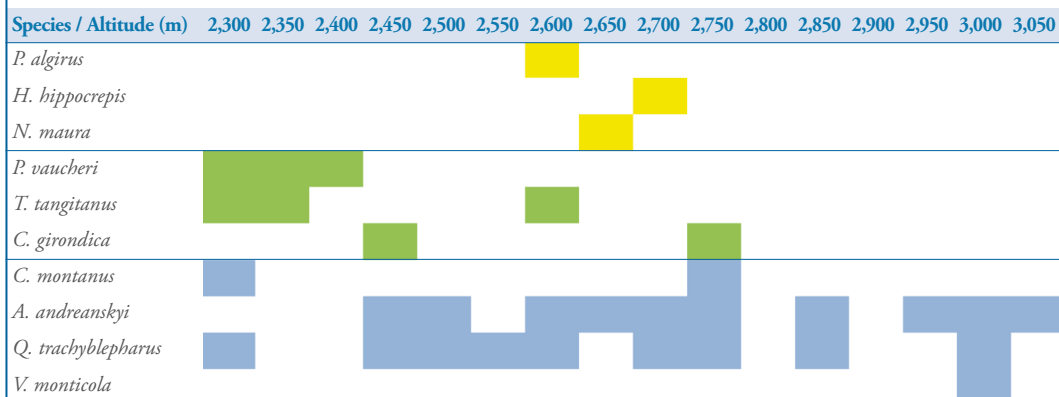
Table 1: Reptile species in Jebel Sirwa, Morocco. Biogeographic affinity (END, mountain endemic; HUM, humid; MES, mesic), year, number of specimens and UTM 1x1 km cells, are depicted.

Tabla 1: Especies de reptiles en el Jebel Sirwa, Marruecos. Se muestra la afinidad biogeográfica (END, endémico montano; HUM, húmedo; MES, méxico), año, número de ejemplares y celda UTM 1x1 km.

Species	Affinity	Year	Specimens	UTM 1x1
<i>Quedenfeldtia trachyblepharus</i>	END	2012 - 2016	>50	PP2998, PP2999, PP3298, PP3299, PQ3100, PQ3101, PQ3200.
<i>Atlantolacerta andreanskyi</i>	END	2012 - 2016	> 100	PP2998, PP2999, PP3099, PP3298, PP3299, PQ3100, PQ3101, PQ3200.
<i>Psammodromus algirus</i>	MES	2016	1	PQ3100.
<i>Podarcis vaucheri</i>	HUM	2012 - 2016	> 100	PQ3101, PQ3201, PQ3202.
<i>Timon tangitanus</i>	HUM	2014 - 2016	3	PP3099, PQ3101, PQ3202.
<i>Chalcides montanus</i>	END	2014, 2016	3	PP2999, PQ3202.
<i>Natrix maura</i>	MES	2012	1	PQ3200.
<i>Hemorrhois hippocrepis</i>	MES	2012	1	PQ3200.
<i>Coronella girondica</i>	HUM	2014 - 2016	3	PP3298, PQ3101.
<i>Vipera monticola</i>	END	2016	1	PP3298.

Table 2: Graphical representation of altitudinal records (in ranges of 50 m) for the ten species detected in the Jebel Sirwa region, Morocco. Species are ranked by biogeographical affinity, see Table 1.

Tabla 2: Representación gráfica de los registros altitudinales (en rangos de 50 m) para las diez especies detectadas en el Jebel Sirwa, Marruecos. Las especies están ordenadas según su afinidad biogeográfica, ver Tabla 1.



ded from the westwards lowland vicinity at the surroundings of Askaoun, Souss Valley (Bons & Geniez, 1996; Slimani *et al.*, 1996; Harris *et al.*, 2010). We also report the occurrence of *C. montanus* (Figure 2a), which was identified by its characteristic striped dorsal design (Bons & Giroto, 1962). The taxonomic status of these specimens deserves further investigations with molecular analyses, as previous surveys to this and near locations at lower altitudes reported the occurrence of other endemic skink, *C. manuelyi*, with a similar dorsal design to *C. montanus* (Barata *et al.*, 2011).

In order to detect *V. monticola*, highlands of the study area were intensively sampled. One specimen was found at the highest elevation within snake records (Table 1). This species has been previously recorded at Iferd-n-Magous (T. Slimani, in: Pillet, 1994), a small depression with a temporary pond located northwestwards to Jebel Sirwa peak (2760 masl; Figure 1). This area was sampled in two campaigns, and the pond and most of the surrounding vegetation were dry.

Assessing the conservation status of *V. latastei-monticola* populations in Morocco is not strai-

ghtforward. On the one hand, the species frequently presents low densities and reduced activity, which are translated into low detectability in the field (Fahd *et al.*, 2005, 2007). On the other hand, the species has particular life-history traits and ecological requirements, which make it highly vulnerable to habitat loss and transformation, and, thus, to local extinction (Santos *et al.*, 2006). In fact, local extinctions due to habitat loss have been reported for this viper in lowland regions of Iberia (e.g., Pleguezuelos *et al.*, 2016) and northern Morocco (e.g., Brito *et al.*, 2011). Considering this background, our sampling effort conducted in the area, plus the observed level of transformation of natural habitats at moderate altitude (because of intensive shepherding), we speculate that *V. monticola* might be experiencing range reductions to higher elevations in the Jebel Sirwa region. This response has been already prognosticated for this species, as well as for other Moroccan endemic reptiles, taking into account climate change scenarios for the near future (Brito *et al.*, 2011; Martínez-Freiría *et al.*, 2013). Reptile upward migration implies range reduction, which



Figure 1: Photos of selected species found in Jebel Sirwa, Morocco. a) *Chalcides montanus*. b) *Hemorrhois hippocrepis*. c) *Coronella girondica*. d) *Vipera monticola*. Photos: Luis García-Cardenete (a) and Fernando Martínez-Freiria (b-d).

Figura 1: Fotos de especies seleccionadas encontradas en el Jebel Sirwa, Marruecos. a) *Chalcides montanus*. b) *Hemorrhois hippocrepis*. c) *Coronella girondica*. d) *Vipera monticola*. Fotos: Luis García-Cardenete (a) y Fernando Martínez-Freiria (b-d).

would increase population isolation, and thus vulnerability to stochastic depression processes (Sinervo *et al.*, 2010).

Further fieldwork campaigns should be conducted in the region to understand patterns of habitat and altitudinal segregation within the reptile community, and also to monitor potential altitudinal shifts in species ranges induced by habitat degradation and climate change. In two of the sampling campaigns, grasslands were notably dry due to the absence of rains. Furthermore, in the four sampling campaigns, we noticed a high number of ovine cattle in the region, which exert an observable strong negative impact on the herbaceous and bushy vegetation; especially at some of the most accessible areas (i.e. flat and low slopes

mostly located less than 2700 masl). Although we have not evaluated their impact, overgrazing and climate change for sure have to exert a generalized impact on the ecosystem with up-down effects on the trophic chains that ultimately would affect top predators as snakes.

The Jebel Sirwa region represents the southernmost limit for some species with relatively wide distributional ranges in the Mediterranean region (e.g., *P. vaucheri*, *C. girondica* and *V. latastei-monticola*), as well as for some endemic species of Morocco (e.g., *Q. trachyblepharus*, *A. andreanskyi*). Thus, altitudinal shifts should be pronounced for these species in the near future (Martínez-Freiria *et al.*, 2013). Sampling is particularly needed in the high altitude mountains surrounding Jebel Sirwa,

as seem the most suitable habitat for *V. monticola*. Although genetic analyses have shown the invalidity of this taxon as species (Velo-Antón *et al.*, 2012), populations from Jebel Sirwa are phylogenetically related to populations from High Atlas (the authors, unpublished data), altogether constituting an independent

lineage within the North African *V. latastei-monticola* complex.

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Mediterranean snake (*Vipera latastei/monticola* group) and high genetic structuring in Southern Iberian populations. *Molecular Phylogenetics and Evolution*, 65: 965-973.

Easternmost record of *Salamandra algira splendens* in Morocco

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RESUMEN: Se describe el descubrimiento de la población más oriental conocida de *Salamandra algira splendens* en el Parc National d'Al-Hoceima. En esta región, *S. algira* ocupa un hábitat de matorral y bosque mediterráneo a baja altitud (220 msnm) y, al igual que en el caso de otras poblaciones, podría favorecer el uso de cuevas.

The North African Fire Salamander *Salamandra algira* Bedriaga, 1883 is the only species of the genus *Salamandra* present in North Africa (Schleich *et al.*, 1996). Its range encompasses from northern Morocco to north-eastern Algeria (Escoriza *et al.*, 2006). In this broad area of distribution four subspecies are currently recognized: *S. algira tingitana* in the Tingitana Peninsula (north-western Morocco), *S. algira splendens* in the Middle Atlas and Rif mountains (northern Morocco),

S. algira spelaea in the Beni Snassen mountains (north-eastern Morocco), and *S. algira algira*, restricted to north-eastern Algeria (Ben Hassine *et al.*, 2016). Recent publications provided accounts on the species' distribution, showing local adaptive divergence throughout its range (Escoriza & Comas, 2007; Beukema *et al.*, 2010). However this species is morphologically very conservative and its origin remains the most important criterion to determine the taxonomic status of the individuals (Ben Hassine *et al.*, 2016).

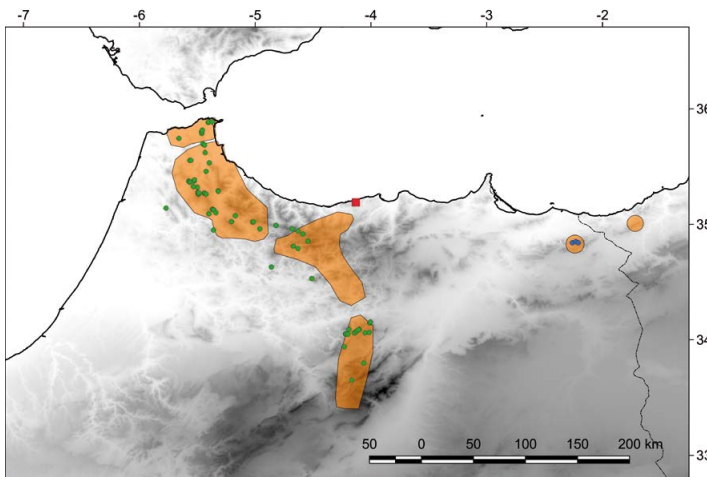


Figure 1: Distribution of *S. algira* in Morocco, according to Beukema *et al.* (2010, 2013) and Escoriza (2016) (*S. algira splendens* / *S. algira tingitana*, green circles; *S. algira spelaea*, blue circles) and IUCN (2014) (orange polygons). The new location is shown as a red square.

Figura 1: Distribución de *S. algira* en Marruecos, según Beukema *et al.* (2010, 2013) y Escoriza (2016) (*S. algira splendens* / *S. algira tingitana*, círculos verdes; *S. algira spelaea*, círculos azules) y IUCN (2014) (polígonos naranjas). La nueva localidad se muestra como un cuadrado rojo.