

Palaeontological analyses across the Ediacaran-Cambrian boundary, Upper Corumbá Group, Brazil

Análisis paleontológicos a través límite Ediacárico-Cámbrico, Grupo Alto Corumbá, Brasil

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ABSTRACT

This work presents the results of a palaeontological analysis focused on twenty-six species sampled in five sections of the Tamengo and Guaicurus formations, Corumbá and Ladário regions: Corcal and Laginha quarries, Porto Sobramil, Porto Figueiras and Ecoparque Cacimba. Besides, palaeoecological and palaeoenvironmental inferences are presented based on the occurrence of this fossil assemblage. *Cloudina carinata* Cortijo *et al.*, 2010, previously documented in Spain and Siberia, presents an unprecedented occurrence in the American continent, in siltstones of the Tamengo Formation at Porto Figueiras section, Municipality of Corumbá, Mato Grosso do Sul State, Brazil. The biota of the Tamengo Formation is updated and composed of three biomineralizing metazoans, including poriferan spicules, putative sponge gemmule, and a sessile epibiontic prokaryotic colony. The present work also deals with the taxonomy and stratigraphic distribution of four ichnospecies and three vendotaenid species that integrate the updated benthic fauna for the upper portion of Corumbá Group. The species diversity of the

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Tamengo Formation was complemented by the occurrence of sixteen microfossil species that possibly represent a marine planktic assemblage. A dramatic change was identified in the palaeoenvironmental conditions of the Tamengo to Guaicurus formations, followed by a mass extinction event, possibly linked to the global Ediacaran-Cambrian mass extinction. In addition, organic-walled microfossils were prepared and analyzed from sections of three countries: nine species from the Nomtsas Formation, Namibia; four species from the Tagatiya Guazu Formation, Paraguay; and six species from the Dengying Formation, China. An international biostratigraphic essay consisting of six biozones is proposed for the uppermost Ediacaran and one biozone for the earliest Cambrian.

Keywords: Ediacaran-Cambrian; Corumbá Group; Biostratigraphy; Micropaleontology.

RESUMEN

Se presenta en este trabajo el análisis paleontológico de 26 especies fósiles muestradas en cinco cortes de las Formaciones de Tamengo y Guaicurus en las regines de Corumbá y Ladário: canteras de Corcal y Laginha, Porto Sobramil, Porto Figueiras y Ecoparque Cacimba. Además, se añaden varias interpretaciones paleoecológicas y ambientales, basadas en el registro fósil. *Cloudina carinata* Cortijo *et al.*, 2010, previamente citada en España y Siberia, aparece por primera vez en el continente Americano, concretamente en limolitas de la Formación Tamengo en el corte de Porto Figueiras, Corumbá, Estado de Mato Grosso do Sul, Brasil. La biota de la Formación Tamengo incluye tres metazoos mineralizados, que incluyen espículas de poríferos, posibles gémulas de esponjas y una colonia sésil de procaiotas epibentónicos. Este trabajo se centra en la taxonomía y distribución estratigráfica de cuatro icnoespecies y tres especies de vendoténidos que forman la fauna bentónica de la parte superior del Grupo de Corumbá. La biodiversidad de la Formación Tamengo ha sido completada con el registro de 16 especies microfósiles que representan posiblemente una asociación plantónica marina. Se ha identificado un cambio drástico en las condiciones ambientales de las Formaciones Tamengo y Guaicurus, que culminan en un evento de extinción masiva posiblemente relacionado con la extinción en masa que marca el tránsito global Ediacárico-Cámbrico. Por otro lado, se han extraído microfósiles de pared orgánica de varios afloramientos: nueve especies de la Formación de Nomtsas (Namibia), cuatro de la Formación Tagatiya Guazu (Paraguay) y seis de la Formación Dengying (China). Se propone un marco bioestratigráfico para el Ediacárico terminal que incluye seis biozonas y una biozona para el Cámbrico basal.

Palabras clave: Ediacárico-Cámbrico; Grupo de Corumbá; Bioestratigrafía; Micropaleontología.

Introduction

The aim of this work is to present an analysis on the taxonomy and stratigraphic distribution of some selected species of the Tamengo and Guaicurus formations, Ediacaran-Cambrian boundary interval in Brazil, in order to propose a chronobiostratigraphic framework for the Ediacaran-Cambrian transition. In addition, palaeoecological and palaeoenvironmental inferences are presented as well as a lithostratigraphic update of the sections in Corumbá and Ladário regions, Mato Grosso do Sul State, Brazil. Considering the scarcity of micropalaeontological data from uppermost Ediacaran sections, samples from three additional localities were prepared and analyzed from the Nomtsas Formation (Namibia), the Tagatiya Guazu Formation (Paraguay) and the Dengying Formation (China). Finally, another objective of this work is to compare the results obtained from the palaeontological analysis of the Tamengo Formation with those already published from uppermost Ediacaran sections, especially in Paraguay, Uruguay, Argentina, Namibia, China, Russia, Canada, United States and Oman.

Results

Twenty-six species integrate the study fossil assemblage of the Tamengo and Guaicurus formations. They were clustered into six categories: biomineralizing metazoans, biomineralizing microfossils, vendotaenids, ichnofossils, organic-permineralized microfossils and organic-walled microfossils.

The studied fossil assemblage of the Tamengo Formation consists of twenty-three species, four of which represent benthic and sessile, biomineralizing epibionts: *Cloudina luciano* (Beurlen & Sommer, 1957), *C. carinata* Cortijo *et al.*, 2010, *Corumbella werner* Hahn *et al.*, 1982 and indeterminate sponge remains. Three ichnospecies represent activity of vagile organisms of benthic habit: *Multina minima* Uchman, 2001, *Gordia marina* Emmons, 1844 and *Pilichnus* cf. *P. dichotomus* Uchman, 1999. *Multina minima* points to an endobiot organism, while *Gordia marina* and *Pilichnus* cf. *P. dichotomus* represent epibiont vagile explorers on the water-sediment interface. Additionally, sixteen species probably derived from planktic organism, fifteen of which

are small organic-walled sphaeromorph microfossils that possibly represent the marine plankton: *Arctacellularia januarensis* Denezine, 2018 *nomem nudum*, *Leiosphaeridia ternata* (Timofeev, 1966), *L. crassa* (Naumova, 1949), *L. jacutica* (Timofeev, 1966), *L. minutissima* (Naumova, 1949), *L. tenuissima* Eisenack, 1958, *L. obsuleta* (Naumova, 1949), *Bavlinella faveolata* Vidal, 1976, *Bambuites erichsenii* Sommer, 1971, *Synsphaeridium* sp., *Jacutianema* sp., *Lophosphaeridium* sp., *Ostiana microcystis* Hermann (in Timofeev *et al.*, 1976), *Navifusa* sp., gen. et sp. 1 and one species of permineralized microfossils, *Chuarua circularis* Walcott, 1899. The sessile epibiont prokaryotic-colony *Vendotaenia antiqua* was previously reported from the Cerradinho and Bocaina formations (Zaine, 1991), and herein the occurrence is confirmed from the Tamengo Formation.

Four species represent the benthic fossil assemblage for Guaicurus Formation: *Eoholynia corumbensis* Gaucher *et al.*, 2005, *Tawuia dalensis* Hofmann (in Hofmann & Aitken, 1979), *Multina minima* and *Didymaulichnus lyelli* (Rouault, 1850). From the total, three species have occurrences restricted to this formation: *Eoholynia corumbensis*, *Tawuia dalensis* Hofmann (in Hofmann & Aitken, 1979) and *Didymaulichnus lyelli*; only *Multina minima* also occurs in the Tamengo Formation. It is noticeable that the Tamengo Formation exhibits the greatest biodiversity.

The integration of the information regarding the taxonomy and stratigraphic distribution of the above-reported species was presented as a biostratigraphic essay composed of seven biozones, respectively named, from base to top: *Cloudina* Assemblage Superzone that is distributed in all 15 analyzed sections. There are three biozones inserted in this superzone distributed in sections of Brazil and Paraguay: *Cloudina lucianoii/Corumbella weneri* Interval Zone; *Corumbella weneri* Range Zone; and *Corumbella weneri/Cloudina lucianoii* Interval Zone (Adórno *et al.*, 2016, 2017). It was possible to propose two subzones: *Bavlinella faveolata - Leiosphaeridia minutissima* Assemblage Subzone inserted in the basal part of *Corumbella weneri* Range Zone and *Vendotaenia antiqua-Cloudina lucianoii* Concurrent-Range Subzone at the upper portion of the *Corumbella weneri/Cloudina lucianoii* Interval Zone. The first subzone spans across Brazil,

Argentina, Uruguay, Namibia and China; the second across Brazil, Namibia, China and Siberia. Finally, *Eoholynia corumbensis* Range Zone was proposed for the base of the Guaicurus Formation at Laginha quarry, lowermost Cambrian. The geographic distribution of this biozone is restricted to Laginha quarry locality so far (Fig. 1).

Conclusions

Twenty-six species were studied from the Tamengo and Guaicurus formations, twenty-three of which represent benthic biomineralizing epibionts of sessile habit: *Cloudina lucianoii*, *C. carinata*, *Corumbella weneri* and an indeterminate species of porifera. *Vendotaenia antiqua* represents a sessile epibiont prokaryotic-colony. Three ichnospecies represent activity of vagile organisms: *Multina minima*, *Gordia marina* and *Pilichnus* cf. *P. dichotomus*. *Multina minima* represents endobiont organisms while *Gordia marina* and *Pilichnus* cf. *P. dichotomus* represent epibiont vagile explorers on the water-sediment interface. Additionally, sixteen species probably derived from planktic organisms, such as *Arctacellularia januarensis nomem nudum*, *Leiosphaeridia ternata*, *L. crassa*, *L. jacutica*, *L. minutissima*, *L. tenuissima*, *L. obsuleta*, *Bavlinella faveolata*, *Bambuites erichsenii*, *Synsphaeridium* sp., *Jacutianema* sp., *Lophosphaeridium* sp., *Ostiana microcystis*, *Navifusa* sp., gen. 1 sp. 1 and one species of organic-permineralized microfossils, *Chuarua circularis*.

Four species represent a benthic fossil assemblage for the Guaicurus Formation: *Eoholynia corumbensis*, *Tawuia dalensis*, *Multina minima* and *Didymaulichnus lyelli*. From the total, three species have occurrences restricted to this formation, and only *Multina minima* shows occurrences in the Tamengo Formation.

Seven biozones were proposed, from bottom to top: *Cloudina* Assemblage Superzone that is distributed in all 15 analyzed sections in Brazil, Paraguay, Uruguay, Argentina, United States, Canada, Namibia, Oman, Russia and China. Inserted in this superzone, there are three biozones, distributed in sections of Brazil and Paraguay: *Cloudina lucianoii/Corumbella weneri* Interval Zone; *Corumbella weneri* Range Zone; *Corumbella weneri/Cloudina lucianoii* Interval Zone. It was possible to propose two subzones: *Bavlinella faveolata - Leiosphaeridia minutissima* Assemblage

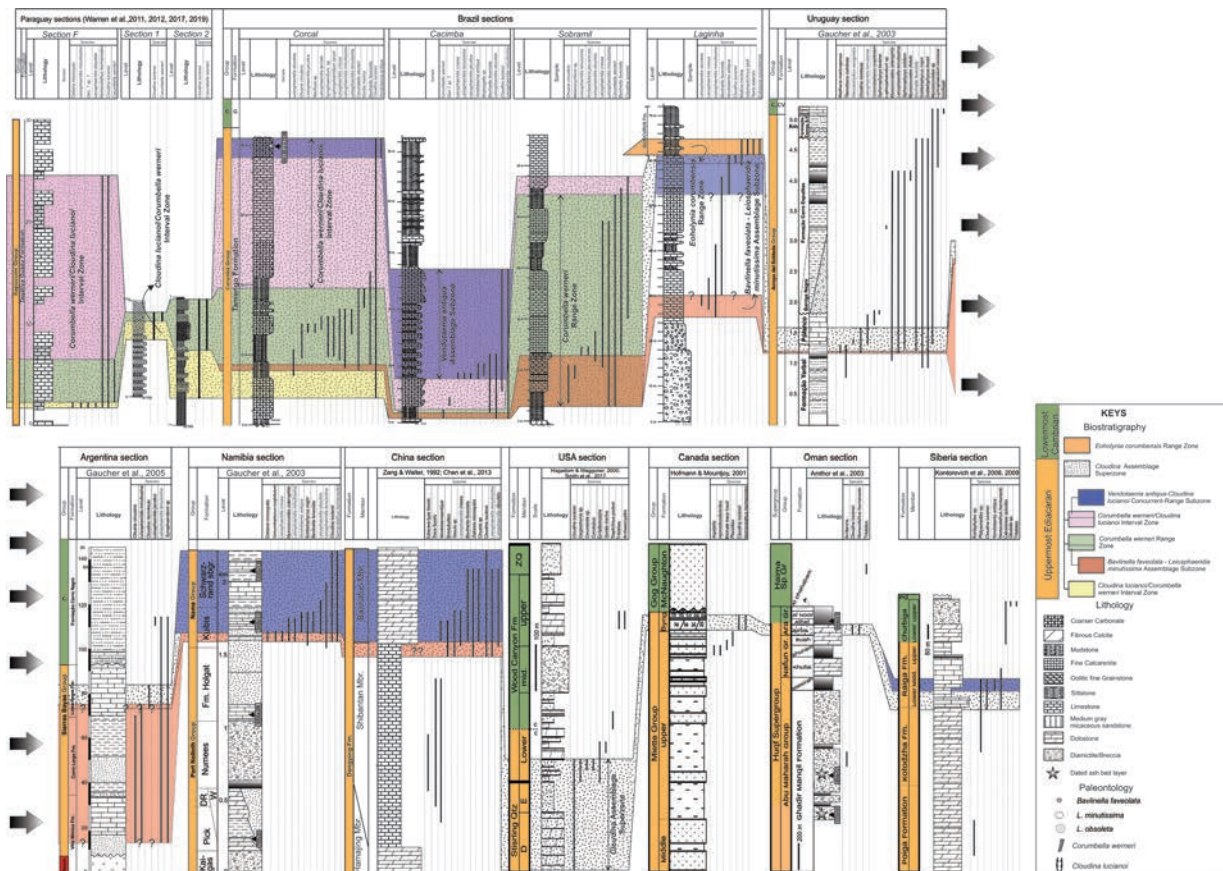


Fig. 1—Biostratigraphic proposal based on the stratigraphic distribution of the species from the Tamengo Formation; palaeontological informations from the selected sections out of Brazil (Zang & Walter, 1992; Hagadorn & Waggoner, 2000; Hofmann & Mountjoy, 2001; Amthor et al., 2003; Gaucher et al., 2005; Kontorovich et al., 2009; Warren et al., 2011, 2012, 2013, 2017, 2019; Smith et al., 2017; Adôrno 2019); data from Corcal quarry after Parry et al. (2017).

Subzone inserted in the base of *Corumbella werneri* Range Zone and *Vendotaenia antiqua-Cloudina lucianoi* Concurrent-Range Subzone at the upper portion of the *Corumbella werneri/Cloudina lucianoi* Interval Zone. The first subzone spans across Brazil, Argentina, Uruguay, Namibia and China, the second across Brazil, Namibia, China and Siberia. Finally, *Eoholynia corumbensis* Range Zone was proposed at the base of Guaicurus Formation at Laginha quarry, lowermost Cambrian. The geographic distribution of this biozone is restricted to Laginha quarry locality so far.

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