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Pesquisas em Geociências, 30 (2): 27-32, set./dez., 2003.

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Publicado por

Instituto de Geociências



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Data de publicação - set./dez., 2003.

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A New Devonian Modiolopsidae (Mollusca: Bivalvia) from the Ponta Grossa Formation, Paraná Basin, Brazil

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(Recebido em 10/02. Aceito para publicação em 09/03)

Abstract - This paper describes the bivalve *Modiolopsis* (?) *clarkei* n. sp. coming from the Curva I outcrop, Ponta Grossa Formation. The species name was given in honor to J. M. Clarke, who first studied it. This fossil also occurs in the Durazno Group, in Uruguay, reinforcing the correlation between the Devonian Paraná Basin invertebrate fauna with others of the Malvinocaffrik Realm, as suggested by previous authors. The classification of *M.* (?) *clarkei* in a typical Ordovician genus or lineage, that can reach the Silurian and Lower Devonian periods, supports an Emsian age to the Curva I outcrop, as have been accepted.

Keywords - Brazil, Devonian, Paraná Basin, Bivalvia, Modiolopsidae.

INTRODUCTION

The Devonian bivalves from the southern area of the Paraná Basin (Apucarana Sub-basin) are relatively well known. Systematic revisions made by Clarke (1913), Kozłowski (1913), Morsch (1986) and less comprehensive papers (Kaiser, 1900; Lange, 1943; Petri, 1967; Morsch, 1984, 1987) show that the bivalve fauna comprises at least 26 species of 17 genera. However, some bivalves, such as those represented by few and/or poorly preserved specimens, remain unsatisfactorily known.

Clarke (1913, p. 184, Pl. XVI, Fig. 8) illustrated and briefly described a specimen referred to *Macrodon* sp. He also figured, but not described, a bivalve assigned to “*Goniophora* or *Modiomorpha*” (Clarke, 1913, Pl. XVI, Fig. 3).

Kotzian (1995), going through the collection previously studied by Clarke (1913), found out that the two “species” in question shared the same characteristics, and also suggested that they could be synonymous. In this paper a systematic review of the Clarke’s species is made, based on the original material, as well as in new better preserved specimens from Brazil (Ponta Grossa Formation) and Uruguay (Durazno Group).

SYSTEMATIC STUDY

Repository: the specimens studied are deposited in the following collections: Catálogo de Fósseis, Seção

de Paleontologia, Departamento de Produção Mineral – Divisão de Geologia e Mineralogia, Rio de Janeiro, RJ (DNPM, DGM – I); Coleção de Moluscos Fósseis, Departamento de Biologia, Universidade Federal de Santa Maria, RS (CMf - UFSM); and in the Coleção de Moluscos Fósseis, Facultad de Humanidades y Ciencias Tristán Narvaja, Universidad de La Republica, Uruguay (UR).

Occurrence: the Uruguayan specimens were collected in rocks of Durazno Group (Devonian). Unfortunately, the precise geographic location of the outcrop that yielded the fossil material is unknown. It probably comes from the southern area of the country, where Lower Devonian (Emsian) rocks are cropping out (Melo, 1988). On the other hand, the specimens deposited in the DNPM were collected in Devonian rocks cropping out at the Ponta Grossa county (State of Paraná, Brazil). This material also comes from unknown localities. The specimen CMf – UFSM 063 is the only for which the precise outcrop location is known. It was collected at the Curva I outcrop, a regional designation to a Devonian exposure that crops out in the railroad that cuts the Ponta Grossa county. Melo (1988, pers. comm.) suggested a possible Emsian age to these rocks. Bergamaschi (1999), studying the Silurian-Devonian sequences of the Apucarana Sub-basin, described an outcrop also located in the Ponta Grossa region, called Fazenda Rivadavea. This outcrop was attributed to the Sequence B (? Late Lochkovian

to Emsian age), that encompasses rocks of the Jaguariaíva Member, and is considered Emsian or Pragian in age. According to Rodrigues (2002), the Curva I outcrop is lithologically and paleontologically very similar to some outcrops of the Sequence B (Bergamaschi, 1999), that are located in Jaguariaíva region. Consequently, it is possible that the rocks of the Curva I outcrop belong to the Sequence B of the Bergamaschi (1999) model. However, its exact stratigraphic context remains uncertain.

Abbreviations and Terminology: in the item “Material Examined” the data are abbreviated and organized as follows: a) specimen number, b) mode of fossilization: composite mold (cm), internal mold (im); c) shell articulation: open articulated (oa); isolated (i); d) valve observed: right (r), left (l), both (r/l); e) measurements: length (L), height (H), width (W), elongation (L/H), obesity (H/W).

The terminology used to describe size, elongation and obesity, and some indexes related to the shell, such as elongation and obesity are the one proposed by Stanley (1970).

Systematic Paleontology: the taxonomy adopted, at suprageneric level, is that of Fang Zongjie & Morris (1997) and Fang Zongjie (1998).

Order MYTILOIDA Férussac, 1832

Superfamily MYTILACEA Rafinesque, 1815

Family MODIOLOPSIDAE Fisher, 1887

Discussion: the diagnosis and differences between the modioliform genera *Modiomorpha* Hall & Whitfield, 1869 and *Modiolopsis* Hall, 1847 were discussed by authors such as William & Breger (1916), Newell (1957), La Rocque & Newell (1969), Babin (1966) and Pojeta (1971). According to them, the hinge of many species attributed to *Modiolopsis* and *Modiomorpha* are not well known.

A long debate exists in the literature regarding the systematic and relationships of Modiomorphidae bivalves. Most of this is based on the nature of the hinge of *Modiomorpha* and *Modiolopsis*.

Pojeta (1971) observed that Modiomorphidae is a “...name vague and uncertain, and probably more than one family-level taxon is included in the Modiomorphidae...” and “especially the hinge-line features, are unknown in the majority of genera”. Based on family-level priority, he also

considered the Modiolopsidae Fisher, 1887 as junior subjective synonym of Modiomorphidae S. A. Miller, 1877.

Latter, well preserved material clarified the hinge structure of Devonian *Modiomorpha concentrica* (type species of *Modiomorpha*) (Bailey, 1983; Pojeta *et al.* 1986). *M. concentrica* has a striated hinge plate with pronounced growth lines and parivincular ligament. Carter (1990) also observed that the species has an external, parivincular, opisthodontic ligament, with a projecting nymph.

Johnston (1993) noted that these features are absent in Ordovician modiomorphids (*Modiolopsis*, *Modiolodon*), and suggested the existence of two separate, but closely related, lineages.

Liljedahl (1994), based on the hinge teeth, erected two new subfamilies to the Modiomorphidae: Modiomorphinae, which had hinge teeth and included the majority of modiomorphids genera, and Modiolopsinae, which lacked hinge teeth and included *Modiolopsis* and other similar genera.

The systematic position and relationships of Modiomorphidae was recently studied and well discussed by Fang Zongjie & Morris (1997) and Fang Zongjie (1998). Based specially on hinge structures they observed that should be reasonable to keep the Devonian modiomorphids and the Ordovician modiolopsids in two different families, Modiomorphidae and Modiolopsidae, respectively. They also proposed to revalidate the Modiolopsidae, which present edentulous hinge, considering that this family could be the early representative of the Mytiloidea, as previously proposed by Pojeta *et al.* (1986) and Liljedahl (1994) (see Fang Zongjie & Morris (1997) and Bradshaw (1999) for further comments). The Modiomorphidae were included in the Anomalodesmata (Pholadomyoidea) and the Modiolopsidae, in the Isofilibranchia (Mytiloidea). Although they had designated no type genera to the families, it is clear that the type genera must be those proposed by Liljedahl (1994) to the subfamilies Modiolopsinae (*Modiolopsis*) and Modiomorphinae (*Modiomorpha*).

Genus *Modiolopsis* Hall, 1847

Type species *Pterinea modiolaris* Conrad, 1838
(by original designation)

Discussion: the most similar genus is *Modiomorpha*, which differs from *Modiolopsis* in having hinge with teeth (Liljedahl, 1994), as previously

discussed. However, features in many modioliform species remain unknown and the exact range of each genus should be revised.

Modiolopsis and others Modiolopsidae (e.g. *Corallidomus*, *Whiteavesia*, *Pholadomorpha*, and *Runnegaria*) are considered typical Ordovician genera (Pojeta, 1971; Fang Zonjie & Morris, 1997; Bradshaw, 1999). However, many species attributed to *Modiolopsis* have been registered in Silurian and/or Lower Devonian beds (Babin, 1966; Liljedahl, 1994).

Modiolopsis (?) *clarkei* n. sp.
(Fig. 1 A,B,C)

Macrodon sp. Clarke, 1913: 184 (Pl. XVI, Fig. 8).
Goniophora or *Modiomorpha* [sic] Clarke, 1913: (Pl. XVI, Fig. 3).

Holotype - DGM-I 131 (Clarke, 1913, Pl. XVI, Fig. 8)

Paratypes - DGM-I 112 (Clarke, 1913, Pl. XVI, Fig. 3), CMf - UFSM 063, UR 847

Type locality - Ponta Grossa, State of Paraná, Brazil

Type stratum - Ponta Grossa Formation

Diagnosis - Shell subquadrate, probably edentulous; ornament of concentric flat threads, evenly spaced; anterior adductor scar regularly projected, striated; posterior ridge slightly marked.

Description - Shell small, reaching approximately up to 2.9 cm long, equivalve, inequilateral, modioliform, subquadrate, elongated to very elongated, convex to very convex, possibly thicker in its anterior and umbonal region. Posterior region not very expanded, elongated, corresponding to, approximately, twice the length of the anterior region.

Posterior ridge regularly pronounced, extending from the umbo to the posteroventral margin. Radial depression moderately marked, wide.

Umbones little pronounced, low, anterior, located at one third of the shell length.

Posumbonal margin subretilinear, parallel to the ventral margin, forming a slight convexity with the posterior margin. Posterior margin regularly curved, continuous along the ventral margin. Ventral margin subretilinear, continuous along the anterior margin, which, on its turn, has a pronounced convexity. Preumbonal margin

subretilinear, continuous along the anterior margin. Anterior cardinal angle with approximately 45 degrees.

Ornament of fine threads, interspersed, at regular intervals, by wide and flat threads.

Ligament area narrow and straight. Hinge probably edentulous.

Anterior adductor scar medium size, conic, regularly pronounced, striated, far from the umbones, and set halfway the length of the anterior margin.

Other internal or external structures not observed.

Etymology - in honor to J. M. Clarke.

Material Examined (in cm) - DGM-I 112: cm, i, r, L 2.2, H 1.4, W 0.5, L/H 1.6, H/W 2.8; DGM-I 131: cm, i, r, L 2.9, H 1.9, W 1.0, L/H 1.5, H/W 2.9; CMf 063: cm, oa, l, L 2.9, H 1.4, W ~1.0, L/H 2.1, H/W 1.2; UR 847: cm, i, r, L 2.3, H 1.4, L/H 1.6; UR (a): im, i, r, L 2.1, H 1.4, L/H 1.5; UR (b): cm, i, L 1, H 2.8, W 1.6, L/H 1.7.

Geographic Range - Brazil, State of Paraná: Jaguariaíva (Clarke, 1913), Ponta Grossa; southern Uruguay.

Stratigraphic Range - Uruguay: Durazno Group/Lower Devonian; Brazil: Ponta Grossa Formation (Jaguariaíva Member?).

Discussion - The material studied shows morphological features that were not mentioned or illustrated by Clarke (1913) in his original description of *Macrodon* sp. There is a conspicuous and pronounced anterior adductor scar (Fig.1B), and the ligament area, particularly visible in the specimen CMf – 063 fossilized with the valves open and articulated (Fig.1C), is straight and pronounced. Such characteristic seems to be typical of the species and contributes in determining the subquadrate shape of the shell, as pointed out by Clarke (1913).

All bivalve shells show little compaction and probably their original width was not intensively modified by taphonomic factors.

In all specimens studied, the wide, concentric, flat and prominent threads are also identified (Fig.1A,B,C). They are interspersed with finer threads, which are diagnostic of the species.

Well preserved internal molds of modioliform bivalves some times present the cardinal teeth, as illustrated by Pojeta (1971, Pl. 13, Fig. 9) and

Bailey (1983, Fig. 47g). However, the internal molds here studied show no vestige of cardinal teeth. Hence, it is possible that they really have an edentulous hinge.

According to Newell (1969), the genus *Macrodon* Buckman, 1844 is a junior synonym of *Parallelodon* Meek & Worthen, 1866, which is characterized by the presence of a broad, grooved ligament area, as well as by the absence of concentric ornamentation.

The specimens here examined have pronounced concentric ornamentation. Besides, there is no evidence, in any of them, of the occurrence of grooves in the ligament area. Therefore, the species described by Clarke (1913) does not have the diagnostic features of *Parallelodon*.

The modioliform to subquadrate shape, the wide and well defined radial depression (Clarke, 1913, p. 184), the pronounced anterior adductor scar and the presence of the posterior ridge (Fig.1B) are features that correspond to some of the diagnostic characteristics of the edentulous genus *Goniophorina* Isberg, 1934. However, the specimens studied do not show the posterior ridge well marked and angular, as it occurs in the typical bivalves of *Goniophorina* (Shimer & Shrock, 1955; La Rocque & Newell, 1969).

In spite of their subquadrate shape and straight ligament area, the specimens could be included in the genus *Modiolopsis* Hall 1847. The modioliform shell, the concentric sculpture, and the pronounced anterior adductor scar are features assigned to many species of this genus (Pojeta, 1971, Liljedahl, 1994). Besides, the space between the straight ligament area, observed in the specimen CMf – UFSM 063 (Fig.1C), is similar to the “dark stain ligament” area figured by Pojeta (1971, Pl. 15, figs. 1,5,6) to *Modiolopsis modiolaris*, and the teeth are probably missing in the bivalves examined.

Due to the probably edentulous condition of the hinge, the species studied is included, with some restrictions, in the edentulous genus *Modiolopsis*.

The morphological characteristics of this species are not present in any other species described and/or shown in the bibliography referred to. Therefore, it must be considered as a new species, named *Modiolopsis (?) clarkei*.

The specimen used by Clarke (1913) to describe *Macrodon* sp. is deposited in the DNPM (DGM-I 131), and it is here designed as holotype. The bivalve not described, but just illustrated, attributed by Clarke (1913, Est. XVI, Fig. 3) to “*Goniophora* or *Modiomorpha*”, is also found in the collection of the DNPM, under the number DGM-I 112. This specimen was chosen as one of the paratypes.

FINAL COMMENTS

The classification of *M. (?) clarkei* in a typical Ordovician genus or lineage, that can reach the Silurian and Lower Devonian periods, supports the hypothesis proposed by Melo (1988) of Emsian age to the Curva I outcrop. The presence of the species in Uruguay reinforces the correlation between the Devonian Paraná Basin invertebrate fauna with others of the Malvinocaffrik Realm, as suggested by previous authors.

The species herein described shows that new taxa can be assigned to the Ponta Grossa Formation and that the studies on the Devonian bivalves of the Paraná Basin must continue.

Acknowledgements - My thanks to the following researchers: Dr. Déa Regina B. Campos, at the time, head of the Seção de Paleontologia of the Departamento Nacional de Produção Mineral (DNPM), Rio de Janeiro; Geol. MSc. José Henrique Gonçalves de Melo, from CENPES – SEBIPE, PETROBRÁS, Rio de Janeiro; Geog. MSc. Elvio P. Bosseti, from the Museu da Casa de Cultura de Ponta Grossa, Ponta Grossa; Prof. Dr. Peter Sprechmann and Prof. Dr. Sérgio Martinez, both from Facultad de Humanidades y Ciencias Tristán Narvaja, Universidad de La Republica, Uruguay; for the kindness in giving information and making the paleontological collections of respective institutions available. I am also grateful to Dr. Marcello G. Simões, from the Departamento de Zoologia, Universidade Estadual de São Paulo, Botucatu, and to Dr. Deusana Machado, from the Departamento de Biologia, Universidade do Rio de Janeiro, Rio de Janeiro, for the critical reading and valuable comments on the manuscript; and to the editors of the Revista Pesquisas em Geociências, for the attention.

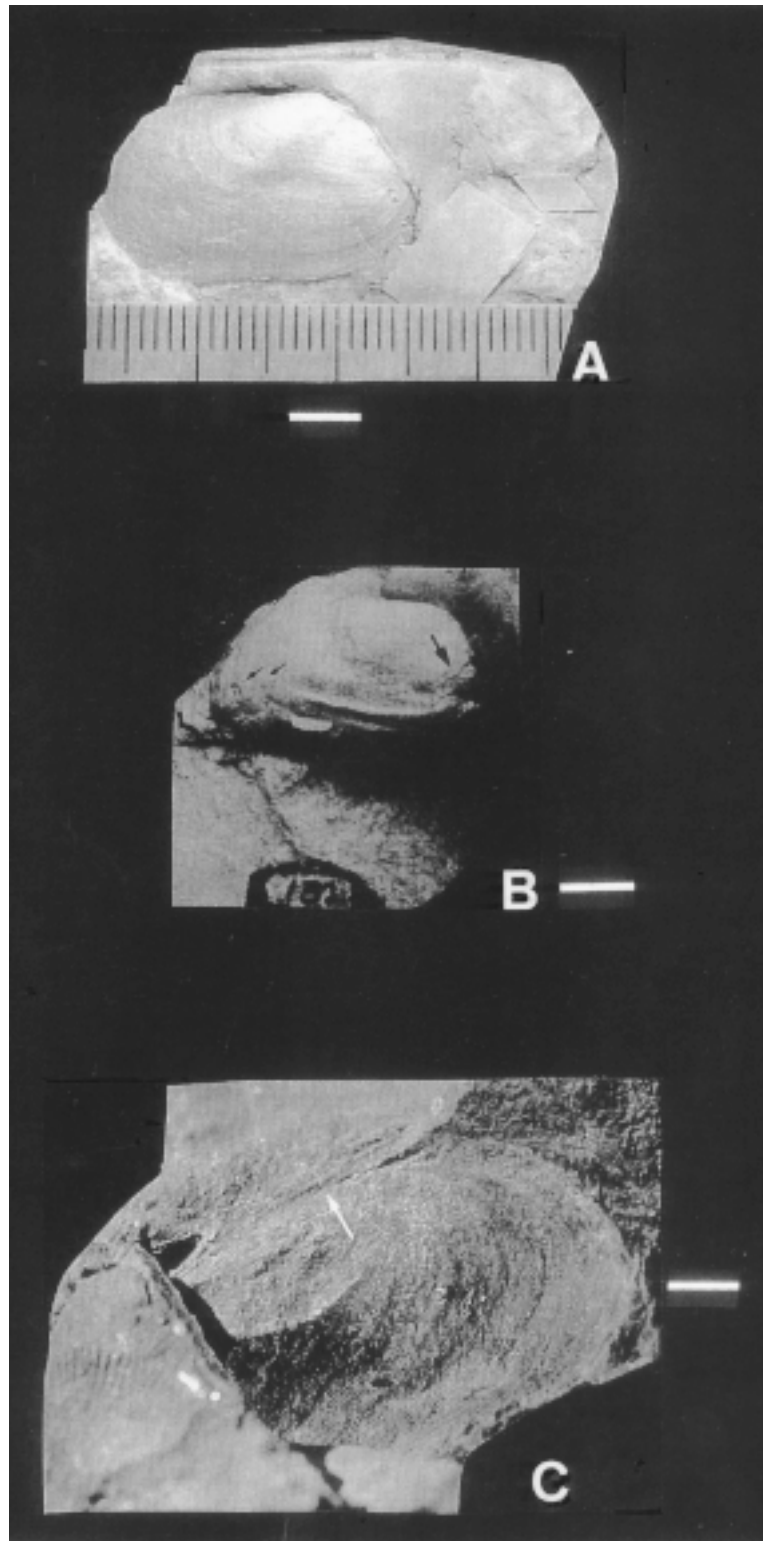


Figure 1 - *Modiolopsis (?) clarkei n. sp.*

A - Holotype DGM-I 112 (Jaguariaíva, PR). Composite mold of a right valve (lateral view), showing the concentric ornamentation. The anterior adductor scar is covered by the rock. Scale \approx 0.5 cm (photo: S. M. Morsch); B - Paratype DGM-I 131 (Ponta Grossa, PR). Composite mold of a right valve (lateral view), showing the flat concentric threads uniformly spaced (small arrows) and the anterior adductor scar (big arrow). Scale \approx 0.7 cm (photo: S. M. Morsch); C - Paratype CMf - 063 (Curva I, Ponta Grossa, PR). Composite mold of a shell with open and articulated valves. Lateral view of the left valve with its anterior area covered by the rock. The arrow shows the straight posterodorsal margin, typical of the species. Scale \approx 0.4 cm.

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