SOME MIDDLE CAMBRIAN AGNOSTOIDS FROM THE PRECORDILLERA ARGENTINA

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ABSTRACT

Agnostoid trilobites are described from Middle Cambrian sediments in the Precordillera of Mendoza and San Juan provinces. The following taxa occur at Solitario Hill, Mendoza: Clavagnostus canotensis, Tomagnostella exsculpta, Agnostus exsulatus, Agnostus? sp., Oedorhachis australis, Ptychagnostus aculeatus and Amagnostus sp. Taxa from the Ojos de Agua locality in San Juan comprise: Kormagnostus seclusus, Peronopsis tenuis and Battagnostus? sp. There are the first agnostoids recorded from the San Juan area. Ptychagnostus aculeatus from Mendoza is here recorded for the first time in Argentina. A late Middle Cambrian age is assigned to the strata containing the assemblages of both Mendoza and San Juan.

Keywords: Trilobita, Agnostoids, Middle Cambrian, Precordillera, Argentina.

INTRODUCTION

The Precordillera Argentina is an elongate geological province extending about 500 km north-south, located between the Andes belt to the west and the tectonic blocks of the Central Argentine Craton to the east. Three well-defined longitudinal belts: Eastern, Central and Western are contained within Precordillera. The three of them are distributed in the provinces of La Rioja, San Juan and Mendoza (Fig. 1). The Precordillera Cambrian is unique in South America with an abundant trilobite facies and a relatively complete sequence.

The Cambrian outcrops are distributed into two palaeogeographic areas: a carbonate platform to the east and continental slope to the west (Figs. 1-2). The Cambrian trilobites are also linked to this biogeographical distribution with endemic species restricted to the carbonate platform, whereas cosmopolitan species are found in the mixed talus facies that interfinger with open platform facies.

PREVIOUS WORK

Middle Cambrian agnostoid trilobites from the Precordillera of Mendoza were first studied by Rusconi (1950a, 1950b, 1951 & 1952) but the taxonomic assignments are generally wrong in need of further review (Harrington et al., 1959). Poulsen (1960) studied the agnostoids from Solitario Hill of Mendoza creating new species, but many of these were revised and reassigned by Robison (1988). Cuerda et al. (1986a) as well as Bordonaro & Banchig (1990) cited the discovery of Middle Cambrian agnostoids in different sections in the Tontal Range. Also, Benedetto et al. (1986) found Middle Cambrian agnostoids in Río Jáchal (Northern of San Juan) that have been studied by Vaccari & Bordonaro (in press). They describe Ptychagnostus praecurrens of middle Middle Cambrian age, from an allochthonous block.

The objective of this paper is to assess the agnostoid systematics of Rusconi and Poulsen, mainly based on new material from both Solitario hill in Mendoza and San Juan.

STRATIGRAPHY

The Cambrian stratigraphy of the Precordillera is only broadly known, and mainly in the carbonate platform facies, where a continuous sequence was established between the late Lower Cambrian to early Ordovician (Baldis & Bordonaro 1985). The stratigraphy of the slope sequences is, however, poorly known due to chaotic sedimentation, abrupt facies changes and isolated fossil localities. The stratigraphical knowledge is synthesized in Fig. 2. More detailed information can be obtained in Bordonaro (1992).

The fauna here described was found both in the open platform carbonate facies of the Solitario Forma-
Figure 1. Geographical and geological setting of Cambrian outcrops of Precordillera Argentina. OA and CS, studied localities.
Figure 2. Cambrian stratigraphy of the Precordillera Argentina. In slope facies, the interrupted beds containing the names of the representative trilobite genera indicate allochthonous blocks within the Los Sombreros Formation. *Stratigraphical occurrence of studied fossils.
tion (Mendoza) and in the terrigenous-carbonate talus facies of the Los Sombreros Formation (San Juan).

The Solitario Formation is an isolated unit outcropping on a small hill from the Canota region located to the north of Mendoza. It contains thinly bedded black limestones and calcilimolites in a section about 20 m thick. A Late Middle Cambrian age was first assigned by Poulsen (1960) based on agnostoid and polimorphic trilobites. The new record of the agnostoids studied here confirms this age.

The Los Sombreros Formation is a thick sequence of almost one thousand meters outcropping on the eastern flank of the Tortal Range in the western Precordillera of San Juan. It contains a typical talus association of shale and thinly bedded limestone with olistoliths, olistostromes, calcareous breccias and channel fill conglomerates. The sedimentation of this unit took place during the Ordovician, since the calcareous olistoliths with Middle and Upper Cambrian trilobites are included within dark green shales with Early and Middle Ordovician graptolites (Cuerda et al., 1983, 1986b).

SYSTEMATIC PALAEONTOLOGY

All material used in this study is identified as Bordonaro collection and its depositary is in Paleontología Invertebrados, Universidad Nacional de San Juan (PIUNSJ), Argentina.

Descriptive terminology follows Harrington et al. (1959) and additional terms defined by Robison (1964, 1982) and Öpik (1967).

Order AGNOSTISTA Salter, 1864
Family Agnostidae M'Coy, 1849
Genus Agnostos Brongniart, 1822

Type species: Entomocrautatus pisiformis Wahlenberg, 1818.

Agnostos exsulatus Poulsen, 1960
Pl. I, Figs. 1-5

1960 Agnostos exsulatus Poulsen, 6, Pl. 1, Figs. 3-4.
1988 Agnostos exsulatus Poulsen; Robison, 32, Pl. 7, Figs. 4-11.
1982 Agnostos exsulatus Poulsen; Pratt, 26.

Material: A complete specimen, two cephalon and four pygidia as external and internal casts (PIUNSJ 608-614).

Remarks: The new material possesses all the characters of Poulsen's species. The complete specimen has two thoracic segments poorly preserved. In the Argentine material of the species, the glabellar and pygidial furrows are deeper than in the specimens described by Robison (1988) from North Greenland.

Occurrence and age: Level 3, Solitario Formation, Canota, Mendoza. It is also found in North Greenland, where it is restricted to the upper Lejopyge laevigata Zone. Late Middle Cambrian age, Lejopyge laevigata Zone.

Agnostus? sp.
Pl. I, Figs. 6-7

Material: Internal and external casts of a cephalon (PIUNSJ 615-616).

Remarks: Cephalon semicircular, highly convex. Glabella wide, slightly convergent forward, deep lateral glabellar furrows and bulky glabellar lobes; the second glabellar furrow (F2) is curved forward, bordering a median node; trapezoidal basal lobes. Wide and deep preglabellar median furrow, effaced near the border furrow; border furrow wide and deep; cephalic border narrow. This specimen is certainly an Agnostus-like cephalon resembling Agnostos exsulatus, but wider.

Occurrence and age: Level 3, Solitario Formation, Canota, Mendoza. Late Middle Cambrian, Lejopyge laevigata Zone.

Family Clavagniostidae Howell, 1937
Genus Clavagniostus Howell, 1937

Type species: Agnostos repandus Westergård, in Holm & Westergård, 1930.

Remarks: Poulsen (1960) erected the genus Stigmagnostus with the only poorly preserved specimen known of Stigmagnostus canotensis Rusconi, 1951. Öpik (1967) considered that this specimen is not a pygidium but that it is a cephalon of a clavagnioid, certainly of generic characters. Finally, Shergold et al. (1990) revised Stigmagnostus and placed it in Clavagniostus, with which we agree.

Clavagniostus canotensis (Rusconi, 1951)
Pl. I, Figs. 8-14

1951 Stigmagnostus canotensis Rusconi, 14, Pl. 26, Fig. 29.
1952 Clavagniostus chiquiinquis Rusconi, 11.
1952 Clavagniostus chiquiinquis Rusconi, 11, Pl. 1, Fig. 11.
1950 Stigmagnostus canotensis (Rusconi); Poulsen, 15, Pl. 1, Fig. 12.
1960 Clavagniostus chiquiinquis (Rusconi); Poulsen, 9, Pl. 1, Fig. 14.
1974 Clavagniostus? rawlingi Jago & Daily, 104, Pl. 12, Figs. 11-12.

Plate 1

1-5 Agnostos exsulatus Poulsen. 1. Internal mold of cephalon. PIUNSJ 608, × 8.4. 2. Internal mold of pygidium. PIUNSJ 610, × 7.3. 3. Internal mold of complete dorsal exoskeleton. PIUNSJ 614, × 9.6. 4. External latex cast of pygidium. PIUNSJ 611, × 8.3. 5. Internal mold of pygidium. PIUNSJ 612, × 9.


19 Ammagnostus sp. Exoskeleton of small cephalon. PIUNSJ 629, × 14.4.
Material: Five cephalon and two pygidia preserved as calcite exoskeletons (PIUNSJ 617-623).

Description: Cephalon subrectangular and convex, anterior margin arched not pointed, anterior border narrow and convex, border furrow narrow; pitted genae with some radiating scrobicules touching the axial furrow. Preglabellar median furrow well defined near the anteroglabella, faint forward and effaced before touching the border furrow. Posteroanteroglabella cylindrical, anteroglabella tapered, simple basal lobes but transversely elongate; posterior lobes faint, median node slightly forward of the mid-point of glabella. Posterior border wide and straight with long posteronlatral spines.

Pygidium quadrangular, axial furrows deep, axis ogival, reaching the posterior furrow with bluntly tapered rear; three well defined axial lobes with median tubercle in the median lobe; posteroaxial ogival, depressed, with two intranotaltur furrows bordering an intranotular ridge. Pleural field faintly convex, pitted and scrobiculate; marginal furrow narrow and shallow, curved forward in the axial area, touching the posteroaxial. Marginal border simple and narrow, maximum width at the axial area with two small posteronlateral spines.

Size: The largest cephalon is 2.5 mm (sag.) long and 2.4 mm (tr.) wide. The largest pygidium is 2.5 mm (sag.) long and 3 mm (tr.) wide. The smallest pygidium is 0.7 mm (sag.) long and 1 mm (tr.) wide.

Otentogey: The pit and scrobicules are present even in the juvenile specimen. All the immature pygidia have a more rectangular shape than the adult ones. A juvenile specimen represented in Pl. I, Fig. 13 has a double preglabellar median furrow on the internal mould.

Discussion: Clavignostus canotensis resembles to Aspidagnostus stictus Opik, 1967 by its similar ornamentation, but differs in its generic characters. According to the new material studied here, Clavignostus sp. rawlingi is considered as a junior synonym of C. canotensis.

Occurrence and age: Levels 1 to 3 of Sollutario Formation, Canuta, Mendoza. Late Middle Cambrian, Lejopyge laevigata Zone.

Family Diplagnostidae Whitehouse, 1936
Genus Baltagnostus Lochman, 1944

Type species: Proagnostus? centerensis, Ressere, 1938.

Baltagnostus? sp.
Pl. I, Fig. 15

Material: Internal and external cast of one pygidium (PIUNSJ 624-625).

Description: Pygidium subquadrangular, convex and smooth, wider than long, acrolobe unconsoltr. Border possessing a pair of short and broad posterolateral spines; border furrow shallow and wide; axis wide and extended to the border furrow, rounded posteriorly, slightly constricted in the middle and with effaced segmentation. Median node large and placed in the anterior half of the axis, with a small secondary node on the tip of the axis.

Remarks: The only pygidium found is provisionally assigned to Baltagnostus due to the expansion of the marginal border between the spines. Our pygidium resembles B. euryphry Robison, 1964 in its general outline, the posterior border and the spines, but differs in the position of median node that is placed at the mid-point of the axis in the Northern American species, Anagnostus? centerensis (Lochman in Lochman & Duncan, 1944) is similar to Baltagnostus? with regard to the pyriform shape of the axis and the position of the median and terminal nodes, but the Northern American specimens have a subcircular outline and the border is uniform in width.

Occurrence and age: Level 1a of Los Sombretos Formation, Ojos de Agua gulle, San Juan. It is placed within the Lejopyge laevigata Zone, late Middle Cambrian.

Genus Oedorachis Ressere, 1938

Type species: Oedorachis typicalis Ressere, 1938.

Oedorachis australis Poulsen, 1960
Pl. I, Figs. 16-18

1960 Oedorachis australis Poulsen, 13, Pl. I, Fig. 8.

Material: One cephalon and two pygidia preserved as calcite exoskeletons (PIUNSJ 626-628).

Description: Cephalon subquadrangular, non-scrobiculate, moderately convex; border rounded and narrow; border furrow wide (delicate) and shallow. Glabella bilobate, slightly expanded forward, anteroglabella semicircular and wider than posteroanteroglabella, transglabellar furrow straight and well defined, median node small in the middle posteroanteroglabella; glabella reared; basal lobes simple and large. Pygidium semicircular, zonate border (collar) between the posterolateral spines, border furrow deliqueut and shallow, axial furrows faint, axis long and wide touching the posterior border furrow, slightly ogival; posteroaxial expanded, subsequently ending in a rounded point; axial node long occupying the anterior third.

Size: Cephalon 3.5 mm (sag.) long and 3.5 mm (tr.) wide. Pygidium 3.2 mm (sag.) long and 3.6 mm (tr.) wide.

Discussion: Poulsen (1960) created this species with only one pygidium that seems to be very closely related to Oedorachis typicalis Ressere, 1938; however O. australis differs by its less abruptly expanding posteroanteroglabella and its less expanded posterior border that is divided by a longer transverse depression extending between the posterolateral spines. Nevertheless Robison (1988) did not consider these differences to be sufficient for a new species and therefore synonymized the two species.

The new material examined allowed a careful comparison between the cephalon and pygidium, and the following diffe-
rences are apparent: the cephalon of *O. typicalis* has a median pointed anterior margin, a more forwardly expanded glabella, a wider anteroglabella and a scrobiculate genae, characters that are not present in *O. australis*; the pygidium of *O. typicalis* has a posterior border more expanded in axial line and an increasing axial gap between the collar and the posterior border. *O. australis* has a gap and uniform posterior border. Also the posteroglabella is more expanded and round in *O. typicalis*.

Therefore we consider *O. australis* a valid species as it is here revised.

**Occurrence and age**: Level 1, Solitario Formation, Canota, Mendoza. Late Middle Cambrian age. It is presently restricted to *Lejopyge laevigata* Zone.

**Family Peronopsidae** Westergárd, 1946  
Genus *Ammagnostus* Ōpik, 1967  
**Type species**: *Ammagnostus psammnitus* Ōpik, 1967.  
*Ammagnostus* sp.  
Pl. I, Fig. 19

**Material**: Only one cephalon, preserved as a calcitic exoskeleton (PIUNSJ 629).

**Remarks**: This single cephalon is similar those identified by Poulsen (1960) in Solitario Hill as *Baltagnostus hospitius* and *Baltagnostus mendozae* which were attributed by Robison (1988) to *Ammagnostus bellensis*, a species also recorded in the upper Middle Cambrian from North Greenland (cf. Robison, op. cit.). But due to the presence in our cephalon of a bulky glabella, the more cautious approach is to leave it under open nomenclature.

**Occurrence and age**: Level 1 of the Solitario Formation, Canota, Mendoza, *Lejopyge laevigata* Zone.

**Genus Kormagnostus** Resser, 1938  
**Type species**: *Kormagnostus simplex* Resser, 1938.  
*Kormagnostus seclusus* (Walcott, 1884)  
Pl. II, Figs. 1-3  
1988 *Kormagnostus seclusus* (Walcott); Robison, 45, Pl. I, Figs. 5-15 (with previous synonymy).

**Material**: One cephalon and two pygidia preserved as calcite exoskeletons (PIUNSJ 630-632).

**Remarks**: As was noted by Robison (1988), *K. seclusus* populations, exhibit exceptional variation in outline and convexity of the pygidal axis and morphological changes also occurred during ontogeny. In our large specimens the axis is well expanded and voluminous rearward, the posterior axial furrow is effaced, the pygidal border is wide and slightly convex; while in specimens of intermediate size the pygidal axis has parallel sides and is less tumid; the pygidal border is wider and flatter.

**Occurrence and age**: Levels 1a and 1b of Los Sombreros Formation, Ojos de Agua guleh, San Juan. Our specimens were found in the *Lejopyge laevigata* Zone.

**Genus Peronopsis** Hawle & Corda, 1847  
**Type species**: *Batrus integer* Beyrich, 1845.  
*Peronopsis tenuis* (Illing, 1916)  
Pl. II, Figs. 4-6  
1988 *Peronopsis tenuis* (Illing); Robison, 47, Pl. 10, Figs. 7, 8, 10-12 (with previous synonymy).

**Material**: One cephalon and three pygidia preserved as calcite exoskeletons (PIUNSJ 633-636).

**Remarks**: The posteroaxial is sharply pointed and the back is depressed with a pronounced down sloping profile; the median node is located a little forward to the middle of the axis and a secondary median node is present near the tip of the posteroaxial. In the Argentine material, the anterior glabellar furrow is straighter and deeper than in the Greenland specimens.

**Occurrence and age**: Level 1a of the Los Sombreros Formation, Ojos de Agua guleh, San Juan. The material found belongs to the *Lejopyge laevigata* Zone.

**Family Ptychagnostidae** Kobayashi, 1939  
Genus *Ptychagnostus* Jaekel, 1909  
**Type species**: *Agnostus punicous* Angelin, 1851.  
*Ptychagnostus aculeatus* (Angelín, 1851)  
Pl. II, Figs. 7-9

1984 *Ptychagnostus aculeatus* (Angelín); Robison, 14, Pl. 8 (with previous synonymy).

**Material**: Three pygidia preserved as internal and external casts (PIUNSJ 637-639).

**Remarks**: The pygidium is covered with prominent granules of uneven size that are widespread both on pleural field and on the axis. The exoskeleton is mostly flattened and deformed. This typical morphology is characteristic of *P. aculeatus* and this is the first reference in Argentina.

**Occurrence and age**: Level 1, Solitario Formation. Canota, Mendoza. *Lejopyge laevigata* Zone.

**Genus Tomagnostella** Kobayashi, 1939  
**Type species**: *Agnostus excelsus* Angelin, 1851.  
*Tomagnostella excelsa* (Angelín, 1851)  
Pl. II, Figs. 10-18

1988 *Tomagnostella excelsa* (Angelín); Robison, 51, Pl. 12, Figs. 8-12 (with previous synonymy).

**Material**: Twenty nine cephalon and eleven pygidia preserved as internal and external casts (PIUNSJ 640-650).

**Remarks**: The cephalic and pygidal characters of the Argentine material agree well with the species *T. excelsa* as was described by Robison (1988). The only observed difference is the steepness of the marginal cephalic border attributed here to a degree of crushing. Some of our specimens have the anterior transglabellar furrow deeper and straighter, although in other specimens the furrow is effaced and curved, similar to the specimen from Greenland. The specimens of *T. excelsa* have the anterior axial furrow less effaced, with an obsolete anterior lobe.

**Occurrence and age**: Levels 1 to 3 of Solitario Formation, Canota, Mendoza. In Argentina it occurs in the *Lejopyge laevigata* Zone, upper Middle Cambrian.

**AGE OF THE FAUNA**

The trilobites from San Juan are found within an olistostome of the Los Sombreros Formation where we have distinguished two fossiliferous levels (Fig. 3).

The agnostid horizon 1a contains an assemblage of *P. tenuis*, *K. seclusus* and *Baltagnostus*? sp. The first mentioned species has a stratigraphic range from the
Psychagnostus gibbus Zone (mid Middle Cambrian) to the Lejyopge laevigata Zone (upper Middle Cambrian), while K. seclusus has an observed stratigraphic range (Robison, 1988) from at least the lower Lejyopge laevigata Zone to the Glyptagnostus solididus Zone (Late Cambrian). Therefore this assemblage belongs to the Lejyopge laevigata Zone. This may be corroborated by the presence of Baltagnostus?, a genus that is a useful index for the late Middle Cambrian (Robison, 1964). The level 1b only has K. seclusus. Its stratigraphical proximity to the last level suggests a similar upper Middle Cambrian age for it.

The studied fauna from Mendoza comes from three stratigraphic levels distributed within the Solitario Formation (Fig. 3).

Level 1 contains P. aculeatus, T. excelsa, Ammagnostus sp., C. canotensis and O. australis. The first mentioned species is reported from the upper two-thirds of the L. laevigata Zone; however, most occurrences seem to be correlated with the upper half of the lower subzone (Robison, 1984). Therefore a L. laevigata Zone is also proposed for this assemblage. The stratigraphical range of T. excelsa (Psychagnostus punctuosus-Lejyopge laevigata zones) and Ammagnostus (L. laevigata-Glyptagnostus solididus zones) are not inconsistent with this proposed age. Consequently, the local species O. australis, only recorded in this level, may be from the L. laevigata Zone.

Level 3 contains A. exsulatus, C. canotensis, T. excelsa and Agnostus? sp. The first agnostoid species is known only from the upper L. laevigata Subzone in North Greenland but additional findings are probably necessary before A. exsulatus can be used as a biostratigraphical index. However, the presence of T. excelsa suggests a L. laevigata Zone. Therefore, the local species S. canotensis, present in the three levels, may be a representative agnostoid of the L. laevigata Zone from Argentina.

Although the material from both the localities belong to the same zone, it is impossible to achieve a more detailed correlation due to the absence of common taxa, as well as to the provenance from allochthonous blocks of the San Juan agnostoids.

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