



***Bailiaspis* (Trilobita) with English affinities from the Mansilla Formation (Cambrian Series 3 of the Iberian Chains; NE Spain)**

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ABSTRACT

A new study of the trilobite record in the Mansilla Formation (Iberian Chains, NE Spain) has led to the discovery of the presence of *Bailiaspis* aff. *tuberculata*, *B. cf. tuberculata* and *Bailiaspis* sp., the first certain citation of this genus in the Mediterranean subprovince. The age of the findings extends from *Eccaparadoxides asturianus* Zone (upper Leonian) to the lowermost *Badulesia tenera* Zone (lower Caesaraugustan), which correspond to the upper part of Stage 5 of Cambrian Series 3 and, probably, the lowermost Drumian.

The specimens show the cranidial anterior border expanding backwards, forming a plectrum that is characteristic of *Bailiaspis*. The main characters of the three taxa include: a low convexity of the cranidium, with a very short or absent preglabellar field, and a cranidial sculpture with numerous densely-packed coarse tubercles. The only species that shows these diagnostic characters is *Bailiaspis tuberculata* from the middle Cambrian of England (Nuneaton, Warwickshire) in horizons inconclusively dated as the *Ptychagnostus gibbus*

RESUMEN

El estudio de del registro de los trilobites de la Formación Mansilla (Cadenas Ibéricas, NE de España) ha permitido reconocer la presencia de *Bailiaspis* aff. *tuberculata*, *B. cf. tuberculata* y *Bailiaspis* sp., supone la primera cita confirmada de este género en la subprovincia Mediterránea. La edad de los hallazgos se extiende desde la Zona de *Eccaparadoxides asturianus* (Leoniense superior) a la parte inferior de la Zona de *Badulesia tenera* (Caesaraugustiense inferior), que se corresponden con la parte superior del piso 5 del Cámbrico y, probablemente, con la parte basal del Drumense (Serie 3 del Cámbrico).

Los especímenes muestran su borde anterior del cranidio expandido posteriormente, constituyendo un plectrum, que es característico del género *Bailiaspis*. Los caracteres principales de los tres taxones estudiados son la baja convexidad del cranidio, un área preglabellar reducida o ausente y una ornamentación densa de tubérculos gruesos. La única especie de este género que presenta estos caracteres diagnósticos

Zone (Cambrian Stage 5). This zone has been previously correlated with the upper Leonian and lower Caesaraugustan; thus, the British and Spanish materials are probably of similar age.

Keywords: Systematic, trilobites, Cambrian Stage 5 and lowermost Drumian (Cambrian Series 3), biostratigraphy.

es *Bailiaspis tuberculata* del Cámbrico medio de Inglaterra (Nuneaton, Warwickshire) procedente de niveles datados con dudas como de la Zona de *Ptychagnostus gibbus* (Piso 5 del Cámbrico). Esta zona, previamente, ha sido correlacionada con el Leonense superior y el Caesaraugustense inferior; por lo que el material británico y español, probablemente, tienen una edad similar.

Palabras clave: Sistemática, Trilobita, Piso 5 del Cámbrico y Drumiense basal (Serie 3 del Cámbrico), bioestratigrafía.

1. INTRODUCTION

The traditional middle Cambrian (or provisional Cambrian Series 3) in the Iberian Chains has provided an important record of polymerid trilobites, together with sporadic myomerids (see Liñán *et al.*, 2008; Gozalo *et al.*, 2008). Polymerid trilobites enable fine stratigraphic subdivision of provisional Cambrian Series 2 through Furongian strata on most of the Cambrian palaeocontinents. The polymerids tend to be endemic and intercontinental correlation of these series is hampered by the strong provinciality of the trilobite fauna. Most of the species recorded in the Iberian Chains are endemic to the Mediterranean subprovince (*sensu* Sdzuy *et al.*, 1999). The problem of correlation is made worse by the scarcity of agnostoids in the Cambrian of the Mediterranean margin of West Gondwana and each new finding of fossils that potentially enables intercontinental correlation merits study and publication. The aim of this paper was to describe a bizarre conocoryphid trilobite from provisional Series 3, Stage 5, in the Iberian Chains. It closely resembles *Bailiaspis tuberculata* Lake, 1940 that has previously been described from Series 3 in England.

2. STRATIGRAPHY AND BIOSTRATIGRAPHY

The studied material of the Iberian Chains was collected in the upper part of the Mansilla Formation (Liñán *et al.*, 1992, 2002, 2004) in the Villafeliche 1 and Jarque 1 sections (Zaragoza province, NE Spain). Both sections are located within the Badules tectonostratigraphic unit (Fig. 1) (Gozalo & Liñán, 1988; Liñán *et al.*, 2008).

The Mansilla Formation is made up of alternations of brown dolostones and limestones and purple and violet shales, containing rich assemblages of trilobites, brachiopods, echinoderms, sponges and algae in its upper part. The formation varies in thickness between 10 to 90 meters and its top is slightly diachronic, ranging from the upper part of the *Eccaparadoxides asturianus* Zone

to the lower part of the *Badulesia granieri* Zone (Fig. 4). However, the material of *Bailiaspis* is very rare: we have identified more than 500 cranidia at specific level, but we only found 4 cranidia assigned to *Bailiaspis*, less than 1% of the classified material.

The Mansilla Formation has a thickness of 13.5 m in the Villafeliche 1 section (see Gozalo *et al.*, 1993, 1996; Fig. 2). We can distinguish two members. The lower member is 5 m thick and it is composed of nodular and thin-bedded decimetre-thick carbonate levels, these levels become metre-thick beds upwards; shales levels of millimetre or centimetre thickness are intercalated. All of them have red to pink colours. The upper member, 8.5 m thick, is composed of an alternation of red and violet shales and marls. This member has many scattered carbonate nodules that sometimes become a continuous decimetre-thick level. The Mansilla Formation is differentiated from other formations of the Mesones Group (which are mainly green or greyish green) by its reddish colours.

The only specimen of *Bailiaspis* aff. *tuberculata* Lake, 1940 was found in the level 1 of this section. The trilobite assemblage recorded at this level is composed of *Peronopsis acadica* (Hartt in Dawson, 1868), *Eccaparadoxides sdzuyi* Liñán, 1978, *E. asturianus* (Sdzuy, 1968), *E. sulcatus* Liñán & Gozalo, 1986, *Asturiaspis inopinatus* Sdzuy, 1968, *Parasolenopleura aculeata* (Angelin, 1851) [senior synonym of *Conocephalites ouangondianus* Hartt in Dawson, 1868, *sensu* Fletcher, 2006], *Parabailiella sebarensis* Sdzuy, 1968, *Parabailiella matutina* Sdzuy, 1968 and *Holocephalina? leve* Gozalo & Liñán, 1996. The age of this level is *Eccaparadoxides asturianus* Zone (upper Leonian; see Figs 2 and 4) that has been correlated with the *Acadoparadoxides pinus* Zone from Baltica (see Sdzuy *et al.*, 1999, fig. 5). Recently, Palacios (2015) analysed several sections with trilobites and acritarchs in the Cantabrian Mountains and proposed the correlation between the *Eccaparadoxides asturianus* Zone and the *Ptychagnostus gibbus* Zone.

The Mansilla Formation has a thickness of 72 m in the Jarque 1 section (see Liñán *et al.*, 1996, 2008; Chirivella Martorell *et al.*, 2003; Fig. 3), where two members are also recognized. The lower member is more carbonate-rich and

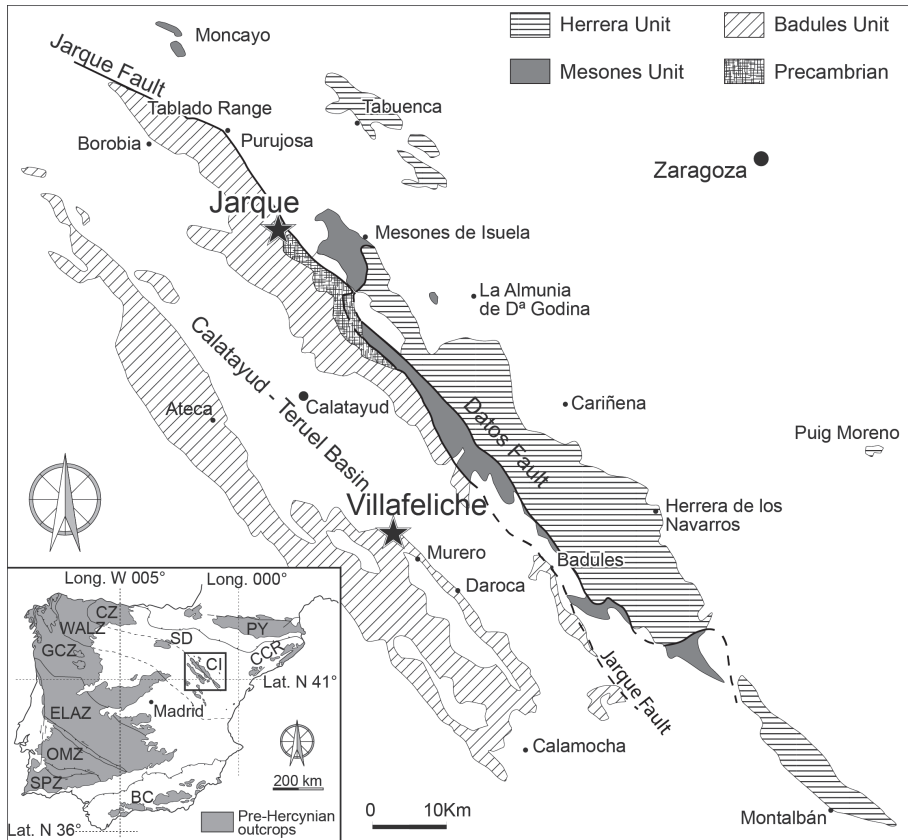


Figure 1. Geological setting of the studied area. The stars indicate the location of studied sections (modified from Gozalo & Liñán, 1988, and Liñán *et al.*, 2008).

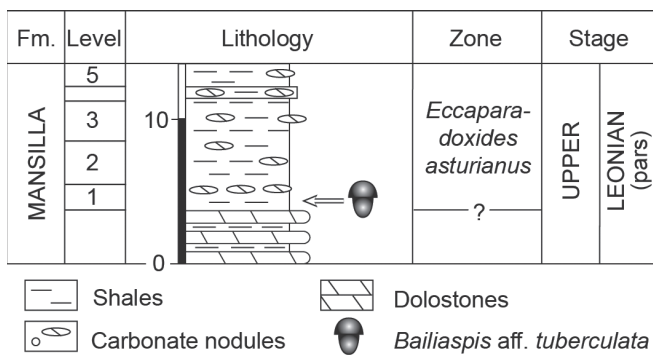


Figure 2. The Mansilla Formation in the Villafeliche 1 (Vi1) section (after Gozalo *et al.*, 1993, 1996).

has a thickness of 26 m. The first 2 m are composed by violet shales with abundant carbonate nodules and marly dolomites; this part constitutes the transition levels with the underlying Valdemiedes Formation. The next 24 meters are mainly composed of purplish nodular dolomitic levels, with interbedded violet shales and loamy dolostones. The upper member, has a thickness of 46 m thick, is composed of violet shales with scattered dolomitic nodules, which occasionally constitute a dolomitic level.

The specimens of *Bailliaspis* Resser, 1936 have been found at levels 156 and 159 of this section. *Bailliaspis*

cf. *tuberculata* Lake, 1940 was recorded at level 156, the trilobites recorded at this level are: *Peronopsis acadica* (Hartt in Dawson, 1868), *Condylopyge* sp., *Eccaparadoxides szzyui* Liñán, 1978, *E. asturianus* (Sdzuy, 1968), *Asturiaspis inopinatus* Sdzuy, 1968, *Parabailiella sebarensis* Sdzuy, 1968, *Parabailiella languedocensis* Thoral, 1946, *Parabailiella matutina* Sdzuy, 1968, *Parabailiella schmidtii* Sdzuy, 1957 and *Badulesia tenera* (Hartt in Dawson, 1868). *Bailliaspis* sp. was recorded in the level 159 of the Jarque 1 together with *Parabailiella schmidtii* Sdzuy, 1957, *Badulesia tenera* (Hartt in Dawson, 1868) and *Eccaparadoxides* sp. The age of both levels is the *Badulesia tenera* Zone (lower Caesaraugustan; see Figs 3 and 4) that has been correlated with the *Ptychagnostus gibbus* Zone (see Sdzuy *et al.*, 1999; fig. 5). Palacios (2015; fig. 3) identified the boundary between his IMC1 and IMC2 acritarch Zones in a level near the base of the *Badulesia tenera* Zone in the Porma section. This author correlates the boundary between both acritarch Zones with the base of the *Tomagnostus fissus* Zone, that is considered as Drumian. In accordance with the new data provided by Palacios (2015), the upper Leonian and the lowermost Caesaraugustan would be correlated with the Stage 5 of Cambrian and the rest of the lower Caesaraugustan would be correlated with the Drumian stage.

Our new specimens have a very similar morphology to *Bailliaspis tuberculata* Lake, 1940 although, all of them

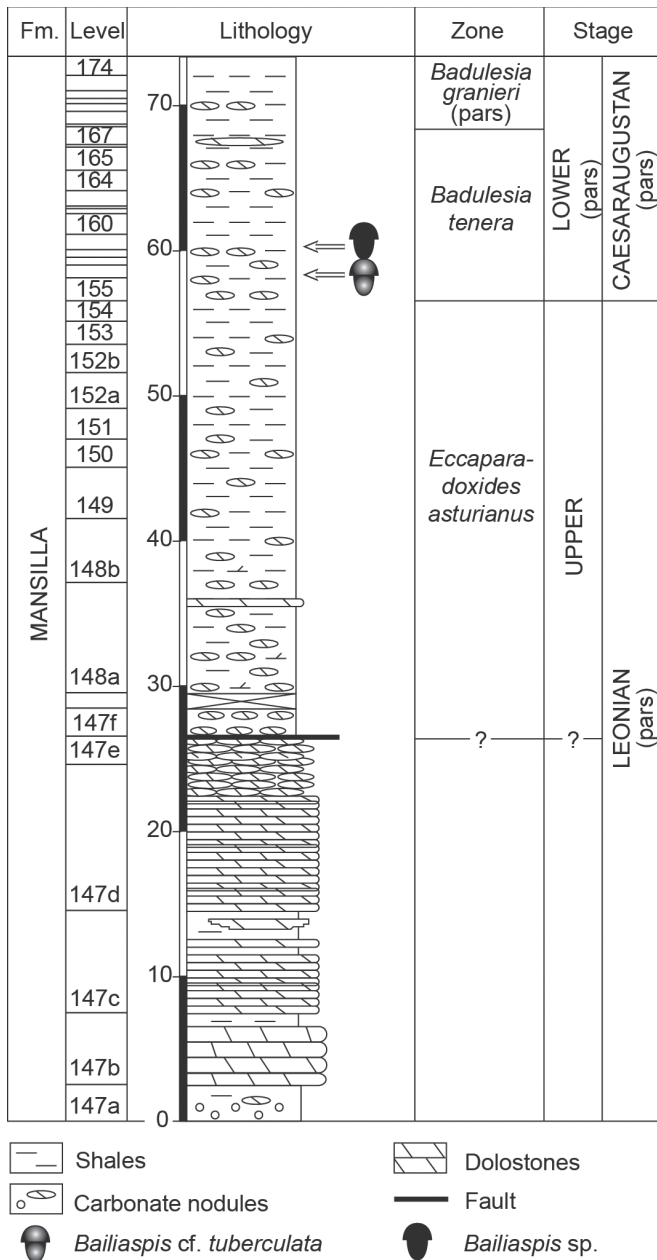


Figure 3. The Mansilla Formation in the Jarque 1 (J1) section (after Liñán *et al.*, 1996, 2008).

IBERIA (Iberian Chains)			ENGLAND (Nuneaton)		GLOBAL	
Formations	Zone	St.	Formations	Zone	Stage	
Murero (pars)	<i>Badulesia granieri</i>	LOWER CAESARAUGUSTAN	Abbey shales (pars)	<i>fissus</i> (pars)	Drumian (pars)	SERIES 3 (pars)
	<i>Badulesia tenera</i>			<i>B.t.</i>		
Mansilla (pars)	<i>Eccaparadoxides asturianus</i>	UPPER LEONIAN	Purley shales (pars)	<i>gibbus?</i>	Stage 5 (pars)	

Figure 4. *Bailiaspis tuberculata* Lake, 1940 (B.t.) distribution and related taxa (B.sp.; B.cf.t.; B.aff.t.). Biostratigraphical sketch from Iberia *sensu* Sdzuy *et al.* (1999), Gozalo *et al.* (2011) and Palacios (2015); data from Nuneaton (England) referred by Rushton (2011, figs. 11, 12), and their comparison with the global proposals of *International Subcommittee on Cambrian Stratigraphy* (Peng & Babcock, 2011).

are bigger than the English specimens. This species was recorded from level A4 in the Abbey Shales Formation, in the *Paradoxides aurora* Zone *sensu* Illing (1916), which level is assigned with uncertainty to the *Ptychagnostus gibbus* Zone (see Rushton, 1979, 1999, 2011; Rees *et al.*, 2014). Rushton (1979) studied the agnostoid fauna published by Illing (1916) including level A4, where *Bailiaspis tuberculata* Lake, 1940 had been found. *Condylopyge rex* (Barrande, 1846) was recorded together at the same level (Illing, 1916; Rushton, 1979). This species has a long biostratigraphic range in the Iberian Chains beginning at the base of the *Pardailhania hispida* Zone (middle Caesaraugustan), following Gozalo *et al.* (2011). Although cephalae of *Condylopyge* sp. have also been found in the lower Caesaraugustan, the lack of pygidia prevents specific identification. On the other hand, the biostratigraphic range of *Paradoxides aurora* Salter in Salter & Hicks, 1869 coincides approximately with the *Ptychagnostus gibbus* Zone in England (see Thomas *et al.*, 1984, fig. 3).

Previously, Sdzuy *et al.* (1999, fig. 5) and Gozalo *et al.* (2007, fig. 6) correlated the *Acadoparadoxides oelandicus* Stage with the Leonian Stage and *Ptychagnostus gibbus* Zone with *Badulesia tenera* Zone (lower Caesaraugustan). The new data provided by Palacios (2015) show that only the base of *Badulesia tenera* Zone is correlated with the top of *Ptychagnostus gibbus* zone, and the rest of the *Badulesia tenera* zone is correlated with the *Tomagnostus fissus* Zone, that is Drumian in age (see Fig. 4). In this figure, we propose a tentative correlation chart between the Iberian Chains and the Nuneaton successions where the fossils from the base of the Abbey Shale Formation would be correlated with the *Badulesia tenera* Zone in accordance with the previous correlation chart and the new acritarch data.

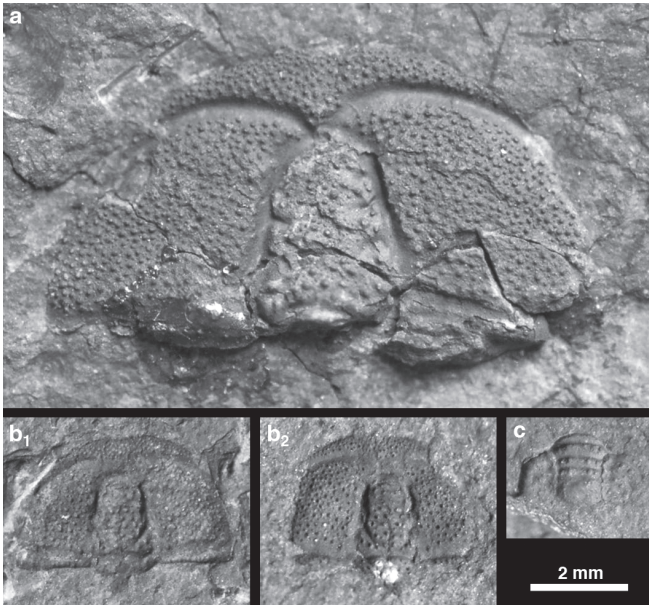


Figure 5. Type material of *Bailiaspis tuberculata* Lake, 1940 from level A4 to the Abbey Shales Formation in the *Paradoxides aurora* Zone (Nuneaton, Warwickshire, England). **a**) Cranidium, internal mould, Holotype, A15633 Sedgwick Museum. **b**) Small cranidium, A224 Sedgwick Museum, **(b1)** internal mould, **(b2)** external mould. **c**) Pygidium, internal mould, A15634 Sedgwick Museum. The magnification of the specimen A15633 figured by Illing (1916, pl. XXXV fig. 2) must be x2.5, there is a small mistake in the legend of the plate.

3. SYSTEMATIC DESCRIPTION

Class TRILOBITA Walch, 1771

Order PTYCHOPARIIDA Swinnerton, 1915

Suborder PTYCHOPARIINA Richter, 1932

Superfamily **Ptychoparioidea** Matthew, 1888

Family **Conocoryphidae** Angelin, 1854

Genus *Bailiaspis* Resser, 1936

Type species: *Conocephalites elegans* Hartt in Dawson, 1868 by original designation.

Remarks. Kim *et al.* (2002) provided a discussion of genus *Bailiaspis* Resser, 1936 that we follow here.

Bailiaspis has been cited previously in the Iberian Chains in two different formations. *Bailiaspis meridiana* Sdzuy, 1958 (see also Sdzuy, 1961); and *Bailiaspis* aff. *meridiana* Sdzuy, 1958 *sensu* Liñán & Gozalo, 1986 from the Murero Formation (middle Caesaraugustan, equivalent to the Drumian, see Gozalo *et al.*, 2011); and *Bailiaspis* ? *glabrata* (Angelin, 1854) from the Valtorres Formation (Guzhangian, see Álvaro *et al.*, 2013). The two former

species have been transferred to *Bailiella* Matthew, 1885 by Kim *et al.* (2002) and the third is assigned, though with uncertainty, to *Bailiaspis*, although previously was tentatively assigned to *Bailiella* (see Sdzuy, 1966; Korobov, 1973). In the phylogenetic analysis carried out by Cotton (2001), *B. glabrata* appears consistently close to *Bailiella levyi* (Munier-Chalmas & Bergeron in Bergeron, 1889) and always outside the main node where other *Bailiaspis* species are located. Thus, the presence of *Bailiaspis* in the Iberian Chains, until now, remained uncertain.

The new specimens found in the Mansilla Formation (upper Leonian and lower Caesaraugustan) show the diagnostic character of genus *Bailiaspis*. They show a true *Bailiaspis* plectrum, i.e., the anterior border expands backwards and the anterior border furrow is bowed sharply posteriorly (Westergård, 1950; Kim *et al.*, 2002). Also, the only species described with cranidial sculpture formed by densely-packed coarse tubercles is *Bailiaspis tuberculata* Lake, 1940 (see Fig. 5). However, the scarcity of material and the morphological differences among the studied specimens, which have been found in different levels, prevent us from considering all of them as only one taxon, presumably united by the sculpture of closely set tubercles, and we prefer to describe them as three taxa in open nomenclature waiting to know the intraspecific variation of *B. tuberculata* by means of new discoveries.

Bailiaspis cf. *tuberculata* Lake, 1940

Figs 6a-6b

Material. Two cranidia preserved as external and internal moulds in red dolomitic marls and blue-grey shales. Housed in the Museo de Ciencias Naturales de la Universidad de Zaragoza – formerly known (until 2012) as Museo Paleontológico de la Universidad de Zaragoza, Spain –, registered with numbers MPZ 2007/1394 and 2007/1395.

Description. Cranidium slightly convex and semielliptical in outline, with length about half the width. Forwardly tapered, bluntly rounded glabella with width at anterior about 50 percent of width at occipital furrow; axial furrows well incised and preglabellar furrow somewhat shallower. Three pairs of lateral glabellar furrows present: S1 long, directed obliquely backwards and extending a third across glabella; S2 short and oblique; S3 very short and subtransverse. Shallow occipital furrow, subtransverse medially, but curved forward distally. Occipital ring occupies about 15 percent of cranidial length. Frontal area occupies about 30 percent of cranidial length and has gently curved posterior margin. Preglabellar field very short or absent, with anterior border furrow and preglabellar furrow confluent. Anterior border thickening sag. (see Figs 6a3 and 6b1), convex with plectrum, and narrows distally. Anterior border furrow is shallow but

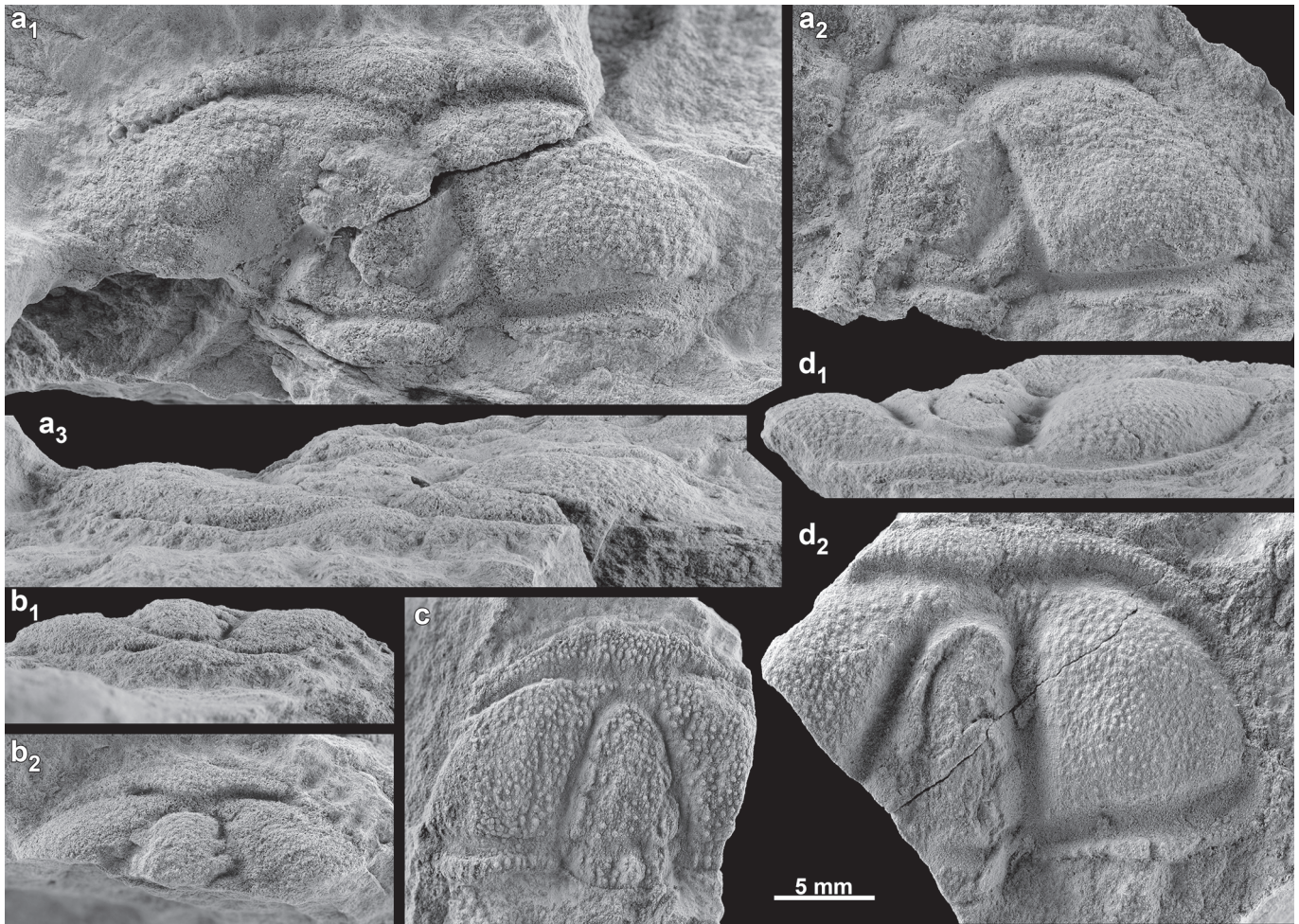


Figure 6. *Bailiaspis* from the Iberian Chains. **a)** *Bailiaspis* cf. *tuberculata* Lake, 1940 cranidium, level 156, Jarque 1 section, MPZ 2007/1394; (**a1**) internal mould; (**a2**) latex cast of the same specimen; (**a3**) anterior view of the internal mould. **b)** *Bailiaspis* cf. *tuberculata* Lake, 1940 cranidium internal mould, level 156, Jarque 1 section, MPZ 2007/1396; (**b1**) anterior and (**b2**) dorsal views. **c)** *Bailiaspis* sp. cranidium internal mould, level 159 Jarque 1 section, MPZ 2007/1395. **d)** *Bailiaspis* aff. *tuberculata* Lake, 1940 cranidium internal mould, level 1, Villafeliche 1 section, MPZ 2007/1397; (**d1**) anterior and (**d2**) dorsal views.

clearly defined and curved forward. Fixigenae convex. Posterior border furrow is broad, shallow groove; posterior border narrow near axial furrow but widens distally. Facial sutures intersect lateral border and furrow. Sculpture on all surfaces except furrows include numerous densely-packed coarse tubercles.

Remarks. Kim *et al.* (2002; p. 830-831) compared the different species assigned to *Bailiaspis* Resser, 1936 in the discussion of *Bailiaspis venusta* Resser, 1937. They stated that the main difference between *Bailiaspis tuberculata* Lake, 1940 and other species of the genus is the cranidial sculpture. The specimens found in the Jarque Section show this characteristic cranidial ornamentation. Furthermore, the preglabellar area is either absent or reduced sagittally to a slim line, a character also found in the English specimens. Finally, the percentage of the cranidium length, compared with the frontal area and occipital ring lengths,

are the same in both English and Spanish specimens. These coincidences in the diagnostic characters of both type and newly found material lead us to consider that they might belong to the same species, but their poor condition and difference in size prevents this specific assignment.

Stratigraphic distribution. The specimens were found in level 156 of the Jarque 1 Section (Fig. 3), *Badulesia tenera* Zone base (lower Caesaraugustan Stage), equivalent to the top of Stage 5 of the Cambrian System (see Fig. 4).

Bailiaspis aff. *tuberculata* Lake, 1940
Fig. 6d

Material. One cranidium preserved as an internal mould in blue-grey shales. Housed in the Museo de Ciencias Naturales de la Universidad de Zaragoza with acronym MPZ 2007/1397.

Description. Cranium slightly convex and semielliptical in outline, with length about 2/3 of the width. Forwardly tapered, bluntly rounded glabella with width at anterior about 50 percent of estimated width at occipital furrow; axial furrows well incised and preglabellar furrow somewhat shallower. Three pairs of lateral glabellar furrows present, but the surface of the glabella is badly preserved. Occipital furrow, shallow. Occipital ring occupies about 20 percent of the glabellar length. Frontal area occupies about 25 percent of the cranial length. Preglabellar field slender, which is crossed by two rows of tubercles. Anterior border slightly thicker (see Fig. 6d1) with weakly developed plectrum, and narrows distally; anterior border furrow shallow but clearly defined. Fixigenae convex. Posterior border furrow is broad, shallow groove; posterior border narrow near axial furrow but widens distally. Facial sutures intersect the lateral border and furrow which is very thin and does not intersect the fixigenae. Sculpture on all surfaces except furrows include numerous densely-packed coarse tubercles.

Remarks. The specimen found in Villafeliche shows a morphology close to that of *Bailiaspis tuberculata* Lake, 1940. But *Bailiaspis* aff. *tuberculata* Lake, 1940 presents a narrower preglabellar area and has a more pronounced plectrum. This character prevents us from including the specimen in *B. tuberculata*, despite the similar cranial sculpture, and we prefer to classify it in open nomenclature.

Rushton (1966; p. 45) described *Bailiaspis* sp. from the top of the Purley shales Formation, just below of the type level of *Bailiaspis tuberculata*. The cranium morphology of *Bailiaspis* sp. and *Bailiaspis* aff. *tuberculata* are very close and with a similar percentages of length occupied by the occipital ring and frontal area. The main difference is the ornamentation composed of fine granules and sparse scattering of large tubercles in the English specimen.

Stratigraphic distribution. The specimen was found in level 1 of the Villafeliche 1 Section, *Eccaparadoxides asturianus* Zone (upper Leonian Stage), equivalent to the upper part of Stage 5 of Cambrian (see Fig. 4)

Bailiaspis sp.
Fig. 6c

Material. One cranium preserved as an internal mould in green-grey shales. Housed in the Museo de Ciencias Naturales de la Universidad de Zaragoza under the number MPZ 2007/1396.

Description. Cranium semielliptical in outline. Forwardly tapered, bluntly rounded glabella with width at anterior about 50 percent of width at occipital furrow; axial furrows well incised and preglabellar furrow somewhat shallower. Three pairs of lateral glabellar furrows present,

but the surface of the glabella is badly preserved. Occipital furrow, shallow. Occipital ring occupies about 20 percent of the glabellar length. Frontal area occupies about 30 percent of the cranial length. Preglabellar field slender, which is crossed by one row of tubercles. Anterior border slightly convex with short plectrum; anterior border furrow shallow but clearly defined and curved forward. Fixigenae slightly convex. Broad posterior border furrow, shallow groove; narrow posterior border near the axial furrow but widens distally. The facial sutures intersect the lateral border and furrow. This is very thin and the facial suture does not intersect the fixigenae. The sculpture is present on all surfaces except furrows and include numerous densely-packed coarse tubercles.

Remarks. The morphological characteristics of the specimen found in Jarque level 159, allows its classification in the genus, this specimen shows a morphology close to the juvenile specimen of *Bailiaspis tuberculata* Lake, 1940. But the specimen of *Bailiaspis* sp. is much bigger than the English specimen. This character prevents us from including the specimen in *B. tuberculata*, despite the similar cranial sculpture, and we prefer to classify it in open nomenclature.

Stratigraphic distribution. The specimen was found in level 159 of the Jarque 1 Section (Fig. 3), lower part of *Badulesia tenera* Zone (lower Caesaraugustan Stage), equivalent to the top of Stage 5 of the Cambrian or base of the Drumian stage (see Fig. 4).

4. CONCLUSIONS

Diverse stratigraphical sections of the Mansilla Formation have been studied. Two of them contain the trilobites *Bailiaspis* aff. *tuberculata*, *B. cf. tuberculata* and *Bailiaspis* sp. These are the first confirmed record of genus *Bailiaspis* in the Iberian Chains and in the Mediterranean subprovince considering that the previous *Bailiaspis* cited had either been rejected or considered doubtful.

Bailiaspis aff. *tuberculata* was found in the *Eccaparadoxides asturianus* Zone (upper Leonian) and has been roughly compared with the *Bailiaspis* sp. found at the top of the Purley Shales Formation (Rushton, 1966). While the specimens of *Bailiaspis* cf. *tuberculata* and *Bailiaspis* sp. recorded in the *Badulesia tenera* Zone (lower Caesaraugustan) have been compared with *Bailiaspis tuberculata* Lake, 1940 of the *Paradoxides aurora* Zone at the base of the Abbey Shale Formation (see Rushton, 1979, 1999, 2011).

Therefore the biostratigraphic distribution of *Paradoxides aurora* belongs to *Ptychagnostus gibbus* Zone *sensu* Thomas *et al.* (1984) and the level with

Bailiaspis tuberculata has been dated with uncertainty as the *Ptychagnostus gibbus* Zone.

Figure 4 shows a tentative correlation chart between the materials of the Nuneaton area (England) and the Iberian Chains (NE Spain) where we propose the correlation of the top of Purley Shales with the upper Leonian and/or the base of lower Caesaraugustan, while the base of Abbey Shales would be correlated with the lower Caesaraugustan.

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