

Project Reports (Paleobiology)

1. Title: Evolutionary, taphonomic and paleoenvironmental implications on the study of *Corumbella weneri* Hahn *et al.* (1982) (Ediacaran, Corumbá Group)

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1.1. Summary

Corumbella weneri was a kind of fixed life form of cnidarian medusas that lived ca. 543 million years ago - *Corumbella* was one of the first animals on Earth capable of secreting a skeleton - Studies on *Corumbella* are important to understand the origin and evolution of skeletonized animals on Earth

1.2. Project Activities/Progress

Corumbella weneri Hahn *et al.*, 1982 was dated at the final Ediacaran period (ca. 543 million years ago) and originally documented in Brazil (Corumbá Group), as a kind of fixed life form of cnidarian medusas, characterized by an elongated polyhedral tube, formed by a relatively thick carapace [Pacheco *et al.*, 2011a]. *Corumbella* was also one of the first known animal capable to build a real skeleton [Pacheco *et al.*, 2011a; Pacheco, 2012; Warren *et al.*, 2012] which would be one major step in the context of ocean chemical changes and feedback links attributed to the evolution of animal skeletogenesis, such as predator/prey, that must ensured selective pressures revealed on new balancing ecosystem factors that triggered high rates of evolution and diversity, and ended up in an explosive appearance of new animal species. Although basic morphology of *C. weneri* is already established [Pacheco *et al.*, 2011a], some aspects of chemical composition and fossilized carapace constitution and inner morphology, has not yet been fully resolved. Hence, we are essentially analyzing the chemical composition of the *C. weneri* carapaces [Pacheco *et al.*, 2011b] and determining the

evolutionary trends of skeletogenesis among Eumetazoa and taphonomical process during the Ediacaran; we are also trying to establish comparisons between the rocks and fossils of metazoan in Tamengo Formation and similar rocks and fossils chronologically related at Iran, Namibia, England and Newfoundland, to better understand the evolutionary context of the Ediacara biota. For the purpose of this study we will apply non-destructive analytical high resolution techniques, such as Raman spectroscopy and X-ray microtomography, for the analysis of these fossils.

1.3. Publications

PACHECO, M. L. A. F. 2012. *Reconstituição morfológica e análise sistemática de Corumbella weneri Hahn et al. 1982 (Formação Tamengo, Ediacarano, Grupo Corumbá), Mato Grosso do Sul, Brasil: implicações paleoecológicas e tafonômicas..* PhD Thesis – Instituto de Geociências, Universidade de São Paulo, São Paulo.

PACHECO, M. L. A. F., LEME, J.M. & MACHADO, A.F. 2011. Taphonomic analysis and geometric modelling for the reconstitution of the Ediacaran metazoan *Corumbella weneri* Hahn et al. 1982 (Tamengo Formation, Corumbá Basin, Brazil). *Journal of Taphonomy*, 9(4): 269-283.

PACHECO, M. L. A. F.; LEME, J. M. & FAIRCHILD, T. R. 2010a. Reinterpretação de atributos morfológicos de *Corumbella weneri* Hahn et al. 1982 (Formação Tamengo, Bacia Corumbá, Mato Grosso do Sul) por meio de uma análise tafonômica básica. In: PALEO SP 2010, Reunião Anual da Sociedade Brasileira de Paleontologia, Rio Claro. *Livro de resumos...*, São Paulo: SBP, 2010a.

PACHECO, M. L. A. F.; LEME, J. M.; FAIRCHILD, T. R. 2010b. Re-evaluation of the morphology and systematic affinities of *Corumbella weneri* Hahn et al. 1982, Tamengo Formation (Ediacaran), Corumbá, Brazil. In: CONGRESO ARGENTINO DE PALEONTOLOGÍA Y BIOESTRATIGRAFÍA, 10., CONGRESO LATINOAMERICANO DE PALEONTOLOGÍA, 7., 2010. La Plata, Argentina. *Libro de resúmenes* p. 193.

PACHECO, M. L. A. F.; GALANTE, D.; RODRIGUES, F.; LEME, J. M. 2011b. *Corumbella weneri*: The rise of animal mineralized skeletons? Activity Report, Brazilian Synchrotron Light Laboratory, p 1–2.

PACHECO, M. L. A. F.; LEME, J. M.; FAIRCHILD, T. R. 2011. Análise tafonômica de *Corumbella weneri* Hahn et al. 1982 (Formação Tamengo, Grupo Corumbá, Mato Grosso do Sul): alterações morfológicas e implicações no estabelecimento de afinidades taxonômicas. In: CONGRESSO BRASILEIRO DE PALEONTOLOGIA, 22., Natal, RN. *Atas...*, Natal: SBP, 2011c. p. 449–452.

WARREN, L.V., PACHECO, M.L.A.F., FAIRCHILD, T.R., SIMÕES, M.G., RICCOMINI, C., BOGGIANI, P.C. & CÁCERES, A.A. 2012. The Dawn of animal skeletogenesis: ultrastructural analysis of Ediacaran metazoan *Corumbella weneri*. *Geology*, 40 (8): 691–694.

1.4. Tags

Corumbella weneri; Ediacaran; Corumbá Group; diagenesis; biomineralization; Metazoa.

1.5. Field Sites

Corumbella are found on quarries and park at the great region of Corumbá city. The sites are described above:

Cacimba Ecopark

Latitude: 18°59'58,811S

Longitude: 57°40'03,243W

Description: The Ecopark Cacimba da Saúde is located at Corumbá urban area. Exceptionally well preserved fossils of *Corumbella* were collected at the shales from Tamengo Formation (Corumbá Group) in an outcrop at the entrance of the park. This outcrop is characterized by a slope of about 10 meters on the boundary with the plain of the Paraguay river.

Laginha Quarry

Latitude: 19°07'17,153S

Longitude: 57°38'28,031W

Description: Located 17 km southern Corumbá, Laginha Quarry is a mining front, open to the exploitation of ore. Inserted in Corumbá Group are observed, due to the exploratory actions, the Bocaina and Tamengo formations. The sedimentary package in the region is interspersed with layers of subordinate siltstones and shales, whose thickness varies from centimetric to metric. The rocks are fractured under the direction NE-SW and NW-SE. It is observed sometimes concentrations of calcite in fracture zones. The carbonate rocks extracted are used in many areas of industry, principally for the manufacture of cement, limestone dust and soil amendments. In Laginha was found the greater occurrence of *Cloudina* fragments associated with ooids. In the same quarry were also found structures in rhythmite faces, and probable *Cloudina luciano*i shells in apparent life position. At Laginha were also found *Corumbella* remains in shales interbedded with limestone.

Sobramil Port (Itaú-Saladeiro Old Quarry)

Latitude: 19°0005,603S

Longitude: 57°3716,683W

Description: The fossils originally described were collected from outcrops of the Tamengo Formation, at a old Itaú-Saladeiro quarry, Corumbá region, where now is the Sobramil Port . Between Corumbá and Ladário, this formation is composed largely by limestone, arranged in relatively homogeneous packets that range from 5 to 10 m in thickness. Specimens were practically entirely from the subordinate shales and siltstones within very dark gray limestone and a few coming from a rhythmic thin-bedded pelitic limestone interval, probably associated to ash falls.

Research description:

In Brazil, in limestone mines located in Corumbá and Ladário, German and Brazilian scientists have described, in the 1980s, the Ediacaran metazoan *Corumbella weneri*. Dated at about 543 million years ago, this was a fossil animal that composed the last evolutionary moment of Ediacara biota as well as fossils of Nama Group (Namibia), in the Ediacaran/Cambrian boundary, when the animals were coming out of the shadow of other beings, such as the extinct giant protists (or vendobionts) and flourishing in its various forms and ecological interactions.

In fact, in many aspects, such as the excellent preservation of fossils and some parts of the geological processes that led to the formation of this exceptional record of life, Tamengo Formation (geologic unit where *Corumbella weneri* is found), can be compared to the famous Burgess Shale. Moreover, since the fossils of Ediacaran/Cambrian boundary make a very rare and fragmented record, analysis and reconstruction of fossil, as their modes of life, are not easy tasks. Thus, for over 30 years, scientists from other parts of the world have been developing and applying advanced and non-destructive techniques to the study of the oldest fossils. In this scenario stand out, paleobiologists and evolutionary biologists trying to understand both the origin and evolution of life on Earth, as well as the establishment of life in the most remote environments.

The paleontologist Martin Brasier (University of Oxford), in a recent partnership with researchers at the University of São Paulo, has helping us driven the use of high-resolution analytical techniques to compare the context of paleontological fossils *Corumbella* and of similar geological units in Iran, Namibia, England and Canada. With these techniques we can, for example, reconstruct important aspects both on the chemical composition and about the oxygenation of water and volcanism events of the environment where these animals settled and evolved.

In this context, the use of advanced techniques have improved studies on morphology, paleoecology and evolution of *Corumbella*, bringing new light not only on the last moments before the Cambrian explosion, worldwide, as well as structuring subsidies for research into optimal conditions for the establishment of multicellular life

both on Earth and in other contexts cosmic. With the recent exploratory missions to Mars and other planets in the solar system, we can use the same techniques we have developed for studying the fossils of our planet to reveal the presence of past life in these environments. This is an issue that paleobiologists and astrobiologists must tackle together, and they may respond if there was life beyond Earth.

The chemical composition of the carapace of *Corumbella* and other fossil her contemporaries, such as *Cloudina* (conical shells preserved as carbonatic in Tamengo Formation and in various other parts of the world) has become a central theme in discussions of biological processes and/or environmental that led to the synthesis of skeletons toughest among animals in remote Ediacaran/Cambrian boundary. Perhaps, even, due to the increase in the abundance of animals capable of producing stronger skeletons (even mineralized), these life forms have had a most favored and preserved record, at this time, giving the impression it was an explosion of life. For the investigation of the chemical composition of *Corumbella* carapace, for example, we have made use of more advanced techniques, in conjunction with Laboratório Nacional de Luz Síncrontron, Brazil (LNLS, Campinas), Instituto de Química and Laboratório de Astrobiologia, at Universidade de São Paulo.

In addition, researchers at the Instituto de Geociências and Laboratório de Astrobiologia from USP, with support from the Foundation for Research Support of the State of São Paulo, together with the Technical University of Munich have applied the most complex and advanced techniques three-dimensional X-ray microtomography for the reconstitution of the internal parts of this animal, at the European Synchrotron Radiation Facility (ESRF, Grenoble, France) and the Deutsches Elektronen Synchrotron (DESY, Hamburg, Germany). The reconstruction of anatomical structures of this animal can provide important information about the ecology of these organisms, such as modes of life, and even reproduction, and, in a way, allows us to see this animal as old coming to life on the computer screen .

So far, we can safely say that *Corumbella* was an animal belonging to the group of cnidarians, living fixed to the substrate. In our recent reconstitution of *Corumbella*, we discovered another feature that comes even closer to the end of the Ediacaran animals: they are bearers of a relatively thick and sturdy carapace, and opening oral innovations that made it one of the most amazing predators of the Ediacaran seas. (Pacheco *et al.*, 2011).

Besides the scientific relevance of *Corumbella* to evolution of animals, the occurrence of this enigmatic Ediacaran fossil, in Corumbá region, has implications for developing strategies in Brazilian Geotourism. The presence of so important and remote fossil, in a shock scenario of extreme, revealed by the presence of recent biogeographical area of the Pantanal (formed even in our current Cenozoic Era) and more stunted Precambrian geological formations, in Mato Grosso do Sul can then

enable the organization the Geopark Bodoquena/Pantanal as candidate to Global Network of National Geoparks, under the auspicious of UNESCO.

Due to importance of *Corumbella*, which name is a tribute to Corumbá city “a bela de Corumbá” (“the beautiful of Corumbá”), some divulgation have been done in the local media and -education projects have been planned.

Interesting sites:

<http://www.journaltaphonomy.com/JT-articles/2011/issue4/jt-122NATI.pdf>

<http://www.geoparkbodoquenapantanal.ms.gov.br/>

<http://sedici.unlp.edu.ar/handle/10915/16933>