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# New ornithopod remains from the Upper Jurassic of Asturias (North Spain)

**José Ignacio Ruiz-Omeñaca, Laura Piñuela and José Carlos García-Ramos**

*Museo del Jurásico de Asturias (MUJA), E-33328 Colunga, Spain.*
*jigruiz@unizar.es; lpinuela.muja@gmail.com;*
*jcgramos.muja@gmail.com*

## Introduction

Ornithopod tracks are relatively frequent in the Late Jurassic of Asturias (north Spain; see Lockley et al., 2008 and references therein). They have been discovered in three geological formations (Vega, Tereñes and Lastres), all Kimmeridgian in age according to ammonites, charophytes and ostracods (see Olóriz et al., 1988; Schudack and Schudack, 2002; and references therein).

Tracks show evidence of both big and small ornithopods. The biggest tracks (up to 45 cm in length) have been assigned to *Iguanodontipus* (cf. *Iguanodontipus*?, Lockley et al., 2008), and the smallest tracks to *Anomoepus* (Piñuela et al., 2008). A third, intermediate, ornithopod footprint morphology has not been assigned to any ichnogenus but they "very tentatively compare with *Moyenisauropus*" (Lockley et al., 2008).

Contrary to tracks, ornithopod bones are scarce in the Late Jurassic of Asturias. A total of 13 ornithopod remains are currently housed in the Jurassic Museum of Asturias (Spanish: Museo del Jurásico de Asturias; MUJA). Seven of them have been previously cited or described:

- three cervical vertebrae from Careñes, assigned to "*Camptosaurus* indet." by Ortega et al. (2006),
- a posterior dorsal centrum from Tazones W-1, described as Ornithopoda indet. (Ruiz-Omeñaca et al., 2007),
- two posterior dorsal centra from Puerto de Tazones, described as Ankylopollexia indet. (Ruiz-Omeñaca et al., 2009), and
- a maxillary tooth from Aranzón, described as Dryomorpha indet. (Ruiz-Omeñaca et al., 2010).

In this paper we present six unpublished remains (Table I) and revise the assignation of the three cervical vertebrae to *Camptosaurus*.

## Localities with ornithopod bony remains

The ornithopod remains come from several localities in the Villaviciosa municipality (Table I).They are from west to east: Aranzón (Quintueles parish), Playa España-E (Villaverde parish), El Trébol-E and Careñes (Careñes parish), and Tazones W-1 and Puerto de Tazones (Tazones parish). All the remains, but two from the Tereñes Formation, come from the Lastres Formation (Table I).

Table I. Ornithopod remains from the Late Jurassic of Asturias. 1: mentioned in Ortega et al. (2006) as "*Camptosaurus* indet."; 2: described in Ruiz-Omeñaca et al. (2007); 3: described in Ruiz-Omeñaca et al. (2009); 4: described in Ruiz-Omeñaca et al. (2010); *: this paper.

| taxon | material | locality |
|---|---|---|
| **Lastres Formation** (Kimmeridgian) | | |
| Dryomorpha indet. | maxillary tooth (MUJA-0857) [4] | Aranzón |
| Ankylopollexia indet. | fragment of ischium (MUJA-0085) * | Aranzón |
| Ankylopollexia indet. | caudal vertebra (MUJA-1971) * | Playa España-E |
| Ankylopollexia indet. | two caudal vertebrae (MUJA-1388) * | Playa España-E |
| Ankylopollexia? indet. | fragment of ossified tendon (MUJA-0194) * | El Trébol E |
| Ankylopollexia indet. | three cervical vertebrae (MUJA-0002) [1] | Careñes |
| Ornithopoda indet. | dorsal centrum (MUJA-1302) [2] | Tazones W-1 |
| Dryosauridae? indet. | fragment of pubis (MUJA-1401) * | Tazones W-1 |
| **Tereñes Formation** (Kimmeridgian) | | |
| Ankylopollexia indet. | two dorsal centra (MUJA-1914,1915) [3] | Puerto de Tazones |

## The cervical vertebrae from Careñes

Three postaxial cervical vertebrae from Careñes (MUJA-0002) were assigned to "*Camptosaurus* indet." by Ortega et al. (2006: 224), by having a combination of 1) vestigial neural spines, and 2) strongly opisthocoelous centra. They also noted that the articular faces of centra were similar to those of *Cumnoria prestwichii* (Hulke 1880) (as *Camptosaurus prestwichii*). Nevertheless, rudimentary postaxial cervical neural spines and strongly opisthocoelous cervicals 4-9 are characters of Ankylopollexia (Sereno, 1999: supplementary material), so it is better to assign the vertebrae to Ankylopollexia indet.

Galton and Powell (1980) recognised two valid species of the genus *Camptosaurus*: *C. dispar* (Marsh 1879) and *C. prestwichii,* being a third, *C. depressus* Gilmore 1909, provisionally accepted. A new species was created four years ago: *C. aphanoecetes* Carpenter *et* Wilson 2008. Last year, *C. aphanoecetes* and *C. depressus* have been renamed as *Uteodon aphanoecetes* and *Osmakasaurus depressus* and the generic name *Cumnoria* has been recovered (McDonald, 2011).

The length of the centra [75 mm] is bigger that in *Cu. prestwichii* [up to 50 mm] and *U. aphanoecetes* [up to 47 mm] (Galton and Powell, 1980: table 1; Carpenter and Wilson, 2008: table 1) and it is in the range size of *C. dispar* [up to 77 mm] (Gilmore, 1909: 242). Cervical vertebrae are not known in *O. depressus.*

## The new, unpublished, ornithopod remains

*Caudal vertebrae.*

Playa España-E site has provided three anterior caudal vertebrae, not associated between them and still in the matrix: one isolated (MUJA-1971) and two articulated ones (MUJA-1388). All bear chevron facets and long sub-horizontal transverse processes at the level of the neural channel. Its morphology is similar to that of *Camptosaurus* and basal styracosternans (Galton and Powell, 1980; Mateus and Antunes, 2001; Carpenter and Wilson, 2008). The centra are higher than wide, and wider than long.

The length of their centra [MUJA-1971: 55 mm; MUJA-1388: 70 and 67 mm] is bigger than in the anterior caudal centra of both Late Jurassic European species *Cu. prestwichii* [up to 53 mm] and *Draconyx loureroi* Mateus *et* Antunes 2001 [up to 52 mm] (Galton and Powell, 1980: table 1; Mateus and Antunes, 2001: table II). As they are non-diagnostic to genus level, we regard these vertebrae as Ankylopollexia indet.

*Ossified tendon.*

A fragment of ossified tendon from El Trébol-E (MUJA-0194), runned by longitudinal striations, measures 130 mm and is lateromedially compressed (20 x 12 mm in their biggest section). It looks like iguanodontian epaxial ossified tendons. By its size it probably belonged to a big (ankylopollexian) ornithopod, but is not diagnostic and assigned tentatively to Ankylopollexia? indet.

**I***schium.*

The distal half of a right ischium from Aranzón (MUJA-0085), preserves 235 mm of its length. The distal end is curved laterally and forms a boot-like expansion; its medial side is flat and bears numerous striations, forming a sutural surface for the left ischium. MUJA-0085 is very similar to the ischium of *Cu. prestwichii* in being rod-shaped and with a rounded expansion (Galton and Powell, 1980: fig. 9L-M).

Galton and Powell (1980: 437) list an ischium character in their diagnosis of the genus *Camptosaurus*: "bar-shaped distal part with dorso-ventrally expanded end". According to its original diagnosis (Carpenter and Wilson, 2008: 233), *C. aphanoecetes* "differs from *C. dispar* in... ischium with small distal foot". These authors also say that "the small rounded distal end of the ischium in *C. prestwichii*, (is) more similar to that of the small ischial foot seen in *C. aphanoecetes* than to the large ischial foot seen in *C. dispar*" (Carpenter and Wilson, 2008: 257). Following the recently revised specific diagnoses (McDonald, 2011: 56, 58), in *C. dispar* the "distal end of ischium forms rounded expansion", while in *U. aphanoecetes* and *Cu. prestwichii* it "forms cranially expanded boot". The ischium is not known in *O. depressus.*

With only the distal end of ischium is not possible to distinguish between *U. aphanoecetes* and *Cu. prestwichii*. MUJA-0085 shows

"camptosaurid" affinities, but as Camptosauridae is paraphyletic (McDonald, 2011), is better to refer this bone to Ankylopollexia indet.

*Pubis*

A fragment of right pubis from Tazones W-1 (MUJA-1401) preserves the acetabular area and parts of the obturator region and the prepubic process. It measures 52 mm in length as preserved. The obturator foramen probably was closed but its posterior wall is broken. The prepubic process is dorsoventrally compressed, the dorsolateral face is convex and has longitudinal striations for muscle insertions, the medial side is smooth and the ventral face is concave.

The mediolateral width exceeds the dorsoventral height, in contrast to ankylopollexian prepubic process that are compressed mediolaterally, with dorsoventral height exceeding mediolateral width (Norman et al., 2011: character 193; see also Norman, 2004: Appendix 19.1, character 56), so MUJA-1401 is from a non-ankylopollexian ornithopod.

Among non-ankylopollexian Late Jurassic ornithopods, this pubis is more similar to the pubis of dryosaurids *Dryosaurus altus* (Marsh 1878) and *Dysalotosaurus lettowvorbecki* Virchow 1919 (Galton, 1981, 1983), than to the pubis of the basal euornithopod *Othnielosaurus consors* (Marsh 1894) (Galton, 1983: figs. 6V, 6X-Y, 8A, 8R-U, plate 2 fig. 24, as *Othnielia rex* (Marsh 1877)).

The rod-shaped form of the prepubis is more similar to *Dy. lettowvorbecki* (Galton, 1981: figs. 5N, 5R; 1983: figs. 12G-M; see also Hübner, 2012: fig. 25) than to *D. altus* which has a more bladelike prepubis (Galton, 1981: figs. 5M, 5Q, 1983: figs. 3A-D, 10A-D, 18L-M). Nevertheless, for being incomplete, is tentatively assigned to Dryosauridae? indet.

## Implications for palaeoichnology

The osseous remains indicate the presence of, at least, two different ornithopod groups in the late Jurassic of Asturias: small non-ankylopollexian ones (*Dryosaurus*-like) and big ankylopollexian ones (*Camptosaurus*-like). This is in accordance with the record from the Late Jurassic Alcobaça and Lourinhã formations (Kimmeridgian-Tithonian) of Portugal, where there have been described remains of both dryosaurids: Aff. *Dryosaurus* sp., and "camptosaurids": *Draconyx loureroi* and *Uteodon aphanoecetes* (Escaso et al., 2010; Malafaia et al., 2010; Mateus and Milàn, 2010).

Non-ankylopollexian small ornithopods may be the track-makers of *Anomoepus* tracks, while ankylopollexians would produce the *Iguanodontipus*? tracks.

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