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A case of kyphosis in adult male Cyren's rock lizard *Iberolacerta cyreni*

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Vertebral malformations have been reported previously from a wide range of reptile taxa. Kyphosis refers to an abnormally excessive convex curvature of the spine in the thoracic and sacral regions, while if the deviation affects the lateral plane of the spinal column, the condition is known as scoliosis. In some cases, these two types of malformation can be combined in the same animal, known as kyphoscoliosis (Garín-Barrio et al., 2011). It appears that kyphosis mainly affects species adapted to aquatic environments (e.g. turtles and crocodiles; Tucker, 1997; Boede & Sogbe, 2000; Tucker et al., 2007), while scoliosis is more common in terrestrial species (snakes and lizards; Grogan, 1976; Simbotwe, 1983; Frutos et al., 2006). Reports of kyphosis (and kyphoscoliosis) from wild lizard populations have increased lately (e.g. *Liolaemus koslowskyi* (Iguandiae) Avila et al. (2013); *Sceloporus torquatus* (Phrynosomatidae) Pérez-Delgadillo et al. (2015); *Norops sericeus* (Dactyloidae) Domínguez-De la Riva and Carbajal-Márquez (2016); *Sceloporus vandenburgianus* (Phrynosomatidae) Valdez-Villavicencio et al., (2016); *Stenocercus guentheri* (Tropiduridae) Ramírez-Jaramillo, (2018); *Marisora brachypoda* (Scinidae) Arrivillaga & Brown, (2019)).

Cyren's rock lizard *Iberolacerta cyreni* (Müller & Hellmich, 1937) is a medium-sized lacertid (average male snout-vent length = 73-80 mm, Martín 2015), distributed along the mountain ranges of Sierra de Guadarrama, Sierra de Gredos and Sierra de Béjar in the Iberian Peninsula (Almeida et al., 2002; Arribas, 2010), where it is restricted to subalpine-alpine habitats (1760 - 2500 m asl) characterised by high cover of granite rocks (Monasterio et al., 2010).

On 4 June 2014, we noosed an adult male individual at the 'Alto del Telégrafo' peak (Sierra de Guadarrama, Madrid Prov., Central Spain, 40° 47' N, 04° 01' W) at an elevation of 1900 m asl. The lizard had vertical curvature of six vertebrae, two behind the head in the thoracic region, one over the pelvic girdle and three along the base of the tail (Fig. 1). Regarding the exact origin of the spine abnormality in this specimen, we could only speculate. According to Martínez-Silvestre et al. (1997) exposure to chemical agents, such as herbicides, may result in spinal malformations and in two reports of kyphosis agrochemicals have been invoked as the causative agents (Pérez-Delgadillo et al., 2015; Ramírez-Jaramillo, 2018). Here, it is unlikely that the malformation was induced by chemical contamination. Environmental effects such as abnormal incubation temperature, embryonic anoxia, excessive relative humidity, desiccation or dehydration of the egg, problems of yolk retraction/ premature fusion of the shell, insufficient nutrients in embryonic development or metabolic bone disease are more plausible (see Martínez-Silvestre et al. , 1997; Mader, 2006; Idrisova, 2018; DiGeronimo & Brandão , 2019). However, the habitat of the population of origin is affected by anthropogenic-induced habitat deterioration (i.e. construction of ski infrastructures), which could have a negative effect on body condition of lizards (Amo et al., 2007). Nevertheless, the potential effects of such human activities on embryonic development are yet to be explored in this population.

Figure 1. Kyphotic adult male *Iberolacerta cyreni* captured at the Alto del Telégrapho (Sierra de Guadarrama, Madrid Prov., Spain)

It is of interest to consider the impact of such a potentially damaging malformation as kyphosis on the lives of lizards. It has been suggested that the generally low prevalence of kyphosis in natural populations may be the outcome of increased mortality rate of affected individuals (Garín-Barrio et al., 2011). On the other hand, in a substantial number of reports the authors mention no negative effects of kyphosis on foraging and mobility (see Martínez-Silvestre et al., 1997; Garín-Barrio et al., 2011; Avila et al., 2013; Pérez-Delgadillo et al., 2015; Domínguez-De la Riva & Carbajal-Márquez, 2016;

Valdez-Villavicencio et al., 2016), suggesting that it might not reduce the chance of survival of affected individuals. Further, Mitchell and Johnston (2014) showed that the growth pattern of a Florida chicken turtle (*Deirochelys reticularia chrysea*) with kyphoscoliosis did not differ from that of individuals of the same population with no abnormalities. Our specimen clearly had adult coloration and did not show any sign of malnutrition. As its malformation apparently had no, or limited, effect on its locomotion during a few days of captivity, we released it at the original capture site.

In summary, this is the first reported occurrence of vertebral malformations in the genus *Iberolacerta*. Reports of kyphotic cases from the wild are increasing in a wide range of lizard genera, consequently, future research should investigate the potential links between anthropogenic activities (e.g. use of agrochemicals, habitat deterioration) and such vertebral malformations. Also, we still have limited knowledge on the long-term survival and reproductive outcome of individuals with kyphosis.

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