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RESEARCH PAPER

New ornithopod fossils and associated faunas from the upper Hauterivian–lower Barremian (Lower Cretaceous) El Castellar Formation in the Province of Teruel

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Abstract

The El Castellar Formation (upper Hauterivian–lower Barremian) usually represents the beginning of Lower Cretaceous sedimentation in the southwest of the Maestrazgo Basin (Province of Teruel, Spain). It is constituted by a lower sedimentary succession of shales, evaporites and sandstones, and an upper one of limestones and marlstones, both deposited in coastal wetland systems. The dinosaur fossil record is mainly composed of fragmentary bone remains and very scarce tracks. However, the osteological record demonstrates that a highly diversity of dinosaurs was present in this region. In the present study, several vertebral centra of a large ornithopod styracosternan are examined. These remains closely resemble others related to the late Hauterivian–early Barremian *Iguanodon galvensis*. The presence of a large styracosternan related to this species appears to be increasingly common in the facies of the El Castellar Formation. In addition, we provide an overview of the dinosaur findings in this lithostratigraphic unit and geological area. The fossil record not only reflects that large-sized ornithopods were the most common dinosaurs in this formation, but also that they coexisted with small basal ornithopods, huge sauropods, spinosaurids, small coelurosaurs and the extremely scarce thyreophorans. Finally, these faunas are highly similar to those of other Early Cretaceous faunas from other regions in the Iberian Peninsula and Europe.

Keywords Saurischia · Ornithischia · Styracosterna · Tracks · Palaeodiversity · Maestrazgo Basin

Nuevos fósiles de ornitópodos y faunas asociadas del Hauteriviense superior-Barremiense inferior (Cretácico Inferior) de la Formación El Castellar en la provincia de Teruel

Resumen

La Formación El Castellar (Hauteriviense superior–Barremiense inferior) suele representar el inicio de la sedimentación del Cretácico Inferior en el suroeste de la Cuenca del Maestrazgo (provincia de Teruel, España). Está constituida por un tramo sedimentario inferior de lutitas, evaporitas y areniscas, y otro superior de calizas y margas, ambas depositadas en sistemas de humedales costeros. El registro fósil de dinosaurios se compone principalmente de restos esqueléticos fragmentarios y de huellas muy escasas. Sin embargo, el registro osteológico demuestra que en esta región estuvo presente una gran diversidad de dinosaurios. En el presente estudio, se examinan varios centros vertebrales de un gran ornitópodo estiracosterno. Los

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fósiles se asemejan mucho a otros relacionados con*Iguanodon galvensis* del Hauteriviense–Barremiense. La presencia de un gran estiracosterno relacionado con esta especie parece ser cada vez más común en las facies de la Formación El Castellar. Además, proporcionamos una visión general sobre los hallazgos de dinosaurios en esta unidad litoestratigráfica y área geológica. El registro fósil refleja que los ornitópodos de gran tamaño fueron los dinosaurios más comunes en esta unidad, pero también que coexistieron con pequeños ornitópodos basales, enormes saurópodos, espinosaurios, pequeños celurosaurios y los extremadamente escasos tireóforos. Por último, estas faunas son muy similares a otras del Cretácico Inferior en otras regiones de la Península Ibérica y Europa.

Palabras Clave Saurischia · Ornithischia · Styracosterna · Icnitas · Paleodiversidad · Cuenca del Maestrazgo

1 Introduction

Nowadays, the recurrent discoveries of fossils in the Lower Cretaceous sediments of the Province of Teruel have evidenced that dinosaurs were highly diverse (Alcalá et al., 2018; Pereda-Suberbiola et al., 2012; Verdú et al., 2019; references therein). In fact, several new genera and species have been erected in the last two decades in the Province of Teruel (e.g., Canudo et al., 2008; Kirkland et al., 2013; McDonald et al., 2012; Ruiz-Omeñaca et al., 2012; Sánchez-Hernández & Benton, 2014; Verdú et al., 2015). The upper Hauterivian–lower Barremian El Castellar Formation (Salas, 1987), in the southwest of the Maestrazgo Basin (Teruel, Spain) (Salas & Guimerà, 1996), has provided a considerable number of osteological fossils of diverse groups of dinosaurs (e.g., García-Cobeña et al., 2022, 2023; Gasca et al., 2009b; Ruiz-Omeñaca, 2006; Verdú et al., 2019). In contrast, dinosaur track findings at present are scarcer and less diverse than direct remains, and all of them are preserved as casts with different degrees of anatomical detail (e.g., Castanera et al., 2022; García-Cobeña et al., 2022, 2023).

Here, we report on several new isolated vertebral centra of a large-sized ornithopod from the site CT-7 (Fon Santi site), in facies of the El Castellar Formation in the municipality of El Castellar (Teruel, Spain). We conduct a systematic study of this material to determine the taxonomic affinities with other Early Cretaceous large ornithopods from Europe. In addition, we review the most relevant dinosaur fossil discoveries from the El Castellar Formation in the Province of Teruel, in order to describe their diversity in this region (Maestrazgo Basin, eastern Iberian Basin).

Institutional abbreviations: CPT- Conjunto Paleontológico de Teruel, Teruel, Spain; MAP, Museo Aragonés de Paleontología, Teruel, Spain.

Other abbreviations: CT, El Castellar sites, El Castellar, Teruel, Spain.

2 Geographical and geological settings

In 1987, Salas formally defined a siliciclastic-carbonatic unit, which he named the El Castellar Formation and whose stratotype is located in the municipality of El Castellar, in the Province of Teruel (Aragón, north–eastern Spain) (Fig. 1a, b).

Geologically, this formation outcrops extensively in the southwest of the Maestrazgo Basin (eastern Iberian Basin) (Fig. 1c), mainly in the Peñagolosa (or Cedramán sensu Salas et a., 2019) and Galve sub-basins (Fig. 1d). Both areas, together with those known as La Saledella, Morella, El Perelló, Aliaga (or Las Parras sensu Soria, 1997) and Oliete, constitute this basin. The Galve and Peñagolosa sub-basins are separated by the Cedrillas normal fault (Salas & Guimerà, 1996) (Fig. 1d).

The El Castellar Formation is, in essence, divided into two stages: a detrital lower one with shales, evaporites and sandstones, and a carbonatic upper one with marlstones and limestones (e.g., Cobos et al., 2012) (Fig. 1e). Fernández-Labrador (2016, unpublished data) interprets the sedimentary system as a coastal wetland system, composed of fluvial, lacustrine and palustrine facies that represent several sedimentary environments. Moreover, Fernández-Labrador (2016, unpublished data) pointed out that it was easily flooded and with a continental contribution. This unit uncomfortably rests on the Villar del Arzobispo Formation (Kimmeridgian-Tithonian sensu Campos-Soto et al., 2017) in both sub-basins, and overlies the Mora de Rubielos Formation (late Berriasian-early Valanginian in age according to Mas et al., 2004; Salas et al., 2001) locally, in the south–southeast of the Peñagolosa sub-basin (Caja-Rodríguez, 2004; Campos-Soto et al., 2017, 2019). Finally, the El Castellar Formation is dated as upper Hauterivian–lower Barremian based on its charophyte content (Martín-Closas, 1989).

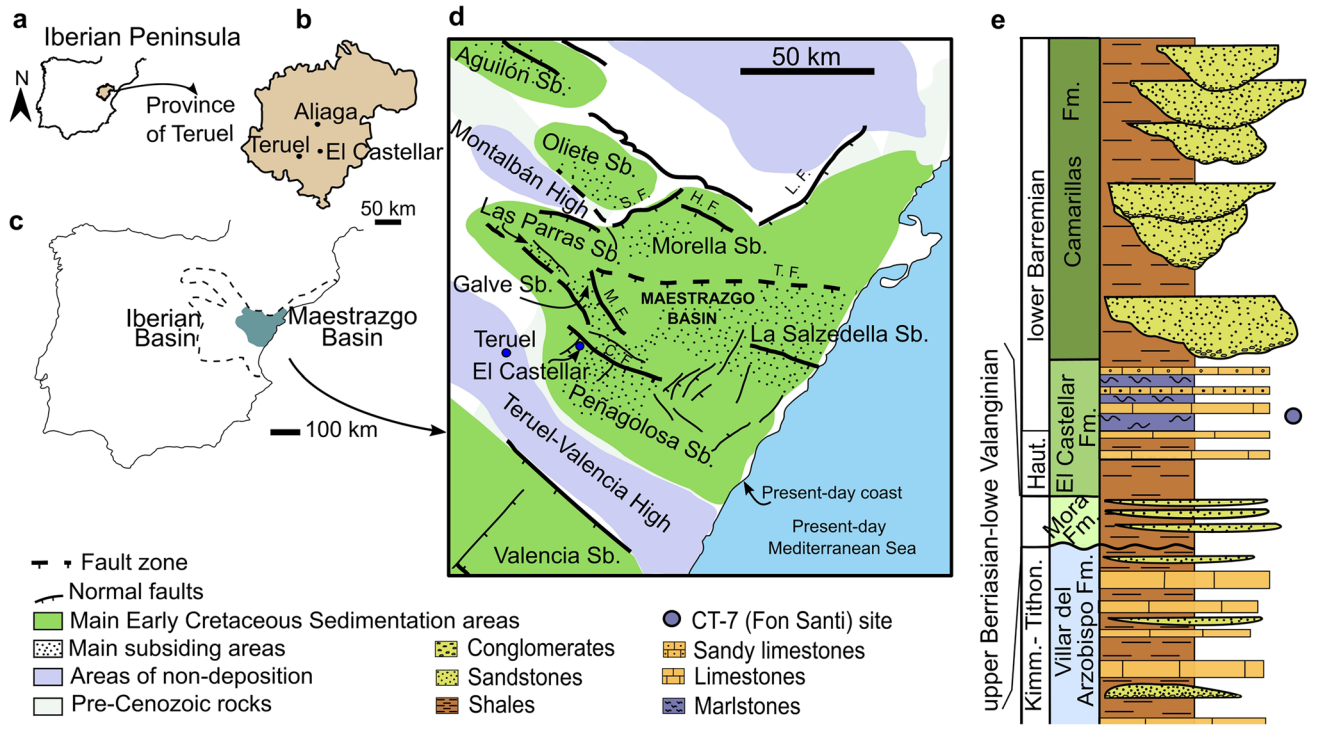

Fig. 1 Geographical and geological settings. **a**, **b** Geographical situation of the study area (Province of Teruel). **c** Map of the Iberian Peninsula with the location of the Maestrazgo Basin (redrawn from Salas et al., 2001). **d** Map of the Maestrazgo Basin (redrawn from Liesa et al., 2019). **e** Simplified stratigraphic section of the Lower Cretaceous (pre-Aptian) of the southwest Maestrazgo Basin (modified from García-Cobeña et al., 2022). Abbreviations: H.F., Herbers Fault; Haut., Hauterivian; Kimm., Kimmeridgian; L.F., La Llaberia Fault; M.F., Miravete Fault; S. F. Segre Fault; Sb., Sub-basin; Tithon., Tithonian; T.F., Turmell Fault

Table 1 Measurements (in mm) of the osteological fossils from the CT-7 site

Collection number	MAP-8343	MAP-8345	MAP-726	CPT-727	CPT-3901	CPT-3904	MAP-8344
Element	Cervical centrum	Dorsal? centrum	Caudal centrum	Caudal centrum	Caudal centrum	Caudal centrum	Caudal centrum
L	89.6	79.1	68.1	62.5	76.8	42.8	81.3
Ha	67.8	79.3*	51.3	48.1*	85.7	33.9	61.9
Hp	54.8	–	44.9*	54.8	86.7	37.9	58.4
Wa	63.7	–	49.8	47.7*	77.8	32.7	52.7
Wp	74.5	–	51.5	54.9*	82.1	35.8	53.43

L length; *Ha* anterior height; *Hp* posterior height; *Wa* anterior weight; *Wp* posterior weight

*Estimated measurements

3 Material and methods

The material of the large ornithopod from the CT-7 site is constituted by one cervical, one potential dorsal and five caudal vertebrae (Table 1). These bone remains are systematically studied using the phylogenetic hypothesis of Iguanodontia by Verdú et al. (2018) as a framework and compared with other Early Cretaceous styracosternans. Measurements of these fossils were taken for the length (L), the anterior (Ha) and posterior height (Hp) and the anterior (Wa) and posterior width (Wp) (Table 1). Assignations in open nomenclature are made following Sigovini et al. (2016).

In addition, our revision of the most significant dinosaur findings from the El Castellar Formation of the southwest Maestrazgo Basin is based mainly on the works of Ruiz-Omeñaca (2006), Gasca et al. (2009b) and Cobos (2011, unpublished). However, we update the general dinosaur record of this lithostratigraphic unit and geological area with the most recent

works. Moreover, we figure some relevant fossils of dinosaurs previously described in this formation.

4 Results

4.1 Systematic palaeontology

Dinosauria Owen, 1842
Ornithischia Seeley, 1887 (sensu Madzia et al., 2021).
Ornithopoda Marsh, 1881 (sensu Madzia et al., 2021).
Iguanodontia Dollo, 1888 (sensu Madzia et al., 2021).
Dryomorpha Sereno, 1986 (sensu Madzia et al., 2021).
Ankylopollexia Sereno, 1986 (sensu Madzia et al., 2021).
Styracosterna Sereno, 1986 (sensu Madzia et al., 2021).

4.2 Styracosterna indet

4.2.1 Referred material

A centrum of a cervical vertebra (MAP-8343; Fig. 2a–e), a fragment of a possible centrum of a middle-to-posterior dorsal vertebra (MAP-8345; Fig. 2f, g), a centrum of an anterior caudal vertebra (CPT-3901; Fig. 2h, i), three centra of middle caudal vertebrae (MAP-8344, CPT-727 and CPT-726; Fig. 2j–o), and a centrum of a posterior caudal vertebra (CPT-3904; Fig. 2p, q).

4.2.2 Site, Horizon, and Age.

The CT-7 (Fon Santi) site, in the El Castellar Village (Teruel, Spain) (Fig. 1a, b). Peñagolosa sub-basin, Maestrazgo Basin (Fig. 1c, d). The El Castellar Formation, upper Hauterivian–lower Barremian (Lower Cretaceous) (Fig. 1e).

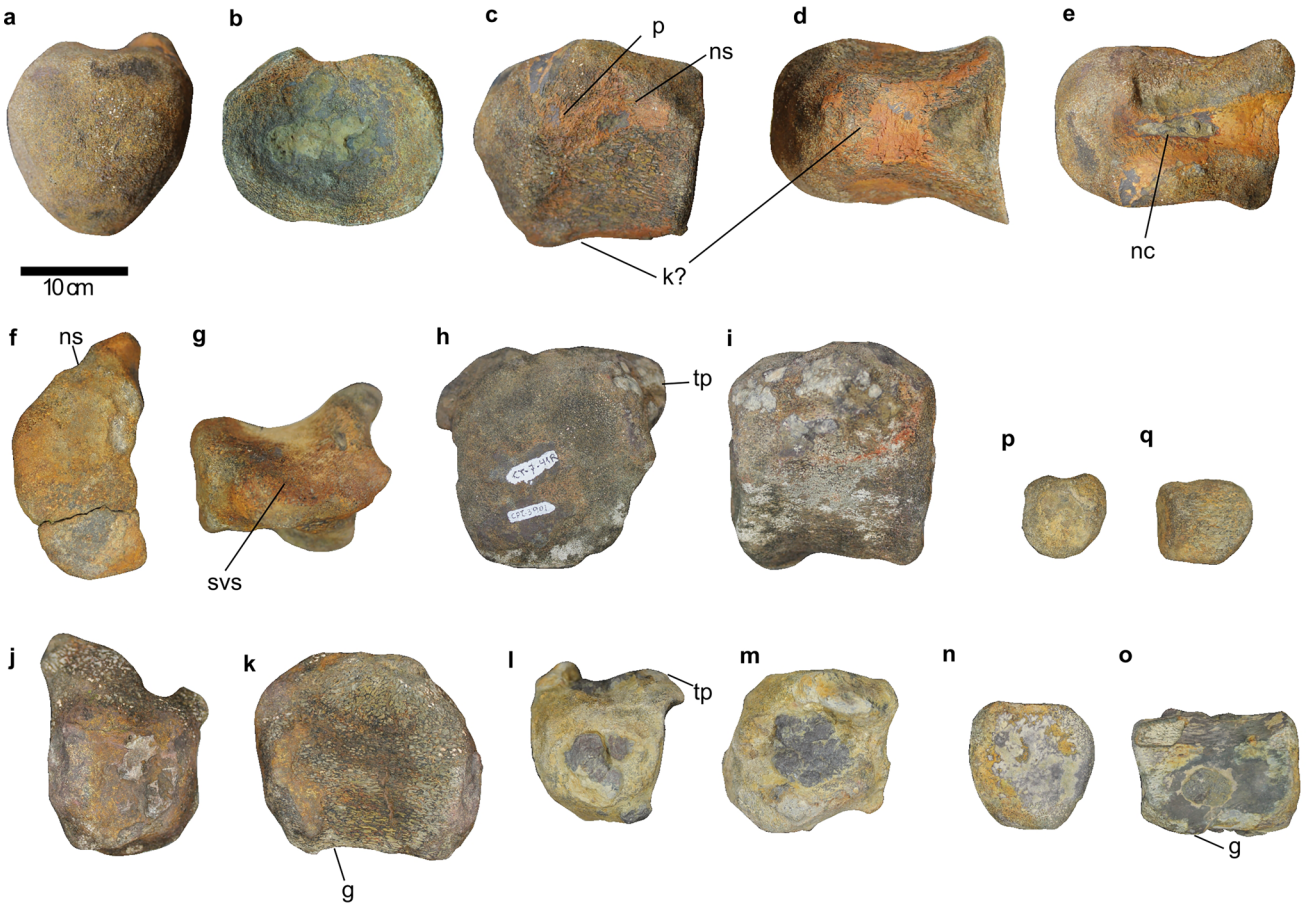

Fig. 2 Styracosterna indet. fossils from CT-7 site. **a**–**e** Cervical centrum MAP-8343 in anterior (**a**), posterior (**b**), lateral (**c**), ventral (**d**) and dorsal (**e**) views. **F**, **g** Centrum of a possible middle-to-posterior dorsal MAP-8345 in anterior (**f**) and ventral (**g**) views. **h**, **i** Anterior caudal centrum CPT-3901 in anterior (**h**) and lateral (**i**) views. **j**, **k** Middle caudal centrum MAP-8344 in anterior (**j**) and lateral (**k**) views. **l**, **m** Middle caudal centrum CPT-727 in anterior (**l**) and lateral (**m**) views. **n**, **o** Middle caudal centrum CPT-726 in anterior (**n**) and lateral (**o**) views. **p**, **q** Posterior caudal centrum CPT-3904 in anterior (**p**) and lateral (**q**) views. Abbreviations: g, ventral groove; k, keel; nc, neural canal; ns, neurocentral suture; p, parapophyses; svs, smooth ventral surface; tp, transverse processes

4.2.3 Descriptions

MAP-8343 is a centrum of a cervical vertebra. The cranial articular facet is heart-shaped (higher than wide) (Fig. 2a) and the caudal articular facet is subelliptical (wider than high) (Fig. 2b). It is rather larger than high and wide and is highly opisthocoelous (Fig. 2c). The lateral surfaces are craniocaudally concave and preserve the base of the parapophyses, which are almost eroded (Fig. 2c). The ventral surface displays a protuberance similar to a non-developed keel in the anterior region (Fig. 2d). In dorsal view, the neural canal becomes wider towards the caudal region. The neurocentral suture is closed (Fig. 2e).

The centrum of a possible middle-to-posterior dorsal vertebra MAP-8345 is highly fractured and eroded. It only preserves its half anterior articular facet, the right lateral and the ventral surface. This centrum is apparently amphiplatyan and higher rather than long (Fig. 2f). In lateral view, it is moderately compressed and preserves a region with a closed neurocentral suture. Moreover, the ventral surface is flat, without a ventral keel (Fig. 2g).

The anterior caudal region is represented only by a platycoelous centrum CPT-3901. The articular facets are subrectangular, and higher than wide (Fig. 2h). In lateral view, it has a rectangular shape, and it is higher than long (Fig. 2i). The neural canal is narrow.

The middle and posterior regions of the tail are represented by MAP-8344, CPT-727, CPT-726, and CPT-3904 centra (Fig. 2j–o). All of them are amphiplatyan (slightly platycoelous) and with hexagonal or subhexagonal articular facets (Fig. 2j, l, n, p). Due to their preservation, they do not show chevron facets. The neural canal, which is already narrow in the case of MAP-8344, becomes even narrower towards the more posterior caudals, as in the case of CTP-3904. A ventral sulcus is only present in MAP-8344 and CPT-726 (Fig. 2k, o). The other centra have an eroded ventral surface.

5 Discussion

5.1 Comparisons of the skeletal remains with other Lower Cretaceous styracosternans

The lack of repetition of osteological remains from the CT-7 site, their considerable size and the concordance in the size of these fossils, reflect that they may belong to a single specimen. Moreover, the presence of a closed neurocentral suture in the centrum of the cervical vertebra MAP-8343 (Fig. 2c), and that of the possible middle-to-posterior dorsal vertebra MAP-8345 (Fig. 2f), evidence that these fossils potentially belonged to a subadult or adult individual (e.g., Hübner, 2018; Verdú, 2017). Moreover, they are identified as belonging to an iguanodontian ornithopod based on the presence of a sinuous neurocentral suture in the vertebral centra and these without pleurocoeli, and middle caudal vertebrae with hexagonal articular facets (Knoll, 2009; Norman, 2004; Pereda-Suberbiola et al., 2011; Verdú et al., 2019, 2020). In particular, they belong to Styracosterna indet. because of the strongly opisthocoely in the cervical centrum MAP-8343 (Fig. 2c), a diagnostic feature of the clade (sensu Norman, 2015). This element resembles those highly opisthocoelous and ventrally keeled (not markedly pronounced in MAP-8343 and more similar to a protuberance, Fig. 2c) cervical vertebrae of other European Early Cretaceous styracosternans—for instance, *Barilium* (Norman, 2011), *Hypselospinus* (Norman, 2015), *Iguanodon* cf. *galvensis* (García-Cobeña et al., 2022; Verdú et al., 2020), *I. bernissartensis* (Norman, 1980), *Mantellisaurus* (Norman, 1986) and *Proa* (unpublished specimen AR-1/103).

The possible centrum of a middle-to-posterior dorsal centrum MAP-8345 (Fig. 2f, g) resembles those higher than long of *Barilium* (Norman, 2011), *Magnamanus* (Fuentes-Vidarte et al., 2016), *I.* cf. *galvensis* (Verdú et al., 2020; García-Cobeña et al., 2022), *Brighstoneus* (Lockwood et al., 2021) and *I. bernissartensis* (Norman, 1980), unlike those longer than high of *Mantellisaurus* (Norman, 1986) and *Morelladon* (Gasulla et al., 2015). Moreover, it apparently lacks a ventral keel, such as the middle and posterior dorsal vertebrae of *I.* cf. *galvensis* (García-Cobeña et al., 2022; Verdú et al., 2020) and *Magnamanus* (Fuentes-Vidarte et al., 2016). In contrast, those of *Barilium* (Norman, 2011), *Hypselospinus* (Norman, 2015), *I. bernissartensis* (Norman, 1980), *Mantellisaurus* (Norman, 1986), *Brighstoneus* (Lockwood et al., 2021), and *Morelladon* (Gasulla et al., 2015) exhibit a ventral keel. Moreover, this centrum is moderately compressed between the articular facets, as in *I.* cf. *galvensis* (García-Cobeña et al., 2022; Verdú et al., 2020) and *Magnamanus* (Fuentes-Vidarte et al., 2016).

For its part, the anterior caudal centrum CPT-3901 is platycoelous with subquadrangular articular facets and a smooth ventral surface (Fig. 2h, i), as in *Hypselospinus* (Norman, 2015), *Magnamanus* (Fuentes-Vidarte et al., 2016), *I.* cf. *galvensis* (García-Cobeña et al., 2022), *I. bernissartensis* (1980) and, apparently, *Brighstoneus* (Lockwood et al., 2021). In contrast, it differs from the amphiplatyan caudal vertebrae of *Barilium* (Norman, 2011), perinates of *I. galvensis* (Verdú, 2017), and *Mantellisaurus* (Norman, 1986).

Therefore, the material of the CT-7 site is assigned to Styracosterna indet. based on the highly opisthocoely of the centrum of a cervical vertebra. Besides, the middle-to-posterior dorsal vertebra with higher than long and moderately compressed centrum with a smooth ventral surface, and the anterior caudal vertebra with platycoelous centrum and subquadrangular articular facets, resemble those vertebrae of some indeterminate

styracosternans from the Barremian of the Province of Teruel (García-Cobeña et al., 2023; Medrano et al., 2023; Verdú et al., 2019) and from the Cape Espichel of Portugal (e.g. Figueiredo et al., 2022), and others related to *I. galvensis* (García-Cobeña et al., 2022; Verdú et al., 2020). This osteological material is clearly different from that of other Early Cretaceous styracosternans of Europe, except for *Magnamanus*, whose relation with *Iguanodon* should be re-assessed (Verdú et al., 2020). Despite this similarity, the fragmentary preservation of these fossils does not allow us to confidently assign them to *Iguanodon galvensis.*

5.2 Dinosaur diversity of the El Castellar Formation in the southwest of the Maestrazgo Basin

Although osteological fossils are abundant in the facies of the El Castellar Formation, they are usually fragmentary (e.g., Gasca et al., 2009b), being vertebral centra, teeth and bone fragments the most common skeletal elements found (García-Cobeña et al., 2022). However, a great variety of direct remains of saurischian and ornithischian dinosaurs have been described in the last few years in the Galve and Peñagolosa sub-basins (e.g. Castanera et al., 2022; Cobos, 2012; Cobos et al., 2012; García-Cobeña et al., 2022, 2023; Gasca, 2011; Gasca et al., 2008, 2009a, b; Ruiz-Omeñaca, 2006; Verdú et al., 2019).

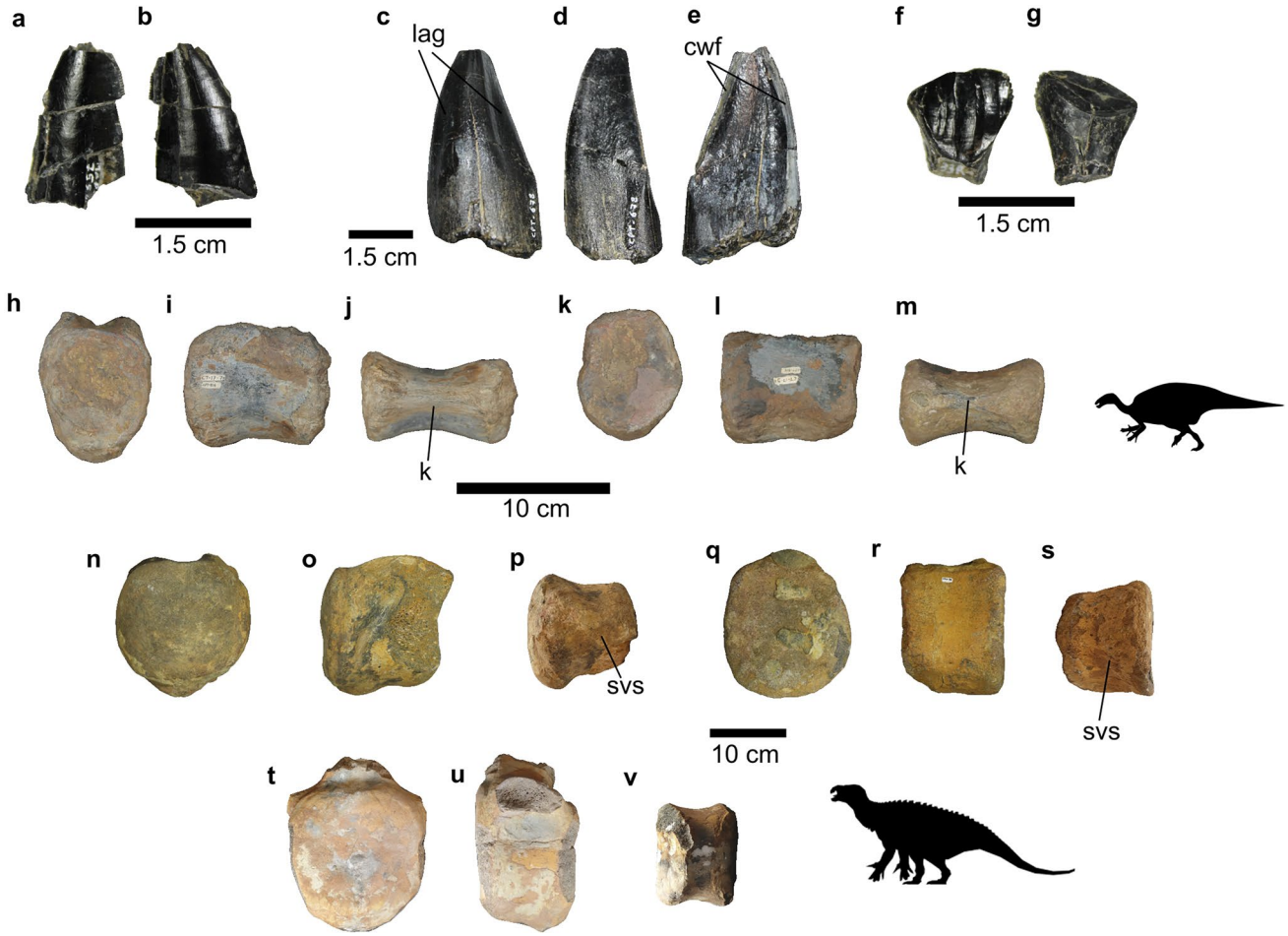

Fig. 3 Some relevant dinosaur fossils from the El Castellar Formation of the Peñagolosa sub-basin. **a**, **b** Tooth of Theropoda indet. (MAP-7555) in lingual (**a**) and labial (**b**) views. **c**–**e** Tooth of *Oplosaurus armatus* (CPT-678) in labial (**c**), distal (**d**) and lingual (**e**) views. **f**, **g** Tooth of Styracosterna indet. (MAP-7566) in lingual (**f**) and labial (**g**) views. **h**–**m** Vertebral centra of the medium-sized styracosternan related to *Morelladon* (sensu Verdú et al., 2019): middle-to-posterior dorsal centrum MAP-816 in anterior (**h**), lateral (**i**) and ventral (**j**) views; middle-to-posterior dorsal centrum MAP-814 in anterior (**k**), lateral (**l**) and ventral (**m**) views. **n**–**v** Vertebral centra of the large-sized *Iguanodon* cf. *galvensis* (sensu García-Cobeña et al., 2022): anterior dorsal centrum MAP-8038 in anterior (**n**), lateral (**o**) and ventral (**p**) views; middle dorsal centrum MAP-8037 in anterior (**q**), lateral (**r**) and ventral (**s**) views; anterior caudal centrum MAP-8043 in posterior (**t**), lateral (**u**) and ventral (**v**) views. Abbreviations: cfw, carina wear facet; k, keel; lag, labial groove; svs, smooth ventral surface

Firstly, several taxa have been described among saurischians: (1) indeterminate theropods (e.g., Guerrero & Cobos, 2017; Fig. 3a, b); (2) basal tetanurans, for instance Allosauroidea? indet. (Ruiz-Omeñaca, 2006), Spinosauridae indet. (Gasca et al., 2018), Baryonychinae indet. (Gasca et al., 2008, 2009a, b) and aff. *Baryonyx* sp. (Gasca et al., 2018); (3) small coelurosaurs, such as Maniraptoriformes indet. (Gasca et al., 2009a, b; Ruiz-Omeñaca, 2006), Maniraptora indet., Velociraptorinae indet. and '*Prodeinodon*' sp. (Ruiz-Omeñaca, 2006); (4) and huge sauropods, such as Camarasauridae? indet., Euhelopodidae indet. (Ruiz-Omeñaca, 2006), '*Pleurocoelus valdensis*' (Ruiz-Omeñaca, 2006; Ruiz-Omeñaca & Canudo, 2005) and *Oplosaurus armatus* (Royo-Torres & Cobos, 2007; Fig. 3c–e).

On the other hand, ornithischians are represented by: (1) basal forms such as Heterodontosauridae indet. (Ruiz-Omeñaca, 2006); (2) thyreophorans such as Ankylosauria indet. (Gasca et al., 2009b); (3) small basal ornithopods, for instance Hypsilophodontidae indet. (Gasca et al., 2009a, b; Ruiz-Omeñaca, 2001, 2006;); and (4) styracosternan ornithopods, such as Styracosterna indet. (e.g., Guerrero & Cobos, 2017; Fig. 2f, g; large-sized and medium-sized morphotypes in Verdú et al., 2019; Fig. 3h–m), Iguanodontoidea indet. (Gasca et al., 2009a, b; Luque et al., 2006), cf. *Iguanodon* sp. (García-Cobeña et al., 2023; Ruiz-Omeñaca, 2006) and *Iguanodon* cf. *galvensis* (García-Cobeña et al., 2022; Fig. 3n–v). Besides, Pereda-Suberbiola et al. (2005) assigned two dermal armour remains from the El Castellar Formation of Galve to Stegosauria indet. However, other authors consider that these fossils come from the underlying Villar del Arzobispo Formation (Cobos et al., 2012; Luque et al., 2006; Royo-Torres et al., 2009).

This faunal composition is strongly similar to that of other Lower Cretaceous regions of the Iberian Peninsula, such as those registered in the facies of the Golmayo Formation of Soria Province (Fuentes-Vidarte et al., 2005, 2016; Pereda-Suberbiola et al., 2007; Royo-Torres et al., 2017), and Europe such as the Isle of Wight (e.g., Barker et al., 2021; Lockwood et al., 2021; Longrich et al., 2021; Martill & Hutt, 1996; Pond et al., 2014).

In contrast to skeletal fossils, tracks are less common in the El Castellar Formation. Despite this, there are some limestones, sandy limestones or sandstone levels that outcrop in the Peñagolosa sub-basin, which show a high number of load-bearing structures that can be attributed to a dinosaurian trackmakers. This phenomenon repeats laterally in other outcrops where the middle-upper stage of the El Castellar Formation appears, at least in this sub-basin (Fig. 4a–d). To date, all these tracks are preserved as casts and related to large-sized ornithopod styracosternan trackmakers (Castanera et al., 2022; García-Cobeña et al., 2022), some of which may be attributed to the genus *Iguanodon* (García-Cobeña et al., 2023). Systematically, García-Cobeña et al. (2022) identified several of these casts as Iguanodontipodidae indet.

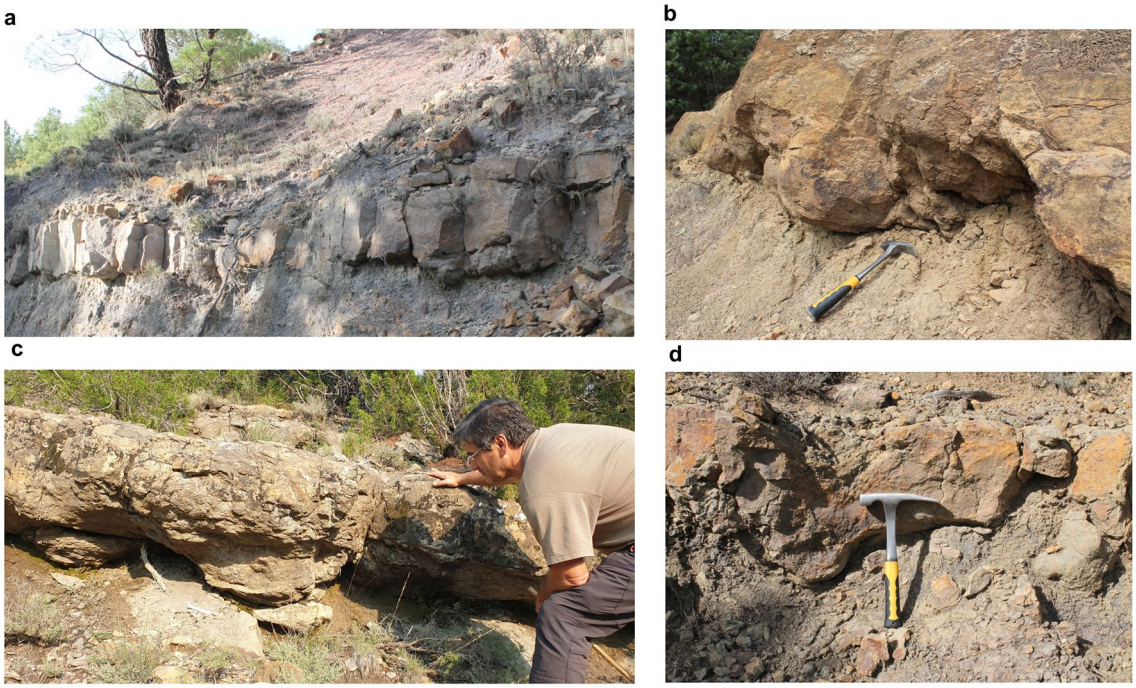

Fig. 4 Levels with load-bearing structures (dinosaur tracks) from the middle to upper part of the El Castellar Formation: several tracks in the same level (**a**), others isolated (**b**), some with a great size and thickness (**c**) and others less thick (**d**)

and others to *Caririchnium*-like morphologies. Posteriorly, García-Cobeña et al. (2023) assigned several tracks to *Caririchnium* isp, including an unusual association of a large manus and pes casts. In addition, Castanera et al. (2022) assigned some highly preserved tracks to the ichnospecies *C. magnificum* in the Galve sub-basin.

6 Conclusions

The El Castellar Formation (upper Hauterivian–lower Barremian) of the southwest of the Maestrazgo Basin represents a clear example of the wide presence of large ornithopods in the Lower Cretaceous of the Iberian Peninsula. The majority of the fossils of these dinosaurs were assigned to styracosternans. Indeed, those from the CT-7 site are here classified as belonging to a large specimen of Styracosterna indet. based on the highly opisthocoely of the cervical centrum. Although these fossils share some features in common with the early Barremian styracosternan *I. galvensis,* their degree of preservation does not allow us to classify them more inclusively.

The presence of these kinds of fossils provides increasing evidence that these dinosaurs, particularly those that may be potentially related to the large-sized *I. galvensis*, were frequent inhabitants of the ancient ecosystems developed in coastal wetland systems during the late Hauterivian–early Barremian, and they shared them with other contemporaneous dinosaurs, such as huge sauropods, spinosaurids, small coelurosaurs, small basal ornithopods and ankylosaurs.

Finally, the faunal composition registered in the El Castellar Formation is similar to other synchronic areas of the Iberian Peninsula and Europe, which reflects the great similarity among dinosaur faunas during the Early Cretaceous (Medrano-Aguado et al. 2023).

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Data availability All authors contributed to the study conception and design. All data supporting the fndings of this study are available within this paper. The remains studied here are deposited in a public institution (Museo Aragonés de Paleontología).

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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