

sustentaba una placa informativa colocada por un club local de montañismo. Esta cita supone un nuevo límite altitudinal para *T. lepidus* en la Cordillera Cantábrica.

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Herpetofauna distribution and species richness in the Litoral Norte Natural Park, Portugal

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RESUMEN: El litoral noroccidental de Portugal presenta importantes características que influyen en las comunidades de herpetofauna. Al margen de pasados muestreos nacionales en el Parque Natural Litoral Norte (PNLN), hasta la fecha no se han realizado estudios detallados sobre la distribución de anfibios y reptiles. Se representaron registros procedentes de trabajo de campo y observaciones bibliográficas, y la riqueza específica, en cuadrículas 1 x 1 km usando una malla UTM. Se analizaron también las principales amenazas para las especies presentes en el PNLN. Se registraron doce especies de anfibios y cinco de reptiles, añadiendo 15 nuevas cuadrículas UTM 10 x 10 km y 35 nuevas cuadrículas 1 x 1 km al último atlas de la herpetofauna portuguesa. Se considera a la actividad turística y a la expansión urbana como las principales amenazas.

When investigating ecological traits of the herpetofauna in a large area or in a specific habitat, establishing the information on species geographic distribution is the first step to estimate abundances and changes in populations and to determine conservation priorities (Heyer *et al.*, 2003; Sillero *et al.*, 2005).

Para ver Anexos ir a <<http://www.herpetologica.es/publicaciones/>>

Iberian herpetofauna distribution is influenced differently by two bioclimatic regions: (1) the Atlantic region in the northern part of the Iberian Peninsula coming down in the northeast until the Mondego river and further south through the Portuguese coast; and (2) the

Mediterranean region in the rest of the peninsula except in high altitude areas in the Central System (Rivas-Martínez, 2005; Sillero *et al.*, 2009). Both regions present different herpetological communities whereas the northern and western part of the Iberian Peninsula shows the highest levels of endemism (Loureiro *et al.*, 2008; Sillero *et al.*, 2009). The northwestern coastal area of Portugal, influenced by the Atlantic climate, shows important ecological features and particular habitats that contribute to amphibian and reptiles high species richness (Almeida *et al.*, 2001; Loureiro *et al.*, 2008; Sillero *et al.*, 2009). Two major types of habitats can be distinguished in this area: wetlands represented by estuaries and ponds (temporary or not) and dry habitats represented by sand dunes (ICNB, 2007). Unfortunately, knowledge on herpetofauna ecology is still poorly informative in this region. Habitat loss and fragmentation due to urban expansion and pressure from construction companies are known to be the main factors affecting coastal habitat conservation in northern Portugal, contributing as well to amphibian and reptile species decline (Loureiro *et al.*, 2008). The Litoral Norte Natural Park (LNNP) is a recent protected area on the coastal seashore that tries to combine biodiversity conservation and human activities. Herpetological studies previously published for the LNNP area (Crespo & Oliveira, 1988; Godinho *et al.*, 1999; Gomes *et al.*, 2002; Malkmus, 2004; ICNB, 2007; Loureiro *et al.*, 2008) confirmed the presence of eight amphibian species: *Salamandra salamandra*, *Lisotriton boscai*, *Discoglossus galganoi*, *Pelobates cultripes*, *Bufo bufo*, *Bufo calamita*, *Hyla arborea* and *Pelophylax perezi*. As for reptiles (Godinho *et al.*, 1999; Malkmus, 2004; ICNB, 2007; Loureiro *et al.*, 2008), six species have been recorded: *Timon lepidus*, *Lacerta schreiberi*, *Podarcis hispanica*, *Podarcis bocagei*, *Natrix maura* and *Natrix natrix*. These publica-

tions combine herpetofauna presence in the LNNP area in 5 x 5 km and 10 x 10 km UTM squares maps: detailed surveys and maps on species distribution in the park are nonexistent. Due to the small area of the LNNP, current geographic information presented on the latest atlas (10 x 10 km UTM squares) is not an useful scale for the official park workers (Godinho *et al.*, 1999; Malkmus, 2004; Loureiro *et al.*, 2008). Minor scale maps for species presence and richness can be required for settling up accurate conservation measures locally. The main goals of this study were (1) to collect systematic information on the

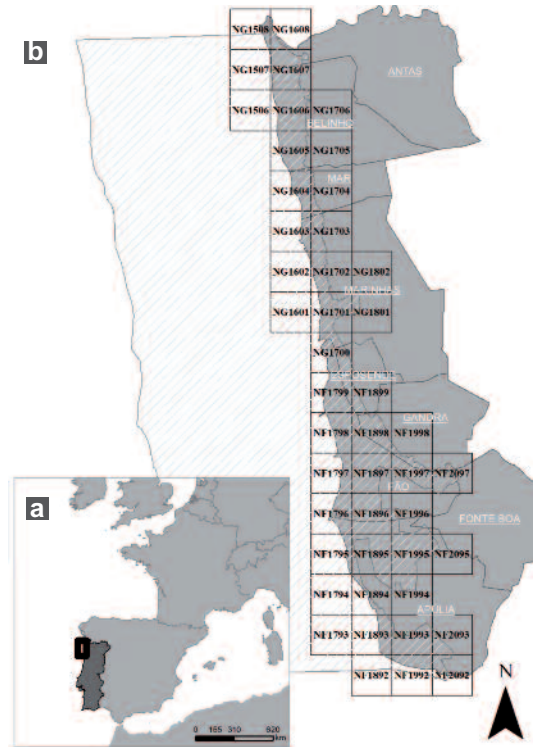


Figure 1: (a) Location of the study area in Portugal. (b) Study area with 1 x 1 km UTM squares; each square is associated with its number. Local administrative limits (dark grey) are represented as well as the limits of the Litoral Norte Natural Park (striped area).

Figura 1: (a) Localización del área de estudio en Portugal. (b) Área de estudio con cuadrículas UTM 1 x 1 km; cada cuadrícula está asociada con su número. Se representan los límites locales administrativos (gris oscuro), así como los límites del Parque Natrual Litoral Norte (área rayada).

spatial distribution of amphibians and reptiles using Geographic Information Systems; (2) to determine high species diversity areas; and (3) to identify possible threats to the herpetofauna presence in the LNNP.

The LNNP extends along 16 km of coast of northern Portugal, between the Neiva river and Apulia village, and covers approximately 88.90 km²: 76.53 km² is marine territory and the remaining 12.37 km² is inland area (41°3' to 41°2'N / 8° 5' to 8°4'W) (Figure 1). The park is integrated into the Litoral Norte Natura 2000 site (PTCON0017), classified under the European Directive nº 92 / 43 / EEC. The LNNP is located between the Douro and Minho landscapes levels (ICNB, 2007), being the maximum altitude 20 masl. Cávado estuary is present in the south of the park, the Neiva river in the north and there are small streams that drain directly into the sea. The LNNP presents a marine climate combined with an Atlantic front, with an annual rainfall average of 1500 mm / year (ICNB, 2007). The coast of Esposende municipality is a typical example of northern Portugal coastline. Forests of *Pinus pinaster* combined with Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) can be found along the area of the park (Gomes *et al.*, 2002).

Nineteen surveys were performed between November 2008 and July 2009, plus two other sporadic surveys in the winter of 2010. Several methodologies were used: (1) transects distributed along the different habitats present in the LNNP, in all periods of the year during day and night using visual encounter survey sampling methods. If rocks or trunks were encountered along the transect these were turned in search of specimens; (2) prospection at amphibian breeding sites with dip net and (3) acous-

tic monitoring in water bodies located in the study area (Heyer *et al.*, 2003). Species geographic position was collected with a portable GPS. In addition, for each individual, species, sex, developmental stage and habitat were recorded. The animals captured for identification were immediately released in the same place. The study area was surveyed using 44 1 x 1 km UTM squares as a reference grid (Figure 1). Observed species distributions, as well as species richness maps for amphibians and reptiles, were combined into a georeferenced 1 x 1 km UTM grid (Geographic coordinate system: WGS84) using ArcGis 9.3 (ESRITM, Redlands, California, USA, 2009) (Figure 1). Species observations were compared with the latest herpetofauna distribution data compiled in the atlas of Portuguese herpetofauna (Loureiro *et al.*, 2008).

Overall, 81 records were obtained in this study: 58 records for 12 amphibian species and 23 records for five reptile species (Appendix 1). These records added 15 new 10 x 10 km UTM squares and 35 new 1 x 1 km UTM squares to the last atlas of Portuguese herpetofauna (Loureiro *et al.*, 2008; Appendix 1; Figure 2).

Considering amphibians, the most registered species were: *S. salamandra*, *P. cultripipes*, *H. arborea*, and *P. perezi*. Observations of *Lissotriton helveticus* and *Alytes obstetricans* are new for the LNNP area (Loureiro *et al.*, 2008).

Pleurodeles waltl is present in the inland and southern parts of Portugal and extends the distribution to the northwest along the coastline, resulting in a U-shaped distribution. The LNNP is the northwest limit known for this species (Matos *et al.*, 2010). *P. waltl* larvae were found on a sand-hill drain directly connected to the sea, at Cepães. Despite *P. waltl* distribution being mostly Mediterranean, the LNNP shows conditions for this species pre-

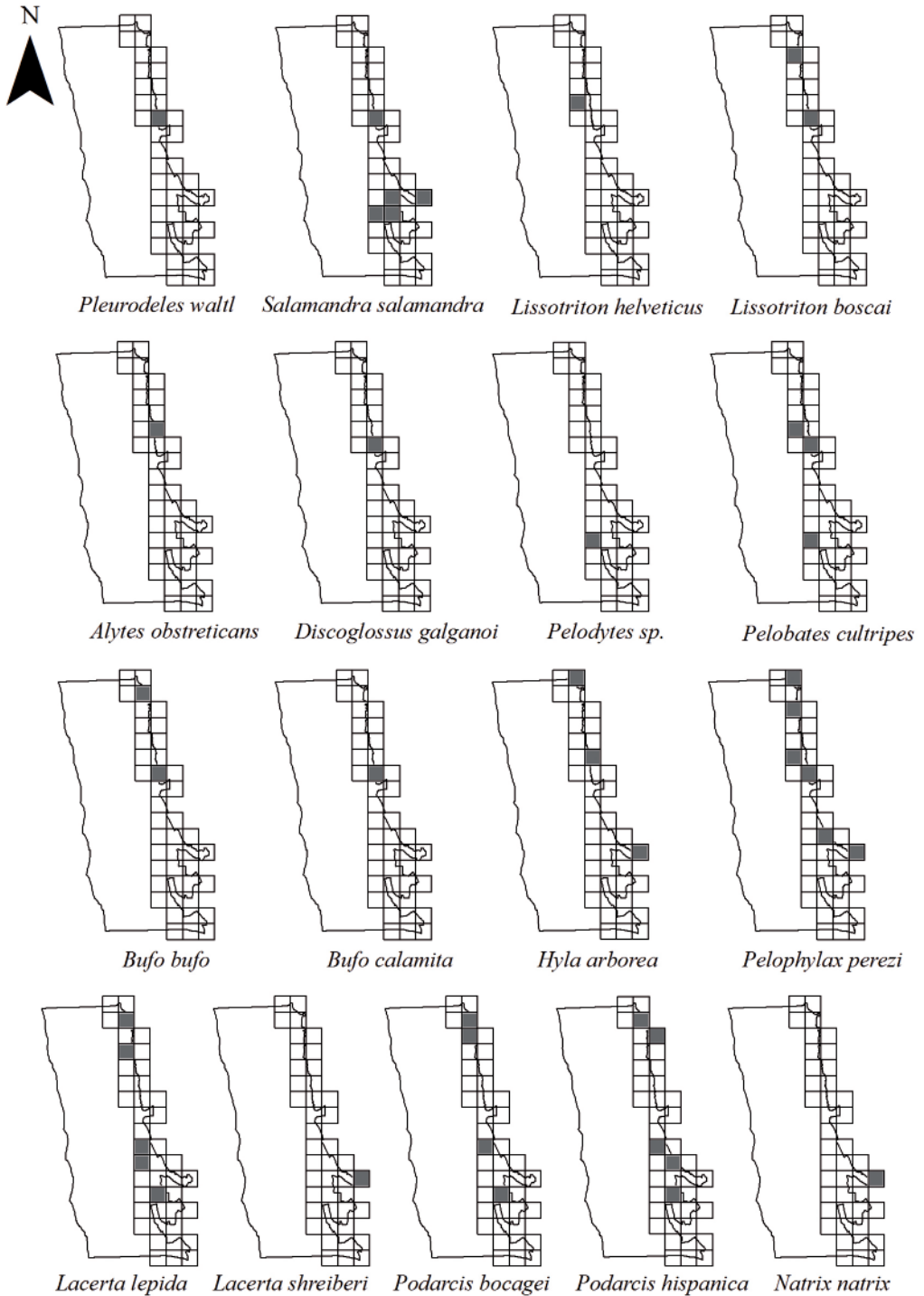


Figure 2: Amphibians and reptiles species distribution in Litoral Norte Natural Park at a 1 x 1 km UTM squares (grey squares).
Figura 2: Distribución de las especies de anfibios y reptiles en el Parque Natural Litoral Norte en cuadrículas UTM 1 x 1 km (cuadrados grises).

sence. Possibly, the presence of sand dunes and several temporary ponds distributed along the north side (north of Cávado estuary) provide an arid microclimate for *P. waltl*.

S. salamandra is a species widely distributed in northern Portugal (Loureiro *et al.*, 2008). This study increases its known distribution range, which is highly fragmented along the sea coast (Loureiro *et al.*, 2008). In the LNNP this species was found around temporary ponds and grasslands located within pine forests. It was also detected in sand dunes nearby Barrelas stream.

L. boscai is an Iberian endemic species, already registered in the LNNP area (ICNB, 2007). However, one new 10 x 10 km UTM square is added to its distribution for the northern coast of Portuguese area (NG10). This urodele was observed in an irrigation system near Regos (South) stream and in Barrelas stream, here in syntopy with *L. helveticus*.

L. helveticus has its distribution limited to western Europe. In the northwest of Portugal, small and dispersed populations are known to be located in Oceanic climate zones, and the LNNP is not an exception. The nearest observations are within 20 km from the study area to the North in the Lima river and to the Northeast in Barcelos (Loureiro *et al.*, 2008). In the park, this species was detected in Barrelas stream. This study contributes with a new 10 x 10 km UTM square for its distribution (NG10) (Loureiro *et al.*, 2008).

A. obstetricans is a species that shows a continue distribution in the north of Portugal, except on the coastline (Loureiro *et al.*, 2008). This study shows the first record in the park for *A. obstetricans* and also adds a new 10 x 10 km UTM square (NG10). In the LNNP this anuran was observed vocalising in the sand dunes near Barrelas stream.

D. galganoi occurrence in northern Portugal is fragmented. Along the northern sea coast, the closest points to Minho nuclei populations are the Mindelo populations in Vila do Conde (Loureiro *et al.*, 2008). *D. galganoi* has already been described for the LNNP area in humid depressions in sand dunes (Malkmus, 2004; ICNB, 2007); in this study this species was found on a sand-hill drain in Cepães.

P. cultripes has a distinct distribution in Portugal: continuous from the interior to the south of the Tejo river and then fragmented along a restrict zone of the coastline (Loureiro *et al.*, 2008). The northern populations show an isolated distribution compared to Parque Natural de Corrubedo y Porto do Son (south Galiza) populations (Galán *et al.*, 2010; Loureiro *et al.*, 2008). In the LNNP, *P. cultripes* is a common species. It was found in Outeiro and Barrelas streams as well as in sand dunes in the north of the Cávado river. Furthermore, its presence was also registered in the south in a temporary pond and in grasslands in Fão. However, the closest records of this species are at least at 20 km far from the park, representing this another isolated nuclei (Loureiro *et al.*, 2008).

Pelodytes spp. is distributed in Portugal from the South (Algarve region) to the North following the coast (Loureiro *et al.*, 2008). Distribution updates previously made reported the LNNP as the new northwest limit for this genus (Matos *et al.*, 2010). This anuran was found vocalising in a temporary pond located in a sand-hill with *P. pinaster* in Fão (Esposende). Previous species records from the atlas of Portuguese herpetofauna were located 20 km to the South (Mindelo, Vila do Conde).

B. bufo occurs continuously along the northern coast line of Portugal. This species is common in the LNNP, occupying all habi-

tat types, from water bodies during the breeding season to sand dunes outside this period (ICNB, 2007). During this study, *B. bufo* was observed in pine forest areas near the Neiva river and in humid sand-hill drains. A new 10 x 10 km UTM square is added to the Portuguese atlas (NG10) (Loureiro *et al.*, 2008).

B. calamita distribution along the shore of the northern coast is fragmented (Loureiro *et al.*, 2008). Its presence was detected in sand dunes close to Barrelas streams and in sand-hill drains in Cepães. The closest record from the LNNP is in Lima basin 10 km to the North, constituting new information on the species distribution both for the LNNP and Portuguese atlas (NG10) (Loureiro *et al.*, 2008).

H. arborea distribution along the Portuguese northern coast line exhibits a significant discontinuity. The highly fragmented distribution of the species appears to be defined with few isolated nuclei, being Póvoa de Varzim populations the closest points to the

Cávado river records (Loureiro *et al.*, 2008). Already detected in the LNNP (ICNB, 2007), *H. arborea* individuals were recorded in the Neiva river, Barrelas stream and Cávado estuary.

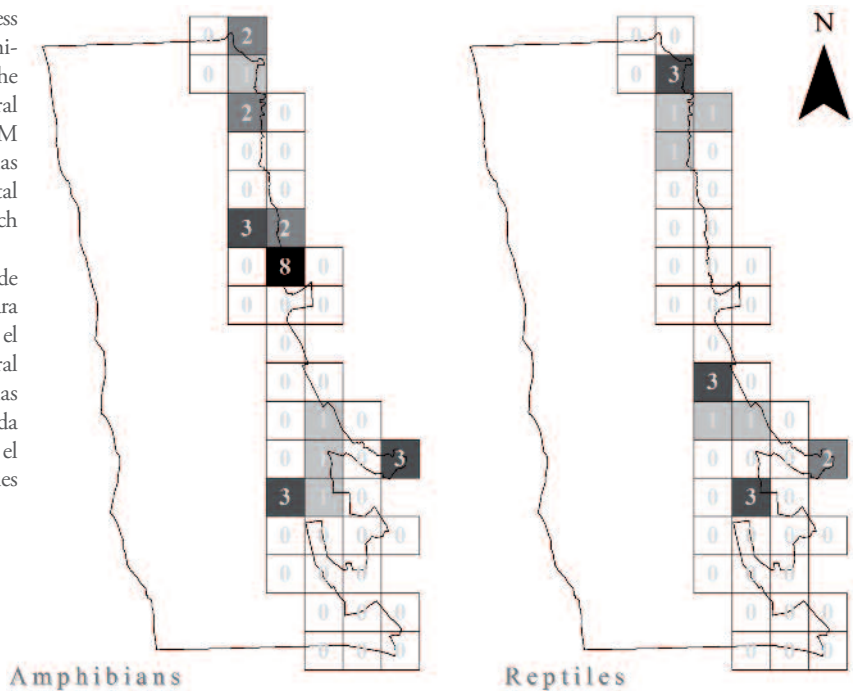
P. perezi is abundantly distributed throughout the Portuguese territory (Loureiro *et al.*, 2008). In the LNNP, individuals were recorded in all types of water bodies, mainly to the north of the Cávado estuary. Nevertheless, a new 10 x 10 km UTM square is added to *P. perezi* national distribution (NG10).

Regarding reptiles, *T. lepidus* and *P. hispanica* were the most recorded species in this study (Figure 3).

T. lepidus presents a regular distribution in northern Portugal, which becomes more fragmented when approaching to the coast line (Loureiro *et al.*, 2008). Being a common species in the LNNP area, *T. lepidus* was observed in sand dunes and pine forest area. Despite being previously detected in the park, a new 10 x 10 km UTM square is added to its national distribution (NG10).

Figure 3: Species richness distribution for amphibians and reptiles in the Litoral Norte Natural Park at a 1 x 1 km UTM grid. Each square has represented the total number of species for each group.

Figura 3: Distribución de la riqueza de especies para anfibios y reptiles en el Parque Natural Litoral Norte en cuadrículas UTM 1 x 1 km. Cada cuadrícula representa el número total de especies para cada grupo.



L. schreiberi is an Iberian endemic species with a continuous distribution in the north of the Tejo river (Loureiro *et al.*, 2008). Despite the continuous appearance, *L. shreberi* population nuclei are highly fragmented. It has already been described for the LNNP area, though this species was only observed once in Cávado estuary (Brito *et al.*, 1998).

P. bocagei is an Iberian endemic species with a strict Atlantic climate distribution (Sillero *et al.*, 2009; Loureiro *et al.*, 2008). This species occupies the northwest zone of Portugal from Espinho to Minho, in certain areas in sympatry with *P. hispanica*. *P. bocagei* was observed on sand dunes areas in Belinho and Cávado estuary.

P. hispanica distribution in northern Portugal is almost continuous, except in several squares along the coast (Loureiro *et al.*, 2008). This lizard was commonly observed on walls both to the north and south of the Cávado estuary. These walls were located in sand dunes, pine forests, urbanised and agriculture areas. These observations have contributed to expand the distribution of this species by adding new 10 x 10 UTM squares (NG10, NF19). The identification of *P. hispanica* morphotype was not assessed.

N. natrix distribution is wider in the North compared to the South. Its presence in the coast line is fragmented and confined to wetlands (Loureiro *et al.*, 2008). It has already been detected in the Cávado estuary where it was found during this study (Godinho *et al.*, 1999).

Both amphibian and reptile species are present in the north and south of the Cávado river (Figure 3) and we may consider the north of the estuary the area showing higher species richness.

Amphibian species are distributed along the coastline focusing within small and large water bodies with preference to Regos, Barrelas e Outeiro streams. Open habitat areas that include



Figure 4: Typical habitats in the Litoral Norte Natural Park where amphibians and reptiles can be found. (a) Image corresponding to the Barrelas stream; (b) view of the coastal area with dunes located to the north of the Cávado river. On the edge of this area we can find forests with *P. pinaster* dominated by *Acacia* spp. shrubs.

Figura 4: Habitats típicos en el Parque Natural Litoral Norte donde anfibios y reptiles pueden ser encontrados. (a) Imagen correspondiente al arroyo Barrelas; (b) vista del área costero con dunas localizado en el norte del río Cávado. En el límite de esta área se pueden encontrar bosques con *P. pinaster* dominados por arbustos de *Acacia* spp.

sand dunes, dunes ridges, sand dunes shrubs and sand humid depressions, combined with agricultural areas and pine forests, provide a landscape mosaic for amphibian high diversity. Amphibian species resilient to salinity like *P. perezi* and *H. arborea* are also present in small tracks of coastal wetlands, including marshlands (Figure 4). Reptiles had greater diversity around the estuary areas and in Belinho sand dunes zone. Although the results for reptile are hardly conclusive because of the low number detected, the occupation of certain habitats is evident. These species occupy forest areas that include dune shrub with

P. pinaster and *Quercus robur*, together with agricultural and urbanized areas (Figure 4).

In the future, the relationship between the factors involved in the decline of the herpetofauna at the LNNP and species abundance and distribution will be analysed. Nevertheless, several potential threats can be pointed for the study area: (1) fragmentation and habitat loss, building construction for touristic purposes and the alteration of the habitats are among the main causes. It seems to be a negative attitude towards wetlands (swamps and ponds), thus being turn into landfill drains (Ferreira & Crespo, 2003); (2) pollution, mainly from agrochemicals. Several drain ditches present eutrophication signals that can compromise the presence of herpetofauna; (3) introduction of exotic species. For example *Acacia* spp. occupies a vast area in the park. Furthermore, *Procambarus clarkii* presence was detected in the Neiva river mouth and Cávado estuary; (4) habitat disturbance: seasonal tourism is a worrying threat since this disturbance in coastal areas is elevated during the tourist season (ICNB, 2007). Despite the numerous prohibitions, dunes are a fragile and exposed target. Reptile species are specially affected during this season since many are reproducing. This

period can be important in terms of public awareness not only for the presence and importance of herpetofauna, but also for the natural values in the LNNP, since it is necessary to work from an integrated and holistic perspective (Almeida *et al.*, 2001; Storfer, 2003; Ferreira & Crespo, 2003; Cunha, 2004; Cabral *et al.*, 2005).

Overall, 17 species were identified in the LNNP, 12 of which were amphibian species and five were reptiles, representing respectively 71% and 17% of the species present in Portuguese mainland. However, the presence of herpetofauna along the northern coast is still poorly studied. In fact, more records between the new and the previous limits are possible and future studies are important to define the distribution limits through the interior of the mainland (Matos *et al.*, 2010). It is not possible to know, currently, if these new records correspond to a regression or a recent expansion process.

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Ampliación del área de distribución de *Lacerta bilineata* en Palencia

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Durante un muestreo en la provincia de Palencia (Castilla y León) el 12 de agosto de 2009, se localizó una hembra de lagarto verde (*Lacerta bilineata*) en el municipio de Pedrosa de la Vega (UTM [European Datum 1950]: 30TUN50;X: 358518;Y: 4703664; 890 msnm). El ejemplar se estaba termorregulando cuando fue observado y los detalles de la coloración externa indicaban que se encontraba fuera del periodo reproductor. La observación se produjo entre la vegetación ribereña (*Populus* sp., *Alnus glutinosa* y *Rubus* spp.) que cubría las orillas de una charca cercana a una carretera local. La charca se encontraba completamente rodeada por cultivos de maíz, siendo la única zona húmeda y con vegetación natural en un radio amplio de terreno. Prospecciones en pequeñas manchas aisladas de robledal y zonas húmedas situadas a la misma latitud en Palencia ofrecieron en todo caso resultados negativos para la presencia de esta especie.

Las poblaciones de lagarto verde más cercanas conocidas se encuentran aproximadamente a 30 km en línea recta en las zonas montañosas de la Cordillera Cantábrica, y tan sólo en el Sistema Ibérico (Soria) se encuentra en localidades más sureñas que ésta (Barbadillo, 2002). Así, es importante resaltar que el hábitat donde se localizó el ejemplar objeto de la presente nota dista mucho de ser el característico de la especie, que muestra una marcada preferencia por los bosques caducifolios, como robledales (*Quercus robur*, *Quercus petraea* y *Quercus pyrenaica*) o hayedos (*Fagus sylvatica*), y prados y herbazales húmedos.

Otras especies de reptiles tales como la culebra viperina (*Natrix maura*) han sido ya localizadas en la cuadrícula indicada. No obstante, esta única cita sobre la presencia de *L. bilineata* obliga a suponer un origen incierto: suelta deliberada, dispersión –aunque dudosa– desde las poblaciones de origen (Fox et