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Class Trilobita (including agnostoids) from Argentine Precordillera

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Keywords: Dataset, trilobite (including agnostoids) fauna, western Argentine, Lower Paleozoic.

SUMMARY

This data paper inventories the records of 1763 trilobites (including agnostoids) from the Middle Cambrian inner and outer platform of the Argentine Precordillera (San Juan and Mendoza provinces). They were collected by Dr. Osvaldo Bordonaro and his colleagues between 1994 and 2013 and studied within the framework of scientific research. The specimens are stored in the Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA, CCT-CONICET Mendoza, Argentina), an official paleontological repository of Mendoza Province and are part of its Paleoinvertebrates Collection. The study of these trilobites contributed to the taxonomy of the group and allowed the establishment of important paleobiogeographic connections between Cuyania and Laurentia during the Cambrian. From a preliminary Microsoft Excel format, the dataset is now included in the Global Biodiversity Information Facility (GBIF, https://www.gbif.org), under the publisher CCT-CONICET Mendoza (Argentina), making it available to the public.

INTRODUCTION

The Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA) stores a paleontological collection of invertebrates, identified with the acronym IANIGLA-PI, which mainly preserves the past biological record of the Cuyo region (central-west Argentina) and some from northwestern Argentina and from Mexico.

The first material was incorporated as a scientific collection in the mid-1990s, with specimens of *Blainia gregaria* (Walcott, 1916) from the Middle Cambrian of La Laja Formation of the Precordillera of San Juan Province (Argentina). The collection was later enlarged with the incorporation of fossils of other phyla, such as Porifera, Mollusca and Hemichordata, being completed at present with fossil remains of Class Insecta from the Upper-Middle Triassic continental sequences of Mendoza (Potrerillos and Cacheuta formations) (Devincenzi, 2018). Even though no more trilobites (including agnostoids) have been added since 2013, this class represents the most abundant group in the collection.

Trilobite (including agnostoids) richness from Precordillera of San Juan and Mendoza provinces has caught the attention of both Argentine and North American paleontologists since mid-20th century (Leanza, 1947; Rusconi, 1950a & b; 1951a & b; 1952a & b; Poulsen, 1958; Borrello, 1963, 1964, 1971; Palmer, 1973; Ross, 1975). More recent research on these trilobites has provided important novelties in taxonomic and paleobiogeographic aspects of the group (see below).

From a preliminary Microsoft Excel format, the dataset was cleaned with OpenRefine, a free and open source software for working with data. Later, the dataset was included in the Global Biodiversity Information Facility (Devincenzi & Bordonaro, 2022), under the publisher Centro Científico Tecnológico (CCT) CONICET Mendoza. The data can also be obtained from the Paleobiology Database (https://paleobiodb.org/classic/basicCollectionSearch?collection_no=200101, https://paleobiodb.org/classic/basicCollectionSearch?collection_no=200106, https://paleobiodb.org/classic/basicCollectionSearch?collection_no=200108, https://paleobiodb.org/classic/basicCollectionSearch?collection_no=200109, https://paleobiodb.org/classic/basicCollectionSearch?collection_no=200114, https://paleobiodb.org/classic/basicCollectionSearch?collection_no=200661).

The aim of this data paper is to compile data on all these specimens, the circumstances of their collection, and the main scientific results obtained from them. The authors of this manuscript are members of the IANIGLA, curator of the Paleoinvertebrates Collection and scientific research respectively.

RESULTS

Summary statistics

The dataset compiles the information on 1763 fossil remains of trilobites (including agnostoids). The specimens come from Argentine Precordillera, mostly from the Middle Cambrian inner and outer platform and a few from the Lower Cambrian and Middle Ordovician sequences. Data was given following Darwin Core quick reference guide (Darwin Core Maintenance Group, 2020; Wieczorek et al., 2012). The dataset lists data of Record-level (type, modified, institutionCode, collection-Code, basisOfRecord); Occurrence (occurrence-ID, catalogNumber, recordedBy, disposition, associatedReferences, occurrenceRemarks); Event (eventDate); Location (higherGeography, continent, country, countryCode, stateProvince, county, locality, decimalLatitude, decimal-Longitude, geodeticDatum, coordinateUncertaintyInMeters, coordinatePrecision, verbatimLatitude, verbatimLongitude, georeferencedDate, georeferenceProtocol, georeferencedSources, georeferencedBy, georeferencedVerificationStatus); GeologicalContext (earliestEonOrLowestEonothem, earliestEraOrLowestErathem, latestEraOrHighestErathem, earliestPeriodOrLowestSystem, latestPeriodOrHighestSystem, earliestEpochOrLowestSeries, latestEpochOrHighestSeries, earliestAgeOrLowestStage, latestAgeOrHighestStage, formation, member, bed); Identification (identificationQualifier, identifiedBy); Taxon (scientificName, namePublishedIn, higherClassification, kingdom, phylum, class, order, family, genus, specificEpithet, scientificNameAuthorship). The dataset was exported to DarwinTest format and then uploaded to the IPT of MINCyT (Ministerio de Ciencia, Tecnología e Innovación Productiva, Argentina).

Data set

Data set name: Registros de la clase Trilobita de la Precordillera de San Juan y Mendoza, Argentina

Character encoding: UTF_8

Format name: csv, comma-separated values

Distribution: the data set is available in Global Biodiversity Information Facility (GBIF). GBIF

UUID 61044ae3-8a80-4cc0-bb62-a7fe2af6490b. Centro Científico Tecnológico (CCT) CONICET Mendoza publishes this resource and is itself registered in GBIF as a data publisher endorsed by GBIF Argentina.

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Alternative identifiers: https://ipt.mincyt.gob.ar/resource?r=susana_bordonaro

Management details

Project title: Class Trilobita from Argentine Precordillera (IANIGLA, CCT-CONICET Mendoza, Argentina).

Database manager: Susana Mariel Devincenzi

Temporal coverage (specimens): Early Paleozoic; Lower and Middle Cambrian, Middle Ordovician.

Temporal coverage (collection formation): 1994-2013.

Record basis: The dataset was created from fossils collected and studied by Dr. Osvaldo Bordonaro and colleagues within the framework of scientific research.

Sampling methods: Quarring

Collection name: Paleoinvertebrates Collection of IANIGLA, CCT-CONICET Mendoza.

Collection identifier: IANIGLA-PI

Curatorial unit: Fossil specimen

Specimen preservation method: Dried; articulated and non-articulated specimens (pygidium, cranidium).

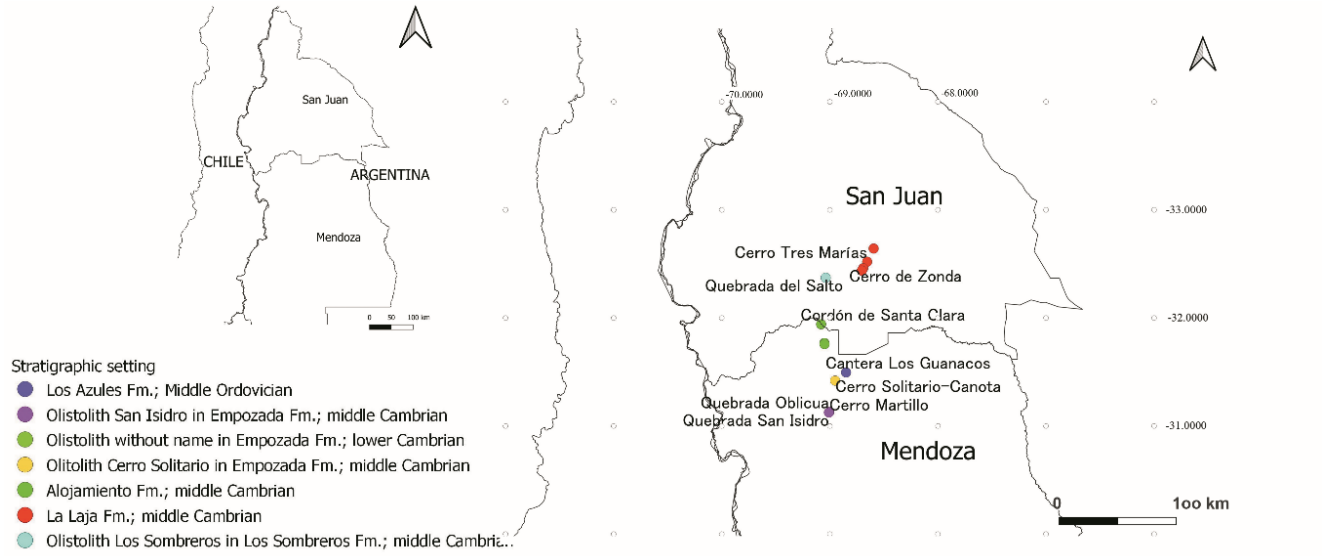

Figure 1. Location map and stratigraphic setting of the trilobite fauna (including agnostoids) included in the dataset.

Funding grants: The collection of the specimens was financed by the following international and national sources: “Cambrian trilobites biostratigraphy from the Soldano Member, La Laja Formation, Eastern Precordillera of San Juan”, PIP CONICET 5793 (2005-2007; “Cambrian Trilobites of the La Laja Formation, San Juan Precordillera”, Project CICITCA – UNSJ (2006 – 2007); “The biotic and Sedimentologic evolution of the Cambrian”, Discovery Grant nº46403, Natural Science and Engineering Research Council of Canada (NSERC) (2002- 2006); “Polymeroids trilobites from Olistoliths San Isidro, Mendoza”, PIP CONICET 0084 (2010-2012).

Geographic coverage

Study area: The study area for this dataset was the Precordillera of western Argentina (San Juan and Mendoza provinces). The dataset mainly compiles data of a northeast-southwest transect that includes Middle Cambrian stratigraphic units (La Laja and Alojamiento formations and olistoliths). A few specimens come from a lenticular layer interbedded in a Middle Ordovician sequence (Los Azules Formation) interpreted as a tempestite, and others from a lower Cambrian olistolith (Figure 1).

La Laja Formation (Figure 2) constitutes the core of Precordilleran terrane (being part of the Cuyania terrane) and represents a restricted platform that contains a trilobite fauna with Laurentian affinities. This fauna occurs in limestone and argillaceous limestone. The Alojamiento Formation and the Middle Cambrian olistoliths represent an external platform with cosmopolitan species, which occurs in mudstones, calcareous shales, and limestones.

A review of the bibliographic references dealing with the general features of the La Laja Formation of the San Juan Province and the Cambrian olistoliths of the Mendoza Province can be found in Bordonaro (2003) and Bordonaro et al. (1993). References on Alojamiento Formation can be found in Banchig (2006).

Bounding box: minimum longitude -68.595131; maximum longitude -69.0810333; minimum latitude -31.358075; maximum latitude -32.8753472. The sampling extended over fossiliferous localities in the following departments: Albardón, Calingasta, Sarmiento, Zonda (San Juan Province, Argentina) and Las Heras (Mendoza Province, Argentina).

Sampling design: The dataset was created including all specimens of Trilobita class (including agnostoids) hosted in the Paleoinvertebrates Collection of IANIGLA, CCT-CONICET Mendoza, Argentina

Quality control for geographic data: Locality descriptions, the corresponding geographic coordinates, and the full georeferences were checked by the collector, O. Bordonaro. The georeferences assigned to the locations were obtained using the point-radius method (Wieczorek et al., 2004), following the Georeferencing Best Practices (Chapman & Wieczorek, 2020), and calculated using the Georeferencing Calculator (Wieczorek & Wieczorek, 2019).

Taxonomic coverage

General description: This dataset focused on trilobites (including agnostoids) followed the Fortey’s classification scheme (1997). According to this scheme, the dataset includes seven orders and 20 families. The most abundant order is Ptychopariida (1182 specimens) followed by Corynexochida (401 specimens) (Figure 3). The predominant species is *Blainia gregaria* (Walcott, 1916) followed by *Bathyuriscus mendozanus* (Rusconi, 1945) (Figure 4; Figure 5. A-B).

Taxonomic ranks: 20 genera and 14 species have been identified (Table 1). The low

diversity is due, on the one hand, to the lack of diagnostic elements (pygidium, thorax or cranidium) of the species and, on the other hand, to the poor preservation of the specimens.

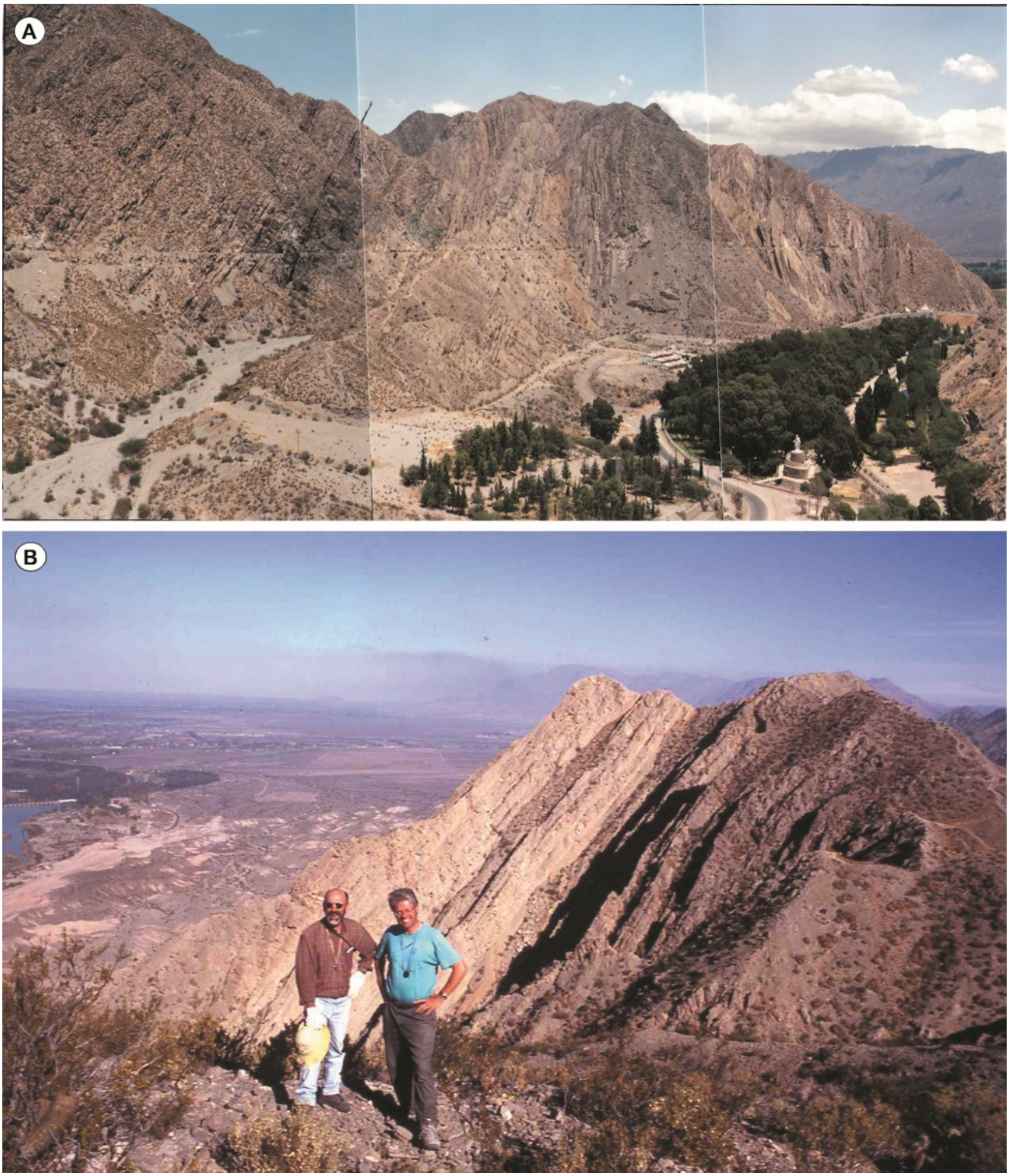

Figure 2. General views of La Laja Formation. A, Panoramic view at Quebrada del Zonda. B, Dr. O. Bordonaro and Dr. B. Pratt at Cerro Tres Marías.

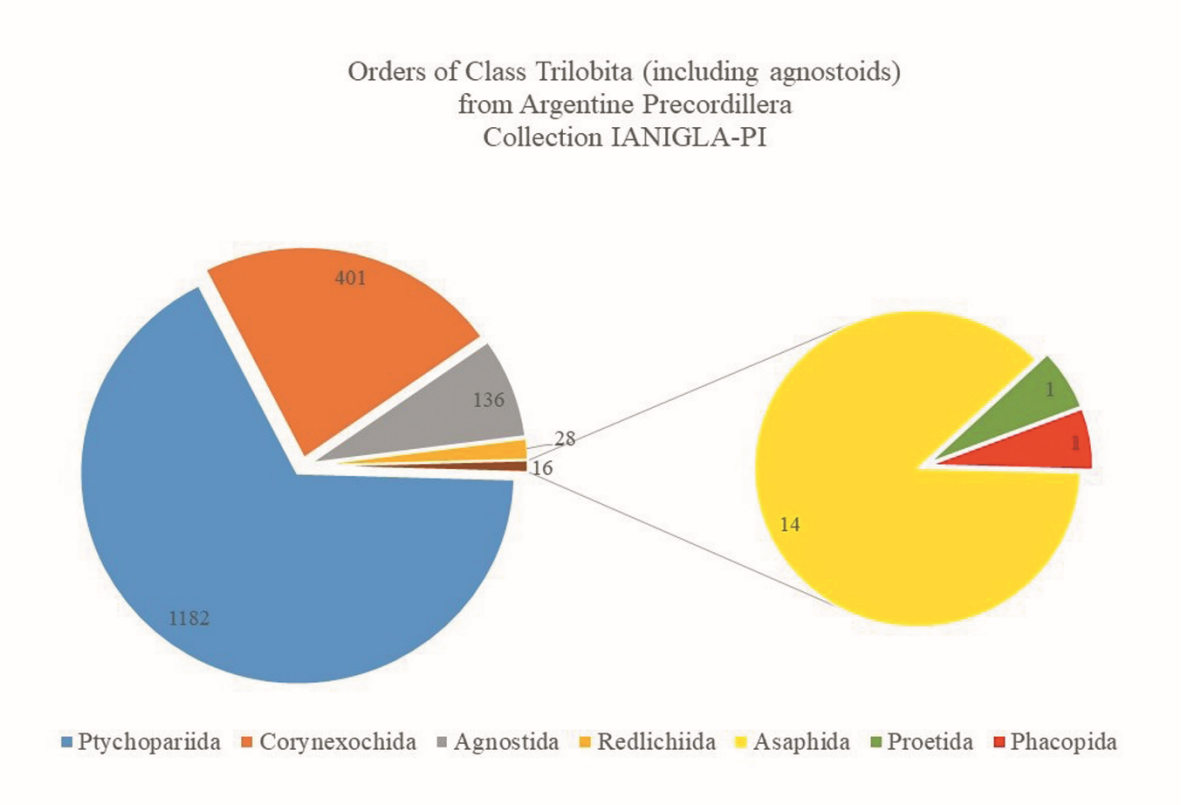

Figure 3. Taxonomic coverage. Distribution of Trilobita orders (including agnostoids) included in the dataset.

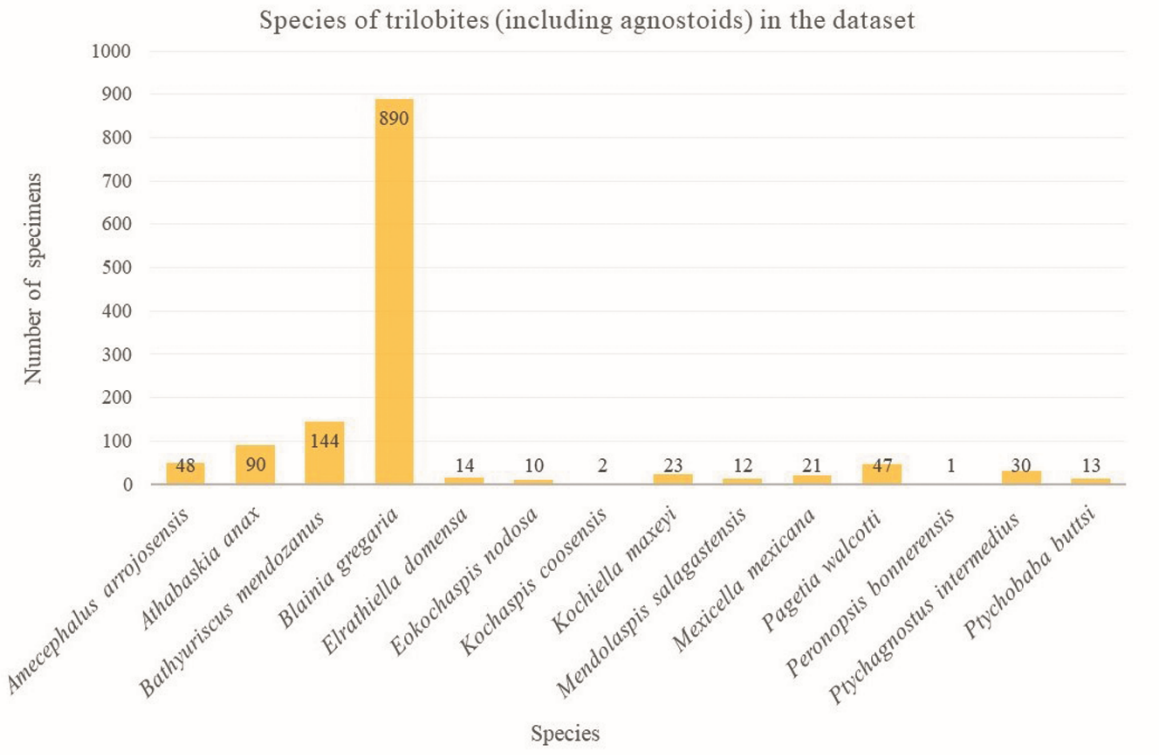

Figure 4. Species of trilobites (including agnostoids) included in the dataset.

Table 1. Taxonomic classification of trilobites (including agnostoids) included in the dataset according to Fortey (1997).

Class Trilobita Walch, 1771		
Order	**Family**	**Genus/Species**
Agnostida Salter, 1864	Eodiscidae Raymond, 1913	*Pagetia walcotti* Rasetti, 1966 *Pagetia* Walcott, 1916
	Metagnostidae Jaekel, 1909	*Geragnostus*? Howell, 1935
	Peronopsidae Westergård, 1936	*Peronopsis bonnerensis* Resser, 1939 *Peronopsis* Hawle & Corda, 1847
	Ptychagnostidae Kobayashi, 1939	*Ptychagnostus intermedius* (Tullberg, 1880) *Ptychagnostus* Jaekel, 1909
Asaphida Salter, 1864 emend. Fortey & Chatterton, 1988	Raphiophoridae Angelin, 1854	*Mendolaspis salagastensis* Rusconi 1951b
	Trinucleidae Hawle & Corda, 1847	
Corynexochida Kobayashi, 1935	Dolichometopidae Walcott, 1916	*Athabaskia anax* (Walcott 1916) *Bathyuriscus mendozanus* (Rusconi, 1945) *Glossopleura* Poulsen 1927
	Dorypygidae Kobayashi, 1935	*Kootenia* Walcott, 1889
	Oryctocephalidae Beecher, 1897	*Oryctocephalites* Resser, 1939 *Tonkinella* Mansuy, 1916
	Zacanthoididae Walcott, 1888	*Zacanthoides* Walcott, 1888
	Illaenidae Hawle & Corda, 1847	
	Leiostegiidae Bradley, 1925	
Phacopida Salter, 1864	Encrinuridae Angelin, 1854	
Proetida Fortey & Owens, 1975	Telephinidae Marek, 1952	
Ptychopariida Swinnerton, 1915	uncertain	*Blainia gregaria* (Walcott, 1916)
	Alokistocaridae Resser, 1939	*Ehmaniella* Resser, 1937 *Elrathia* Walcott, 1924 *Elrathiella domensa* Sundberg, 1994 *Elrathiella* Poulsen, 1927 *Proehmaniella* Sundberg 1994
	Asaphiscidae Raymond 1924	*Blountia* Walcott 1916
	Cedariidae Raymond, 1937	*Cedaria* Walcott 1924
	Ptychopariidae Matthew, 1887	*Amecephalus arrojosensis* (Lochman in Cooper et al., 1952) *Eokochaspis nodosa* Sundberg & McCollum, 2000 *Hadrocephalites* Sundberg & McCollum, 2002 *Kochaspis coosensis* Resser 1938 *Kochiella maxeyi* Rasetti, 1951 *Kochiella* Poulsen, 1927 *Mexicella mexicana* Lochman, 1948 *Ptychobaba buttsi* (Resser, 1938)
	Marjumiidae Kobayashi, 1935	*Marjumia* Walcott, 1916
Redlichiida Richter, 1932	Olenellidae Walcott, 1890	*Fremontella* Harrington, 1956 *Olenellus* Hall, 1861

Table 2. Taxonomic classification of trilobites (including agnostoids) included in the dataset according to Adrain (2011).

Class	Order	Family	Genus/Species
Trilobita Walch, 1771	Agnostida Salter, 1864	Metagnostidae Jaekel, 1909	*Geragnostus*? Howell, 1935
		Peronopsidae Westergård, 1936	*Peronopsis bonnerensis* Resser, 1939
			Peronopsis Hawle & Corda, 1847
		Ptychagnostidae Kobayashi, 1939	*Ptychagnostus intermedius* (Tullberg, 1880)
			Ptychagnostus Jaekel, 1909
	Eodiscida Kobayashi, 1939	Eodiscidae Raymond, 1913	*Pagetia walcotti* Rasetti, 1966
			Pagetia Walcott, 1916
	Redlichiida Richter, 1932	Olenellidae Walcott, 1890	*Fremontella* Harrington, 1956
			Olenellus Hall, 1861
	Corynexochida Kobayashi, 1935	Dolichometopidae Walcott, 1916	*Athabaskia anax* (Walcott 1916)
			Bathyuriscus mendozanus (Rusconi, 1945)
			Glossopleura Poulsen 1927
		Dorypygidae Kobayashi, 1935	*Kootenia* Walcott, 1889
		Oryctocephalidae Beecher, 1897	*Oryctocephalites* Resser, 1939
			Tonkinella Mansuy, 1916
		Zacanthoididae Swinnerton, 1915	*Zacanthoides* Walcott, 1888
		Illaenidae Hawle & Corda, 1847	
		Leiostegiidae Bradley, 1925	
	Phacopida Salter, 1864	Encrinuridae Angelin, 1854	
	Aulacopleurida Adrain, 2011	Alokistocaridae Resser, 1939	*Ehmaniella* Resser, 1937
			Elrathia Walcott, 1924
			Elrathiella domensa Sundberg, 1994
			Elrathiella Poulsen, 1927
			Proehmaniella Sundb**erg** 1994
		Marjumiidae Kobayashi, 1935	*Marjumia* Walcott, 1916
		Telephinidae Marek, 1952	
	Asaphida Salter, 1864 emend. Fortey & Chatterton, 198	Raphiophoridae Angelin, 1854	*Mendolaspis salagastensis* Rusconi 1951
		Trinucleidae Hawle & Corda, 1847	
	Olenida Adrain, 2011	Asaphiscidae Raymond 1924	*Blountia* Walcott 1916
		Cedariidae Raymond, 1937	*Cedaria* Walcott 1924
	Uncertain	Ptychopariidae Matthew, 188742	*Amecephalus arrojosensis* (Lochman in Cooper et al., 1952)
			Eokochaspis nodosa Sundberg & McCollum, 2000
			Hadrocephalites Sundberg & McCollum, 2002
			Kochaspis coosensis Resser 1938
			Kochiella maxeyi Rasetti, 1951
			Kochiella Poulsen, 1927
			Mexicella mexicana Lochman, 1948
			Ptychobaba buttsi (Resser, 1938)
			Blainia gregaria (Walcott, 1916)

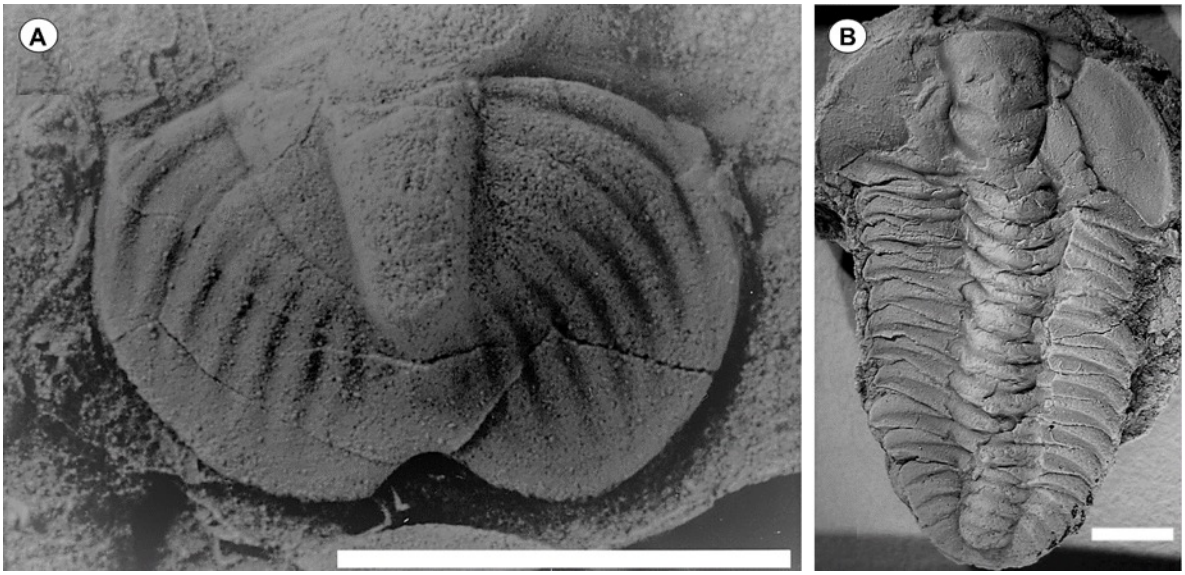

Figure 5. A, *Blainia gregaria* (Walcott, 1916), pygidium (modified from Bordonaro et al., 2013). Scale bar = 5 mm. B, *Bathyuriscus mendozanus* (Rusconi, 1945), complete carapace (modified from Bordonaro & Fojo, 2011). Scale bar = 2.5 mm.

A new classification scheme for the Class Trilobita Walch, 1771 was proposed by Adrain (2011) who modified from that of Fortey (1997). Among the discrepancies in the taxonomy can be mentioned the exclusion of agnostoids from the Class Trilobita; the incorporation of two new orders, Aulacopleurida and Olenida; and the inclusion in a group of the taxa belonging to an uncertain order of many families previously assigned to the polyphyletic Order Ptychopariida. Table 2 shows the taxonomy of the 1763 arthropods collected according to this scheme. Raphiophoridae and Trinucleidae have been regarded as members of a new order, Trinucleida, by Bignon et al. (2020). This scheme was not considered in this dataset.

Taxon specialists: Osvaldo Bordonaro, Brian Pratt, Aldo Banchig, and Carlos Fojo

Quality control for taxonomic data: The record comes from the paleontological field works, planned from a bibliographic review and an exhaustive geological knowledge of the area. The specimens collected were cleaned through percussion and vibration methods, and later bleached with magnesium oxide. They were examined using an Olympus SZ61 binocular microscope.

Additional information: The specimens are referred in published bibliography (Beresi et al., 2017; Bordonaro, 2014a & b; Bordonaro & Banchig, 2007; Bordonaro & Fojo, 2011; Bordonaro et al., 2008, 2013; Pratt & Bordonaro, 2014).

Study extent description: The dataset has greatly contributed to the knowledge of the Precordilleran Cambrian trilobite taxonomy that, in turn, has supported the proposal of a paleobiogeographic relationship between the microcontinent Cuyania and Laurentia during the Cambrian.

Concerning taxonomy, the Laurentian species *Athabaskia anax* (Walcott, 1916), from San Isidro Olistolith in Empozada Formation (Mendoza Province), led to the revision of the holotypes of *Clavaspidella digesta* Leanza, 1947, *Mendospidella asperoensis* Rusconi, 1952a, *Mendospidella quebradensis* Rusconi, 1952a, and *Mendospidella digesta* (Leanza) Poulsen, 1958, which were proposed as synonymous names of *Athabaskia anax* (Bordonaro, 2014a). In turn, *Plesioparabolina mendozana* Rusconi, 1945, from the outer

platform, was reassigned to the species *Bathyuriscus mendozanus* (Bordonaro & Fojo, 2011). Likewise, *Glyphaspis* Poulsen, 1927 was synonymized with *Blainia* Walcott, 1916, and their 30 species with *Blainia gregaria* (Bordonaro et al., 2013).

The Andean Precordillera (a terrane integrated in Cuyania) is one of the geological provinces of western Argentina, recognized and described since the end of the 19th century (Burmeister, 1876; Stelzner, 1876; Bondenbender, 1902; Ramos, 1999). It was interpreted through different geotectonic models of the paleogeographic evolution of the South American continent during Neoproterozoic-Eopaleozoic. The Precordillera was understood as both an autochthonous or parautochthonous terrane to Gondwana and as an allochthonous terrane from a Late Proterozoic - Early Cambrian rifting event in the southern Laurentia (Aceñolaza & Toselli, 1988; Benedetto, 1993; Yrigoyen, 1999).

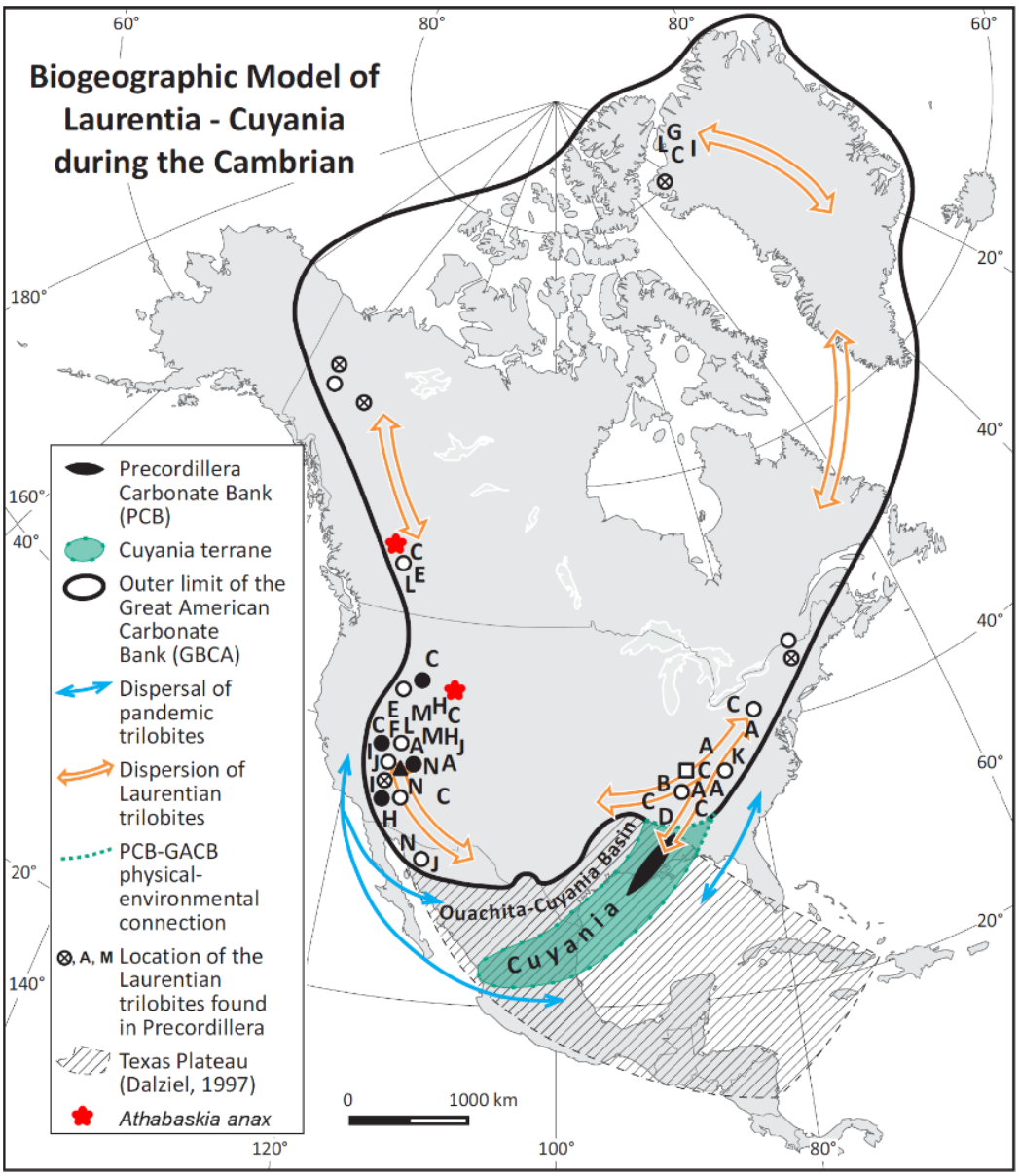

Figure 6. Biogeographic model of Laurentia – Cuyania during the Cambrian (modified from Bordonaro, 2016).

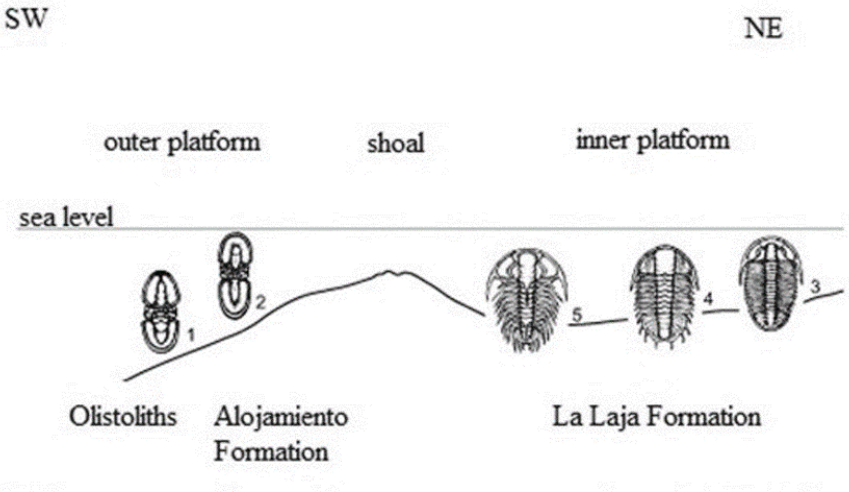

Figure 7. Environmental distribution of trilobites (including agnostoids) included in this dataset across the Precordillera inner and outer platform. 1 and 2, *Bathyuriscus mendozanus*, *Ptychagnostus intermedius*, *Elrathiella domensa*, *Athabaskia anax*, *Peronopsis bonnerensis*, *Pagetia walcotti*; 3, 4 and 5, *Blainia gregaria*, *Eokochaspis nodosa*, *Ptychobaba buttsi*, *Amecephalus arrojosensis*, *Kochiella maxeyi*, *Mexicella mexicana*, *Kochaspis coosensis* (modified from Bordonaro et al. 2008).

During the Cambrian, Laurentia was characterized by endemic species of trilobite fauna that could not cross the Great American Carbonate Bank and disperse into deep seas. However, *Blainia gregaria* Walcott, 1916, an endemic Laurentian species that inhabited the internal carbonate platform, was recognized in the Precordillera of western Argentina (Bordonaro et al., 2013).

The main limitation of both autochthonous - parautochthonous and allochthonous models was the impossibility of internal platform trilobites being able to disperse. According to this, Bordonaro (2016, 2017) revised the different models and proposed a new model that complements other hypotheses, claiming that Precordillera was attached to Laurentia, but while the rifting event started in the southwest, the northeast was still fixed and could therefore share the same inner platform. During the Cambrian, Precordillera and Laurentia would have maintained an environmental connection of their carbonate shelf. This connection occurred through northeast coast of Ouachita Bay and allowed the dispersion of trilobite endemic fauna. The trilobites from La Laja Formation points out a marked endemism associated to its isolation. Although this fauna was distributed around different platforms in North America, it was always within the limits of the carbonate barrier. The Precordillera stratigraphic units would point to a connection between Precordillera and Laurentia. Figure 6 shows the biogeographic model of Laurentia – Cuyania during the Cambrian.

This dataset compiles seven of the 14 endemics species of polymeroid ptychoparioid trilobites recognized in La Laja Formation: *Blainia gregaria* (Walcott, 1916); *Kochaspis coosensis* Resser 1938; *Mexicella mexicana* Lochman, 1948; *Ptychobaba buttsi* (Resser, 1938); *Kochiella maxeyi* Rasetti, 1951; *Eokochaspis nodosa* Sundberg & McCollum, 2000 and *Amecephalus arrojosensis* (Lochman in Cooper et al., 1952) (Bordonaro et al. 2013; Pratt & Bordonaro, 2014). This fauna, which is typically Laurentian, has never been registered

in other continents. Figure 7 shows an environmental distribution of trilobites (including agnostoids) included in this data set.

ACKNOWLEDGMENTS

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