
Reply

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INTRODUCTION

A recent discussion by Buatois and Mángano on the article published in the special volume “Advances in the knowledge of the Cambrian System” (Aceñolaza, 2003a), focused on several geological aspects of the Cambrian sequences in northern Argentina. I would like to express my gratitude to the early referred authors for some interesting observations made regarding the paper, that originally had as a goal to provide wide bibliographical data for those readers interested in these South American sequences.

Unfortunately, I believe that this information was made available rather late in the processing of the manuscript. After almost three years of the original handling of revised papers, some of the ideas discussed and data observed are considered in a similar direction. Buatois and Mángano have based their discussions and judgments, mostly on data fully published after the acceptance of the final paper (Buatois and Mángano, 2003a, b and c; Buatois et al., 2003; Mángano and Buatois, 2003a and b; Mángano and Buatois, 2004; Mángano and Buatois, in press). Besides, some aspects of the Cambrian sequences of North-western Argentina have been clarified in later publications (Aceñolaza and Aceñolaza, 2001, 2003; Aceñolaza, 2004).

The original special volume was published as a result of the VI field meeting of the Subcommittee on Cambrian Stratigraphy (IUGS) held in Argentina in the year 2000. The papers were finally published in March 2003. As stated by Buatois and Mángano, views on these topics are changing at a very fast pace, based on an important number of publications during the last years. This amount

of publications in different media resulted in the “rather convolute story frequently going back and forth” mentioned by them, where updated information published mostly as short papers and abstracts came out before the discussed paper. Aceñolaza and Aceñolaza (2001) is a clear example of this situation, where a short paper presented at the 2001 field meeting of the Subcommittee held in China, one year after the Argentine meeting, was published before the discussed paper.

Some aspects related to the discussion done by Buatois and Mángano shall be clarified as follows:

PUNCOVISCANA FORMATION (S.L.)

Most of the observations are figure based analysis. As stated by Buatois and Mángano, tackling such a complex topic in a perfect manner giving summarized stratigraphical and temporal schemes for a basin with different lithologies and ages over 400 000 km² is strictly not possible. As expected, time lines will cut different units, facies and lithologies included in the Puncoviscana Formation (*s.l.*), depending on the relative basinal position of the analyzed material. All figures are referred as “sketch”, a terminology that allows a certain generalization. Most figures were taken and slightly adapted from early publications, in the same manner as Buatois and Mángano did as main co-authors in Aceñolaza et al. (1999), supporting the ideas of this paper one year before the Argentine meeting. Some figures are shared and adapted from the mentioned publication.

Under the denomination of Puncoviscana Formation (*s.l.*) we understand a series of lithologies, from slates to

conglomerates and limestones, clearly different one from another. Limestones, conglomerates and shales, to mention some facies represented in the unit, do not sediment under the same paleoenvironmental conditions, so it is incorrect to believe all the Puncoviscana Formation (*s.l.*) as deposited entirely in a deep water setting. To detail on obvious subjects will generate “phraseology”, a common practice already noticed by Keighley (2002) in Buatois and Mángano. Most trace fossils were historically recovered from interpreted deep sea facies, as recently referred by Buatois and Mángano (2003b), resulting in a frequent mention of this environmental setting. In the last mentioned paper, authors recall a publication by Aceñolaza et al. (1999) as “deposited entirely in deep submarine fans” (*sic.*). Contrary to what was claimed by Buatois and Mángano (2003b, p. 572), Aceñolaza et al. (1999) have never documented or mentioned an exclusive deep water setting. In a similar manner, Buatois and Mángano (2003b, p. 573) mentioned that “ongoing studies” suggest an eastern shallow-marine facies while to the west deep-marine environments were developed. A shallower area was already clearly interpreted and figured during the last century by Borrello (1969, p. 55, 60). “Impact papers” refreshing ideas born during the 60’s as own will not solve the problems in the Cambrian siliciclastic sequences of NW Argentina.

In addition, it is incorrect to believe that all the Puncoviscana Formation shall be restricted to the Lower Cambrian as stated by Mángano and Buatois (Nemakit-Daldynian). The depositional and diagenetical age is still controversial. Most probably, a Lower Cambrian age could be used only if referred strictly to the ichnofossiliferous strata and the unit defined by Turner (1960, *sensu stricto*). If the Puncoviscana Formation is considered on its generalized use, unifying different lithologies and outcrops (*sensu lato*), it should be considered Precambrian – Lower Cambrian. Adams et al. (1990), Do Campo et al. (1994) and Do Campo (1999) presented K-Ar data reflecting older ages of deposition and diagenesis, ranging from 545 to >670 +/- 27 Ma. Finally, if we consider C-isotope stratigraphy as one of the most powerful tools in Precambrian chronostratigraphy, specially when sediments lack recognizable animal fossils (Kaufman, 1988), we shall mention that Sial et al. (2001) have recently analyzed the C and Sr isotopic evolution of a limestone unit included in the Puncoviscana Formation, concluding that the Precambrian / Cambrian transition should be placed within the upper sector of the limestone facies. “Filtered” geochronologic data is used by Buatois and Mángano in their contributions and discussion.

MESÓN GROUP

Again, data is analyzed by means of the scheme of fig. 2, and not with the written text. On page 28, the last

paragraph states that the age of the Mesón Group ranges between the Lower and Upper Cambrian, highlighting the incongruity on the data provided by fossiliferous information included in their different units. *Syringomorpha nilssonni* is mentioned in the Campanario Formation as one of the problematic biostratigraphic data.

Buatois and Mángano added that the trilobite mentioned by Aceñolaza (1973) and Aceñolaza and Bordonaro (1990) has been recently reassigned to *Leiostrigium douglassi* by Vaccari and Waisfeld (2000). Fossil material is housed in the Invertebrate Paleontological Collections of the Facultad de Ciencias Naturales and Instituto Miguel Lillo (where I am the curator) and has never been asked for loan neither by the authors of the review nor by Buatois and Mángano.

Neither the data given on page 28 with the reference in the text to *Syringomorpha* and the “*Asaphiscus-Leiostrigium*” dilemma is mentioned by Buatois and Mángano in their discussion. Facts have been only partially presented to the readers.

Concerning the presence of the Santa Rosita Formation in Azul Pampa locality, again, they are arguing with recent field work and data not available at that moment. Today, own observations support the existence at that locality of a lower quartzitic member within the Santa Rosita Formation (referred to the partially equivalent Casayoc Formation).

Environments represented in the Mesón Group were described by several authors and mentioned in the text of pages 27-28 (Moya, 1998; Sánchez, 1999; Sánchez and Salfity, 1999), so it is clear that a translation mistake referred the strata to a shoreline. Most of the deposition of the Mesón and Santa Victoria groups took place on a shoreface setting as stated in different parts of the discussed publication and in several papers (Moya, 1988, 1998 and 1999; Aceñolaza, 1996; Aceñolaza and Poiré, 1999; Aceñolaza and Aceñolaza, 2002; Di Cunzolo et al., 2003).

SANTA VICTORIA GROUP

As stated by Buatois and Mángano, the Iruya unconformity separates the Mesón and Santa Victoria groups (*lapsus calamis*), while the Tilcara unconformity is placed below, separating the Puncoviscana Formation from the Mesón Group as correctly placed in fig. 2 of page 25. Old and recent publications by the author support the existence of this Iruya unconformity, supporting an erosional unconformity related to a sea level fall in a same manner than Moya (1988, 1998) and Buatois et al. (2000). Interestingly, Aceñolaza (1996) almost ten years ago named

the sea level fall responsible for the Iruya unconformity as “Iruya Eustatic Event”, data well known but never mentioned by Buatois and Mángano.

New interdisciplinary field work on this unconformity supports a fourth possibility that could be added to the three original interpretations considered by Buatois and Mángano: (1) Tectonism; (2) Sea level fall; (3) Conformable transition and (4) a dual tectono-eustatic origin. Nowadays, a conformable transition between the discussed formations is not considered by anyone in Argentina as erroneously stated by Buatois and Mángano (Moya, 2002; Aceñolaza, 2003b, c; Aceñolaza and Nieva, 2003; Aceñolaza et al., 2003). Again, data in the discussion have been arranged to confuse the reader.

Finally, some informal units mentioned by Buatois and Mángano are of a local use, restricted to a small area of the Cambrian basin (e.g. the Tilcara member of the Quebrada of Humahuaca), and should not be considered in an overview of the Cambrian System in NW Argentina. Figure 1 of Buatois and Mángano (page 68, this volume), should not be used as a reference stratigraphic sketch for the Cambro/Ordovician transition in NW Argentina.

TRACE FOSSIL DATA

Taxonomic re-evaluation of the fossils included in the Cambrian sequences was not the goal of this part of the paper. Materials were listed as originally mentioned by authors providing for the first time a taxonomic list open to a wide spectrum of readers worldwide. Interested readers could locate from the bibliographical lists the items of interest and refer to them in relation to their needs. The asterisk indicates the record of a genus in the analyzed data, and not the occurrence and taxonomic status worldwide. For example, even though *Phycodes pedum* is the ichnospecies that defines the Cambrian/Precambrian boundary it was only described in the Ordovician strata of the Santa Victoria Group, and not in older units (today considered an over imposed rusophycid tace). The recent paper by Aceñolaza (2004) documented for the first time the presence of *Treptichnus* cf. *aequalternus* in the Lower Cambrian strata of the Puncoviscana Formation. The taxonomic status of *Phycodes/Treptichnus/Trichopycus* is still a matter of debate, not conclusively solved as mentioned by Buatois and Mángano (“more correctly, *Treptichnus pedum*” *sic.*). Erdogan et al. (2004) presented the taxonomic status of this trace as a lively matter of debate. After a detailed analysis, these authors decided to keep the oldest name of *Phycodes pedum* in their paper. Taxonomy of these three related forms today shall consider early interpretations of open burrows or feeding structures (Uchman et al., 1998;

Erdogan et al., 2004 see *Skolithos* traffic –on line forum on trace fossils–). *Phycodes* was included in *Trichopycus* (Geyer and Uchman, 1995) and later in *Treptichnus* (Jensen et al., 2000). However, Erdogan et al. (2004) mentioned that “separation of open burrows and feeding structures in *Treptichnus* should be made at first with all taxonomic consequences of this treatment”.

Mángano and Buatois (2003a) have recently published the presence of *Rusophycus leiferikssoni* (*sic.*) in the Cambrian strata of the Mesón Group. This ichnotaxon has been incorrectly misspelled by them since 2001 (Mángano and Buatois, 2001; 2003a). *Rusophycus leiferikssoni* was originally described by Bergstöm (1976) after Leif Eiriksson, a Greenland viking who left his traces in Newfoundland about 1000 years ago. Structures referred to as “soft body faunas” in the discussed contribution are now considered microbial activity structures, as it is well known, but not mentioned by Buatois and Mángano (e.g. Aceñolaza and Aceñolaza, 2001, 2003; Aceñolaza, 2004).

Again, a taxonomic analysis and re-assessment of traces was not the goal of the appendix.

FINAL REMARKS

The discussion by Buatois and Mángano gives the impression that the authors considered that no proper reference was made to the work that is being carried out by them, with eight papers/abstracts in two years (Buatois and Mángano, 2003a, b and c; Buatois et al., 2003; Mángano and Buatois, 2003a, b; Mángano and Buatois, 2004; Mángano and Buatois, in press). Most of the data mentioned in their discussions has been published after the acceptance of the analyzed paper.

Sketch based analysis are not enough to advance in the knowledge of the Cambrian System of NW Argentina. As entitled in the paper (“stratigraphic and palaeontological framework”), giving a detailed sedimentological and sequence stratigraphical analysis and an ichnotaxonomical re-assessment of early mentioned taxa was not the objective of the paper. Detailed field work and new data are the only reliable source of information. “Impact papers” refreshing old born ideas or filtering the bibliographical data will not solve the problems in the Cambrian siliciclastic sequences of NW Argentina.

Surprisingly, Buatois and Mángano worked in my institute and knew well the publishing timing of my contributions. However, they never discussed with me the paper content. Data have been used in such a way that confuse the reader.

I wish to end this reply by repeating an obvious path mentioned by the discussers: "Further efforts to integrate structural, geochemical, ichnologic and sedimentologic data within a stratigraphic framework are essential to advance on this topic", with appropriate methodologies and consistent and precise terminology.

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Manuscript received July 2004;
revision accepted September 2004.