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Intermediate forms and syntopy among vipers (*Vipera aspis* and *V. latastei*) in Northern Iberian Peninsula

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THE general distribution pattern of the European vipers is mostly parapatric (Saint-Girons, 1980). However, several biogeographical studies conducted in contact zones between the distributions of different species confirm an allopatric distribution at a local scale (Saint-Girons, 1975; Saint-Girons, 1980; Saint-Girons & Duguy, 1976; Duguy & Saint-Girons, 1978; Monney, 1996; Bea, 1985; Naulleau, 1986; Brito & Crespo, 2002). Only a few cases of syntopy between European vipers have been reported, mostly between *Vipera aspis* and *V. berus*, such as in a narrow band of 1–2 km in the Atlantic-Loire region, west of France (Saint-Girons, 1975), and in a 70 ha area in the Pre-Alps, west of Switzerland (Monney, 1996).

In the Iberian Peninsula there are three viper species, one Euro-Siberian, *V. seoanei*, and two sibling Mediterranean species, *V. aspis* and *V. latastei* (Garrigues *et al*., 2005), which have several contact zones in their distribution areas. Biogeographical analysis of contact zones between no-sibling species, such as between *V. seoanei* and *V. latastei* in Peneda-Gerês National Park, northwest Portugal, or between *V. seoanei* and *V. aspis* in the Spanish Bask country, revealed differential habitat selection patterns, even opposite, suggesting an allopatric distribution at the local scale (Bea, 1985; Brito & Crespo, 2002). The two sibling species, *V. aspis* and *V. latastei*, exhibit a wide contact zone with populations in apparent sympatry south of the Pyrenees, northeast Spain (Pleguezuelos *et al*., 2002). However, *V. aspis* selects fresh and humid areas in north-faced slopes whereas *V. latastei* selects rocky and dry areas in south-faced slopes, thus no syntopy was detected (Duguy *et al*., 1979; Pleguezuelos & Santos 2002). In this area, some specimens are difficult to classify as belonging to *V. aspis* or *V. latastei* due to intermediate morphological traits between these vipers in the snout, shape and colour pattern (Duguy *et al*., 1979; Gosá, 1997).

Sympatry between the three Iberian vipers was reported for an area located in the high course of Ebro River (Fig. 1A), between south-eastern of Santander and north-western of Burgos provinces, northern Spain (Duguy *et al*., 1979; Barbadillo 1987; Pleguezuelos *et al*., 2002). In this area, sympatry was reported at a regional scale (10x10 km UTM squares), but nothing was known at the local scale. In this note it is reported syntopy and intermediate morphological traits between the two sibling Iberian vipers for northern Spain.

The study area covers 1.200 km^2 and it is located in the transition between Euro-Siberian and Mediterranean regions (latitude 42º37.7'N to 42º58.7'N and longitude 3º58.5'W to 3º37.3'W). It consists mostly in limy plateaus excavated by the Ebro River and its tributaries, Rudrón and Panero rivers, forming canyons and sloppy valleys (Fig. 1B). Altitude ranges from 590 to 1256

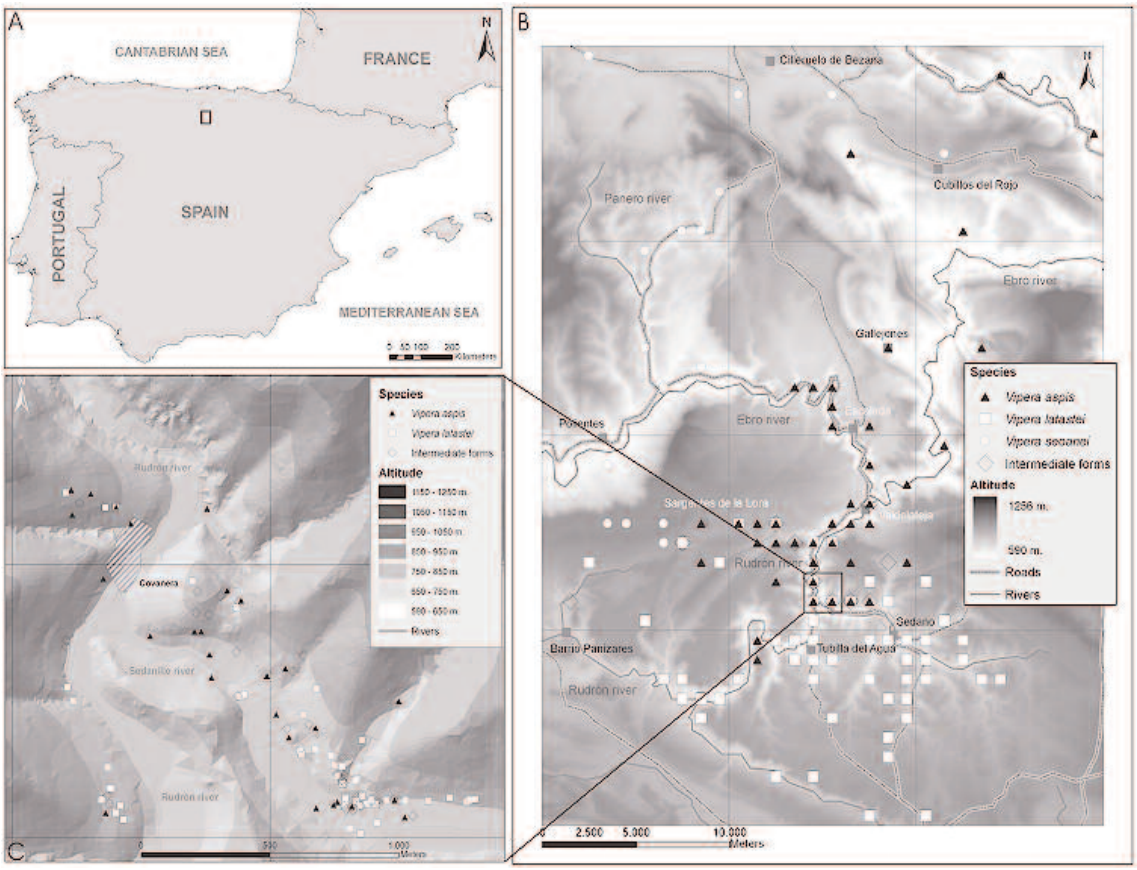

Figure 1. A) Geographic location of the study area in the Iberian Peninsula. B) Distribution of the three vipers and the intermediate forms between *Vipera aspis* and *V. latastei* based on UTM 1x1 squares. C) Distribution of *V. aspis*, *V. latastei* and intermediate forms in the sympatry area.

m.a.s.l. Climate is sub-humid Mediterranean with Central European tendency (Andrade, 1990). Although the most representative bioclimatic stage is the Supra-Mediterranean there are elements of the Mountain stage of the Euro-Siberian region, mostly in the northern and north-western areas (Rivas-Martínez 1987). Correspondingly, the climate is characterised by low levels of precipitation, average annual rainfall of 740 mm/year (range: 614-959 mm/year), low average annual minimum temperature (-0.8ºC, ranging from -2.0 to 0.0ºC) and high average annual maximum temperature (25.9ºC, ranging from 22.8 to 28.0ºC) (SIGA 2005).

Between March 2004 and October 2005, visual encounter surveys based in UTM 1x1 km squares and road sampling were performed throughout the study area. Specimens were captured by hand and their geographic location (UTM coordinates in the European-1950 datum) was recorded with a G.P.S. Specimens were sexed, measured, counted for pholidosis, photographed, and classified as *V. seoanei*, *V. aspis*, *V. latastei* or intermediate forms. Criteria for the classification of specimens included a combination of morphological traits: 1) snout elevation and number of apical scales: very small snout with two apical scales in *V. seoanei*, snout slightly upwards with two to three apical scales in *V. aspis* and snout upwards, forming an appendix with three to nine apical scales in *V. latastei* (Bea, 1998; Bea & Braña, 1998; Braña, 1998a; Brito *et al*., 2006); 2) shape of the dorsal stripe: alternated cross bands with a thin vertebral line (type 0) or narrow angular zigzag (type 1) in *V. aspis* (Bea, 1998), wide zigzag (type 2) or rounded-rhomboidal marks running together to

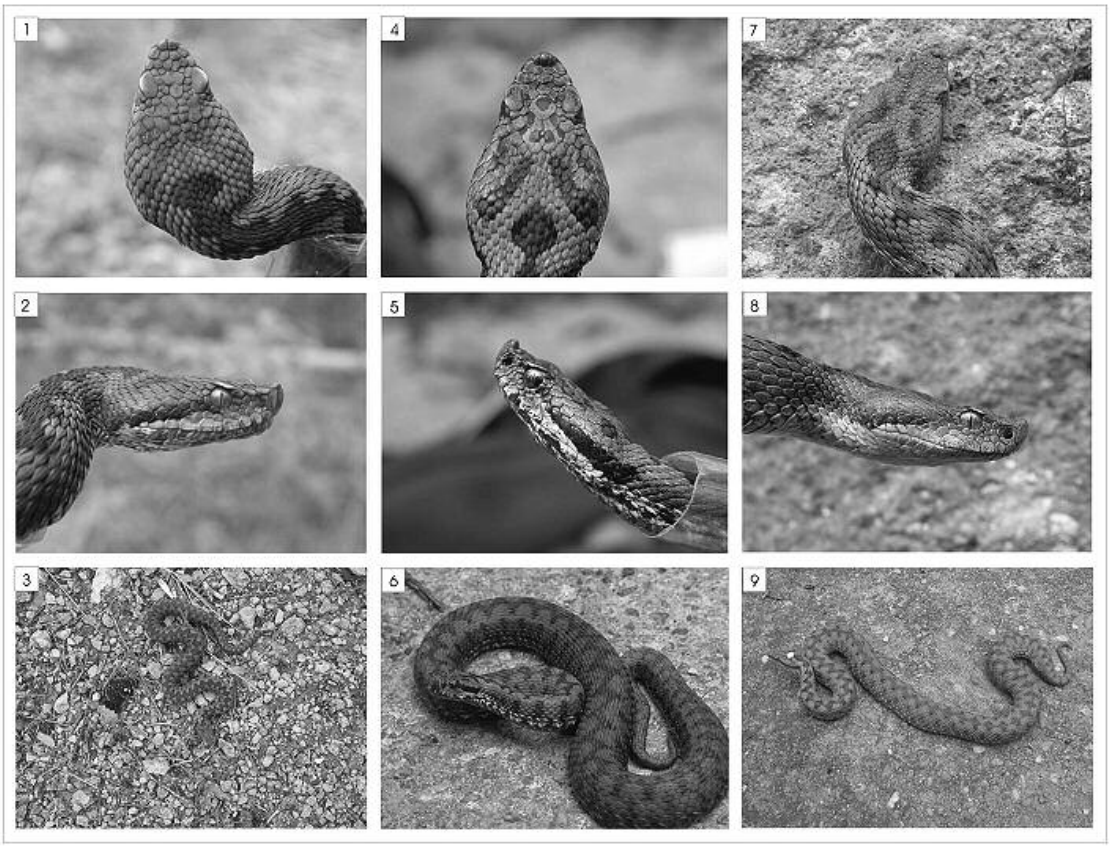

Figure 2. Three specimens collected in the sympatry area classified as intermediate forms between *V. aspis* and *V. latastei*: sub-adult male with two apical scales, dorsal pattern type 2 and 51 dorsal marks (1, 2 and 3); adult male with three apical scales, dorsal pattern mixture of types 1/2, and 48 dorsal marks (4, 5 and 6); adult female with five apical scales, dorsal pattern mixture of types 1/2, and 46 dorsal marks (7, 8 and 9).

form a wavy or zigzag stripe (type 3) in *V. latastei* (Bea & Braña, 1998), and short alternated or opposite bands with a wide vertebral line (type 4) in *V. seoanei* (Braña, 1998b); 3) number of dorsal marks: 60 to 80 in *V. seoanei*, 45 to 78 in *V. aspis* and 33 to 57 in *V. latastei* (authors, unpublished data). Specimens were classified as intermediate forms when exhibiting contradictory or intermediate morphological traits.

A total of 327 specimens were collected, 12 belonging to *V. seoanei*, 138 to *V. aspis* and 124 to *V. latastei*. *Vipera seoanei* was restricted to the north and north-western zone of Euro-Siberian influence, and occupied pastures and meadows (Fig. 1B). At a local scale, no syntopy was found between *V. seoanei* with the other two vipers. This allopatric distribution seems to be similar to the pattern identified for north-western Portugal (Brito & Crespo, 2002), where differential habitat selection precludes sympatry. *V. aspis* was distributed throughout the central and north-eastern zone while *V. latastei* occurred in the southern zone (Fig. 1B). Both species selected similar habitats, but *V. aspis* tended to select more humid habitats and with denser vegetation cover than *V. latastei*.

Vipera aspis and *V. latastei* were located in sympatry in the central zone of the study area, in the middle-lower course of the Rudrón river, lower course of its tributary Sedanillo River and in La Lora Plateau (Fig. 1B). These were characterized by the abundance of abandoned fields with disaggregated stone walls, herbaceous vegetation and thorny bushes. The sympatry area was a 15 km

east-west oriented band and a total of eight UTM 1x1 km squares were detected with the two sibling species present (Fig. 1B and 1C). Fifty three specimens with intermediate morphological characteristics between *V. aspis* and *V. latastei* were collected in 13 UTM 1x1 square mostly inside the sympatry area (Fig. 1C). These specimens presented two to five apical scales, the shape of the dorsal stripe including type 1, mixture of types 1/2 and types 2/3, and with 37 to 59 dorsal marks (Fig. 2). Intermediate forms were not observed in nearby populations of *V. aspis* to the north and *V. latastei* to the south (authors, personal observation). No intermediate specimens were detected between *V. seoanei* with *V. aspis* or with *V. latastei*.

During spring mating season in the sympatry area some specimens of *V. aspis* and *V. latastei* were found together in syntopy, forming part of mixed populations with typical specimens of each species and intermediate forms. The occurrence of intermediate forms and syntopy between specimens of both species during the reproductive period suggests that hybridization between *V. aspis* and *V. latastei* may occur. In order to enlighten this question and establish the correspondent evolutionary scenario according to the allopatric speciation theory (Brown & Lomolino, 1998; Garrigues *et al*., 2005), further studies about gene flow and comparative biology of these two sibling species are currently being developed.

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Spelerpes variegatus = *Bolitoglossa mexicana*. Reproduced from an original lithographic plate in *Biologia Centrali-Americana; Reptila and Batrachia* (Albert C. L. G. Gunther, 1902).