



On some bythocytherid (Ostracoda) from the Viséan of Triollo (N Palencia, Cantabrian Mountains, Spain)

Luis C. SÁNCHEZ DE POSADA*, Silvia BLANCO-FERRERA & Javier SANZ-LÓPEZ

Departamento de Geología, Universidad de Oviedo, c/Jesús Arias de Velasco, 33005 Oviedo, Spain; lposada@geol.uniovi.es; silvia.blanco@geol.uniovi.es; jasan@geol.uniovi.es

* Corresponding author

Sánchez de Posada, L.C., Blanco-Ferrera, S. & Sanz-López, J. 2016. On some bythocytherid (Ostracoda) from the Viséan of Triollo (N Palencia, Cantabrian Mountains, Spain). [Algunos bythocytheridos (Ostracoda) del Viseense de Triollo (N de Palencia, Cordillera Cantábrica, España)]. *Spanish Journal of Palaeontology*, 31 (1), 221-230.

Manuscript received 19 January 2016

Manuscript accepted 07 March 2016

© Sociedad Española de Paleontología ISSN 2255-0550

ABSTRACT

Viséan rocks are widespread in the Cantabrian Mountains, but despite the abundance of some fossil groups (particularly conodonts and cephalopods) in these strata, very few ostracods have been reported. Rich silicified ostracod faunas have been found in the Viséan of the Triollo area (north Palencia, Cantabrian Mountains, Spain). Among numerous elements, some belong to the family Bythocytheridae, a conspicuous element of the Thuringian Paleozoic Mega-Assemblage. Three species of the bythocytherid genus *Paraberounella* are described in this paper. One of them, *Paraberounella? wagneri* n. sp., is assigned to the genus with some reservations.

Keywords: Ostracoda, systematics, Carboniferous, Viséan, Cantabrian Mountains.

RESUMEN

Los materiales viseenses están ampliamente representados en la Cordillera Cantábrica, pero, a pesar de ello y a pesar también de la abundancia de algunos grupos fósiles (especialmente conodontos y cefalópodos), las referencias a ostrácodos son escasas. Algunas asociaciones ricas en ostrácodos silicificados se encontraron en los alrededores de Triollo (norte de Palencia, Cordillera Cantábrica). Entre otros muchos elementos, las faunas de Triollo incluyen representantes de la familia Bythocytheridae, un elemento destacado de la “Mega-asociación turíngica”. En este trabajo se describen tres especies del género *Paraberounella*, una de ellas, *Paraberounella? wagneri* n. sp., asignada con reservas al género, es nueva.

Palabras clave: Ostracoda, sistemática, Carbonífero, Viseense, Cordillera Cantábrica.

1. INTRODUCTION

Viséan and Serpukhovian rocks are widespread in the Cantabrian Mountains. These strata are often represented by the well known, condensed (usually no more than 20 m thick) Alba Formation (“Griotte de Puente de Alba” of Comte, 1959; Genicera Formation of Wagner *et al.*, 1971). These rocks have been divided in several members (see Wagner *et al.*, 1971; Sanz-López *et al.*, 2004). The Alba Formation has yielded mainly conodonts and cephalopods, but also foraminifers, radiolarians, tintinnids, corals, brachiopods, trilobites, crinoids and some ostracods. However, despite its great areal extension very few ostracods have been reported from these strata. Bate (1968) described *Bairdia wagneri* n. sp. (*recte Acantoscapha wagneri*) and Sánchez de Posada (1973, 1976) reported *Kirkbya* sp., both from a section to the north of Entrago (Teverga, Asturias). Later on, Sánchez de Posada (1987) and Sánchez de Posada (*in* Sánchez de Posada & Sanz-López, 2010) described *Gruendelella jordani* n. gen. n. sp. and *Pseudocriboconcha prinsii* n. gen. n. sp. from the same locality. The succession in which the first of these species was found was at that time considered to form the base of the overlying Barcaliente Formation (defined in Wagner *et al.*, 1971), but these rocks are now regarded to be the upper part of the Alba Formation.

The Triollo ostracods belong to the Thuringian Mega-Assemblage of Casier (2004), corresponding to the “Thüringer Ökotype” of Becker (*in* Bandel & Becker, 1975), one of the three main ostracod assemblages recognized in the Paleozoic (together with the Eifelian and Myodocopid Mega-Assemblages). Recently, Sánchez de Posada *et al.* (2012) provided a preliminary list of species from the Viséan Triollo section (northern Palencia Province), which included several characteristic taxa of

the Thuringian Mega-Assemblage, such as *Tricornina*, *Rectonaria*, *Rectoplacera*, *Rectospinella*, *Acantoscapha*, *Praebythoceratina* and *Paraberounella*. These ostracods were collected from the “Carrion Unit” of Wagner & Winkler Prins (*in* Nemyrovskaya, 2005 – named Carrion Formation by Nemyrovskaya *et al.*, 2011), which replaces the Alba Formation in the thrust slices north of the Ruesga Fault. The Carrion Unit, a mid-Viséan to lower Serpukhovian succession, about 16 m thick and composed of gray limestones with some nodular and chert intercalations, crops out at approximately 1 km north of the village of Triollo (Fig. 1).

Since the pioneering studies on those faunas, mainly by Blumenstengel (1965) and Gründel (1961, 1962), a considerable number of papers have been devoted to the study of ostracods of the Thuringian Mega-Assemblage, especially in Western Europe. Most of Carboniferous ostracods belonging to this Mega-Assemblage have been found in Tournaisian rocks, especially in Thuringia (Gründel, 1961, 1962), but also in the Rhenish Mountains (Becker *et al.*, 1993; Becker, 1999), Poland (Olempska, 1997), Montagne Noire (Lethiers & Feist, 1991), and China (Wang, 1988). For a more extensive review of Late Devonian and early Carboniferous ostracod assemblages in Europe the reader is referred to Becker *et al.* (1993).

In the Cantabrian Mountains ostracods belonging to the Thuringian Mega-Assemblage have been described or quoted in strata of Devonian and Carboniferous ages (Bless & Michel, 1967; Sánchez de Posada, 1973, 1976; Sánchez de Posada *et al.*, 2012; and particularly Becker, 1977, 1981, 1982). Most of these faunas come from Famennian strata.

The Viséan ostracods from the Triollo section studied here correspond to a period for which ostracods of the Thuringian Mega-Assemblage are poorly known. Among the taxa found at this locality, three species of

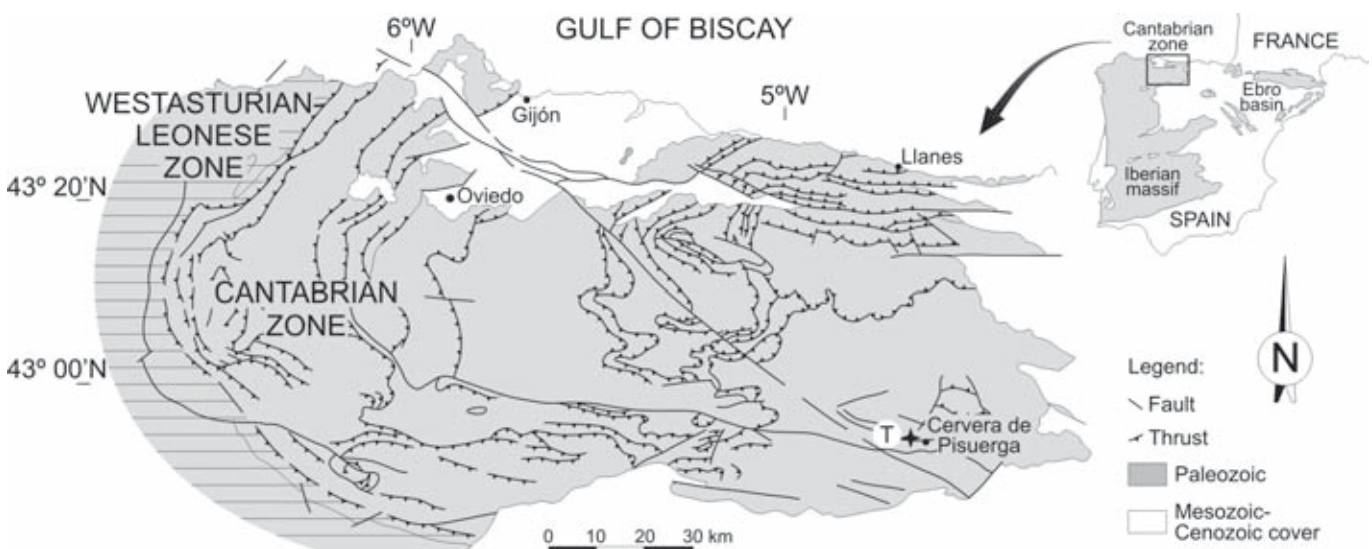


Figure 1. General sketch of the Geology of the Cantabrian Zone with the location of the Triollo Section (T).

Paraberounella (Bythocytheridae), including a new species, are described herein.

2. MATERIALS AND METHODS

Some samples of the Triollo section, initially processed for conodonts through acid dissolution, yielded diverse silicified ostracod assemblages. Additional sampling of the strata with ostracods was carried out by Cor Winkler Prins (Nationaal Natuurhistorisch Museum, Leiden) together with one of the present authors (LCSP) in order to obtain a better knowledge of the faunas. The ostracods come from the lower half of the “Carrion Unit”, in rocks belonging to the *Gnathodus praebilineatus*, *G. bilineatus* and *Lochriea nodosa* zones according to Nemyrovskaya (2005), hence from mid to late Viséan in age (Fig. 2).

3. RESULTS

The ostracod assemblages of Triollo consists of *Acantoscapha wagneri* (Bate, 1968), *Acantoscapha* sp., *Acratia* spp., *Anahuacia* sp., *Aurigerites* n. sp., *Bairdia* cf. *filiungibba* Becker, 1982, *Bairdia* spp., *Bairdiocypris* sp., *Pseudocriboconcha* sp., *Bohlenatia* spp., *Coronakirkbya*? sp., “*Fellerites*”? sp., *Gerodia* sp., *Gruendelella* sp., *Healdianella*? cf. *kielcensis* Olempska, 1979, *Healdiopsis thuringensis* (Gründel, 1961), *Hercynocythere*? sp., *Kirkbya* sp., *Kirkbyella* sp., *Kirkbyellina*? sp., *Monoceratina* sp., *Necrateria* aff. *trapezoidalis* (Gründel, 1962), *Necrateria*? sp., *Orthonaria* aff. *rectagona* (Gründel, 1962), *Orthonaria* spp., *Paraberounella* aff. *saalfeldensis* (Gründel, 1961), *Paraberounella* aff. *thuringica* Gründel, 1973, *Paraberounella*? *wagneri* n. sp., *Paragerodia*? n. sp., *Praebythoceratina* sp., “*Pribylites*” cf. *elongatus* Blumenstengel, 1965, *Processobairdia* sp., *Ranicella* sp., *Rectonaria* aff. *inclinata* Gründel, 1961, *Rectonaria* aff. *muelleri* Gründel, 1961, *Rectonaria* cf. *varica* Gründel, 1961, *Rectonaria*? n. sp., *Rectospinella* sp., *Schornimichaila* sp., *Spinoalacia* spp., *Tetrasacculus*? n. sp., *Tricornina* (*Bohemina*) sp., *Tricornina* (*Tricornella*)? sp., *Timorhealdia* cf. *nitidula* (Richter, 1869), *Timorhealdia* cf. *ratra* (Gründel, 1961), *Timorhealdia* n. sp., *Triplacera* cf. *triquetra* Gründel, 1961, and *Triplacera* sp. (see Table 1 and Figs 3 and 4).

3.1. Systematic paleontology

All specimens described and illustrated in this paper are housed in the collection of the Geology Department Museum of the University of Oviedo, and bear the

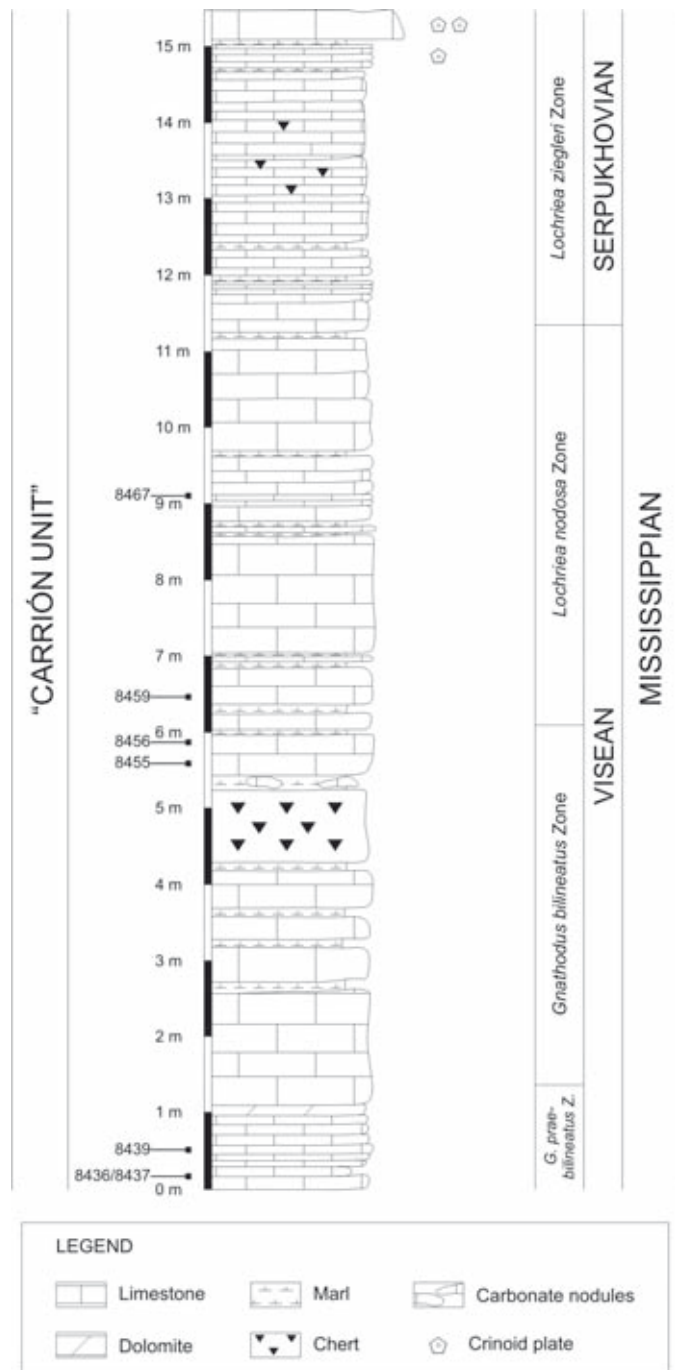


Figure 2. Stratigraphic column of the Triollo section and position of the samples with ostracods.

collection heading DGO. In the following descriptions L = length and H = height.

Family **Bythocytheridae** Gründel & Kozur, 1971

Genus *Paraberounella* Blumenstengel, 1965

Type species *Paraberounella lobella* Blumenstengel, 1965

Remarks. The genus *Paraberounella* was proposed for an ostracod genus found in Upper Devonian strata

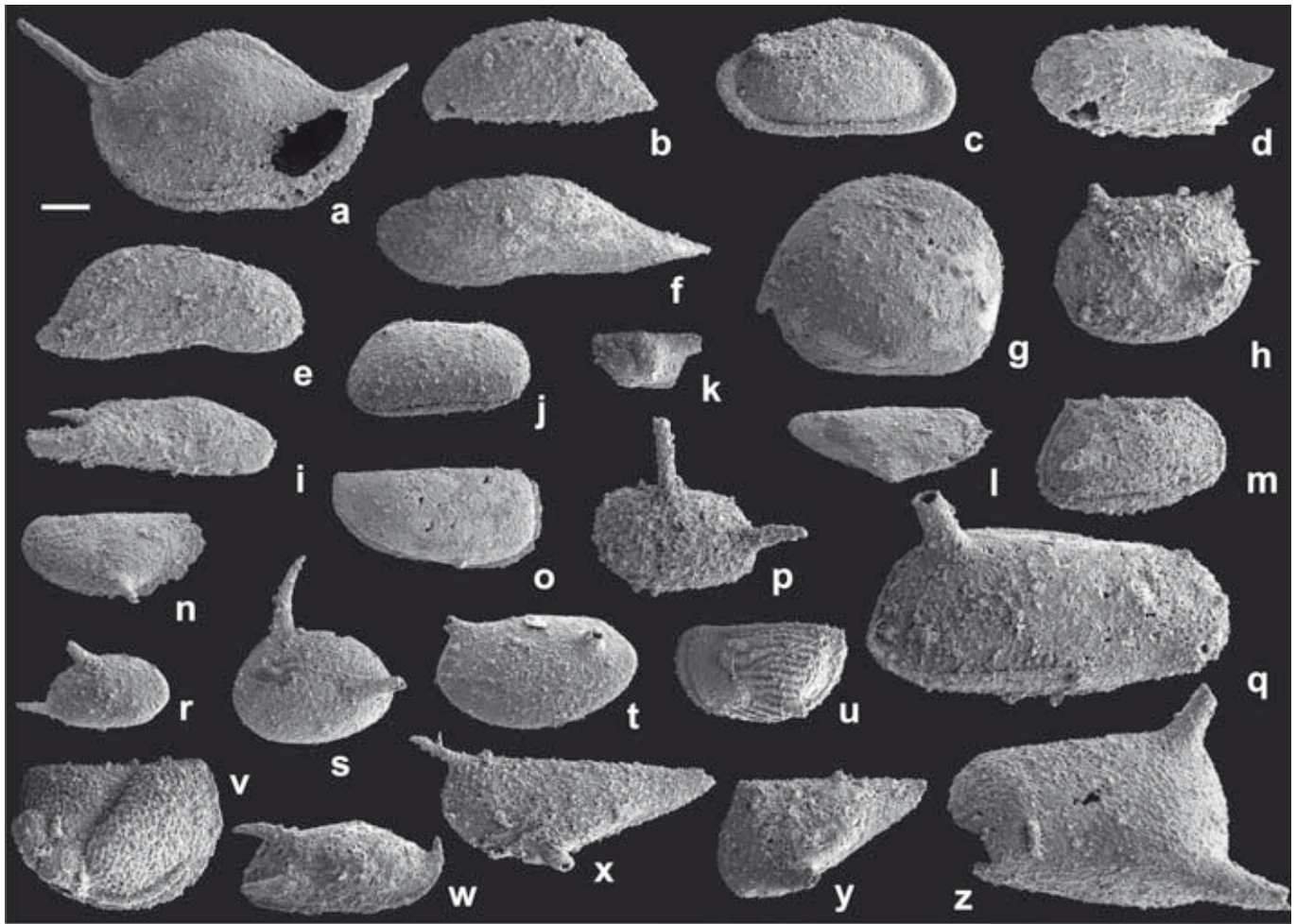


Figure 3. Selected species of the Triollo ostracod assemblages. **a)** *Acantoscapha wagneri* (Bate, 1968), DGO7365, left view of carapace, sample WP8455. **b)** *Acratia* sp., DGO7366, LV, sample WP8437. **c)** *Anahuacia* sp., DGO7367, RV, sample WP8455. **d)** *Aurigerites* sp., DGO7368, LV, sample WP8455. **e)** *Bairdia* (*Bairdia*) cf. *feliumgibba* Becker, 1982, DGO7369, RV, sample WP 8455. **f)** *Bohlenatia* sp., DGO7370, LV, sample WP8455. **g)** Cypridinoidea indet., DGO7371, LV, sample WP8456. **h)** “*Fellerites*” sp., DGO7372, LV, sample WP8439. **i)** *Gruendelella* sp., DGO7373, RV, sample WP8455. **j)** *Healdianella?* cf. *kielcensis* Olempska, 1979, DGO7374, right view of carapace, sample WP8455. **k)** *Kirkbyellina?* sp., DGO7375, LV, sample WP8459. **l)** *Monoceratina?* sp., DGO7376, RV, sample WP8455. **m)** *Necrateria* aff. *trapezoidalis* Gründel, 1962), DGO7377, RV, sample WP8437. **n)** *Praebythoceratina* sp., DGO7378, LV, sample WP8456. **o)** “*Pribylites*” cf. *elongatus* Blumenstengel, 1965, DGO7379, RV, sample WP 8455. **p)** *Rectonaria* aff. *inclinata* Gründel, 1961, LV, DGO7380, sample WP8437. **q)** *Rectonaria* aff. *muelleri* Gründel, 1961, DGO7381, RV, sample WP8455. **r)** *Rectonaria* cf. *varica* Gründel, 1961, DGO7382, RV, sample WP8455. **s)** *Rectonaria?* n. sp., DGO7383, LV, sample WP8455. **t)** *Rectospinella* sp., DGO7384, LV, sample WP8455. **u)** *Spinoalacia* sp., DGO7385, LV, sample WP 8455. **v)** *Tetrasacculus?* n. sp., DGO7386, LV, sample WP8437. **w)** *Timorhealdia* n. sp., DGO7387, VD, sample WP8439. **x)** *Tricornina* (*Bohemina*) sp., DGO7388, LV, sample WP8455. **y)** *Tricornina* (*Tricornella*) sp., DGO7389, LV, sample WP8455. **z)** *Triplacera* cf. *triquetra* Gründel, 1961, DGO7390, LV, sample WP8439. Scale bar = 200 µm. LV: left valve. RV: right valve.

of Thuringia (Germany). The original diagnosis of Blumenstengel, 1965 is the following: “Eine gattung der Berounellinae mit einem einfachen nach unten durchgebogenen Lobus, der nach dem DR hin eine Furche umschließt, Seitenumriss dreieckig bis leicht rechteckig mit nach oben abgestutztem zugespitztem HE, auf den hinteren Teil des lobus ein Dorn, Vorderrand verschiedenartig bestachelt”. Subsequently, the genus was placed in the family Bythocytheridae (Gründel & Kozur,

1971; Schornikov & Mikhailova, 1990), and Gründel (1973) stressed the variability of the median sulcus, which may even be absent, as well as the presence of two pits in the area of the median sulcus.

At least 19 species of *Paraberounella*, ranging in age from Devonian to Triassic, have been described. Six of them, *P. cuneata* (Gründel, 1961), *P. thuringica* Gründel, 1973, *P. aff. thuringica* Gründel, 1973, *P. saalfeldensis* (Gründel, 1961), *P. kahlleitensis* Gründel, 1973, and

*P. gattendorfin*a Gründel, 1973 have been this far reported from Carboniferous strata. None of them have been previously described in the Carboniferous of the Cantabrian Mountains, although Becker (1982) described and figured a species of this genus, *Paraberounella cuneata* (Gründel, 1961), from Famennian strata of the Vidrieros Formation in the Montó area (SE of the Cantabrian Mountains). Moreover, Sánchez de Posada *et al.* (2012) mentioned *Paraberounella* aff. *thuringica* Gründel, 1973, *P.* aff. *saalfeldensis* (Gründel, 1961) and *Paraberounella* n. sp. in a preliminary list of the ostracod faunas found in Viséan strata of the Triollo area (northern Palencia, SE Cantabrian Mountains). These species are described herein.

Paraberounella aff. *saalfeldensis* (Gründel, 1961)
(Figs 4c-4d)

Material. 5 left valves (DGO 7358-60, sample WP 8455; DGO 7361a, sample WP 8437) and 2 right valves (DGO 7362, sample WP 8455, DGO 7361b, sample WP 8437).

Measurements. DGO 7358. L: 0.72 mm; H: 0.34 mm. DGO 7359. L: 0.76 mm; H: 0.36 mm. DGO 7362. L: 0.64 mm; H: 0.28 mm.

Relevant morphological features. Lateral outline trapezoid elongated. Posterior border rounded. Postero-ventral border nearly straight. Central region of the valve distinctly swollen. Maximum width centro-posterior. In one specimen (DGO 7362) a distinct sulcus can be seen in the antero-dorsal region of the valve. No pit can be observed in the area of insertion of the lateral spines. Anterior spine medium-sized, located in the upper half of the anterior margin. A flattened area exits along the free margins of the valve. In lateral view this flattened area can be clearly seen along the anterior and posterior borders, but at the ventral border it is hidden by the swollen central region of the valve. Although in the specimens in hand the lateral spine is broken, it seems to be short. This spine is located on the postero-central region, a little below the middle of the valve.

Discussion. The specimens from Triollo are rather similar to some species described by Gründel (1961, 1973), especially to *Paraberounella* (*Paraberounella*) *cuneata* (Gründel, 1961), *P.* (*P.*) *saalfeldensis saalfeldensis* (Gründel, 1961) and *P. saalfeldensis kahleitensis* Gründel, 1973 (the last two subspecies are usually now considered as independent species). In the absence of well preserved material these species are hard to distinguish due to the difficulty to observe some important anatomical features, particularly the characteristic pits present on the lateral surface. In the specimen DGO 7362 the dorsal pit

seems to be located just below the dorsal border as in *P. saalfeldensis* and *P. kahleitensis*, but the flattened area along the free margin of our valves does not seem to be continued at the posterior part of the dorsal border as in *P. kahleitensis*. In this way the material from Triollo seems to be closer to *P. saalfeldensis* than to *P. kahleitensis*.

The lateral outline of the specimens figured by Gründel (1961, pl. 3, fig. 3; 1973, fig. 4) is not as elongated as that of the Triollo material. Nevertheless, Becker *et al.* (1993) illustrated material of this species with a remarkable variability of shape.

On the other hand, some differences seem to exist between the specimens from Triollo and the type material of *P. saalfeldensis*. In the specimens described in this paper the median pit is not visible and the dorsal pit is longer in the Spanish material. The possibility that the material described here represents a new species cannot be entirely ruled out. Our specimens are very similar to those described by Wang (1988) from the Wangyou Formation (Tournaisian) of Guangxi (China).

Paraberounella aff. *thuringica* Gründel, 1973
(Figs 4a-4b)

Material. 2 left valves, (DGO 7363, sample WP 8455 and DGO 7364, sample WP 8437).

Measurements. DGO 7363. L: 0.73 mm; H: 0.29 mm. DGO 7364. L: 0.7 mm; H: 0.35 mm.

Relevant morphological features. Lateral outline trapezoid elongated, evenly convex. Median sulcus distinct. Two strong spines are present, at the antero-dorsal angle and in the centro-posterior area of the lateral surface. The latter is inserted in the region of maximum convexity of the valve and points obliquely towards the posterior and exterior. The antero-dorsal spine points antero-dorsally and slightly towards the exterior of the valve (even though it can be deformed). Ventral and posterior borders are rimmed by a flattened part of the valve (in the anterior border the rim is not seen but this could be due to bad preservation). In lateral view the rim is not hidden by the inflated part of the valve. In ventral view the outline of the valves is sub-trapezoid, rather flat, with straight sides in the central region and straight to slightly concave in the anterior and posterior part.

Discussion. The material on hand is very similar to *Paraberounella thuringica* Gründel, 1973, especially due to the presence of an anterior spine, well-developed median sulcus, spiny anterior border and outline. Judging from the original description of *P. thuringica*, in the type material of this species, in contrast to the Spanish specimens, the median sulcus is connected to the dorsal border.

Table 1. Ostracod distribution in the different samples.

Taxa	Samples						
	8436	8437	8439	8455	8456	8459	8467
<i>Acantoscapha wagneri</i> (Bate)		x		x			
<i>Acantoscapha</i> sp.		x	?	x	x		
<i>Acratia</i> spp.	x	x	x	x	x		
<i>Anahuacia</i> sp.			x				
<i>Aurigerites</i> n. sp.		x	x	x			
<i>Bairdia</i> cf. <i>filiumgibba</i> Becker		x	x	x			
<i>Bairdia</i> spp.	x	x	x	x	x		
<i>Bairdiocypris</i> sp.				x			
<i>Bohlenatia</i> spp.		x		x			
<i>Coronakirkbya?</i> sp.		x					
<i>Cyprinoidea</i> indet.					x		
" <i>Fellerites</i> "? sp.			x				
<i>Gerodia</i> sp.				x			
<i>Gruendelella</i> sp.		x		x			
<i>Healdianella?</i> cf. <i>kielcensis</i> Olempska		x	x	x			
<i>Healdiopsis thuringensis</i> (Gründel)		x	x	x	x		
<i>Hercynocythere?</i> sp.				x			
<i>Kirkbya</i> sp.				x	x		
<i>Kirkbyella</i> sp.				x			
<i>Kirkbyellina?</i> sp.						x	
<i>Monoceratina</i> sp.				x			x
<i>Necrateria</i> aff. <i>trapezoidalis</i> (Gründel)		x	x				
<i>Necrateria?</i> sp.			x			x	
<i>Orthonaria</i> aff. <i>rectagona</i> Blumenstengel		x					
<i>Orthonaria</i> spp.	x	x	?	x			
<i>Paraberounella</i> aff. <i>saalfeldensis</i> (Gründel)		x	x	x			
<i>Paraberounella</i> aff. <i>thuringica</i> (Gründel)		x		x			
<i>Paraberounella?</i> <i>wagneri</i> n. sp.		?		x	x	x	
<i>Paragerodia?</i> n. sp.				x			
<i>Praebythoceratina</i> sp.		x		x	x	x	
" <i>Pribylites</i> " cf. <i>elongatus</i> Blumenstengel		x	x	x			
<i>Ranicella</i> sp.				x	x		
<i>Rectonaria</i> aff. <i>inclinata</i> Gründel		x		x	x		
<i>Rectonaria</i> aff. <i>muelleri</i> Gründel		x	x	x			
<i>Rectonaria</i> cf. <i>varica</i> Gründel				x			
<i>Rectonaria?</i> n. sp.	x	x		x			x
<i>Rectospinella</i> sp.				x			
<i>Schornimichaila</i> sp.					x		
<i>Spinoalacia</i> spp.			x	x	?		
<i>Tetrasacculus</i> n. sp.		x		?			
<i>Tricornina</i> (<i>Bohemina</i>) sp.	x	x	x	x		x	x
<i>Tricornina</i> (<i>Tricornella?</i>) sp.		x	x	x	x		
<i>Timorhealdia</i> cf. <i>nitidula</i> (R. Richter)			x				
<i>Timorhealdia</i> cf. <i>ratra</i> (Gründel)			x				
<i>Timorhealdia</i> n. sp.			x	x			
<i>Triplacera</i> cf. <i>triquetra</i> Gründel		x	x	x			
<i>Triplacera</i> sp.		x		x			

Paraberounella? wagneri n. sp.
(Figs 4e-4h)

Derivatio nominis. The species is named in honor of Dr. R.H. Wagner for his contribution to Carboniferous geology and evolution of fossil macroflora.

Holotype. A left valve (DGO 7356, sample) figured on Figures 4e, 4f.

Paratypes. 3 left valves: (DGO 7353, sample WP 8459/92, DGO 7354, sample WP 8455/92, DGO 7357, sample WP 8456/92) and 1 right valve (DGO 7350, sample WP 8455).

Measurements. Holotype DGO 7356. L: 0.66 mm; H: 0.22 mm. Paratypes. DGO 7352. L: 0.4 mm; H: 0.14 mm. DGO 7353. L: 0.57 mm; H: 0.21 mm. DGO 7354. L: 0.44 mm; H: 0.16 mm.

Locus typicus. Triollo Section, eastern slope of the Carrión Valley, 1 km north of Triollo.

Stratum typicum. Limestone bed 5.8 m above the base of the "Carrión Unit" (bed WP 8456), *Gnathodus bilineatus* Zone according to Nemyrovskaya (2005), upper Viséan.

Diagnosis. Small ostracod with elongated sub-trapezoidal bythocytherid outline (L/H more than 2.5), ventral part of the anterior margin nearly straight and dorsal part curved. A small spine is present at the junction of the dorsal and ventral parts of the anterior margin. Faint median sulcus. Small central spine directed posteriorly.

Description. Small sized ostracod with elongated sub-trapezoid lateral outline. Dorsal border straight to slightly convex. Ventral border straight, faintly concave in the middle. Posterior end below the dorsal margin, rounded to weakly pointed. Dorsal third of the anterior border faintly curved, ventral part almost straight, meeting the ventral margin at a distinctly obtuse angle. A tiny spine directed forwards is present at the junction of the dorsal and ventral parts of the anterior margin. Central, centro-anterior, centro-dorsal and centro-ventral parts of the valves nearly flat. Maximum width centro-ventral. A faint sulcus is present just in front of the middle of the valve. It extends from near the dorsal margin to a point close to the ventral border. In the central part of the valve a small spine with posterior direction can be seen. Free margin of the valves depressed and not covered by the swollen centro-ventral area of the valves. Calcified inner lamella is distinct, more developed at the anterior margin.

Discussion. The small size of the carapace, the lateral outline, the small anterior spine, and the size and direction

of the central spine are the most distinctive features of the new species. The elongated lateral outline, the faint median sulcus and the ventro-lateral spines are typical for *Paraberounella*. The median sulcus is barely perceptible, and similarly for the two pits, which are recognized in all species of *Paraberounella* described up to now. The possibility that the material of the new species from Triollo belongs to a new genus may not be entirely ruled out.

3.2. Ostracod association in the Thuringian Mega-Assemblage

The ostracod assemblages of Triollo include characteristic genera of the Thuringian Mega-Assemblage, such as *Tricornina*, *Rectonaria*, *Rectoplacera*, *Rectospinella*, *Acantoscapha*, *Praebythoceratina* and *Paraberounella*. Many of the taxa present in the Triollo assemblage have a fine, smooth or little ornamented carapace and many of them are provided with long distinctive spines. These forms are supposed to have lived in calm, perhaps cold waters (Becker & Bless, 1990) and are mainly known from sediments deposited in the outer part of the neritic or even in oceanic realms. These environments are in agreement with what has been inferred from the sedimentological and conodont studies, representing an open marine (perhaps basinal) environment of probably quite cold water well below the wave base (Nemyrovskaya & Samakassou *in* Nemyrovskaya, 2005).

On the whole, the Triollo fauna shows remarkable similarities with older Carboniferous faunas from Thuringia (Gründel, 1961, 1962), Harz (Gründel, 1972), Guangxi, China (Wang, 1988), and Montagne Noire (Lethiers & Feist, 1991). Viséan and Serpukhovian ostracods belonging to the "Thuringian Mega-Assemblage" have been little studied. Most of the Carboniferous "Thuringian-type" ostracods have been found in Tournaisian rocks, especially in Thuringia (and also in the eastern part of the Rhenish Mountains). Of prime importance are the two pioneering papers of Gründel (1961, 1962), who described the classical diversified faunas from the *Gattendorfia* Stufe of eastern Thuringia. In more recent years, several other papers dealing with "Thuringian" ostracods of the Devonian-Carboniferous transitional boundary beds have been published (Becker *et al.*, 1993; Olempska, 1997). The "Thuringian-type" ostracods closest in age to the fauna dealt with in this paper are those described by Gründel (1972) from strata probably belonging to the *Scaliognathus anchoralis* Conodont Zone of the Harz (Germany), the ostracods of the German Cu II γ unit studied by Lethiers & Feist (1991) from Montagne Noire (France), the late Tournaisian to early Namurian faunas from the western Pyrenees studied by Crasquin *et al.* (1989), and the upper Viséan of western Morocco (Bless & Simon *in* Dreesen *et al.*, 1985). The precise age of most of the species quoted by

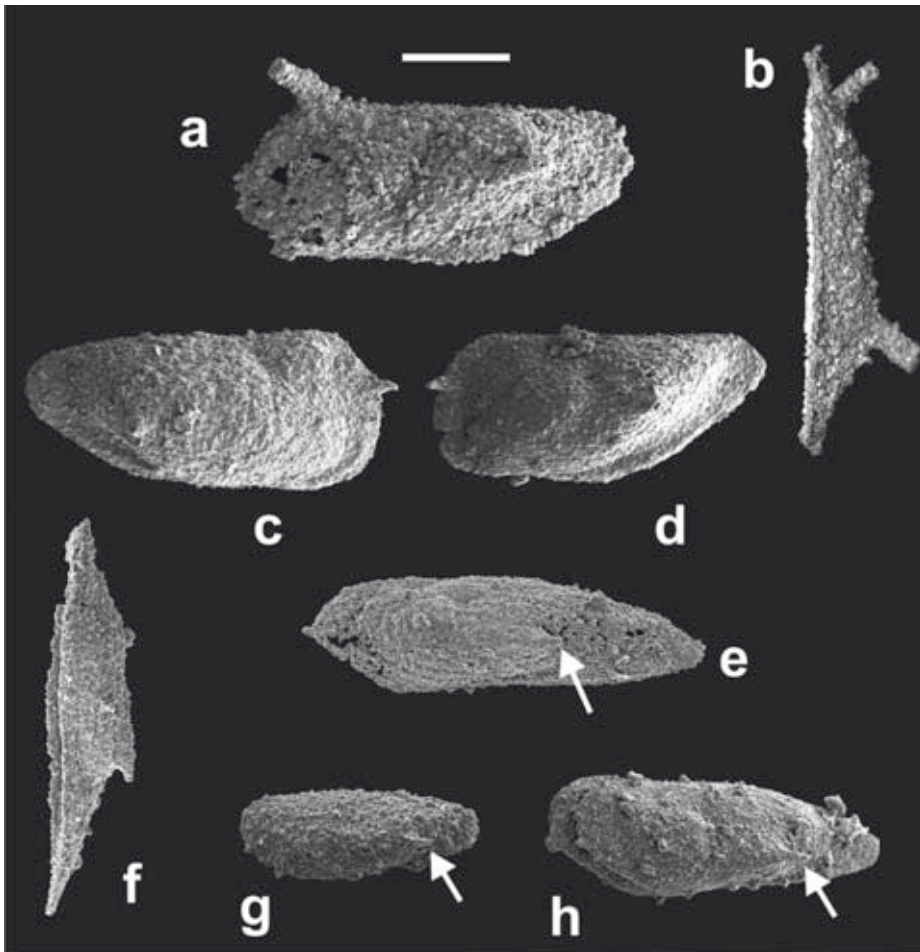


Figure 4. **a-b)** *Paraberounella* aff. *thuringica* Gründel, 1973, DGO7363, lateral and ventral views of LV. **c-d)** *Paraberounella* aff. *saalfeldensis* (Gründel, 1961), lateral views of RV (DGO 7362) and LV (DGO 7358). **e-h)** *Paraberounella?* *wagneri* n. sp. (**e-f**) Holotype (DGO 7356), LV. Lateral and ventral views. (**g**) Paratype (DGO 7354), LV of a juvenile specimen, lateral view. (**h**) Paratype (DGO 7353), LV, lateral view. The arrow points to the ventral spine. Scale bar = 200 μ m. LV: left valve. RV: right valve.

Crasquin *et al.* (1989) and Dreesen *et al.* (1985) remains uncertain.

4. CONCLUSIONS

The ostracods from Triollo represent a diverse Viséan fauna belonging to the “Thuringian Mega-Assemblage”. The open marine depositional environment indicated by these ostracods agrees with that inferred from the conodont and sedimentological studies. In contrast to the better known Upper Devonian and lowest Mississippian associations, the ostracods from Triollo illustrate a poorly known period for the Thuringian Mega-Assemblages.

ACKNOWLEDGEMENTS

The authors are very grateful to the reviewers, Professor J.G. Casier (IRSNB) and Dr. R. Gozalo (Departamento de Geología, Universidad de Valencia). Their comments and critical reading of the manuscript greatly contributed

to improve this article. We are also greatly indebted to the editors, Dr. C. Álvarez-Vázquez (Real Jardín Botánico de Córdoba) and Professor F.J. Rodríguez Tovar (Departamento de Estratigrafía y Paleontología, Universidad de Granada) for their careful editorial work. Thanks are given to Dr. J. Knight who kindly revised the English version of the manuscript. The photos of the specimens were taken with the SEM Jeol-6100 of the Servicios Científico-Técnicos of the Universidad de Oviedo. Thanks are also given to Mr. Alfredo Quintana for his assistance.

REFERENCES

- Bandel, K. & Becker, G. 1975. Ostracoden aus pelagischen Kalken der Karnischen Alpen (Silurium bus Untekarbon). *Senckenbergiana lethaea*, 56, 1-83.
- Bate, R.H. 1968. A new bairdiid ostracod from the Carboniferous of Spain. *Journal of Natural History*, 2, 111-115; doi:10.1080/00222936800770661.
- Becker, G. 1977. Thuringian ostracods from the Famennian of the Cantabrian Mountains (Upper Devonian, N Spain). In: *Aspects of ecology and zoogeography of Recent and*

- fossil Ostracoda* (eds. Löffler, H. & Danielopol, D.). W Junk, The Hague, 459-474.
- Becker, G. 1981. Ostracoda aus cephalopoden-führendem Oberdevon in Kantabrischen Gebirge (N-Spanien). 1. Hollinacea, Primitiopsacea, Kirkbyacea, Healdiacea und Bairdiocypridacea. *Palaeontographica*, A173, 1-63.
- Becker, G. 1982. Ostracoden aus cephalopoden-führendem Oberdevon in Kantabrischen Gebirge. (N-Spanien). 2. Bairdiacea, Cytheracea und Entomozoacea. *Palaeontographica*, A178, 109-182.
- Becker, G. 1999. Verkieselte Ostracoden vom Thüringer Ökotyp aus den Devon/Karbon-Grenzschichten (Top Wocklumer Kalk und Basis Hangenberg-Kalk) im Steinbruch Drewer (Rheinisches Schiefergebirge. Die "natürliche" D/C Grenze. *Courier Forschungsinstitut Senckenberg*, 218, 1-159.
- Becker, G. & Bless, M.J.M. 1990. Biotope indicative features in Palaeozoic ostracods: a global phenomenon. In: *Ostracoda and global events* (eds. Whatley, R. & Maybury, C.). British Micropalaeontological Society Publication Series, Chapman & Hall, London, 421-436; doi:10.1007/978-94-009-1838-2_32.
- Becker, G., Clausen, C.D. & Leuteritz, K. 1993. Verkieselte Ostracoden von Thüringer Ökotyp aus dem Grenzbereich Devon/Karbon des Steinbruchs Drewer (Rheinisches Schiefergebirge). *Courier Forschungsinstitut Senckenberg*, 160, 1-131.
- Bless, M.J.M. & Michel, M.P. 1967. An ostracod fauna from the Upper Devonian of the Gildar-Montó-Region (NW Spain). *Leidse Geologische Mededelingen*, 39, 269-271.
- Blumenstengel, H. 1965. Zue Taxionomie und Biostratigraphie verkieselter Ostracoden aus dem Thüringer Oberdevon. *Freiberger Forschungshefte*, C183, 1-127.
- Casier, J.G. 2004. The mode of life of Devonian entomozocean ostracods and the Myodocopid Mega-Assemblage proxy for hypoxic events. *Bulletin de l'Institute Royal des Sciences Naturelles de Belgique, Sciences de la Terre*, supplément 74, 73-80.
- Comte, P. 1959. Recherches sur les terrains anciens de la Cordillère Cantabrique. *Memorias Instituto Geológico y Minero de España*, 60, 1-440.
- Crasquin, S., Aguirre, P. & Perret, A.F. 1989. Premiers ostracodes profonds du Carbonifère inférieur français (Pyrénées occidentales). *Comptes Rendus de l'Académie des Sciences, Paris*, II, 309, 389-95.
- Dreesen, R., Bless, M.J.M., Conil, R., Flajs, G. & Laschet, Ch. 1985. Depositional environment, paleoecology and diagenetic history of the "Marbre rouge à crinoïdes de Baelen" (Late Upper Devonian, Verviers Synclinorium, Eastern Belgium). *Annales de la Société géologique de Belgique*, 108, 311-359.
- Gründel, J. 1961. Zur Biostratigraphie und Fazies der Gattendorfia-Stufe in Mitteldeutschland unter besonderer Berücksichtigung der Ostracoden. *Freiberger Forschungshefte*, C111, 55-173.
- Gründel, J. 1962. Zur Taxionomie der Ostracoden der Gattendorfia-Stufe Thüringens. *Freiberger Forschungshefte*, C151, 51-105.
- Gründel, J. 1972. Ostracoden (Crustacea) aus dem Visé des Harzes (Kulm-Fazies). *Freiberger Forschungshefte*, C276, 19-30.
- Gründel, J. 1973. Bythocytheridae (Ostracoda) aus dem Oberdevon/Dinant des Thüringer Schiefergebirges. *Zeitschrift für Geologische Wissenschaften*, 1, 329-345.
- Gründel, J. & Kozur, H. 1971. Zur Taxonomie der Bythocytheridae und Tricorninidae (Podocopida, Ostracoda). *Monatsberichte der Deutschen Akademie der Wissenschaften zu Berlin*, 13 (10-12), 907-037.
- Lethiers, F. & Feist, R. 1991. Ostracodes, stratigraphie et bathymétrie du passage Dévonien-Carbonifère aus Viséen inférieur en Montagne Noire (France). *Geobios*, 24, 71-104; doi:10.1016/0016-6995(91)80038-2.
- Nemyrovskaya, T.I. 2005. Late Viséan/early Serpukhonian conodont succession from the Triollo section, Palencia (Cantabrian Mountains, Spain) (with an appendix by Elias Samankassou). *Scripta Geologica*, 129, 13-89.
- Nemyrovskaya, T.I., Wagner, R.H., Winkler Prins, C.F. & Montañez, I. 2011. Conodont faunas across the mid-Carboniferous boundary from the Barcaliente Formation at La Lastra (Palentian Zone, Cantabrian Mountains, northwest Spain); geological setting, sedimentological characters and faunal descriptions. *Scripta Geologica*, 143, 127-183.
- Olempska, E. 1997. Changes in benthic ostracod assemblages across the Devonian-Carboniferous boundary in the Holy Cross Mountains, Poland. *Acta Palaeontologica Polonica*, 42, 291-332.
- Sánchez de Posada, L.C. 1973. *Ostrácodos carboníferos de la Cordillera Cantábrica*. PhD Thesis, Universidad de Oviedo (unpublished).
- Sánchez de Posada, L.C. 1976. Quelques remarques au sujet de la répartition des faunes d'Ostracodes carbonifères dans la Chaîne Cantabrique. *Annales de la Société Géologique du Nord*, 96, 407-412.
- Sánchez de Posada, L.C. 1987. *Gruendelella*, a new ostracod genus from the Namurian of the Cantabrian Mountains (N. Spain). *Journal of Micropalaeontology*, 6, 103-109; doi:10.1144/jm.6.1.103.
- Sánchez de Posada, L.C. & Sanz-López, J. 2010. *Pseudocriboconcha prinsii*, gen. et sp. nov. (Ostracoda) from the Late Mississippian (Carboniferous of the Cantabrian Zone (northern Spain). *Scripta Geologica*, Special Issue 7, 35-42.
- Sánchez de Posada, L.C., Sanz-López, J. & Blanco-Ferrera, S. 2012. Viséan ostracods from the Triollo section (Palencia, Cantabrian Zone). *XXVIII Jornadas de la Sociedad Española de Paleontología y Simposios de los Proyectos 587 y 596 del PICG*, Homenaje a Guillermo Colom Casanovas, (1900-1993), 311-314.
- Sanz-López, J., Blanco-Ferrera, S. & Sánchez de Posada, L.C. 2004. Estratigrafía del Serpukhoviense y el Bashkiriense inferior (Carbonífero) en la provincia de Pliegues y Mantos, Zona Cantábrica. *Geotemas*, 6, 131-14.
- Schornikov, E.I. & Mikhailova, E.D. 1990. Ostracods at early stage of development. Comparative morphology, paleoecology and evolutionary pathways. *Akademia Nauk*

- SSSR Dal'nevostochnoe Otdelenie Institut Biologii Moskva*, Moscow, 1-276 (in Russian with English summary).
- Wagner, R.H., Winkler Prins, C.F. & Riding, R.E. 1971. Lithostratigraphic units of the lower part of the Carboniferous in northern León, Spain (with a "Note on some goniatite faunas" by C.H.T. Wagner-Gentis). *Trabajos de Geología*, 4, 603-663.
- Wang, S. 1988. Ostracode faunas from the early Carboniferous Wangyou Formation in Nandan of Guangxi and their paleoecotype. *Memoires of Nanjing Institute of Geology and Palaeontology, Academia Sinica*, 4 (1988), 269-315 (in Chinese with English summary).