

Early Cretaceous non-marine bivalves from the Cameros and Basque-Cantabrian basins of Spain

Bivalvos no marinos del Cretácico Inferior de las cuencas de Cameros y Vasco-Cantábrica (España)

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Abstract

Large unionids from the Weald facies of northern Spain are described. Three hundred seventeen specimens belonging to the Order Unionoida have been studied. Two species from the family Margaritiferidae were identified from the Cameros Basin. *Margaritifera idubedae* (Palacios and Sánchez, 1885) was recorded from the Urbión Group (Hauterivian-Barremian in age), being a very frequent bivalve in these fluvial sediments. *Margaritifera valdensis* (Mantell, 1844) was collected from the Enciso Group (Aptian in age) and is an uncommon bivalve in this lacustrine environment.

A new genus with a new species called *Protoanodonta conchae* Delvene and Araujo, family Unionidae, is described from the Basque-Cantabrian Basin. Samples came from the Viviparus Bed Member (Vega de Pas Formation, Hauterivian-Barremian), interpreted as freshwater environment lacustrine in origin.

Keywords: Bivalvia, Unionoida, *Margaritifera*, Lower Cretaceous, Cameros Basin, Basque-Cantabrian Basin, Spain

Resumen

Se han descrito las grandes náyades de las facies Weald del Norte de España. Se han estudiado trescientos diecisiete ejemplares pertenecientes al Orden Unionoida. Se han identificado dos especies de la Familia Margaritiferidae en la Cuenca de Cameros. *Margaritifera idubedae* (Palacios & Sánchez, 1885) se ha registrado en el Grupo Urbión (de edad Hauteriviense-Barremiense) siendo un bivalvo muy frecuente en estos materiales fluviales. *Margaritifera valdensis* (Mantell, 1844) ha sido registrada en el Grupo Enciso (de edad Aptiense) y es un bivalvo poco común en estos ambientes lacustres.

Se ha definido un nuevo género que incluye una nueva especie, perteneciente a la Familia Unionidae, denominada *Protoanodonta conchae* Delvene and Araujo en la Cuenca Vasco-Cantábrica. Los ejemplares proceden del Miembro Capas de Viviparus (Formación Vega de Pas) y son de una edad Hauteriviense-Barremiense. Este ambiente de agua dulce se interpreta como lacustre.

Palabras clave: Bivalvia, Unionoida, *Margaritifera*, Cretácico Inferior, Cuenca de Cameros, Cuenca Vasco-Cantábrica, España.

1. Introduction

The so called “Wealden” facies are present in Spain in the Basque-Cantabrian Basin (Fig. 1). They developed at the northern paleo-margin of the Iberian Plate during the late Jurassic / early Cretaceous rifting stage. The remaining Spanish “Wealden” basins are located in the Iberian System: Cameros, Columbretes, Sur-iberian and Maestrazgo basins dating from the Upper Jurassic to Lower Cretaceous.

Molluscs (bivalves and gastropods) are the most abundant invertebrates in the Lower Cretaceous “Wealden” facies in Spain. Bivalves are dominant in terms of diversity, however the number of individuals is relatively low. González Linares (1878) mentioned the existence of bivalves ascribed to *Unio waldensis* (sic.) Mantell (1844) and gastropods assigned to *Paludina* from the province of Santander. Mengaud (1920) described with little detail the bivalves and gastropods from the “Wealden” facies of

the Cantabrian region. Among the bivalves, he identified *U. valdensis* Mantell 1844 from the locality “Casar de Periedo” and two morphotypes ascribed to “*Unio*” coming from “San Vicente de la Barquera”. Mengaud (1920) described and illustrated one from “San Vicente de la Barquera” (page 81, fig.12) and stated it resembled *Unio idubedae* Palacios and Sánchez, 1885. However, neither the drawing or description corresponds to *U. idubedae*.

Palacios and Sánchez (1885) described *Unio idubedae* in a work carried out by the *Spanish Geological Map Commission*. The samples came from the Wealden Formation of the Soria and Logroño provinces. The authors did not designate a holotype or paratypes for the new species. However, Delvene (2005) figured the syntypes (lectotype and paralectotypes) according to the article 73.2 of the *International Code of Zoological Nomenclature* (I.C.Z.N.). These type specimens are housed in the Museo Geominero (Instituto Geológico y Minero de España, IGME). The specimens and additional field samples re-

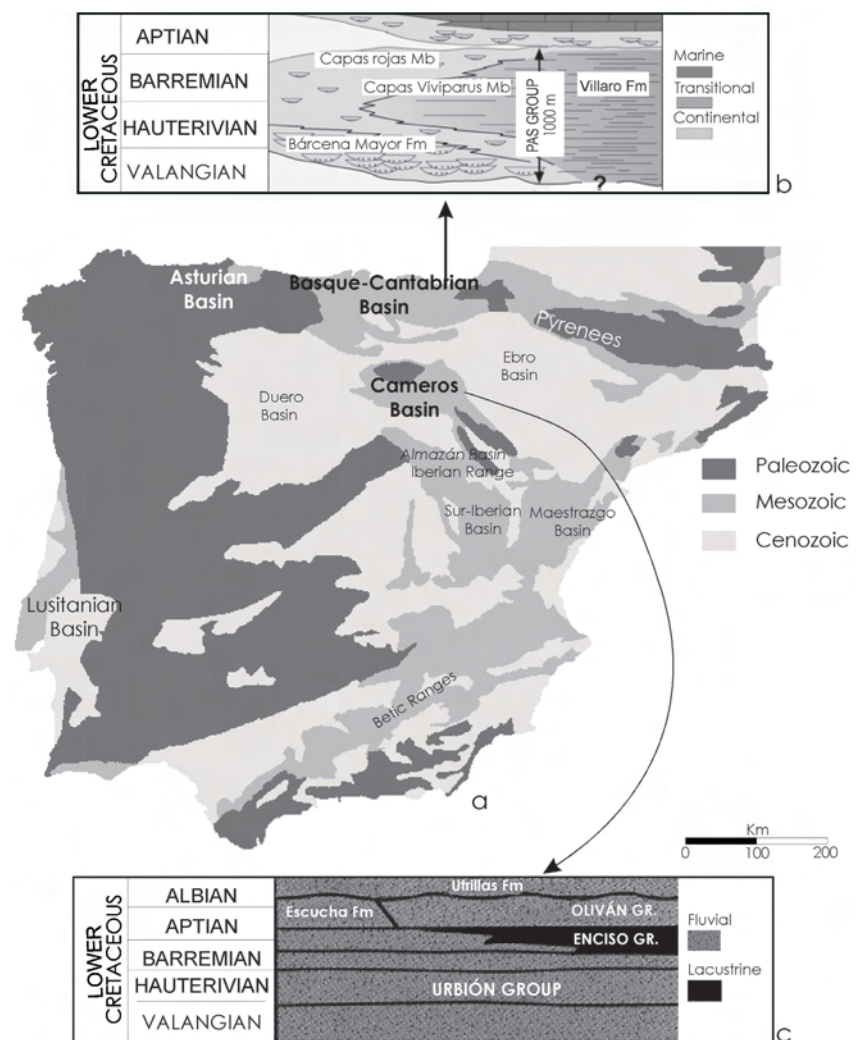


Fig. 1.- (a) Simplified geological map of the Iberian Peninsula showing the location of the Basque-Cantabrian and Cameros basins. (b) Lithostratigraphic units of the Lower Cretaceous of the Basque-Cantabrian Basin (modified after Pujalte *et al.*, 2004). (c) Lithostratigraphic units of the Lower Cretaceous of the Cameros Basin (modified after Mas *et al.* 2005).

Fig. 1.- (a) Mapa geológico simplificado de la Península Ibérica mostrando la situación de las cuencas de Cameros y Vasco-Cantábrica. (b) Unidades litoestratigráficas del Cretácico Inferior de la Cuenca Vasco-Cantábrica (modificado de Pujalte *et al.*, 2004). (c) Unidades litoestratigráficas del Cretácico Inferior de la Cuenca de Cameros (modificado de Mas *et al.*, 2005)

cently collected were ascribed to *Margaritifera idubedae* in previous taxonomic reviews (Bermúdez-Rochas *et al.*, 2006; Delvene *et al.*, 2006).

Yen (1966) reviewed the molluscs of the Wealden facies, with emphasis on the gastropods of the Santander area. Amongst the bivalves, *Anodonta cf. becklesi* Newton (1910) and *Unio cf. valdenis* Mantell, 1844 were identified but no illustration were provided. Mongin (1966) studied the bivalves from different Wealden facies basins in Spain. The author described and illustrated *Margaritifera (Pseudunio) idubedae* (Palacios & Sánchez, 1885) and described, but did not illustrate *Margaritifera (Pseudunio) valdensis* Mantell (1844). However, the figured specimens of *M. idubedae* were unusual forms, very different from the typical shape and may belong to another species. In fact, Mongin's specimens were similar to another specimen that Palacios and Sánchez (1885) ascribed to a poorly preserved *U. idubedae*, or to a variety of the same species (Palacios and Sánchez, 1885: 29, Plate 6, Fig. 5).

The main objective of this work is to describe the characteristic taxonomic features of the large unionoids recorded from "Wealden" facies in the north-northwest of Spain and their paleoautecological life history traits.

2. Geological setting

The studied material originates from two different geographical areas in the north of the Iberian Peninsula (Spain): The Basque-Cantabrian Basin and Cameros Basin.

Vega de Pas I outcrop is located at the westernmost domain of the Basque-Cantabrian Basin, the so called Cantabrian Basin (Pujalte, 1982) or Santander Basin (Pujalte, 1989a, b). The site is situated in the Pas river bed near the town of Vega de Pas in the Province of Cantabria. The Viviparus Bed Member (Hauterivian-Barremian), is thought to represent a lacustrine environment. The sedimentological and depositional environments of the Vega de Pas Formation have been discussed in detail by Pujalte (1974; 1976; 1981; 1982).

The other area studied is in the Cameros Basin, in the northwest of the Iberian Chain. Samples came from two different lithological groups from the province of La Rioja. The *Valdehierro* and *Valdemadera* outcrops belong to the Urbión Group, dating to the upper Hauterivian-lower Barremian. The paleoecosystem is interpreted as a meandering fluvial floodplain with small temporary shallow carbonate lakes (Barrenechea, 1993). On the other hand *Cornago G* outcrop is part of the Enciso Group, whose paleoenvironment is interpreted as lacustrine and is considered to be Aptian (Mas *et al.*, 2005).

3. Systematic Paleontology

All studied specimens are provisionally housed at the Museo Geominero. Specimens belonging to the collections of this museum are coded with the letters MGM, a number, and the letter C (for Cretaceous). Specimens coded with the letters that stand for the abbreviation of the outcrop's name (VH= *Valdehierro*, VM= *Valdemadera* and CG= *Cornago*) belong to and will be housed in one of the paleontological centres of La Rioja province when the study is finished.

A biometrical analysis has been carried out to separate the three identified species. All the figured specimens were coated with sublimated Ammonium Chloride. The asterisk indicates the type species.

Order Unionoida Stoliczka, 1871

Family Margaritiferidae Haas, 1940

Genus *Margaritifera* Schumacher, 1816

Margaritifera idubedae (Palacios and Sánchez, 1885)
Figs. 2 and 3; Table 1

* 1885 *Unio idubedae* sp. nov. - Palacios and Sánchez: 28, plate, 6a, figures 4, 4a, 4b.

non 1966 *Margaritifera (Pseudunio) idubedae* (Palacios and Sánchez) - Mongin: 42, plate. IV figures 1, 2, 3.

non 1966 *Margaritifera (Pseudunio) idubedae* (Palacios and Sánchez) var. *fisciformis* -Mongin: 43, plate 1, figure 8.

2005 "*Unio*" *idubedae* Palacios and Sánchez - Delvene: 168, plate 1, figures 1a-b, 2a-c.

2006 *Margaritifera (Pseudunio) idubedae* (Palacios and Sánchez) - Bermúdez Rochas, Delvene and Hernán: figures 3a-b.

Material

The type series comprises the lectotype (MGM924C) and paralectotypes (MGM941C, MGM946C, MGM1780C, MGM7414C), which are housed at the Museo Geominero (Instituto Geológico y Minero de España, Madrid). This material was collected by Palacios and Sánchez (1885).

Recently collected specimens: 202 from Valdehierro, coded VH1-202 (53 articulated specimens, 70 right valves, 51 left valves and 28 shell fragments) and 50 specimens, mostly fragmented, from Valdemadera (coded VM1-50).

Description

Shell solid, equivalve and inequilateral (Figs. 2 and 3), very tumid. Dorsal and ventral margins convex. Anterior part truncated, convex, rounded, and very thick. Posterior

Specimen	Height	Shell thick
VH-2	47.4	5.5
VH-4	9.5	2.2
VH-6 (juvenile)	-	1.6
VH-8 (juvenile)	-	1.4
VH-10	59.2	7
VH-11	-	4.9
VH-13	-	7.2
VH-18	51.5	7

Table 1. Measures in mm of *Margaritifera idubedae* (Palacios and Sánchez, 1885)

Tabla 1. Dimensiones en mm de *Margaritifera idubedae* (Palacios y Sánchez, 1885)

part much thinner and usually broken. Shell very thick (7.2 mm maximum). Umbones rounded, prominent and prosogyrous, the apex very acute (Fig. 2: 3). Sculpture of the umbo typically, consisting of concentric double waves, rounded in front and beaked behind, parallel to the shell's growth lines (Fig. 2: 2b, 3; Fig. 3: 2, 4a, 5). The "heart-shape" of this sculpture near the apex vanishes in the adult shell and becomes a single curve. Lunule well developed in front of the umbones (Fig. 2: 3). The hinge of *Margaritifera idubedae* resembles both the one of *M. auricularia* and that of *P. littoralis*. Left valve with two massive cardinal teeth, the posterior teeth very tall and pyramidal, crenulated and well separated from the anterior tooth by a gap that is also crenulated. Anterior cardinal tooth conical, with a smooth anterior face joining the muscular scars and a posterior face with crests and holes. Anterior adductor muscle impression small, extremely rough, kidney-shaped and close to the shell margin. The anterior pedal retractor scar is excavated in the base of the anterior cardinal, just close to the adductor scar. Below the adductor impression the marks of the two pedal protractor muscles form an ear shaped mark. Right valve

with only one cardinal tooth, which is very thick. Muscle impressions similar to the ones on the left valve. Lateral teeth and posterior adductor muscle scars unknown in both valves. In some of the better preserved specimens small mantle muscle scars are visible in the inner side of the valve (Fig. 3:1, 3a, 3b).

Discussion

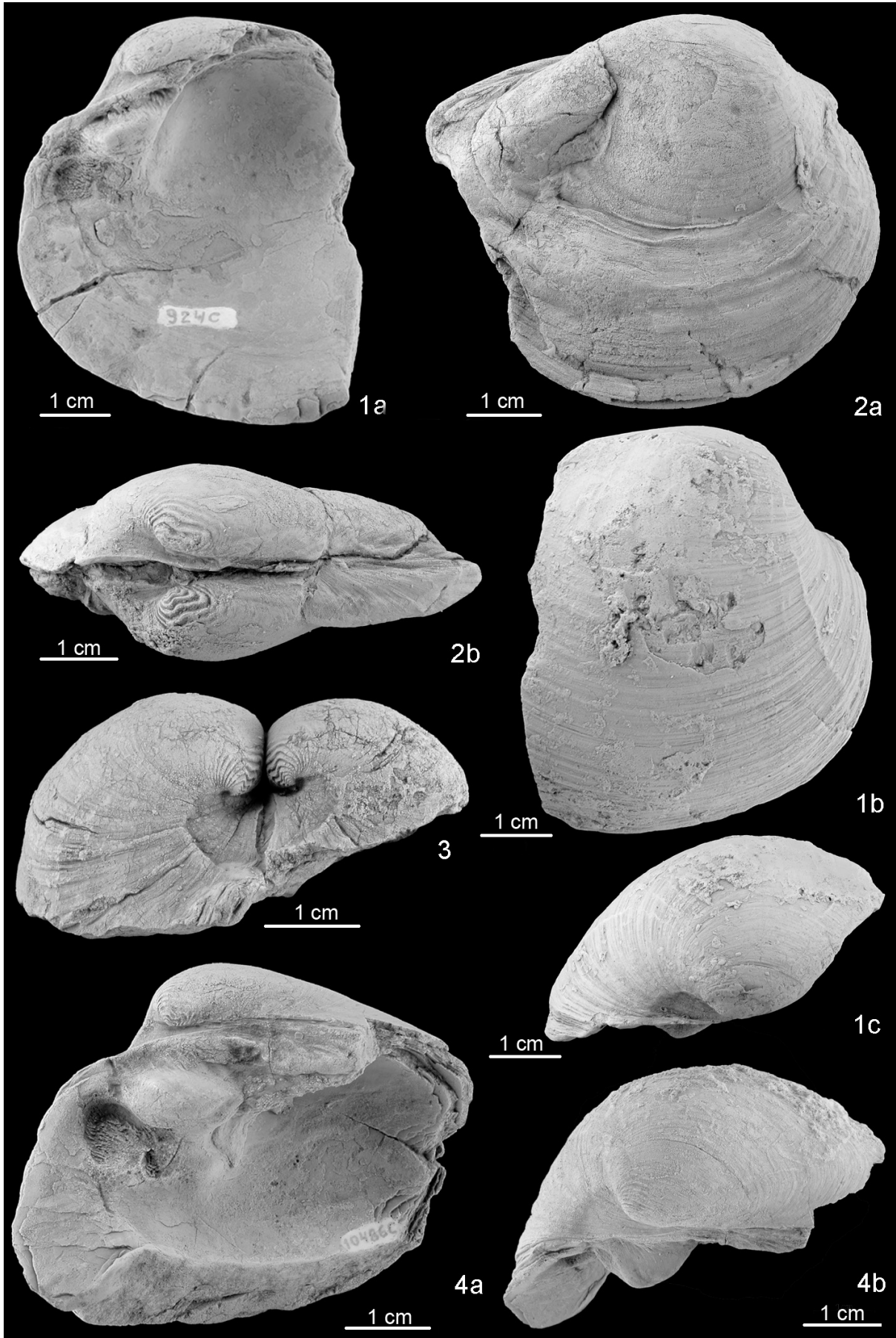
The assignation of this species to the genus *Margaritifera* is based on external features, hinge characters and muscle impressions. This species' shell has an outline shape similar to the small recent *Margaritifera auricularia* (Spengler, 1793) and *Potomida littoralis* (Cuvier, 1798), although the complete shape is known from only a few specimens. The umbonal sculpture of *M. idubedae* seems to be similar that of *P. littoralis* (Bourguignat, 1864: Pl. XVIII, fig. 6), but the shell of other species like *Unio* or *Anodonta* could also present a similar ornamentation to this species (Kennard, Salisbury and Woodward, 1925). In fact, juvenile specimens of *M. valdensis* (Mantell, 1844) housed in Natural History Museum of London show an identical heart-shape sculpture on the umbones (Fig. 3: 6) that is also present in other Lower Cretaceous "*Unio*" species. The mantle muscle scars on the inner side of the valve, the arborescent rugosity and the absence of knobs on the adductor impression scars, the later being a character in *P. littoralis*, makes *Margaritifera* the most probable genus to include the species in. This genus was cited from the Wealden by Mongin (1961) including the *M. valdensis* Mantell (1844). *M. idubedae* was placed in the genus *Margaritifera* by Mongin (1966). However, this was based upon the study of a specimen very different from the type of *Unio idubedae* (Palacios and Sánchez, 1885), which does not belong to the same species. The different outline shape of the shell and the absence of the hinge in the specimen described by Mongin (1966) demonstrate that she was dealing with a different species.

Fig. 2 (opposite page).- *Margaritifera idubedae* (Palacios and Sánchez, 1885)

1. Right valve; (a) Internal view; (b) External view; (c) Dorsal view. Lower Cretaceous, Sierra de Alcarama (Navajún, La Rioja). Lectotype. MGM 924C. Figured by Delvene (2005: plate 1, Figure 2a-c).
2. Articulated specimen; (a) Right view; (b) dorsal view. Lower Cretaceous, Sierra de Alcarama (Navajún, La Rioja). Paralectotype. MGM7414C. Figured by Delvene (2005: plate 1, Figure 1a-b).
3. Anterior view of an articulated specimen. Lower Cretaceous, Valdehiero site from Urbión Group (Navajún, La Rioja). VH-193
4. Right valve; (a) Interior view; (b) dorsal view. Lower Cretaceous, Valdehiero site from Urbión Group (Navajún, La Rioja). MGM10486C. Figured by Bermúdez-Rochas *et al.* (2006: Figure 3b).

Fig. 2. (página opuesta).- *Margaritifera idubedae* (Palacios y Sánchez, 1885)

1. Valva derecha; (a) Vista interna; (b) Vista externa; (c) Vista dorsal. Cretácico Inferior en la Sierra de Alcarama (Navajún, La Rioja). Lectotipo. MGM 924C. Figurado por Delvene (2005: lámina 1, Figura 2a-c).
2. Ejemplar articulado; (a) Vista derecha; (b) Vista dorsal. Cretácico Inferior en la Sierra de Alcarama (Navajún, La Rioja). Paralectotipo. MGM7414C. Figurado por Delvene (2005: lámina 1, Figura 1a-b).
3. Vista anterior de un ejemplar articulado. Cretácico Inferior en el yacimiento de Valdehiero del Grupo Urbión (Navajún, La Rioja). VH-193
4. Valva derecha; (a) Vista interior; (b) Vista dorsal. Cretácico Inferior en el yacimiento de Valdehiero del Grupo Urbión (Navajún, La Rioja). MGM10486C. Figurado por Bermúdez-Rochas *et al.* (2006: Figura 3b).



Indeed, other specimens included by Mongin (1966) in the *M. (Pseudunio) idubedae* var. *ficiformis* did not correspond to *M. idubedae*. The main differences between *idubedae* and *valdensis* are the following: *M. idubedae* is shorter than *M. valdensis* which has a more elongated shape, the umbones of *M. idubedae* are more pointed than in *M. valdensis* where they are more rounded. Furthermore, *M. idubedae* has a well developed lunule and the cardinal tooth in the right valve, which is much thicker than in *M. valdensis*.

Occurrence. Hauterivian-Barremian (Urbión Group, Unit B) at Valdehiero and Valdemadera sites (Navajún, province of La Rioja) from Cameros Basin.

Paleoautecology. Recent *Margaritifera* live burrowed partially in pebble-cobble substrates in rapid flow or highly oxygenated waters. *M. idubedae* probably lived in a similar habitat, as it is recorded from sediments interpreted as a meandering fluvial floodplain. The recent *M. auricularia* live in meanders of large rivers as a filter-feeder organism.

Margaritifera valdensis (Mantell, 1844)

Fig. 3: 6, Fig. 4, Fig. 5: 1-3; Table 2

* 1844 *Unio valdensis* sp. nov. - Mantell: 403, figures 1, 2, 3.

1846 *Unio valdensis* Mantell - J. de C. Sowerby: plate 646, figures 1, 2, 3.

1961 "*Unio*" *valdensis* Mantell - Mongin: 340, plate 15; plate 16, figures 1a, 1b.

? 1961 "*Unio*" *valdensis* Mantell - Mongin: plate 16, figure 2.

1966 *Margaritifera (Pseudunio) valdensis* Mantell - Mongin: 44.

1998 *Margaritifera (Pseudunio) valdensis* (Mantell) - Radley and Barker: figures 3a, 7.

Material

A total of 46 specimens from Cornago site (coded CG-G4-1-46) coming from recent fieldworks: 33 articulated specimens, 10 left valves and 3 right valves.

Description

Shell oval, large, equivalve and inequilateral. Dorsal and ventral margins convex. Anterior part short and convex, posterior part slightly elongated but not resembling the *Unio* shape. Umbones rounded and obtuse, not prominent, without sculpture. Left valve with two crenulated

Specimen	Length	Height	Convexity	Shell thick
CG-G4-1	73.2	-	-	2.7
CG-G4-2	42.9	31.3	10	-
CG-G4-3	70.8	-	-	5.7
CG-G4-4	85.5	53	-	-
CG-G4-5	83	58	-	-

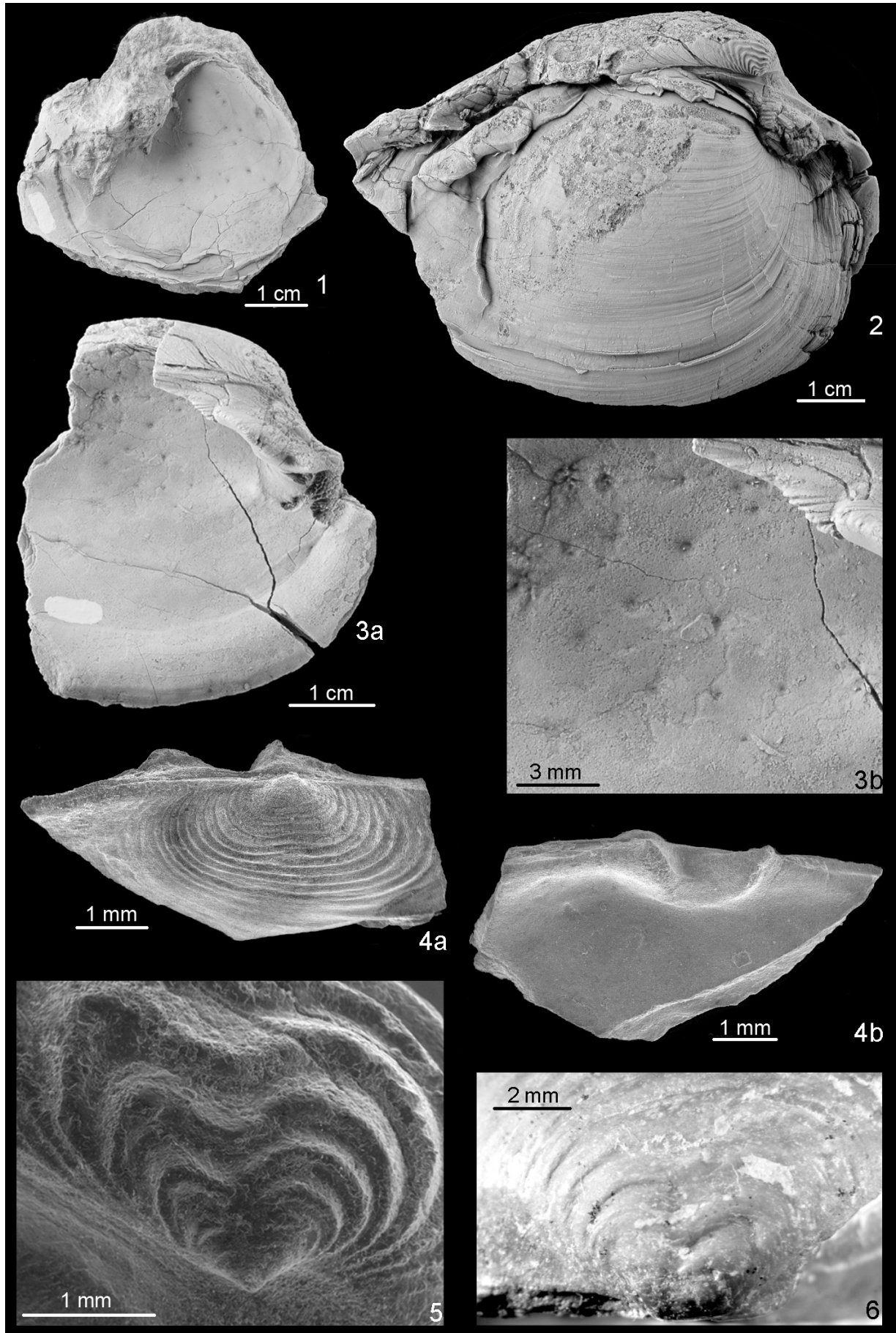
Table 2. Measures in mm of *Margaritifera valdensis* (Mantell, 1844)
Tabla 2. Dimensiones en mm de *Margaritifera valdensis* (Mantell, 1844)

Fig. 3 (opposite page).- *Margaritifera idubedae* (Palacios and Sánchez, 1885)

1. Interior view of a shell fragment showing the small mantle muscle scars. Lower Cretaceous, Valdehiero site from Urbión Group (Navajún, La Rioja). VH-178.
2. View of an articulated specimen with displaced valves. Lower Cretaceous at Valdehiero site from Urbión Group (Navajún, La Rioja). MGM10462C. Figured by Bermúdez-Rochas *et al.* (2006: Figure 3a).
3. (a) Interior view of left valve showing the small mantle muscle scars; (b) Detail of the mantle muscle scars. Lower Cretaceous, Valdehiero site from Urbión Group (Navajún, La Rioja). VH-144.
4. Left valve of a juvenile specimen; (a) External view; (b) internal view. Lower Cretaceous, Valdemadera site from Urbión Group (Navajún, La Rioja). VM-1.
5. Detail of the umbo sculpture of *Margaritifera idubedae* (Palacios and Sánchez, 1885) by scanning electronical microscope.
6. Detail of the umbo sculpture of *Margaritifera valdensis* (Mantell, 1944). Lower Cretaceous at Isle of Wight (England). Specimen housed at Natural History Museum of London

Fig. 3 (página opuesta).- *Margaritifera idubedae* (Palacios y Sánchez, 1885)

1. Vista interior de un fragmento de concha mostrando las pequeñas impresiones musculares del manto. Cretácico Inferior en el yacimiento de Valdehiero site del Grupo Urbión (Navajún, La Rioja). VH-178.
2. Vista derecha de un ejemplar articulado con las valvas desplazadas. Cretácico Inferior en el yacimiento de Valdehiero site del Grupo Urbión (Navajún, La Rioja). MGM10462C. Figurado por Bermúdez-Rochas *et al.* (2006: Figure 3a).
3. (a) Vista interior de una valva izquierda mostrando las pequeñas impresiones musculares del manto; (b) Detalle de las impresiones musculares del manto. Cretácico Inferior del yacimiento de Valdehiero del Grupo Urbión (Navajún, La Rioja). VH-144.
4. Valva izquierda de un ejemplar juvenil; (a) Vista externa; (b) Vista interna. Cretácico Inferior en el yacimiento de Valdemadera del Grupo Urbión (Navajún, La Rioja). VM-1.
5. Detalle de la ornamentación umbonal de *Margaritifera idubedae* (Palacios y Sánchez, 1885) fotografiado en microscopio electrónico de barrido (SEM).
6. Detalle de la ornamentación umbonal de *Margaritifera valdensis* (Mantell, 1944). Cretácico Inferior de la Isla de Wight (Inglaterra). Ejemplar depositado en el Museo de Historia Natural de Londres. NGRSZ 392828.



cardinal teeth very close together, and two thick lateral teeth (only the anterior part preserved). Hinge of the right valve unknown. Muscular impression in both valves with arborescent rugosity.

Discussion

Although the anterior cardinal tooth of the studied specimen does not fit exactly with that of the types (Mantell, 1844; Mongin, 1961), the external aspect of the shell and hinge of the left valve allow us to identify our specimens as *M. valdensis*. This species has high morphological variability, a common feature in many unionoids. For instance the thickness of the shell and ligament depend directly on the sedimentary environments, according to Tevesz and Carter (1980) and own observations. A review of the type series indicates that the lectotype (one articulated specimen, BM3281) and syntype (the two separated valves of the same specimen, BM3282) correspond to different sediments than those of the topotype, L9744 (Mongin, 1961: plate 15). Therefore this specimen (L9744) is not considered as a topotype in the museum where it is housed (NHM), being a good example of the mentioned morphological variability of the species. The Spanish fossils belong to this second morphotype. Although Mongin (1961: 341) did not mention any umbonal ornamentation on English specimens, we did observe it on some specimens. Even if rarely visible, probably due to the acid waters that dissolve the umbo (Radley and Barker, 1998, and Munt *personal communication*), the ornamentation was present only on juveniles (Fig. 3: 6). Although the Spanish specimens do not preserve umbonal sculpture, this heart-like ornamentation could be a common character of both margaritiferae, *M. idubedae* and *M. valdensis*.

Occurrence. Aptian (Enciso Group) at Cornago (province of La Rioja) from Cameros Basin.

Paleoautecology.

M. valdensis is interpreted in the same way as *M. idubedae*, but it is recorded from some sediments that are in-

terpreted as lacustrine deposits, where they were partially burrowed while filtering water.

Family Unionidae Fleming, 1828

Genus *Protoanodonta* gen. nov.

Delvene and Araujo

Fig. 5: 4, Figs. 6-8; Table 3

Derivatio nominis

Proto (Greek, $\pi\rho\omega\tau\omicron$) = first, early

Anodonta = without teeth

Type species

Protoanodonta conchae sp. nov.

Diagnosis

Shell large and flat, rounded to oval, equivalve and inequilateral, similar to *Anodonta*, but with a solid, flat shaped and crenulated cardinal teeth on the right valve.

Protoanodonta conchae sp. nov.

Delvene and Araujo

Derivatio nominis

After Conchita Ibarrola, the mother of G. Delvene, who loved and supported the vocation of her daughter as palaeontologist.

Material

Holotype: Partial right valve (MGM10727C).

Paratypes: Right valves (MGM10728C, MGM10731C), articulated specimens (MGM10729C, MGM10730C, MGM10795C).

A total of 19 specimens (MGM10716C-MGM10733C; MGM10795C), including type material, coming from recent fieldworks and the donation of Jose Luis Sañudo's fossil collection to the Museo Geominero (Instituto Geológico y Minero de España, Madrid): 8 right valves, 4 articulated specimens, 2 left and 5 undetermined valves.

Fig. 4 (opposite page).- *Margaritifera valdensis* (Mantell, 1844)

1. Internal view of a partial left valve. Lower Cretaceous, Cornago site from Enciso Group (La Rioja). CG-G4-6.

2. Left valve; a: external view, b: internal view, c: detail of the anterior adductor muscle scar. Lower Cretaceous, Cornago site from Enciso Group (La Rioja). CG-G4-1.

3. Articulated specimen; a: right view, b: left view. Lower Cretaceous, Cornago site from Enciso Group (La Rioja). CG-G4-4.

4. Juvenil articulated specimen; a: left view, b: right view. Lower Cretaceous, Cornago site from Enciso Group (La Rioja). CG-G4-2.

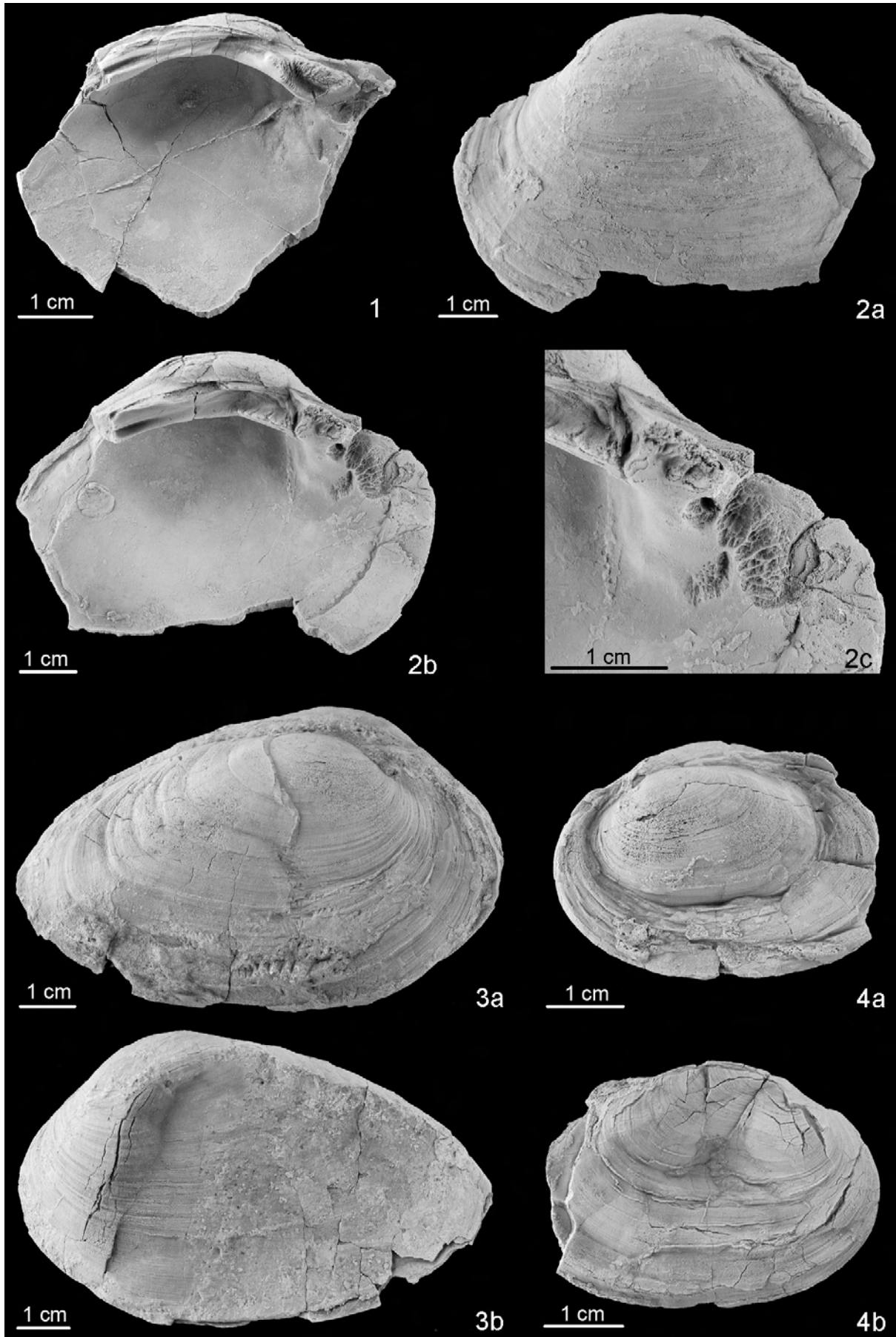
Fig. 4 (página opuesta).- *Margaritifera valdensis* (Mantell, 1844)

1. Vista interna de una valva izquierda fragmentada. Cretácico Inferior del yacimiento de Cornago del Grupo Enciso (La Rioja). CG-G4-6.

2. Valva izquierda; a: vista externa, b: vista interna, c: detalle de la impresión muscular. Cretácico Inferior del yacimiento de Cornago del Grupo Enciso (La Rioja). CG-G4-1.

3. Ejemplar articulado; (a) vista derecha, (b) vista izquierda. Cretácico Inferior del yacimiento de Cornago del Grupo Enciso (La Rioja). CG-G4-4.

4. Ejemplar juvenil articulado; (a) vista izquierda, (b) vista derecha. Cretácico Inferior del yacimiento de Cornago del Grupo Enciso (La Rioja). CG-G4-2.



Diagnosis

The same as the new genus *Protoanodonta*.

Synonyms

2007 ?*Margaritifera valdensis* (Mantell) - Bermúdez-Rochas *et al.*: Figure 2.

Description

Shell large and flat, equivalve and inequilateral. Shape convex to oval, dorsal and ventral margins arched. Anterior part short and convex, posterior margin convex or beaked. Shell very thin, becoming thicker in the mid-dorsal area. Umbos rounded and prominent, globose and without sculpture. Right valve with a solid, flat shaped and crenulated cardinal teeth; the remains of a poorly preserved posterior cardinal may be observed under the umbo, also the initial portion of a lateral tooth. Hinge and muscle scars of the right valve unknown. Anterior adductor muscular impression hardly observable, but probably smooth.

Discussion

Protoanodonta conchae resembles *Anodonta becklesi* Newton (1910: 116, plate 1, figures 1-4), but some important differences justify the necessity of defining the new genus and species. The description of *Anodonta becklesi* Newton, 1910 is based only on external features, and the hinge is unknown. A review of the type series and other complementary specimens of the same sediments housed in the *Natural History Museum, London*, show that the ascription to the genus *Anodonta* without checking the hinge is at best doubtful. The examination of the best preserved specimens shows that the hinge was not very strong and that the teeth were probably absent. Apart from the hinge, another main difference between *A. becklesi* and *P. conchae* is that the former has a very marked umbonal posterior carina resulting in a slight wing and in a square outline of the shell. Moreover, the shell of *A. becklesi* is thicker than *P. conchae*, although these differ-

ences can depend on environments features.

Anodonta-like specimens could have a thin shell, from heavily hinged to edentulous. The thin shell and the habitat where *P. conchae* was found allow us to suggest its taxonomical proximity to the genus *Anodonta*. Nevertheless, the presence of at least a very clear cardinal tooth and lateral teeth and the absence of umbonal sculpture make the adscription of these shells to this genus difficult.

Type locality

Vega de Pas site (province of Santander) from Basque-Cantabrian Basin.

Type horizon

Viviparus Bed Member (Vega de Pas Formation, Pas Group) Hauterivian-Barremian.

Paleoautecology

Recent *Anodonta*-like specimens live burrowed in a wide range of substrates, from mud to sand or gravel, sometimes in lakes and slow flowing waters. *P. conchae* has been recorded from sediments interpreted as lacustrine environments together with a large number of speci-

Specimen	Length	Height	Convexity	Shell thick
MGM10727C (holotype)	104	64	-	4.4
MGM10728C	98.9	62.7	-	6.2
MGM10795C	98.5	65	17.7	-
MGM10729C	66.5	57.2	15.4	-
MGM10730C	123.9	89.4	25.8	-

Table 3. Measures in mm of *Protoanodonta conchae* Delvene and Araujo.

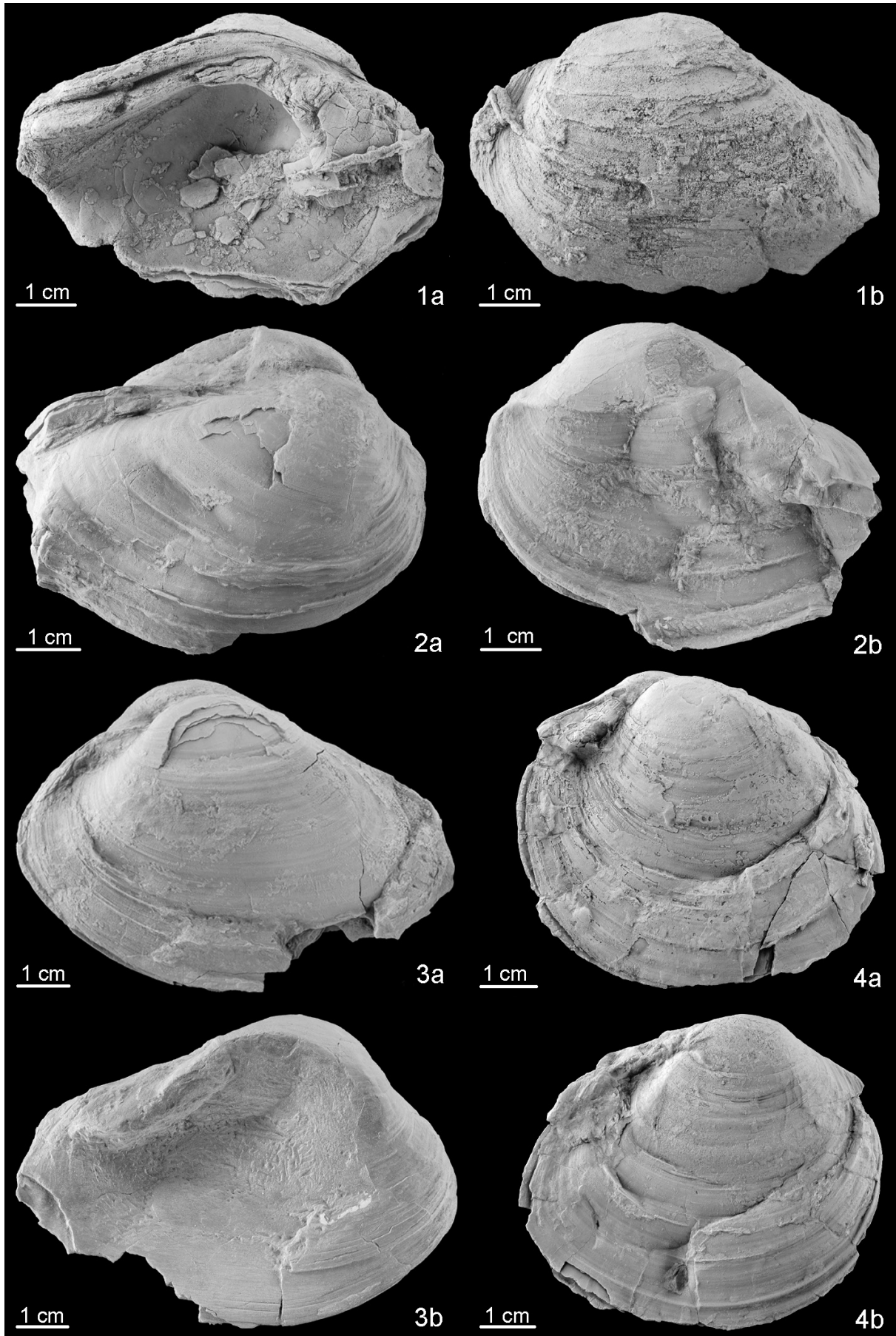
Tabla 3. Dimensiones en mm de *Protoanodonta conchae* Delvene y Araujo.

Fig. 5 (opposite page).- 1-3 *Margaritifera valdensis* (Mantell, 1944)

1. Left valve; (a) internal view, note the lateral teeth, (b) external view. Lower Cretaceous at Cornago site from Enciso Group (La Rioja). CG-G4-3.
2. Articulated specimen; (a) right view, (b) left view. Lower Cretaceous at Cornago site from Enciso Group (La Rioja). CG-G4-7.
3. Articulated specimen; (a) left view, (b) right view. Lower Cretaceous at Cornago site from Enciso Group (La Rioja). CG-G4-5.
4. *Protoanodonta conchae* (Delvene and Araujo). Articulated specimen; (a) left view, (b) right view. Lower Cretaceous at Vega de Pas site from Viviparus Member (Cantabria). MGM10729C.

Fig. 5 (página opuesta).- 1-3: *Margaritifera valdensis* (Mantell, 1944)

1. Valva izquierda; (a) vista interna, fijarse en el diente lateral, (b) vista externa. Cretácico Inferior del yacimiento de Cornago del Grupo Enciso (La Rioja). CG-G4-3.
2. Ejemplar articulado; (a) vista derecha, (b) vista izquierda. Cretácico Inferior del yacimiento de Cornago del Grupo Enciso (La Rioja). CG-G4-7.
3. Ejemplar articulado; (a) vista izquierda, (b) vista derecha. Cretácico Inferior del yacimiento de Cornago del Grupo Enciso (La Rioja). CG-G4-5.
4. *Protoanodonta conchae* (Delvene y Araujo) Ejemplar articulado; (a) vista izquierda, (b) vista derecha. Cretácico Inferior en el yacimiento de Vega de Pas del Miembro Capas de Viviparus (Cantabria). MGM10729C.



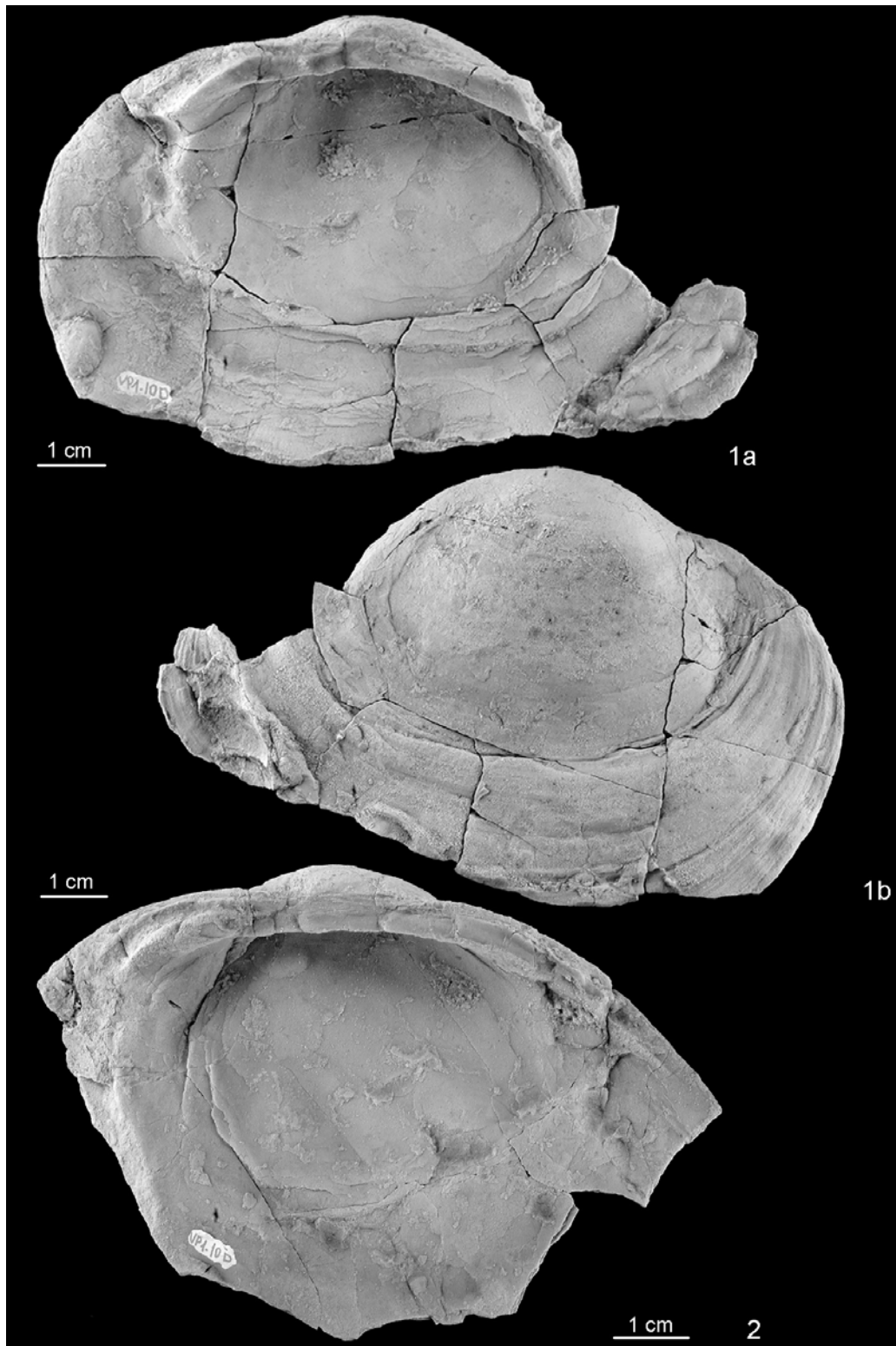


Fig. 6.- *Protoanodonta conchae* (Delvene and Araujo)

1. Right valve; (a) internal view, (b) external view. Lower Cretaceous, Vega de Pas site from Viviparus Member (Cantabria). Holotype. MGM10727C.

2. Internal view of a right valve. Lower Cretaceous, Vega de Pas site from Viviparus Member (Cantabria). Paratype. MGM10728C.

Fig. 6.- *Protoanodonta conchae* (Delvene y Araujo)

1. Valva derecha, (a) vista interna, (b) vista externa. Cretácico Inferior en el yacimiento de Vega de Pas site del Miembro Capas de Viviparus (Cantabria). Holotipo. MGM10727C.

2. Vista interna de una valva derecha. Cretácico Inferior en el yacimiento de Vega de Pas del Miembro Capas de Viviparus (Cantabria). Paratipo. MGM10728C.

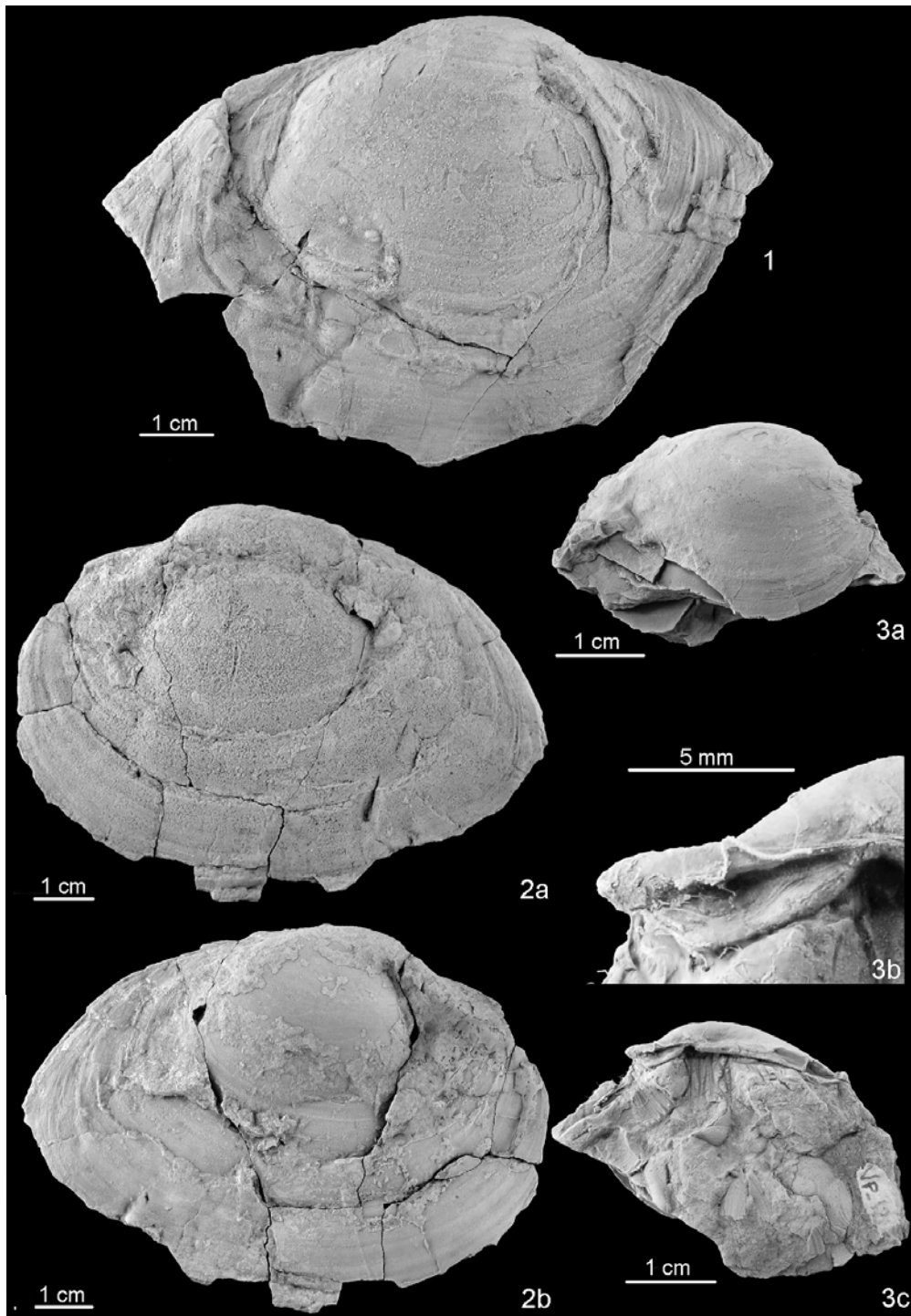


Fig. 7.- *Protoanodonta conchae* (Delvene and Araujo)

1. External view of a right valve. Lower Cretaceous, Vega de Pas site from Viviparus Member (Cantabria). Paratype. MGM10728C.
2. Articulated specimen; (a) left view, (b) right view. Lower Cretaceous, Vega de Pas site from Viviparus Member (Cantabria). Paratype. MGM10795C.
3. Right valve of a juvenile specimen; (a) external view, (b) detail of the cardinal teeth, c: internal view. Lower Cretaceous, Vega de Pas site from Viviparus Member (Cantabria). Paratype. MGM10731C.

Fig. 7.- *Protoanodonta conchae* (Delvene y Araujo)

1. Vista externa de una valva derecha. Cretácico Inferior en el yacimiento de Vega de Pas site del Miembro Capas de Viviparus (Cantabria). Paratipo. MGM10728C.
2. Ejemplar articulado; (a) vista izquierda, (b) vista derecha. Cretácico Inferior en el yacimiento de Vega de Pas site del Miembro Capas de Viviparus (Cantabria). Paratipo. MGM10795C.
3. Valva derecha de un ejemplar juvenil; (a) vista externa, (b) detalle del diente cardinal, c: vista interna. Cretácico Inferior en el yacimiento de Vega de Pas site del Miembro Capas de Viviparus (Cantabria). Paratipo. MGM10731C.

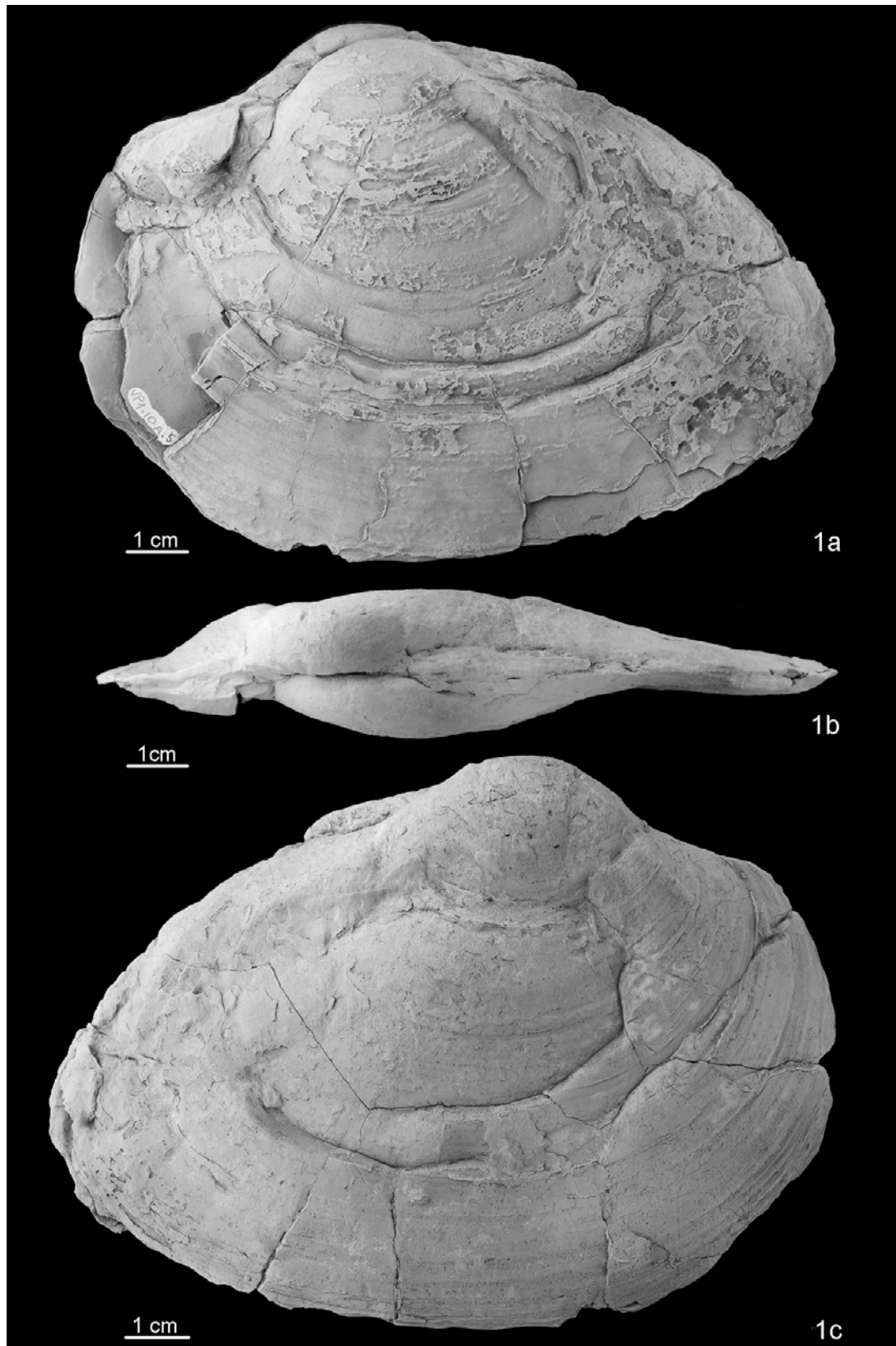


Fig. 8.- *Protoanodonta conchae* (Delvene and Araujo)

1. Articulated specimen; (a) left view, (b) dorsal view, (c) right view. Lower Cretaceous, Vega de Pas site from Viviparus Member (Cantabria). Paratype. MGM10730C

Fig. 8.- *Protoanodonta conchae* (Delvene y Araujo)

1. Ejemplar articulado de gran tamaño; (a) vista izquierda, (b) vista dorsal, (c) Cretácico Inferior en el yacimiento de Vega de Pas site del Miembro Capas de Viviparus (Cantabria). Cretaceous at Vega de Pas site from Viviparus Member (Cantabria). Paratype. MGM10730C.

mens of *Viviparus*. As other unionoids, they were filter-feeder at least in the adult stage.

4. Conclusions

Two species of unionoids from the Lower Cretaceous at Cameros Basin have been identified, both belonging to the Family Margaritiferidae (Order Unionoida). *Margaritifera idubeade* (Palacios and Sánchez, 1885) is very common in the Urbión Group, which is interpreted as a fluvial system. In contrast with the English Weald where it is abundant, *Margaritifera valdensis* (Mantell, 1844) is an uncommon species in Spain. Here it is recorded from Enciso Group that is considered as a lacustrine environment.

Protoanodonta conchae Delvene and Araujo has been defined as a new genus and a new species of the Family Unionidae (Order Unionoida), from the Lower Cretaceous. It comes from the the *Viviparus* Bed Member (Vega de Pas Formation), which is interpreted as being a lacustrine environment, located at the Basque-Cantabrian Basin.

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References

Barrenechea J.F. (1993): *Evolución de la mineralogía de arcillas en el tránsito diagénesis-metamorfismo de bajo grado en el Grupo Urbión (Cretácico inferior) de la cuenca de Los Cameros (Soria - La Rioja)*. Tesis Doctoral. Universidad Complutense de Madrid. Facultad de Ciencias Geológicas. Madrid, 299 p.

- Bermúdez-Rochas, D.D., Delvene, G., Hernán, J. (2006): Estudio preliminar del contenido paleontológico del Grupo Urbión (Cretácico Inferior, Cuenca de Cameros, España): restos ictiológicos y malacológicos. *Boletín Geológico y Minero*, 117 (monográfico especial): 531-536.
- Bermúdez-Rochas, D.D., Delvene, G., Moratalla, J., Hernán, J., De la Fuente, M. (2007): Primeros datos paleontológicos del yacimiento del Cretácico Inferior Vega de Pas 1 (Cuenca Vasco-Cantábrica, Cantabria, España). *II Semana de Jóvenes Investigadores del IGME*, IGME, Madrid: 23-28.
- Bourguignat, M. J. R. (1864): *Malacologie de L'Algérie. Histoire Naturelle des animaux. Mollusques terrestres et fluviatiles recuillis jusqu'a ce jour dans nos possessions du Nord de L'Afrique*. Tome Second. Paris. 380 p.
- Delvene, G. (2005): El material tipo de las especies de "Unio" (Bivalvia) del Cretácico Inferior del Museo Geominero (IGME, Madrid). *Boletín Geológico y Minero*, 116 (2): 167-172.
- Delvene, G., Araujo, R., Bermúdez-Rochas, D.D. (2006): Cretaceous Spanish margaritiferids. *Organisms Diversity and Evolution* 6 (Electronic Supplement), 16 (1): 24. <http://www.senkenberg.de/odes/06-16.htm>.
- González-Linares, A. (1878): La existencia del terreno Wealdico en la Cuenca del Besaya (provincia de Santander). *Anales de la Sociedad Española de Historia Natural*, 7: 487-489.
- International Commission on Zoological Nomenclature. (1999): *International Code of Zoological Nomenclature*. International Trust for Zoological Nomenclature. <http://www.iczn.org/iczn/index.jsp>.
- Kennard, A. S., Salisbury, A. E., Woodward, B. B. (1925): Notes on the British post-Pliocene Unionidae, with more especial regard to the means of identification of fossil fragments. *Proceedings of the Malacological Society of London*, 16: 267-285.
- Mantell, G. A. (1844): On the Unionidae of the river of the country of the Iguanodon. *The American journal of Science and Arts*, 47 (1): 402-406.
- Mas, R., Benito, M.I., Arribas, J., Serrano, A., Guimerà, J., Alonso, A., Alonso-Azcárate, J. (2005): La Cuenca de Cameros: desde la extensión finijurásica-eocretácica a la inversión tericaria-implicaciones en la exploración de hidrocarburos. *Zubía Monográfico*, 14: 9-64.
- Mengaud, L. (1920): *Recherches géologiques dans la Région Cantabrique*. Thèse Faculté Science, Paris. Bonnet, Toulouse, 370 p.
- Mongin, D. (1961): "Unio" valdensis Mantell, from the Wealden beds of England: its taxonomic position and geographical distribution. *Proceedings of the Malacological Society of London*, 34: 340-345.
- Mongin, D. (1966): Description paleontologique de quelques lamellibranches limniques des facies wealdiens d'Espagne. *Notas y Comunicaciones del Instituto Geológico y Minero de España*, 91: 41-60.
- Newton, R. B. (1910): On an undescribed Anodonta from the English Wealden formation, with remarks on the other Unio-

- nidae of the same period. *Proceedings of the Malacological Society of London*, 9: 114-117.
- Palacios, P., Sánchez, R. (1885): La formación Wealdense en las provincias de Soria y Logroño. *Boletín de la Comisión del Mapa Geológico de España*, 12: 1-32.
- Pujalte, V. (1974): Litoestratigrafía de la facies Weald (Valanginiense superior-Barremiense), en la provincia de Santander (norte de España). *Boletín Geológico y Minero*, 85: 10-21.
- Pujalte, V. (1976): Posibilidad de una nueva división estratigráfica de los sedimentos no marinos del Jurásico superior y Cretácico inferior, en la provincia de Santander. *Boletín Geológico y Minero*, 87: 101-118.
- Pujalte, V. (1981): Sedimentary succession and paleoenvironments within a fault-controlled basin: the «Wealden» of the Santander area, northern Spain. *Sedimentary Geology*, 28: 293-325.
- Pujalte, V. (1982): La evolución paleogeográfica de la Cuenca «Wealdense» de Cantabria. *Cuadernos de Geología Ibérica*, 8: 65-83.
- Pujalte, V. (1989a): *Macrosecuencias deposicionales del Oxfordiense-Barremiense de la región Vasco-Cantábrica: implicaciones estratigráficas y paleogeográficas*. Asociación de Geólogos y Geofísicos Españoles del Petróleo (AGGEP). Libro Homenaje a Rafael Soler: 105-114.
- Pujalte, V. (1989b): Ensayo de correlación de las sucesiones del Oxfordiense – Barremiense de la Región Vasco-Cantábrica basado en macrosecuencias deposicionales: implicaciones paleogeográficas. *Cuadernos de Geología Ibérica*, 13: 199-215.
- Pujalte, V., Robles, S., García-Ramos, J.C., Hernández, J.M. (2004): El Malm-Barremiense no marinos de la Cordillera Cantábrica. In: Vera, J.A. (Ed. Ppal.) *Geología de España*: Instituto Geológico y Minero de España. Sociedad Geológica de España. Madrid: 288-291.
- Radley, J.D., Barker, M. J. (1998): Palaeoenvironmental analysis of shell beds in the Wealden Group (Lower Cretaceous) of the Isle of Wight, southern England: an initial account. *Cretaceous Research*, 19: 489-504.
- Tevesz, M.J.S., Carter, J.G. (1980): Environmental relationship of shell form and structure of Unionacean Bivalves. In: D.C. Rhoads, Lutz, R.A. (ed.): *Skeletal growth of aquatic organisms*: 295-322. Plenum Publishing Corporation, New York.
- Yen, J. T. C. (1966): A molluscan fauna of the Wealden Formation in Spain. *Notas y Comunicaciones del Instituto Geológico y Minero de España*, 82: 87-98.