Bringing together research, geoconservation and reaching a broad public in the form of a geotourism project: the Ichnite Route of Soria (Spain)

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Abstract

A detailed evaluation of the palaeoichnological work carried out in the Highlands ("Tierras Altas") of Soria (Spain) over the last 35 years is provided. The scientific research performed by different teams on the vertebrate tracksites of the Early Cretaceous deposits of the Huérteles Fm. has engendered and fostered the "Ruta de las icnitas de Soria" (Ichnite Route of Soria) project, which consists both of geoconservation work on the main vertebrate tracksites and of drawing public attention to their existence. The ichnite route represents a good example of how scientific research may help to promote projects based on geotourism. Further, the research has also led to the recovery of a significant collection of vertebrate footprints that are currently housed in the Numantine Museum ("Museo Numantino") in Soria. This collection is one of the finest from the beginning of the Early Cretaceous both in terms of the number and quality of the tracks and in terms of their ichnodiversity (footprint types). Drawing increased attention to this collection by putting it on public display would be an exceptional complement to the ichnite route, as it would mean that visitors could also see other tracks.

Keywords

Vertebrate tracksites, paleontological spreading, Berriasian, Cameros Basin, Iberian Range

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appreciated.

Introduction

Interest in the geological heritage (or geoheritage) of the country, has notably increased in Spain in the last few years (Carcavilla et al. 2009). Recently, the Spanish Geological Survey has proposed 144 geosites (García-Cortés 2008, 2009) around the country covering interests that range across a variety of geological disciplines (tectonics, stratigraphy, palaeontology, petrology, etc.). The palaeontological sites include sites associated with the vertebrate footprint record of the Iberian Range, such as the dinosaur tracksites of La Rioja (Pérez-Lorente, 2015) or the dinosaur tracksites of Galve in Teruel (Pérez-Lorente, 2009). In fact, one of the 20 Spanish frameworks proposed for the Global Geosites project (Fossils and ichnofossils from the continental Cretaceous of the Iberian Peninsula) directly mentions the ichnological record of the Cretaceous of the Iberian Peninsula. Similarly, the dinosaur ichnites of Upper Jurassic of Asturias have also been declared Natural Monument (Carcavilla et al. 2009). With this increasing interest in the geological heritage of Spain, the geoconservation of the ichnological record is of primary significance. Several authors have pointed out the geoconservation work and heritage development carried out at various dinosaur tracksites in Spain, as has occurred in the provinces of La Rioja (Pérez-Lorente 2000; Díaz-Martínez et al. 2010a; García-Ortíz et al. 2014; Fuertes-Gutiérrez et al. 2016), Asturias (García-Ramos et al. 2006; García-Ramos and Piñuela Suárez, 2006), Teruel (Cobos 2004; Mampel et al. 2009; Alcalá et al. 2016), Burgos (Torcida Fernández-Baldor et al. 2015) and Barcelona (Vila et al. 2008; Bates et al. 2008). This increasing interest in the geoconservation of dinosaur tracksites is a general trend. As in Spain, several other countries around the world are trying to enhance, conserve and protect their tracksites, taking into account their importance not only from a scientific point of view but also for their educational value and their potential for sustainable tourism (Marty et al. 2004; Santos et al. 2008; Díaz-Martínez et al. 2010b; Wings et al. 2012; Lockley et al. 2012; Enniouar et al. 2014; Chabou et al. 2015; Sá dos Santos et al. 2015; Al-Wosabi and Al-Aydrus 2015).

Although not included among the Spanish geosites, the dinosaur tracks from the Highlands of Soria ("Tierras Altas") in the north of the province of Soria are an outstanding instance, forming part of the Dinosaur Tracks of Cameros (Fuentes Vidarte 1996; Fuentes Vidarte et al. 2001; 2005a; Barco and Ruiz-Omeñaca 2005; Hernández Medrano et al. 2008; Moratalla and Hernán 2010). Carcavilla et al. (2009) pointed out that the development of geological itineraries is becoming more frequent in Spain. This is precisely what has been done in the region of Highlands of Soria inside the project of the Ichnite Route of Soria ("Ruta de las icnitas de Soria").

The Highlands of Soria is a rural area in the north of the province of Soria. The region lives mainly from crop farming and animal husbandry, but in recent years tourism has increased. This increase is related to the geotourism resulting from Ichnite Route of Soria project (Barco et al. 2009, 2013). This turned to account one of the characteristic features of the region, namely the large number of tracksites (close to 200) from the beginning of the Early Cretaceous, including more than 7000 vertebrate (mainly dinosaur) footprints (Fuentes Vidarte et al. 2005a; Hernández Medrano et al. 2008). In addition to this heritage of the fossil sites, the Highlands of Soria has preserved a great footprint collection that is housed in the Numantine Museum ("Museo Numantino") in Soria. This museum is known for its significant archaeological collection (Arlegui Sánchez 2014), but it also houses a notable palaeontological collection featuring the footprint collection from the Highlands of Soria. The aim of this paper is to present the Ichnite Route of Soria project as an example of the geoconservation of the geological and palaeontological heritage and to show how this project has been combined in recent decades with scientific reasearch and the task of bringing the fruits of this research to the public attention. By these means, moreover, the heritage value and the importance of the conservation of the palaeoichnological collection housed in the Numantine Museum in Soria are enhanced.

Geographical and geological setting

The Highlands of Soria lies within the northern region of the province of Soria, forming a boundary with the province of La Rioja to the north (Fig. 1). It has around 1,600 inhabitants (Spanish Statistical Office, http://www.ine.es/) and the region is characterized by a high level of depopulation (2.2 inhabitants / km^2). Much of the population is retired; the birth rate is low; and many of the younger people have emigrated to large cities. The region is composed of 19 municipalities, San Pedro Manrique being the main town of the region (almost 600 inhabitants). The Ichnite Route of Soria is composed of 15 tracksites. These are located in the villages of Yanguas (resin copy of El Majadal tracksite), Villar del Río (Serrantes, Fuentesalvo and Valdegén tracksites), Bretún (Fuente Lacorte-El Frontal, La Matecasa, La Peña-El Corral de la Peña tracksites), Santa Cruz de Yanguas (Santa Cruz and Los Tormos tracksites), Los Campos (Salgar de Sillas tracksite), Ventosa de San Pedro (San Roque tracksite), Matasejún (Las Adoberas tracksite), Valdelavilla (Valles de la Valdelalosa tracksites), El Royo (El Royo tracksite) and Almarza (Dehesa de Gallinero tracksite). Furthermore, in Fuentes de Magaña the Miraflores I tracksite has also been developed and it is a supplement to the route.

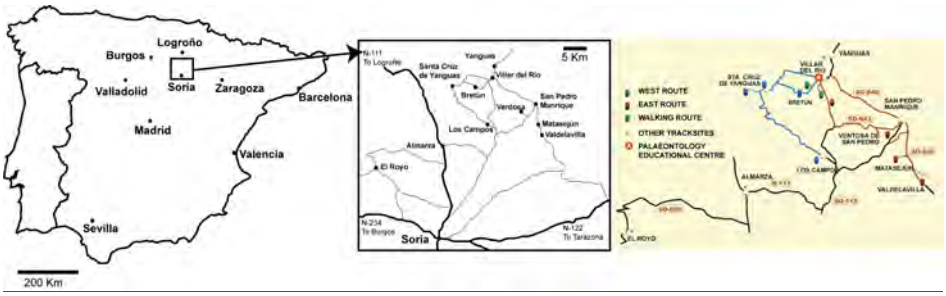

Fig. 1: Geographical setting of the Ichnite Route of Soria ("Ruta de las icnitas de Soria") showing the three routes (east, west and walking route) trough the tracksites (modified from www.rutadelasicnitas.com). The majority of the slabs collected and now housed in the Numantine Museum from Soria come from sites located in these localities.

Geologically, the Highlands of Soria is part of the eastern Cameros Basin, which is located in the north part of Spain. The Cameros Basin was developed during the rifting phase that occurred in Iberia from the Late Jurassic to the Early Cretaceous knows as Iberian Mesozoic Rift System. The infill of the basin has been divided into eight depositional sequences that span from the Tithonian to the early Albian (Mas et al. 2004, 2011). Except El Majadal and El Royo, all the localities that form part of the route or where the majority of the slabs have been collected belong to the Huérteles Formation, which is included in the Oncala Group, representing depositional sequence 3 of the infill of the Cameros Basin. This formation is mainly composed of siliciclastic deposits (Mas et al. 2004; 2011; Quijada et al. 2013). It was thought to have been deposited in alluvial plain systems distally connected with playa-lake systems, with the tracksites located in the proximal environments (Gómez-Fernandez and Meléndez 1994; Meléndez and Gómez-Fernández 2000). Recent sedimentological work on the formation (Quijada et al. 2016) has demonstrated that the absence of marine fossils and classic tidal features is not a sufficient criterion to rule out other environments with a tidal influence. The authors thus suggest that the Huérteles Fm. was deposited in broad, low-gradient, tidal flats, traversed by meandering channels. The age of the Huérteles Formation is Berriasian according to the ostracod and charophyte content (Schudack and Schudack 2009). In contrast, El Majadal and El Royo tracksites belongs to the Urbión Group which age span from the Valanginian to the Aptian (Mas et al. 2004; Hernández Medrano et al. 2008).

Scientific research on the ichnites in the Highlands of Soria

The first papers on the Huérteles Formation were published at the beginning of the 1980s (Aguirrezabala and Viera 1980, 1983). Since then, the number of publications has been constantly increasing, and by now more than

a hundred publications (including scientific journals, popular journals and abstract proceedings) have appeared. Hernández Medrano et al. (2008) put together a compilation of data on the number of tracks (more than 7,000) and tracksites (almost 200) preserved in the Sorian part of the Cameros Basin. It should be noted that some of the tracksites are ichnological points rather than proper tracksites and that the majority of them are preserved in a single geological unit, the Huérteles Fm (Oncala Group). One of the most significant aspects of the tracks from this geological unit is the age of the tracksites, which have been dated to the Berriasian (Lower Cretaceous, ca. 145 Ma). This period of time is the first age of the Cretaceous, and the study of the deposits from this age is crucial for an understanding of what happened around the Jurassic/Cretaceous boundary (Tithonian-Berriasian boundary), as there was a considerable decrease in the diversity of the different fossil groups (Tennant et al. 2016). Moreover, this period of time is characterized worldwide by a relatively low number of sites, making the tracksites from the Tierras Altas region (those of the Huérteles Fm.) a particular rarity during this age.

The great amount of literature that has appeared has led to the description of tracks from different groups of dinosaurs (Fig.2), such as theropods (Lockley et al. 1998; Barco et al. 2004, Hernández Medrano et al. 2006; Pascual-Arribas and Hernández-Medrano 2011), sauropods (Meijide Fuentes et al. 2001; Pascual-Arribas and Hernández-Medrano 2010) and ornithopods (Pascual-Arribas and Hernández-Medrano 2010; Castanera et al. 2013). However, the footprint records that are most remarkable in terms of the abundance and quality of their tracks belong to other groups of tetrapods. Especially abundant are tracks made by pterosaurs (Fuentes Vidarte et al. 2004a, 2004b; Sánchez-Hernández et al. 2009; Pascual Arribas and Hernández Medrano, 2012; Pascual-Arribas et al. 2015), there being tracksites with thousands of footprints (Pascual Arribas and Sanz-Perez 2000). In addition, crocodyliform (Fuentes Vidarte and Meijide Calvo 2001; Pascual Arribas et al. 2005) and turtle tracks (Fuentes Vidarte et al. 2003; Pascual-Arribas and Hernández-Medrano 2015) have been described. One of the most significant features of the footprint record is thus the large number of different types of footprint preserved (the ichnodiversity).

Fig. 2: Pictures of some footprints preserved in the tracksites that compose the Ichnite Route of Soria ("Ruta de las icnitas de Soria"). A) Large theropod tracks in the tracksite of La Matecasa (*Megalosauripus* isp., Barco et al. 2004). B) Tiny theropod track (*Kalohipus bretunensis*, Fuentes Vidarte and Meijide Calvo 1998) in the tracksite of Santa Cristina. C) Sauropod trackway in the tracksite of Las Cuestas I (Pascual-Arribas and Hernández-Medrano, 2010). D) Medium-sized ornithopod track related to *Iguanodontipus* (Castanera et al. 2013) in the tracksite of La Peña. E) Ornithopod trackway in the tracksite of Santa Cruz. F) Large pes pterosaur track (*Pteraichnus palacieisaenzi*, Pascual-Arribas et al. 2015) in the tracksite of Los Tormos. G) Small manus-pes pterosaur track set (*Pteraichnus*) Pascual Arribas and Hernández Medrano, 2012). Scale card = 10 cm (A) and 8 cm (E). Scale bar = 1 cm.

Other important sources of information emerging from the study of tracksites are the palaeoecological information, the mode of locomotion that can be inferred from them as well as the relationship between the trackways and possible paleogeographic influence. For example, the Fuentesalvo tracksite is a good example of the gregarious behaviour of certain groups of dinosaurs (Barco et al. 2006; Castanera et al. 2013). Some tracksites show possible evidence of quadrupedalism in ornithopod dinosaurs (Castanera et al. 2013), while others show how the footprint morphology can vary through the same trackway due to the substrate conditions (Razzolini et al. 2014). In some of the most recent papers innovative new techniques such as LIDAR scanning or photogrammetric models (Castanera et al. 2013; Razzolini et al. 2014) or Geometric Morphometrics (Castanera et al. 2015) have been used for the study of the tracks. These non-invasive techniques are extremely useful for

the study of track morphology, but are also a good way of preserving the ichnological heritage (Bates et al. 2008; Mallison and Wings, 2014). Besides, Moratalla and Hernán, (2010) have reported that the trackways from the Huérteles Fm. show a predominant directional orientations to the NW and NNE and thus the dinosaur movement were influenced by the palaeogeographic and palaeoenvironmental conditions of the area, some of the trackways being "more or less parallel to the distribution of the facies belt".

The scientific research carried out over more than 35 years has been pursued by different teams and different institutions. The first work was developped by members of the Aranzadi Natural Science Society ("Sociedad de Ciencias Naturales Aranzadi", Aguirrezabala and Viera 1980, 1983). Subsequently, two teams, one led by Carolina Fuentes Vidarte and Manuel Meijide Calvo and another by Carlos Pascual and Nieves Hernández, have been responsible for most of the published papers (Fuentes Vidarte et al. 2005a; Hernández Medrano et al. 2008). The work of these two teams has resulted in many publications and the recovery of a great number of slabs with dinosaur (and other tetrapod) tracks, which are now housed in the Numantine Museum (see section 5). Moreover, some of the tracksites of the Huérteles Fm. were described in the first PhD thesis on dinosaur tracks in the whole of the Iberian Peninsula (Moratalla García 1993), undertaken at the Universidad Autónoma of Madrid. Besides, some recopilatory and divulgative works that deal on tracks from the Highlands of Soria were published (Sanz et al. 1997; Rubio de Lucas 2001). At the beginning of 2001, members of the Aragosaurus-IUCA Research Group from the University of Zaragoza started to work on the tracksites as well. As a consequence of this scientific research, the Sorian tracksites have formed part of two PhD theses defended at that institution (Barco 2009; Castanera 2013) and another one due to be defended in 2017 at the Autonomous University of Barcelona (Novella Razzolini). In addition to the aforementioned institutions, other institutions involved in the study of the tracksites have been the Spanish Geological Survey ("Instituto Geológico y Minero de España") (Moratalla and Hernán 2010), the Catalonian Institute of Palaeontology ("Institut Catalá de Paleontologia") (Razzolini et al. 2014) or the Politechnical University of Madrid ("Universidad Politécnica de Madrid") (Sanz-Pérez et al. 2016).

The Ichnite Route of Soria ("Ruta de las icnitas de Soria") project: geoconservation and spreading the palaeontological word

The early 1990s saw the first attempts to draw attention to some of the tracksites, after some of the first discoveries had been published. The Palaeontology Educational Centre was opened in the locality of Villar del

Río in 1996, and a number of documents showing the location and fossil content of the tracksites were printed. This was the inception of the Ichnite Route of Soria (Rasal et al. 2005; Barco et al. 2005, 2009, 2013). Some years later, thanks to collaborative efforts and investments on the part of various institutions and the regional government, the Ichnite Route of Soria project was launched in 2001. The project started with the idea that research and palaeontological knowledge should be its basis and driving force, but that tourism development based on bringing palaeontology and related activities to the public attention should be the main purpose. At this point, a variety of work on the tracksites was carried out in the following years with the purpose of improving the facilities of the tracksites; moreover, the Palaeontology Educational Centre was remodelled.

The Ichnite Route of Soria is an exhibition space composed of 15 selected tracksites (Fig. 3), which complement the Palaeontology Educational Centre. These tracksites were carefully selected on the basis of their scientific significance and subsequently cleaned, protected and prepared for tourist visits (Barco et al. 2005, 2009, 2013). The work on each tracksite (Fig. 3) consisted in the construction of protection fences and platforms that provide a better view of the tracksite, consolidation of the rock, the painting of some of the trackways, and the provision of information panels that explain different geological and palaeontological aspects of the tracksites and the area (Barco et al. 2009). More recently, new campaigns have been undertaken to clean the tracksites.

Fig. 3: Pictures of some of the tracksites that composed the Ichnite Route of Soria. A) Tracksite of Fuente Lacorte (bottom of the picture) and tracksite of El Frontal (top of the picture) in the locality of Bretún. Note the *Allosaurus* between the tracksites. B) Tracksite of San Roque with a representation of an iguanodontid that could be arguable of an ornithopod iguanodontid. C) Tracksite of Fuentesalvo. D) Tracksite of Miraflores I with a new representation of a diplopocoid sauropod.

Since then, the institutions responsible have continued to invest in the Ichnite Route of Soria. Their aim has been double: on one hand the conservation of the sites as a palaeontological heritage protected by both national legislation (Law 16/1985, dated 25 June, of Spanish Historical Heritage) and regional legislation (Law 12/2002, dated 11 July, of the Cultural Heritage of Castilla y León). On the other hand the maintenance of the associated facilities to ensure that visits are attractive and safe for tourists. This investment has taken place in two clearly differentiated stages. A first stage was between 2002 and 2008, involving consolidation work and annual maintenance, inventory management and planning with a view to improve the running of the tracksite record, as well as providing support for research work. A second stage, marked by the economic crisis that has had Spain in its grip, has featured a substantial cut in the investment in culture and cultural heritage. During this stage, investment has been irregular and has occurred less frequently, and has always been promoted by institutions whose main objective has been the development of tourism as an economic engine in the region.

As regards tourism, a new department designated the Educational and Cultural Action Department (DEAC, "Departamento de Educación y Acción Cultural") was created. This had the purpose of designing and providing educational activities for the visitors, updating and making the latest palaeontological research known to the public, and evaluating the satisfaction of the visitors (Barcelona et al. 2005). In addition, the Soria Tourist Board ("Patronato de Turismo de Soria") has printed new documents, and a new website has been created: www.rutadelasicnitas.com. The fruit of all this effort was an increase in tourist visits (with around 2500 people in six months in 2004; and 1500 in two months in 2005). The Educational and Cultural Action Department was in operation mainly during the years 2004-2008, but it is no longer so at present. However, the premise of its creation is still valid and it is hoped that it will return to operation in the forthcoming years. The number of visitors has decreased in recent years as a consequence of the economic crisis. This is probably due both to the decline in purchasing power of potential visitors and also to the limitations on the number and quality of the activities within the route (Barco et al. 2013).

In the course of the route, there are several dinosaur simulations (Fig. 3) that also show how scientific research and knowledge on dinosaurs have evolved. Some of the tracksites show images of certain dinosaurs that are

quite different from how the dinosaurs are visualized today (e.g. the sauropod brachiosaurid of Villar del Río, the triceratops of Bretún or the ornithopod iguanodontid of San Roque, Fig. 3). In this regard, it should be noted that this simulations were created as decoy for the tourists but without a scientific correlation with the footprint record of the route. Nonetheless, there are other simulations that are more consistent with current knowledge on both the footprint record and their possible trackmakers, such as the theropod *Allosaurus* of Bretún or the iguanodontid of the Palaeontology Educational Centre. Only a few years ago, a sauropod dinosaur model (Fig. 3) of about 30 metres in length was installed at the Miraflores I tracksite in the locality of Fuentes de Magaña.

As regards the protection of the tracksites by legislative measures, some of the tracksites were in 2005 declared Goods of Cultural Interest (BIC, "Bienes de Interés Cultural") within the category of "archaeological zones" by the Office for Heritage and Cultural Promotion of the Castilla y León Government (Official Bulletin from 11/5/2005, Resolution 53/2005).

The Ichnite Route of Soria is subdivided in three parts (Fig. 1): the east and west routes and the walking route (one can set off walking directly from the Palaeontology Educational Centre). The east route is made up of eight tracksites located in the villages of Bretún (La Matecasa, La Peña, El Corral de la Peña, Fuente Lacorte and El Frontal tracksites), Santa Cruz de Yanguas (Santa Cruz and Los Tormos tracksites) and Los Campos (Salgar de Sillas). At these tracksites the visitor can contemplate footprints from a variety of groups of dinosaurs, ranging from large theropod footprints or extremely large sauropod footprints to medium-sized ornithopod or pterosaur footprints. The west route is composed of five tracksites located in the villages of Villar del Río (Fuentesalvo), San Pedro Manrique (San Roque, Las Adoberas and Valdelavilla) and Fuentes de Magaña (Miraflores I). On this route the visitor can see ornithopod footprints showing gregarious behaviour and medium-sized theropod and ornithopod tracks. Finally, on the walking route starting from the Palaeontology Educational Centre, the visitors can acceed to two tracksites located in Villar del Río (tracksites of Serrantes and Valdegén). It is noteworthy that the tracksite of Fuentesalvo has been adapted to provide access for the physically and visually handicapped, it being the first and only site with such facilities in Spain (Rasal et al. 2005). In 2016, various projects are envisioned, such as the redesign of the website of the route of the ichnites, the creation of a gymkhana for very young visitors, and the refurbishment of the Palaeontology Educational Centre. The aim is to turn it into a new activity centre that combines a modern exhibition space, a reception centre for visitors, and a multidisciplinary space allowing for activities associated with palaeontology and social activities for the Highlands of Soria.

The impact of the project on the region's tourism is apparent, though conditioned both by the degree of investment and the purchasing power of visitors and thus by the above-mentioned economic crisis. Irrespective of this, however, the ichnite route is an exceptional asset for the tourism of the region. Particularly noteworthy among its achievements is the contribution it has made in one way or another to the development of various private initiatives associated with the Centre for Tourism Initiatives of the Highlands of Soria, such as the establishment of a number of rural tourism lodges; the development of fieldwork camps for the cleaning and upkeep of the tracksites (organized by the municipal council of Villar del Río, the Castilla y León Government, and the wind power company "Compañía Eólica de Tierras Altas"); and the increase in the number of visitors to the Palaeontology Educational Centre, which grew almost three times in its first three years of activity (Barco et al. 2013). At present, the figures are showing a slight decline, but the upturn in inland tourism in Spain and the new activities being undertaken are cause for optimism and give good reason to continue believing in the value of a project such as the Ichnite Route of Soria in terms of its economic, social, educational, cultural and scientific benefits and as part of the heritage.

The footprint collection of the Numantine Museum

As mentioned in previous sections, the Huérteles Fm. has yielded a great number of slabs recovered by researchers, which are housed in the Numantine Museum in Soria (Fig.4). This museum was created to house the archaeological collections from the site of Numancia, located close to Soria (Arlegui Sánchez 2014). Although the main collection of the museum consists of archaeological remains, it also has a significant vertebrate palaeontological collection comprising both skeletal and footprint material, which comes from different sites across the province of Soria and dates from a variety of ages (from Late Jurassic to Early Cretaceous). Outstanding among the osteological remains is the collection from the Early Cretaceous site of Zorralbo, where remains assigned to Dinosauria (Sauropoda, Theropoda, Ornithopoda, Ankylosauria), Crocodylomorpha and Chelonia have been described (Fuentes Vidarte et al. 2005b), as well as an isolated femur from the Late Jurassic which was found below the church in the locality of Tera (Canudo et al. 2010). However, the museum also preserves a large collection of vertebrate tracks collected from different outcrops from the Huérteles Formation in the Highlands of Soria indeed, the collection has more than 70 slabs.

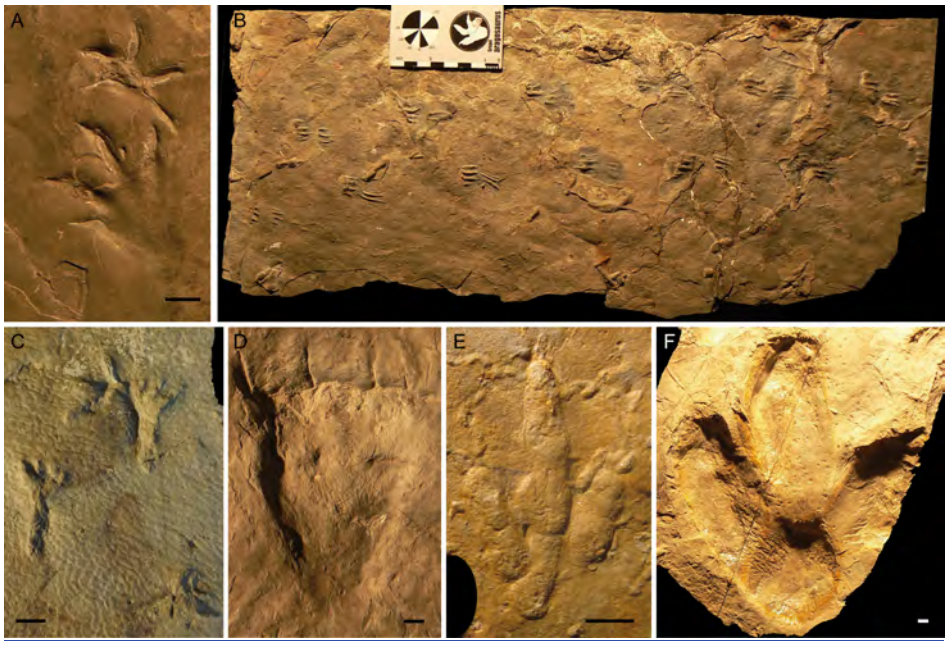

Fig. 4: Pictures of some of the slabs housed in the Numantine Museum. A) Close up picture a a manus-pes set of the holotype of *Crocodylopodus meijidei* (MNS2002-96-02) from the tracksite of Fuente Lacorte (Fuentes Vidarte and Meijide Calvo, 2001). B) Slab with the holotype trackway of *Emydhipus cameroi* (MNS2002-96-38) from the tracksite of Valduérteles IV. C) Close up picture of the holotype of *Pteraichnus longipodus* (MNS2003-92-5) from the tracksite of Serrantes. D) Large pterosaur track (MNS-2011/19-b) assigned to *Pteraichnus palacieisaenzi* from tracksite of Serrantes (Pascual-Arribas et al. 2015). E) Tiny theropod track (MNS2005-111-4A) assigned to *Kalohipus bretunensis* from the tracksite of Valdehijuelos (Pascual-Arribas and Hernández-Medrano, 2011; Castanera et al. 2015). F) Ornithopod track (MNS-2002-96-2) related to *Iguanodontipus* (Castanera et al. 2013) from Villar del Río.

From the point of view of heritage and science, the most significant material is composed by the holotypes of various vertebrate ichnotaxa, although there are other significant specimens that belong to ichnotaxa also described in other regions. Though accessible to researchers, the collection is not on display to the general public, yet it could be a great additional attraction for visitors to the "Ruta de las icnitas". A quick overview of the collection cannot fail to highlight the holotypes of *Crocodylopodus meijidei* Fuentes Vidarte and Meijide Calvo, 2001 (Fig. 4A) and *Emydhipus cameroi* Fuentes Vidarte et al. 2003 (Fig. 4B), which are among the few ichnotaxa assigned to crocodylomorphs and chelonians, respectively. In terms of heritage, their value is particularly considerable given the low number of ichnotaxa (and footprints) that have been described from either group worldwide (Avanzini et al. 2005; Lockley et al. 2010). In addition, the collection houses a great number of slabs with pterosaur tracks, some of which are holotypes of ichnospecies assigned to the ichnogenus *Pteraichnus* (see reviews in Sánchez-Hernández et al. 2009; Pascual-Arribas et al. 2015). It includes the

holotypes of *P. parvus*, *P. longipodus* (Fig. 4C), "*P. manueli*" and tracks assigned to "*P. vetustior*" (Sánchez-Hernández et al. 2009). There are also tracks belonging to the ichnospecies *P. palacieisaenzi* (Fig. 4D), the holotype of which is preserved at the Los Tormos tracksite (Pascual-Arribas et al. 2015) and tracks assigned to *P. cf. stokesi* (Pascual-Arribas and Hernández-Medrano, 2016). This collection is a reference point for the study of pterosaur tracks, since it preserves almost half of the ichnospecies attributed to *Pteraichnus* in the world (Pascual-Arribas et al. 2015).

Furthermore, the Numantine Museum houses a varied and significant collection of dinosaur tracks. Of particular note for their exquisite preservation are the tiny theropod tracks (with a footprint length of ca. 5 cm, Fig. 4E) (Pascual-Arribas and Hernández-Medrano 2011), recently assigned to *Kalohipus bretunensis* (Castanera et al. 2015), and the large theropod tracks of the ichnotaxon *Iberosauripus* (Castanera et al. 2015). Both ichnotaxa have only been described in the Iberian Range. Additionally, the collection includes ornithopod tracks (Fig. 4F) related to the typical ornithopod ichnotaxa *Iguanodontipus* (Castanera et al. 2013; Díaz-Martínez et al. 2015), as well as specimens of stegosaur tracks (*Deltapodus*), one of them being the only as yet known stegosaur track in the Early Cretaceous of Europe (Pascual et al. 2012). Other significant tracks are the huge sauropod casts from the tracksite of Las Cuestas I (Pascual-Arribas and Hernández-Medrano 2010), which have preserved clear claw marks in detail, a feature not usually reported in sauropod tracks (Wright 2005).

Conclusions

The Highlands of Soria is one of the European areas with most dinosaur tracksites from the Early Cretaceous. These belong to the Huérteles Formation wich is Berriasian in age. Since the first work more than 35 years ago, scientific research in the area has been continuously increasing. This research has on the one hand provided the impetus for the Ichnite Route of Soria project, which consists of a trail around the main dinosaur tracksites in the area combined with a visit to the Palaeontological Educational Centre. This project, which has developed over the last 15 years, has involved both geoconservation work on the tracksites and efforts to bring the palaeoichnological sites to the public attention in order to foster tourism in this depopulated rural area.

On the other hand, the scientific research has also resulted in the recovery of significant slabs from the outcrops in question. These are housed in the Numantine Museum in Soria and represent one of the most significant collections of dinosaur (and other tetrapod) tracks in Europe. The special interest of the collection resides in the number of holotypes, the quality of anatomical details preserved in some of the tracks, and the fact that there are few places in the world with tracks from this particular period of time (Berriasian). Additionally, it throws new light on our knowledge of the faunas at the base of the Cretaceous in this part of the Iberian Peninsula. The

research into both the tracksites and the palaeontological collection increases the value of the palaeoichnological record not only from a scientific point of view, but also from the point of view of the heritage it represents and of drawing public attention to it. The display of the palaeoichnological collection would be a magnificent complement to the Ichnite Route of Soria project.

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Figure Captions:

Fig. 1: Geographical setting of the Ichnite Route of Soria ("Ruta de las icnitas de Soria") showing the three routes (east, west and walking route) trough the tracksites (modified from www.rutadelasicnitas.com). The majority of the slabs collected and now housed in the Numantine Museum from Soria come from sites located in these localities.

Fig. 2: Pictures of some footprints preserved in the tracksites that compose the Ichnite Route of Soria ("Ruta de las icnitas de Soria"). A) Large theropod tracks in the tracksite of La Matecasa (*Megalosauripus* isp., Barco et al. 2004). B) Tiny theropod track (*Kalohipus bretunensis*, Fuentes Vidarte and Meijide Calvo 1998) in the tracksite of Santa Cristina. C) Sauropod trackway in the tracksite of Las Cuestas I (Pascual-Arribas and Hernández-Medrano, 2010). D) Medium-sized ornithopod track related to *Iguanodontipus* (Castanera et al. 2013) in the tracksite of La Peña. E) Ornithopod trackway in the tracksite of Santa Cruz. F) Large pes pterosaur track (*Pteraichnus palacieisaenzi*, Pascual-Arribas et al. 2015) in the tracksite of Los Tormos. G) Small manus-pes pterosaur track set (*Pteraichnus*) Pascual Arribas and Hernández Medrano, 2012). Scale card = 10 cm (A) and 8 cm (E). Scale bar = 1 cm.

Fig. 3: Pictures of some of the tracksites that composed the Ichnite Route of Soria. A) Tracksite of Fuente Lacorte (bottom of the picture) and tracksite of El Frontal (top of the picture) in the locality of Bretún. Note the *Allosaurus* between the tracksites. B) Tracksite of San Roque with a representation of an iguanodontid that could be arguable of an ornithopod iguanodontid. C) Tracksite of Fuentesalvo. D) Tracksite of Miraflores I with a new representation of a diplopocoid sauropod.

Fig. 4: Pictures of some of the slabs housed in the Numantine Museum. A) Close up picture a a manus-pes set of the holotype of *Crocodylopodus meijidei* (MNS2002-96-02) from the tracksite of Fuente Lacorte (Fuentes Vidarte and Meijide Calvo, 2001). B) Slab with the holotype trackway of *Emydhipus cameroi* (MNS2002-96-38) from the tracksite of Valduérteles IV. C) Close up picture of the holotype of *Pteraichnus longipodus* (MNS2003-92-5) from the tracksite of Serrantes. D) Large pterosaur track (MNS-2011/19-b) assigned to *Pteraichnus palacieisaenzi* from tracksite of Serrantes (Pascual-Arribas et al. 2015). E) Tiny theropod track (MNS2005-111-4A) assigned to *Kalohipus bretunensis* from the tracksite of Valdehijuelos (Pascual-Arribas and Hernández-Medrano, 2011; Castanera et al. 2015). F) Ornithopod track (MNS-2002-96-2) related to *Iguanodontipus* (Castanera et al. 2013) from Villar del Río.