

A Review of *Orbiculoidea saltensis* Reed, Brachiopoda: Discinidae, of the Upper Carboniferous of Argentina.

Roberto Ricardo LECH¹

Abstract. A REVIEW OF ORBICULOIDEA SALTENSIS REED, BRACHIOPODA: DISCINIDAE, OF THE UPPER CARBONIFEROUS OF ARGENTINA. The purpose of this paper is to present a review of *O. saltensis* Reed, presenting a new diagnosis based in the study of some articulated specimens. These fossils were found in the marine sedimentary rocks of the Late Paleozoic of the Precordillera of Mendoza and San Juan, Argentina. Also, the species described by Reed is compared with other species of discinoid brachiopods from the Paleozoic of South America, and some of the proposals for the taxonomic identification of them are modified.

Resumen. REVISIÓN DE ORBICULOIDEA SALTENSIS REED, BRACHIOPODA: DISCINIDAE, DEL CARBÓNIFERO SUPERIOR DE ARGENTINA. Se presenta la revisión de la morfología del braquiópodo perteneciente a la Familia Discinidae: *Orbiculoidea saltensis* Reed, proponiendo un diagnóstico modificado basado en el estudio de algunos especímenes fósiles articulados. Estos fósiles fueron encontrados en las rocas sedimentarias marinas del Paleozoico tardío de la Precordillera de Mendoza y San Juan, Argentina. Además, la especie descrita por Reed se compara con otros especímenes pertenecientes a la misma familia del Paleozoico de América del Sur.

Key words: Brachiopoda, Discinidae, *Orbiculoidea saltensis*, re-description, Upper Carboniferous, Argentina.

Palabras clave: Braquiópodo, Discinidae, *Orbiculoidea saltensis*, re-descripción, Carbonífero Superior, Argentina.

Introduction

The inarticulate brachiopods of the Family Discinidae Gray (1840) of the Late Palaeozoic of Argentina are relatively poorly studied, and assigned in all cases to genera *Oeblertella* Hall and Clarke (1890) or *Orbiculoidea* d'Orbigny (1847), with *Oeblertella annae* Feruglio (1933) and *Orbiculoidea saltensis* Reed (in Du Toit, 1927) as unique species. These brachiopods have generally a thin-walled shell and lack a solid articulate system. After the death of these brachiopods, both valves were separated and the erosion makes it difficult to study.

The present study is a revision of one of those species: *Orbiculoidea saltensis* Reed, proposing an emended diagnosis based on the study of some articulated specimens. Also, *O. saltensis* is compared with other species of the genus *Orbiculoidea* described for the Paleozoic of South America and are proposed to belong to other genera of discinoid brachiopods for some of them.

Fossils of this study were found in the marine sedimentary rocks of the Late Paleozoic of the Precordillera of Mendoza and San Juan, Argentina (Figure 1). These were deposited in the paleontological collections of the "Instituto Superior de Correlación Geológica – CONICET", Tucumán, Argentina, (PIL "Paleontología de Invertebrados Lillo") and of the "Centro Nacional Patagónico – CONICET" (CNP-IPPC "Colección Paleontología de Invertebrados e Icnología", Puerto Madryn, Chubut, Argentina).

¹ Centro Nacional Patagónico-CONICET. Brown 2915 (U9120ACD), Puerto Madryn, Chubut, Argentina.
E-mail: lechrr@yahoo.com.ar

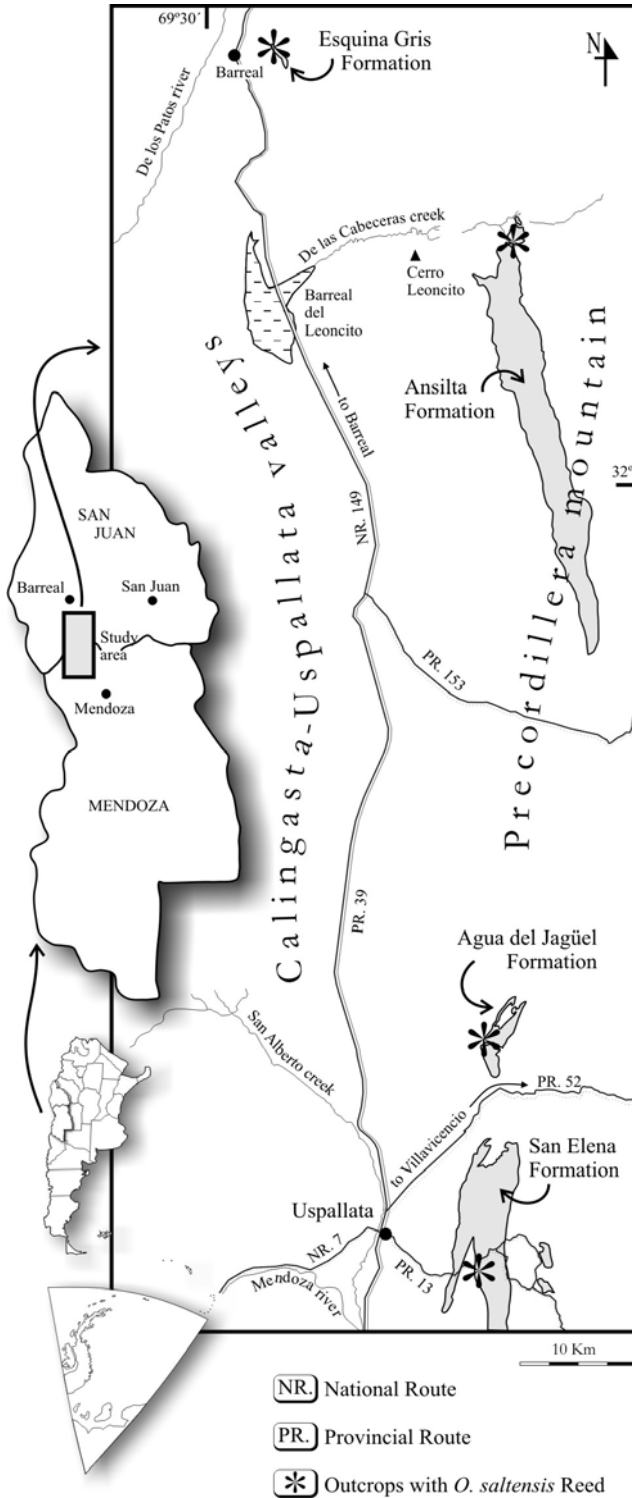


Figure 1. A simplified map showing the location of the Carboniferous stratigraphic units here mentioned.

Systematic Palaeontology

The systematic palaeontology used in this group of invertebrates has been proposed by Holmer and Popov (2000), which little differs from that presented in the first edition of *The Treatise of Invertebrate Paleontology, Part H, Brachiopoda* (Rowell, 1965a).

Orden: Lingulida Waagen, 1885
 Superfamily: Discinoidea Gray, 1840
 Family: Discinidae Gray, 1840
 GENUS *Orbiculoidea* d'Orbigny, 1847

Type species.- *Orbicula forbesii* Davidson, 1848; Silurian (Wenlock), England.

Diagnosis (emended by Mergl, 2006).- "Shell strongly dorsibiconvex, sub-circular, with sub-trapezoidal outline of the posterior shell part; shell thin walled; ornament of both valves composed of regular raised concentric file separated by broader interspaces; dorsal valve conical to sub-conical with sub-central apex; ventral valve depressed conical with sub-central apex; pedicle track narrow, tapering posteriorly, anteriorly closed by shallow listrium; foramen in posterior end of listrium with short internal tube".

Comparisons.- *Orbiculoidea* d'Orbigny is a cosmopolitan genus of the Ordovician – Permian and many described species. According to Mergl and Massa (2005) and Mergl (2006), some of these species of *Orbiculoidea* can be attributed to the genus *Arosaccus* Willard (1928) or *Gigadiscina* Mergl and Massa (2005), so the biocron and geographical distribution of the genus of d'Orbigny can be modified substantially. *Orbiculoidea* differs from the other members of the Family Discinidae by the shell strongly dorsibiconvexa and sub-circular, with sub-trapezoidal outline to the posterior shell part.

The genus *Arosaccus* Willard (1928), of the Ordovician of U.S.A. and Silurian of England, differs from *Orbiculoidea*, principally by having their valves equally convex and the apex dorsal near the centre; and with the genus *Schizotreta* Kutorga (1848) of the Ordovician of Russia and Silurian of England, differs in its elongate oval outline, short pedicle track and long internal pedicle tube.

The genus *Rugadiscina* Mergl (2006), of the Silurian of England, differs from *Orbiculoidea*, principally by their convexo-concave to convexo-plane valves, and their short pedicle track surrounded by a depression; with the genus *Roemerella* Hall and Clarke (1890), of the Devonian of U.S.A., differs by having a pedicle track on a broadly elevated area, but shares a high conical dorsal valve and ornament. *Roemerella* is poorly known and could be a synonym of *Orbiculoidea* (Mergl, 2006).

The genus *Gigadiscina* Mergl and Massa (2005), of the Lower Devonian of Algeria, differs from *Orbiculoidea*, in its very short pedicle track and its great size, but the ornament shell outline and convexity indicate the close affinity of both genera.

Orbiculoidea saltensis Reed
 Figure 2; Figure 3. A-G.

1927 - *Orbiculoidea saltensis* Reed. In Du Toit: 132; pl. 13, fig. 1.

1972 - *Orbiculoidea* aff. *saltensis* Reed. Antelo: 162; pl. 1, fig. 5; pl. 2, fig. 6.

1979 - *Orbiculoidea* aff. *saltensis* (Reed). Amos: 71; 2 figs.

1990 - *Orbiculoidea* aff. *saltensis* Reed. Lech: 17; pl. 1, fig. 7.

Holotype and paratype.- The specimens are deposited in South African Museum, N° 7335. Other fossil material: N° 7340 and N° 7310.

Type horizon and locality. Esquina Gris Formation, Layer 4. Quebrada de Tres Saltos, Barreal, San Juan, Argentina (Mésigos, 1953).

Remarks.- The new species proposed by Cowper Reed is based on three specimens deposited at the Museum of South Africa with the numbers 7310, 7335 and 7340, which are described as: "Shell subcircular. Upper valve low, conical, with excentral apex situated at about one-third of the diameter from posterior margin. Surface ornamented with about fifteen coarse rounded subequidistant concentric liræ, mostly bearing small, low, closely placed, hollow tubercles, the whole crossed by very delicate radial striæ. Lower valve (incompletely known) flattened or gently concave, with hollow, low, conical apex and a small foramen at the end of a partly in closed broad groove to posterior margin." (in Du Toit, 1927: 132-133).

However, Arturo J. Amos when studying the specimen N° 7335 (in Du Toit, 1927, plate 13, fig. 1), noted that the ornamentation described as belonging to *Orbiculoidea* is an overprinting of the ornamentation of gastropod *Glabrocingulum argentinus* (Reed) on the ventral valve of this brachiopod. Amos did not study the rest of the specimen collected by Du Toit because these were not in the collection of the South African Museum (Antelo, 1972).

Diagnosis.- (emended in this paper).- Shell dorsibiconvex, sub-circular, with slightly sub-trapezoidal outline of the posterior shell part. Both valves ornamented by concentric fila separated by broader inter-space, gently concave, and crossed by fine growth lines. Dorsal valve sub-conical, with the apex sub-central. Ventral valve depressed conically, with sub-central apex, posterior flank convex, anterior flank concave and flanks convex to flat. Pedicle track narrow, tapering posteriorly, formerly closed by the listrium; foramen in posterior end of listrium with short internal tube.

Material.- Four ventral valves and an external mould of the ventral valve in negative; two internal moulds of dorsal valves and an external mould of dorsal valve; all specimens in negative (PIL 13209a-l, CNP-PIIc 0269). An internal mould of both valves articulated in negative (PIL 13452). An external mould of the ventral valve in negative (PIL 13455). Two dorsal valves and two ventral valves (PIL 13464a-d). All specimens partially preserved and with remains of original shell.

Stratigraphy and Geographic Distribution.- PIL 13209a-l, PIL 13452, CNP-PIIc 0269: Agua del Jagüel Formation (Harrington, 1971), fossiliferous zone N° 5 (Lech 2002); Agua del Jagüel mountain, Paramillo de Uspallata, Mendoza, Argentina. PIL 13455: Ansilta Formation (Harrington, 1971), perfil A-A' (Bercowsky *et al.*, 1996) Quebrada del Telégrafo, Ansilta mountain, San Juan, Argentina. PIL 13464a-d, Santa Elena Formation (Yrigoyen, 1967), Seccion I (Rodríguez, 1966), fossiliferous level E (Archangelsky and Lech, 1987); "Quebrada de Uspallata", Uspallata, Mendoza, Argentina.

Extended description.- The shell is large (30-32 mm long in adult forms), dorsibiconvex, rectimarginate, and thin-shelled compared to shell size. The dorsal valve is semi-globose to sub-conical (12.5 mm to maximum height) and the ventral valve is sub-conical and low (2.5 mm to maximum height). The outline of the shell is circular in appearance, with less rounded posterior outline and slightly extended posterior margin, forming a sub-trapezoidal outline in posterior half of the shell. The length / width ratio is nearly 1, with the maximum width slightly anterior to the mid-length. The ornament of both valves consists of concentric rugellae, occasionally discontinuous, arranged at regular distances, and separated by broadly U-shaped interspaces covered by growth lines. There are 12 to 14 rugellae per 5 mm in the middle of the anterior slope of both valves.

The dorsal valve is high, semi-globose to sub-conical, with the apex located around the middle of the shell and slightly turned to the posterior margin. The posterior slope is slightly convex and forms an angle of 45° to the commissural plane. The anterior slope and side slopes are convex. The inside of the dorsal valve is unknown.

The ventral valve is low, sub-conical, with the apex located around the middle of the length of the shell. The posterior slope is slightly convex and the anterior slope is slightly concave. The lateral slopes are slightly convex to flat. The pedicle track is narrowly spindle-shaped, occupying

two thirds of the posterior slope. The bottom of the pedicle track is covered by the listrium. The listrial plates are convex, but are not in contact with each other in the center of the pedicle track, and are covered by the growth lines. The ventral valve interior lacks a distinct visceral area and the vascular system is poorly impressed.

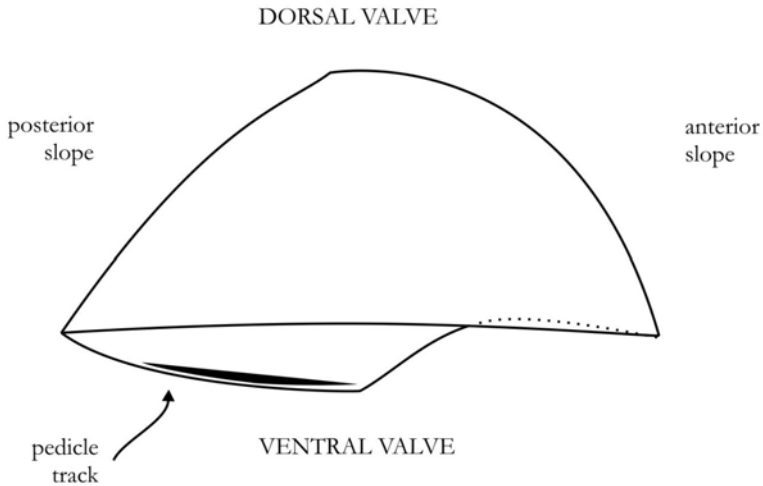


Figure 2. Diagrammatic cross section of *Orbiculoidea saltensis* based on PIL 13209a-b.

Comparisons.- *Orbiculoidea saltensis* Reed is less globose, the pedicle track is narrower and the sub-trapezoidal profile is less marked than the type species *O. forbesii* Davidson.

Although there are many mentions of the *Orbiculoidea* genus in sediments of the Late Paleozoic of South America, there are very few species described.

Oliveira (1930) described *O. guarauensis* (Oliveira) for the Subgroup Itararé, Upper Carboniferous of central Brazil, characterized by its small size and large pedicle track. In the same geological time, Chronic (in Newell *et al.*, 1953) described to *O. prietana* Chronic for the Tarma Formation, Cerros de Amotape, northeastern Peru. This species has similar morphological characteristics from the genus *Gigadiscina* Mergl and Massa (2005), such as the ventral valve flat to slightly concave and short pedicle track; but differs from *Rugadiscina* Mergl (2006) because it owns the flat ventral valve different mainly in its ornamentation and the small depression of the pedicle track.

Several species attributed to the genus *Orbiculoidea* were described in the Lower Palaeozoic of South America, some of them re-assigned to the genus *Gigadiscina* by Mergl and Massa (2005). Among them are: *G. bainii* (Sharpe), of the Lower Devonian of Argentina (Kayser, 1897; Méndez-Alzola and Sprechmann, 1971; Morris and Sharpe, 1846; Sharpe, 1856; Baker, 1923), and of the Devonian of Bolivia (Schuchert, 1897; Knod, 1908; Branisa, 1965), of Brazil (Ammon, 1893; Clarke, 1913; Kozłowski, 1913) and of Uruguay (Méndez-Alzola, 1934). Also, it is present in Antarctic and South Africa (Rowell, 1965b; Reed 1903, 1925). Other species of *Orbiculoidea* reassigned to the new genus by Mergl and Massa (2005) are: *G. bodenbenderi* (Clarke), of the Lower Devonian of Argentina (Baker, 1923) and of Brazil (Clarke, 1913) and *G. collis* (Clarke), of the Lower Devonian of Argentina (Leveratto, 1968; Méndez-Alzola and Sprechmann, 1971), of Brazil (Clarke, 1913; Kozłowski, 1913; Boucot *et al.*, 2001), and of Uruguay (Mendez -Alzola, 1934, 1938). And it is also present in the Lower Devonian of South Africa (Reed, 1925). *Orbiculoidea falklandensis* Rowell (1965b) of the Lower Devonian of Argentina, and of Brazil (Boucot *et al.*, 2001) presents similar morphology to *O. saltensis*. However, this species is smaller than *O. saltensis* and it has the conical ventral valve low and the dorsal valve depressed. Other species assigned to the genus *Orbiculoidea* are: *O. keideli*, *O. crucecita* and *O. baldisi*, described for the Devonian of

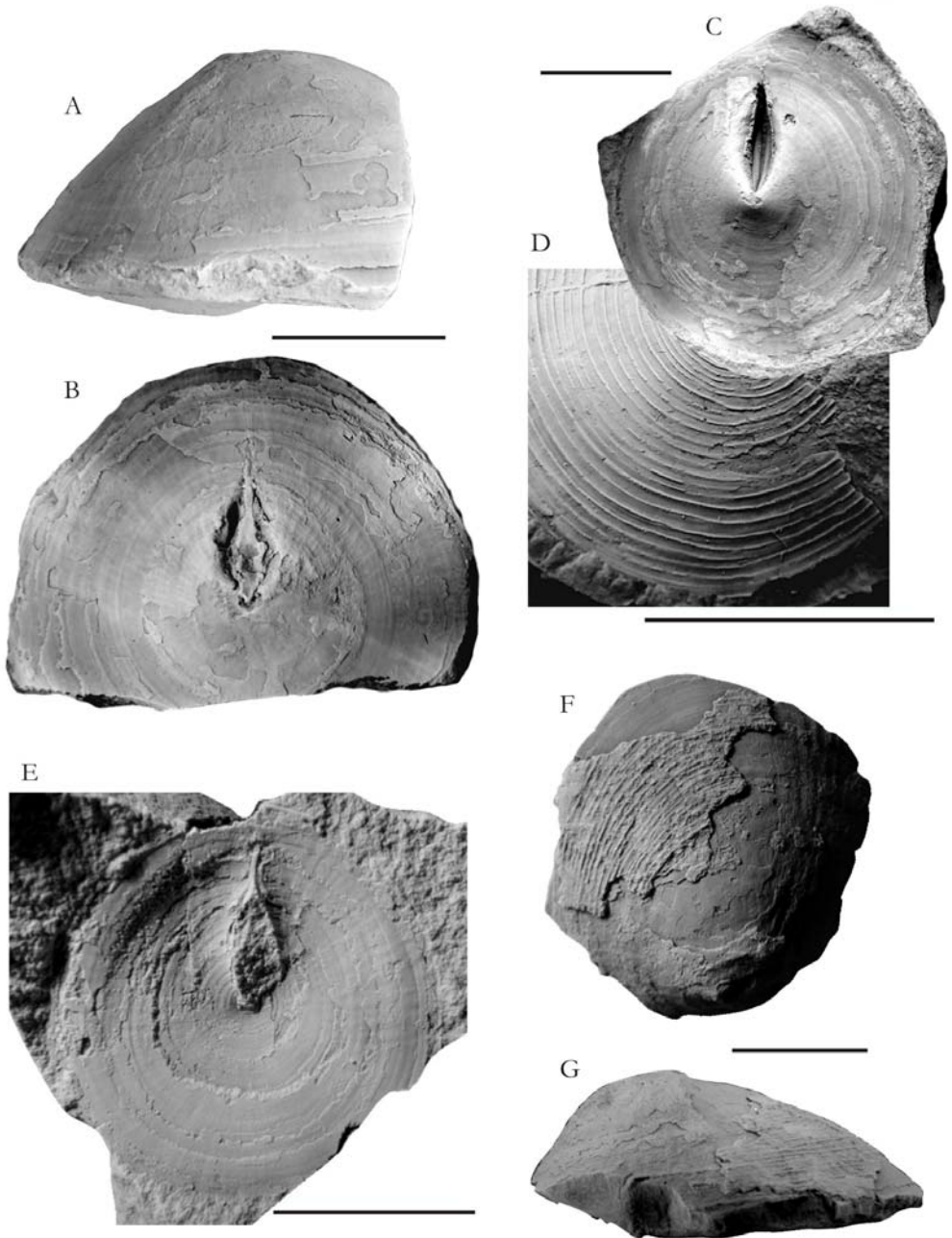


Figure 3. A-G, *Orbiculoidea saltensis* Reed. Agua del Jagüel Formation: **A**, PIL 13209a, lateral view of both valves partially preserved; **B**, ventral valve of the same specimen; **C**, PIL 13,209b, ventral valve partially decortication; **D**, PIL 13209c, latex cast of a fragment of ventral valve with details of the ridges. Santa Elena Formation: **E**, PIL 13.464a, interior of ventral valve. Ansilta Formation: **F-G**, PIL 13455, fragment of dorsal valve with a detail of the ridges and the side profile. (Graphic Scale 1 cm).

Argentina by Méndez-Alzola and Sprechmann (1971). These authors based their diagnosis of the first two species only in the respective dorsal valves, while the morphometry of the ventral and dorsal valves of *O. baldisi* are more similar to *Rugadiscina* Mergl (2006) than of the *Orbiculoidea* genus.

Stratigraphic distribution and geological age.- Although *Orbiculoidea saltensis* Reed is mentioned in different geological units of the Neopaleozoic of Argentina, this study confirms its presence in the Agua del Jagüel, Ansilta and Santa Elena Formations. In addition to the fossil localities mentioned in this work, *O. saltensis* was described for the Esquina Gris Formation, Barreal (in Du Toit, 1927), and for the Quebrada Larga Formation, Punilla mountain (Antello, 1972), both formations outcropping in the province of San Juan, Argentina.

The outcroppings of these formations are in the Precordillera of the provinces of San Juan and Mendoza, Argentina. Also, the abundant fossiliferous record present in these formations is what allows us to propose different biozones, and more than one interpretation regarding the geological ages attributed to them (see Azcuy *et al.* 2007; Césari *et al.* 2007; Gutiérrez 2006, 2008).

In the Esquina Gris Formation, *Orbiculoidea saltensis* is present in the Biozone *Balakbonia peregrina* – *Geniculifera tenuiscostata*, with an Upper Carboniferous age estimated by Taboada (1997). Instead, *O. saltensis* is in the Quebrada Larga Formation with other marine invertebrates referring to the Biozone *Tivertonía jachalensis* – *Streptorhynchus inaequiornatus* (Sabattini *et al.*, 1991) with an estimated age late Late Carboniferous to early Early Permian (Archangelsky *et al.*, 1996a).

O. saltensis is also present in Agua del Jagüel Formation, in the fossiliferous zone N° 5, with *Histosyrinx jaguelensis* (Lech), *Costatumulus* sp., *Spiriferellina* sp., *Streptorhynchus inaequiornatus* Leanza, and *Crurithyris* sp. This fossiliferous association is in the upper terms of the Agua del Jagüel Formation, approximately 320 meters above the pillow lavas dated at 307.2 ± 5.2 million years, estimating its age in the late Late Carboniferous by Lech (2002).

Koukharsky *et al.* (2005, 2009) confirmed this latest geological information provided by Lech (2002) and discovered new outcrops of volcanic rocks contemporaneous with the sedimentation of the Agua del Jagüel Formation. Also, they analyzed the geochemical and isotopic data of the volcanic rocks and suggested that were deposited in an ensialic retroarc marine basin during the Upper Carboniferous age.

Instead, Taboada (2006) discarded the submarine magmatic events, also presupposes an unusual condition to the radiometric data presented in Lech (2002) and based on the similarity between species in another region of Gondwana gives a younger age (Early Permian) to the Biozone *Costatumulus amosi* Taboada (1998) present in Agua del Jagüel Formation. This younger age assigned to this formation is based on comparison with the marine invertebrates described for the Permian of Australia, where there are not geological records to the "Late Pennsylvanian" (cfr. Azcuy *et al.*, 2007).

One of the brachiopod associated to the Biozone *Costatumulus amosi* in the Agua del Jagüel Formation is *Coolkilella keideli* Taboada (1998), with a Lower Permian age for comparison with similar species from the Permian of Australia (Taboada, 1998).

Also, it may be present in the fossiliferous Zone 2 (= *Canocrinella?* sp. in Lech *et al.*, 1998) to the Ciénaga Larga del Tontal Formation (Banchig *et al.*, 1998; Barredo and Ottone, 2003), Tontal Mountain, San Juan. The estimated age of this formation is late Early Carboniferous to late Late Carboniferous, based both in the marine invertebrate fossils associations (Banchig *et al.*, 1998; Lech and Milana, 2006), as in the palinological association sub-biozone A of the Biozone *Raistrickia densa* - *Convolutispora muriornata* as reported by Barredo and Ottone (2003), of the early Late Carboniferous age (Césari and Gutierrez, 2000).

Lech and Raverta (2005) suggested that the association of brachiopod fossils in the Agua del Jagüel Formation are a mixture of species of the biozones of *Tivertonía jachalensis* - *Streptorhynchus inaequiornatus* and *Costatumulus amosi*. Instead, Taboada (2006) considered that there is biocronological contiguity between the biozones by the occurrence of taxa in common. It is also possible that the mixture of these biozones is due both to the biostratigraphic contiguity, as well as by environmental factors as suggested by Cisterna *et al.* (2006).

Other brachiopod associated to the Biozone of *Costatumulus amosi* also present at the Agua del Jagüel Formation, is *Tivertonía leanzai* Taboada (2006). This species is similar to *T. jachalensis* (Leanza) but both are attributed different geologic ages. *Tivertonía jachalensis* with *Streptorhynchus inaequiornatus* Leanza are indicative of the Biozone *T. jachalensis* – *S. inaequiornatus* (Sabattini *et al.* 1991), which restrained the presence of both species in this biozone by Archangelsky *et al.* (1996a,

1996b) and Taboada (2006).

Conclusions

In this paper, a review of the morphology of the brachiopod discinoid is presented: *Orbiculoidea saltensis* Reed, proposing an amended diagnosis based in the study of some articulated specimens.

This species described by Reed has been compared with other species discinoid of the Paleozoic of South America, and some of the taxonomic identifications of these inarticulate brachiopods have been modified. *O. guaraunensis* (Oliveira, 1930) and *O. prietana* Chronic (Newell *et al.*, 1953), both species from the Carboniferous of Peru and Brazil, respectively, have similar morphological characteristics of the genus *Gigadiscina* Mergl and Massa (2005) and probably correspond to this last genus.

O. saltensis has been mentioned in different geological units of the Neopaleozoic of Argentina, and this study confirms its presence in Agua del Jagüel and Santa Elena formations, Province of Mendoza, as well as Ansilta, Quebrada Larga and Esquina Gris formations, San Juan province, with an age estimated in the Upper Carboniferous.

References

- Amos, A.J. 1979. *Guía Paleontológica Argentina. Parte 1: Paleozoico. Sección 5. Faunas Carbónicas. Sección 6. Faunas pérmicas.* Publicación del Consejo Nacional de Investigaciones Científicas y Técnicas. 158 pp.
- Antelo, B. 1972. Los braquiópodos del Carbonífero Superior de la Quebrada Larga, en las Cabeceras del Río Blanco, Provincia de San Juan. *Ameghiniana*, 9(2), 159-172.
- Archangelsky, A. and Lech, R.R. 1987. Presencia de *Cancrinella* aff. *farleyensis* (Eth. and Dunn) en las capas plegadas de la "serie Tramojo", Pérmico inferior de la Precordillera de Mendoza. *Asociación Geológica Argentina, Serie A, Monografía y Reuniones*, 2, 187-191.
- Archangelsky, S., Azcuy, C.L., Césari, S.N., González, C.R., Hünicken, M.A., Mazzoni, A. and Sabattini, N. 1996a. Correlación y edad de las biozonas. In Archangelsky S. (ed.). *El Sistema Pérmico en la República Argentina y en la República Oriental del Uruguay.* Academia Nacional de Ciencias, 203-226.
- Archangelsky, S., González, C.R., Cúneo, R., Sabattini, N., Césari, S., Aceñolaza, F.G., García, G.B., Buatois, L., Ottone, E., Mazzoni, A.F., Hünicken, M.A. and Gutiérrez, P.R. 1996b. Paleontología, bioestratigrafía y paleoecología de las cuencas Paganzo, Calingasta – Uspallata, Río Blanco y San Rafael. In Archangelsky S. (ed.). *El Sistema Pérmico en la República Argentina y en la República Oriental del Uruguay.* Academia Nacional de Ciencias, 177-201.
- Azcuy, C., Beri, Á., Bernardes-de-Oliveira, M.E.C., Carrizo, H., di Pasquo, M., Díaz Saravia, P., González, C.R., Iannuzzi, R., Lemos, V.B., Melo, J.H.G., Pagani, A., Rohn, R., Amenábar, C.R., Sabattini, N., Souza P.A., Taboada, A. and Vergel, M del M. 2007. Bioestratigrafía del Paleozoico Superior de América del Sur: Primera etapa de trabajo hacia una nueva propuesta cronoestratigráfica. *Asociación Geológica Argentina, Serie: Publicación Especial*, 11, 9-65.
- Baker, H.A. 1923. *Final Report on Geological Investigations in the Falkland Islands, 1920-1922.* Government Printer, Stanley.
- Banchig, A.L., Milana, J.P. and Lech, R.R. 1998. Formación Casa de Piedra, una nueva unidad Neopaleozoica glaciárica en la Sierra del Tontal, Precordillera Occidental, San Juan. *Segundas Jornadas de Geología de Precordillera, San Juan*, 1, 16-21.
- Barredo, S. and Ottone, E.G. 2003. Formación Ciénaga Larga del Tontal, *nomen novum* para la Formación Casa de Piedra, Carbonífero, Precordillera de San Juan. *Revista de la Asociación Geológica Argentina*, 58(2), 267-270.
- Bercowsky, F., Vallecillo, G. and Lech, R.R. 1996. Facies de Plataforma Marina en la Formación Ansilta (Neopaleozoico), Precordillera, Provincia de San Juan, Argentina. *6º Reunión Argentina de Sedimentología*, 1, 199-204.
- Boucot, A.J., Rowell, A.J., Racheboeuf, P., Pereira, E., Gonçalves de Melo, J.H. and Peixoto de Siqueira, L. 2001. Position of the Malvinokaffric Realm's northern boundary (Early Devonian) based on newly discovered brachiopods from the Parecis Basin (Brazil). *Journal of the Czech Geological Society*, 46, 109–120.
- Branisa, L. 1965. *Los fósiles guías de Bolivia. I. Paleozoico.* Servicio Geológico de Bolivia, Boletín, 6, 282 pp., 80 Láminas.
- Césari, S., Gutiérrez, P.R., Sabattini, N., Archangelsky, A., Azcuy, C.L., Carrizo, A., Cisterna, G., Crisafulli, A., Cúneo, R.N., Díaz Saravia, P., Di Pasquo, M., González, C.R., Lech, R.R., Pagani, M.A., Sterren, A., Taboada, A.C. and Vergel, M.M. 2007. *Paleozoico Superior de Argentina: un registro fosilífero integral en el Gondwana occidental.* In: Archangelsky, Sanches y Tonni (Eds.), *Ameghiniana 50º Aniversario, Publicación Especial*, 11, 35-54.
- Césari, S.N. and Gutiérrez, P.R. 2000. Palynostratigraphy of Upper Paleozoic sequences in central-western Argentina. *Palynology*, 24, 113-146.
- Cisterna, G.A., Sterren, A.F. and Archbold, N.W. 2006. A review of the *Tivertonia jachalensis* – *Streptorhynchus inaequioratus* Biozone in La Delfina Creek, San Juan Province, Argentina. *Ameghiniana*, 43(2), 487-492.
- Clarke, J. M. 1913. Fósseis Devonianos do Paraná. *Monographias do Serviço Geológico e Mineralógico do Brasil*, 1, 1-353, pl. 1-27.
- d'Orbigny, A. 1847. Considérations zoologiques et géologiques sur les brachiopodes ou palliobranches. Academy Science. Paris, *Comptes Rendus*, 25, 193-195, 266-269.

- Davidson, Th. 1848. Sur les brachiopods du système silurien supérieur de l'Angleterre. *Société Géologique de France, Bulletin*, ser. 2, 54, 309-338, 370-374.
- Du Toit, A.L. 1927. A Geological Comparison of South America with South Africa. With a Palaeontological Contribution: Upper Carboniferous Fossils from Argentina, by F.R.C. Reed. *Carnegie Institution of Washington, Publication*, 381, viii-158 p, 16 plates, 1 map, 7 text-figures. Washington DC.
- Feruglio, E. 1933. Fossili liassici della valle del río Genoa (Patagonia). *Giornale di Geologia, Annali del Museo Geologico di Bologna*, 9: 1-54.
- Gray, J.E. 1840. *Synopsis of the contents of the British Museum*. (42° edition). London, 370 p.
- Gutiérrez, P.R. (Editor), 2006. *Léxico Estratigráfico de la Argentina. Volumen VII Pérmico*. Servicio Geológico Minero Argentino, Publicación 167, 368 pp.
- Gutiérrez, P.R. (Editor), 2008. *Léxico Estratigráfico de la Argentina. Volumen VI Carbonífero*. Servicio Geológico Minero Argentino, Publicación 169, 224 pp.
- Hall J. and Clarke, J.M. 1890. *Extract from Volume VIII, Palaeontology of New York*, p. 2 (120)-20 (160), pl. 4E-4F (Albany).
- Harrington, H.J. 1971. *Descripción Geológica de la Hoja Ramblón 22c, provincias de Mendoza y San Juan*. Dirección Nacional de Geología y Minería, Boletín 114, 87 pp.
- Holmer, L.E. and Popov, L.E. 2000. *Class Lingulata*. In Williams *et al.* (eds): *Treatise on Invertebrate Paleontology, Part H (Brachiopoda)*, 30-146.
- Kaysers, F.H.E. 1897. Beiträge zur Kenntniss einiger paläozischer Faunen Süd-Amerikas. *Deutsche geologische Gesellschaft, Zeitschrift*, 49, 274-317.
- Knod, R. 1908. Devonische Faunen Süd-Amerikas. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*, 25, 493-600. Taf. 21-31
- Koukharsky, M., Kleiman, L., Etcheverría, M., Quenardelle, S. and Bercowski, F. 2009. Upper Carboniferous retroarc volcanism with submarine and subaerial facies at the western Gondwana margin of Argentina. *Journal of South American Earth Sciences*, 27, 299-308.
- Koukharsky, M., Kleiman, L., Etcheverría, M., Quenardelle, S. and Litvak, V., 2005. Transición entre un ambiente marino y uno subaéreo en volcanitas del Paleozoico Superior, Cordón Agua del Jagüel, provincia de Mendoza. *16° Congreso Geológico Argentino, Acta 1*, 821-828.
- Kozłowski, R. 1913. Fossiles Devoniens de l'Etat de Paraná (Brésil). *Annales de Paléontologie*, 8, 105-123.
- Kutorga, S.S. 1848. Über die Brachiopoden-Familie der Siphonotretaee: Russisch-Kaiserlichen Mineralogischen Gesellschaft zu St. Petersburg, Verhandlungen 1847, 250-286, pl. 6-7.
- Lech, R.R., 1990. Distribución de la Fauna de Braquiópodos en la Formación Agua del Jagüel (Carbonífero superior - Pérmico inferior), Provincia de Mendoza, Argentina. *11° Congreso Geológico Argentino*, 2, 223-226.
- Lech, R.R. 2002. Consideraciones sobre la edad de la Formación Agua del Jagüel (Carbonífero Superior), Provincia de Mendoza, Argentina. *15° Congreso Geológico Argentina*, Santa Cruz, Acta 3, 142-146.
- Lech, R.R. and Milana, J.P. 2006. Nuevos registro de moluscos Carboníferos en la Sierra del Tontal, Precordillera de San Juan, Argentina. *Revista de la Asociación Geológica Argentina*, 61(1), 57-62.
- Lech, R.R., Milana, J.P. and Banchig, A. 1998. Braquiópodos del Carbonífero de la Sierra del Tontal, Provincia de San Juan, Argentina. *Ameghiniana*, 35(4), 21-12.
- Lech, R.R. and Raverta, V. 2005. *Histosyrinx* Massa, Termier y Termier, 1974, (Septosyringothyridinae, Brachiopoda) en el Carbonífero Superior de Argentina. *Revista de la Asociación Geológica Argentina*, 60(2), 377-382.
- Leveratto, M.A. 1968. Geología de la zona al oeste de Ullúm-Zonda, borde oriental de la Precordillera de San Juan, eruptividad subvolcánica y estructura. *Revista de la Asociación Geológica Argentina*, 18(2), 129-158.
- Méndez-Alzola, R. 1934. Contribución al conocimiento de la Fauna Devónica de Rincón de Alonso. *Instituto de Geología y Perforaciones*, Boletín 21, 21-54.
- Méndez-Alzola, R. 1938. Fósiles Devónicos del Uruguay. *Instituto de Geología y Perforaciones*, Boletín 24, 1-115, lám. 1-15.
- Méndez-Alzola, R. and Sprechmann, P. 1971. Algunas orbiculoideas devónicas de la Precordillera de San Juan, Rep. Argentina. *Revista de la Asociación Geológica Argentina*, 26(4), 517-525.
- Mergl, M. 2006. A review of Silurian discinoid brachiopods from historical British localities, *Bulletin of Geosciences*, 81(4), 215-236.
- Mergl, M. and Massa, D. 2005. A new giant discinoid brachiopod from the Lower Devonian of Algeria. *Palaeontologica Polonica*, Acta 50(2), 397-402.
- Mésigos, M. 1953. El Paleozoico superior de Barreal y su continuidad austral. Sierra de Barreal. Provincia de San Juan. *Revista de la Asociación Geológica Argentina*, 8(2), 65-109.
- Morris, J. and Sharpe, D. 1846. Description of Eight Species of brachiopodus shells from the Paleozoic rocks of the Falkland Island. *Quarterly Journal of the Geological Society of London*, 2, 274-278. Figures 10-12.
- Newell, N.D., Chronic, J. and Roberts, Th.G. 1953. Upper Paleozoic of Peru. *The Geological Society of America, Memoir*, 58, 1-276.
- Oliveira, E.P. 1930. Fosséis marinhos de Série Itararé do Estado de Santa Catarina. *Academia Brasileira de Ciências, Anais* 2(1), 1-18.
- Reed, F.R.C. 1903. Brachiopoda from the Bokkeveld Beds. *South African Museum, Annals* 4, 165-200.
- Reed, F.R.C. 1925. Revision of the fauna of the Bokkeveld Beds. *South African Museum, Annals* 22, 27-225.
- Rodríguez, E.J. 1966. Contribución al conocimiento del Carbónico del extreme sur occidental de la precordillera. *Acta Geológica Lilloana*, 7, 303-331.
- Rowell, A.J. 1965a. *Inarticulata*. In: Moore, R. C. *Treatise on Invertebrate Paleontology, Part H, Brachiopoda, Vol. 1, H260-H269*. Geological Society of America and University of Kansas Press, Boulder.
- Rowell, A.J. 1965b. *Inarticulate brachiopoda*. In Doumani, G.A. *et al.* Lower Devonian fauna of the Horlick Formation, Ohio Range, Antarctica. *Geology and Paleontology of the Antarctic*, 6, 241-281.

- Sabattini, N., Ottone, E.G. and Azcuy, C.L. 1991. La zona de *Lissochonetes jachalensis* – *Streptorhynchus inaequiomatus* (ex Fauna Intermedia) en la localidad de la Delfina, provincial de San Juan. *Ameghiniana*, 27(1/2), 75-81.
- Schuchert, Ch. 1897. A synopsis of American fossil Brachiopoda including bibliography and synonymy. *U.S. Geological Survey*, Bulletin 87, 464 pp.
- Sharpe, D. 1856. Descriptions of Paleozoic Mollusca from South Africa. *Transactions of the Geological Society of London*, Series 2, 7, 206-215
- Taboada, A.C. 1997. Bioestratigrafía del Carbonífero marino del Valle Calingasta-Uspallata, provincias de San Juan y Mendoza. *Ameghiniana*, 34(2), 215-246.
- Taboada, A.C. 1998. Dos nuevas especies de Linoproductidae (Brachiopoda) y algunas consideraciones sobre el Neopaleozoico sedimentario de las cercanías de Uspallata. *Acta Geológica Lilloana*, 18(1), 69-80.
- Taboada, A.C. 2006. *Tivertonia* Archbold (Chonetidina, Brachiopoda) del Pérmico inferior de la subcuenca Calingasta – Uspallata, Precordillera argentina. *Ameghiniana*, 43(4), 705-716.
- von Ammon, L. 1893. Devonische Versteinerungen von Lagoinha in Mato Grosso (Brasilien). *Zeitschrift der Gesellschaft für Erdkunde*, 28: 352-366, 7 figs.
- Waagen, W.H. 1885. Salt Range fossils, Palaeontological. *Indica*, ser.13, Part 4(2) Brachiopoda, fasc.5, 729-770.
- Willard, B. 1928. The brachiopods of the Ottosee and Holston formations of Tennessee and Virginia. *Harvard Museum of Comparative Zoology*, Bulletin 68, 255-292.
- Yrigoyen, M. 1967. *Geology of the Triassic Formation of Northern Mendoza area*. 1° International Symposium on Gondwana Stratigraphy and Paleontology. Asociación Geológica Argentina, Guidebook 1, 1-13.

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