Figure 1. Lordotic juvenile *E.orbicularis* with two normal shaped juveniles.

Table 1. Measurements of the specimens captured in the pond where the lordotic turtle (in bold) was found. Sex was classified as M (male), F (female) or J (Juvenile with no external sexual characters). Weight was measured in grams and the carapace length (CL) in millimeters.

ID	Sex	Weight (g)	CL (mm)
Neo10_04	J	12	38.49
Neo10_08	J	13	40.28
Neo10_02	J	13	40.38
Neo10_09	J	17	43.6
Neo10_05	J	17	45.16
Neo10_03	J	18	45.98
Neo09_04	J	21	46.63
Neo10_07	J	21	49.08
Neo10_06	J	22	49.49
Neo10_10	J	26	51.79
2454	J	72	73.28
2463	J	67	74.58
2450	F	141	92.26
2462	F	136	94.22
2446	F	152	97.76
2460	M	169	104.14
2465	M	207	111.7
2461	M	222	112.08
2457	F	260	112.76
2449	M	224	113.57
2455	M	234	118.79
2447	F	416	131.46

First case of lordosis in a wild- caught European pond turtle (*Emys orbicularis*)

Even though osteological abnormalities are very rare in wild reptiles (Telemaco et al. 2013, Löwenborg & Hagman 2017), they are more frequent in captivity as a consequence of a deficient care, especially related to nutrition and UV deficiencies (Mendyk 2008). In chelonians, in some cases, it is also related to soft shell and pyramidism (Museti et al. 2014).

Kyphosis and lordosis are problems related to the vertebral column, namely kyphosis when the column is extruded and lordosis when the column is intruded. There are several cases of both anomalies described in lacertids (Garin-Barrio et al. 2011), skinks (Arrivillaga & Brown 2019) and sea turtles (Drenen 1990). Nevertheless, in freshwater turtles only kyphosis is relatively common (Saumure 2001, Trembath 2009, Moldowan et al. 2015), with few documented lordosis cases (Mitchell 2014; Selman 2019).

In wild *Emys orbicularis* several deformities have been described such as microophtalmia (Escoriza 2012), axanthism (Cavalcante & Bruni 2018), pholydosis abnormalities as accessory scutes (Cordero et al. 2008) or accessory and absent scutes (Lada & Voldireva 2018). Here, we report the first case of lordosis in a European freshwater turtle (*Emys orbicularis*), being the first reported case of a lordotic wild turtle in Europe.

The turtle was captured on the 22th July 2011 in "Río Areta", which is a Special Area of Conservation (ES2200013), in Navarre (Spain), in a little cattle pond (42º42'N; -1º16'E), where the majority of turtles were juveniles (Table 1), including the lordotic turtle, showing a differential habitat selection among juveniles and adults (Ayres & Cordero 2007). It was a three-year-old turtle (CL = 46,6 mm, weight = 21 g) with algae encrusted on the carapace, and a concave deformity in the middle of the carapace (Fig.1). However, there was apparently no lack of mobility.

The pond had a maximum depth of less than 1 meter, with abundant water plants, macroinvertebrates and frogs. Neither fishes nor crayfishes were present in the pond, although they are present in the Areta River, where adult turtles commonly live. In addition, it is possible to consider the population and their individuals completely wild since the location was very far from cities, villages or touristic or recreational areas. Hence, it is very improbable that the animal could be maintained in captivity and released later in the wild.

The turtle was carried to CRFS Ilundáin, where it was radiographed, and it was released again the following day in the pond where it was captured.

In radiographs taken in dorso-ventral (Fig. 2A) and latero-lateral (Fig. 2B) projection, the angle between the last cervical and first thoracic vertebrae as well as the top of lumbar vertebrae and the top of the sacrum vertebrae are clearly acute and not concavous. Neither fusion, demi-neralization

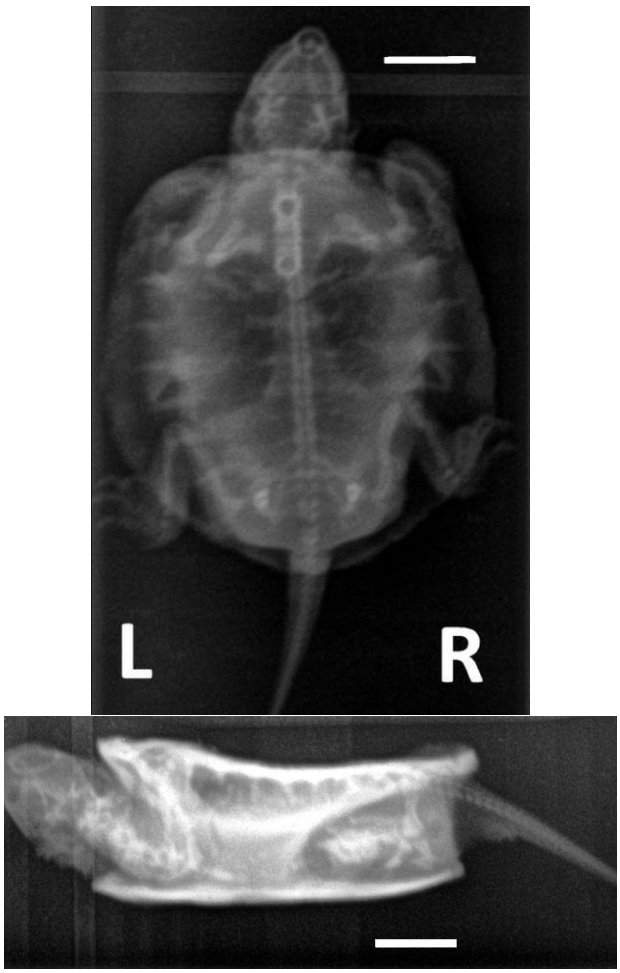

Figure 2. Radiographs taken in dorso-ventral (A) and latero-lateral (B) projection with 1cm white bar as scale, showing lordosis.

nor infectious signs (local deformities or osteolysis) are observed in any affected vertebrae (Rotschild et al. 2013). However, Figure 2B shows that abnormal curvature affected not only the vertebral column but also the plastral bones. Ventral bones had a light lordotic curvature but with a less acute angle than the one observed in vertebral spine. Despite a common belief that lordosis could be a risk factor for back pain, behavioural evidences in this turtle revealed that there was no back pain symptoms during locomotion. Regarding the dermal scales, neither duplication or fusion, nor vertebral or costal scutes were observed.

In reptiles, spinal malformations or spinal teratology can be due to incorrect conditions during the incubation of eggs, i.e. excessively low or high temperatures and low relative humidity; though notably, toxics and pollutants (e.g. insecticides) might also be responsible for malformations observed in wild reptiles (Bellairs 1981). Several hypotheses have been proposed to explain the origin of shell abnormalities in chelonians. Most of them are related to problems during embryonic or early juvenile development (Rothschild et al. 2013, Caracappa et al. 2016, Nagle et al. 2018, Zimm et al. 2018, Langer et al. 2020). There is evidence that polychlorinated biphenyls (PCBs), atrazine and glyphosate have a negative effect on bone development during incubation on freshwater turtles (Adams et al. 2016; Mendoçal et al. 2016). Additional studies have also shown that inbreeding of reptile populations with low genetic diversity can cause malformations (Madsen et al. 1992; Olsson et al. 1996). In captive turtles, spinal malformations can also be caused by metabolic bone diseases (Frye 1991, Museti et al. 2014).

In turtles, the thoracic and lumbar vertebrae cannot move in the join due to the fact that they merge forming aconvex column in the early stages of development (Pritchard 2008). In our case, the shell concavity and the absence of upright posture could have been developed since the first development stages of the turtle. Mineral deficiencies were discarded by radiographic analyses, and the turtle seemed to have grown normally as well as the other turtles found in the pond, so that nutritional problems should not be the cause of the lordosis. Environmental pollutants are also a highly unlikely cause, as indicated by the absence of other affected animals such as turtles or other aquatic organisms around the area. As there was no shield fusion, the cause of the abnormality could be congenital.

Acknowledgements. European pond turtles were captured under licence of the Navarre Regional Government Number 581/2011. The CRFS Ilundáin, depending on the Government of Navarre and managed by the public enterprise 'Gestión Ambiental de Navarra', assumed the costs of the radiographs.

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Key words: osteological abnormalities, *Emydidae*, Spain, herpetology, teratology.

Article No: e207503
Received: 23. June 2020 / Accepted: 19. August 2020
Available online: 23. August 2020 / Printed: December 2020

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