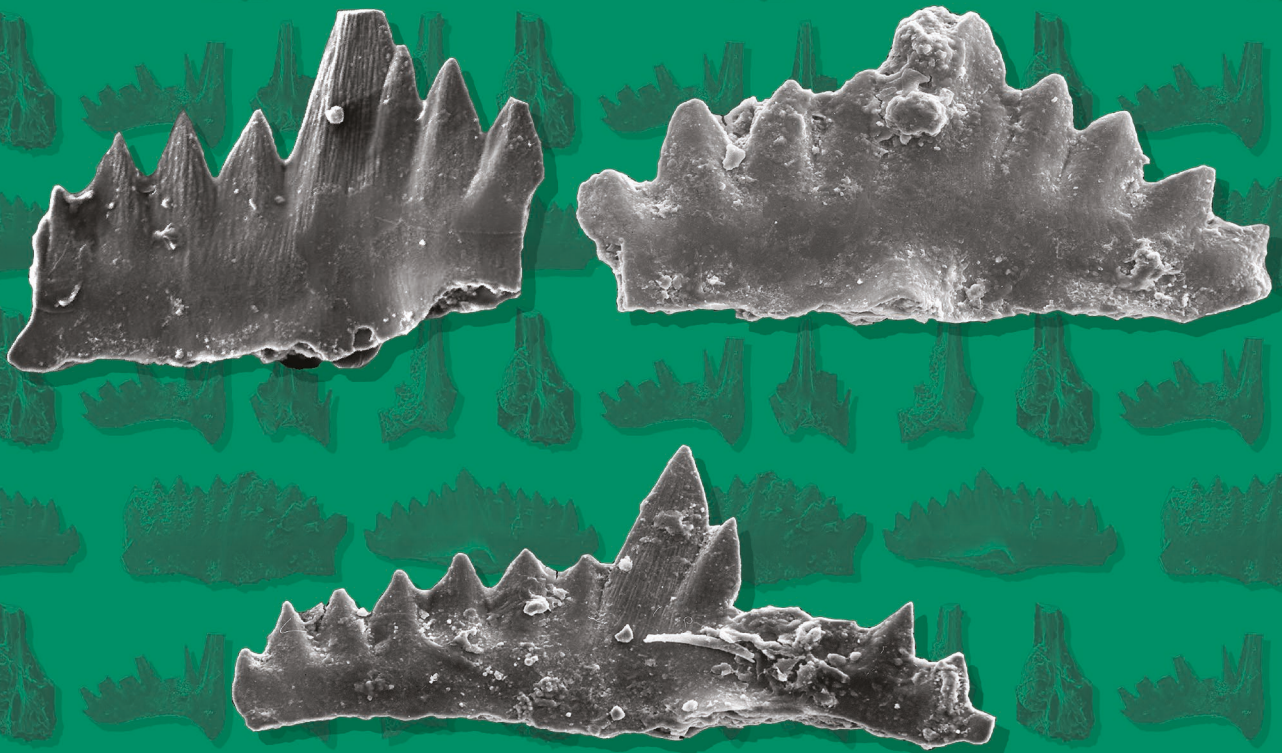


Condorodus n. gen., a new Ordovician conodont
genus from Argentina: origin, evolution
and dispersal through the western
margin of Gondwana

Josefina M. T. CARLOROSI, Ana I. MESTRE & Susana E. HEREDIA



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ISSN (imprimé / print) : 1631-0683/ ISSN (électronique / electronic) : 1777-571X

Condorodus n. gen., a new Ordovician conodont genus from Argentina: origin, evolution and dispersal through the western margin of Gondwana

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Submitted on 8 October 2020 | Accepted on 15 June 2021 | Published on 5 October 2022

urn:lsid:zoobank.org:pub:ED52ADBA-7A12-44E7-8887-1AE949BAD8F9

Carlorosi J. M. T., Mestre A. I. & Heredia S. E. 2022. — *Condorodus* n. gen., a new Ordovician conodont genus from Argentina: origin, evolution and dispersal through the western margin of Gondwana. *Comptes Rendus Palevol* 21 (34): 747-769. <https://doi.org/10.5852/cr-palevol2022v21a34>

ABSTRACT

Ordovician conodont collections from several Argentinian basins including the Eastern Cordillera, Famatina and Precordillera allow recognition of a group of conodonts that comprise a new genus here named *Condorodus* n. gen. Species of this genus have an apparatus composed of six elements recovered so far: Pa, Pb, Sb1, Sb2, Sc and Sd. The differences mainly between the P elements support recognizing three species, from the older to younger: *C. diablensis* n. gen., n. sp., *C. graciellae* n. gen., n. sp. and *C. chilcaensis* n. gen., n. sp., that appeared in the upper Floian (Lower Ordovician) and vanished in middle Darriwilian time (Middle Ordovician). The Eastern Cordillera is here assumed as the place of origin of the *Condorodus* n. gen. lineage during the late Floian, and then this genus dispersed through the western margin of Gondwana, reaching the Precordillera in the early Darriwilian, from there it could have dispersed to different regions of Gondwana, Perigondwana and Laurentia during the late Darriwilian, and probably give rise to conodont apparatuses of similar morphology in the Late Ordovician.

KEY WORDS

Condorodus,
conodonts,
Ordovician,
Argentina,
new genus,
new species.

RÉSUMÉ

Condorodus n. gen., nouveau genre de conodonte de l'Ordovicien d'Argentine : origine, évolution et dispersion à travers la marge ouest du Gondwana.

Les collections de conodontes de l'Ordovicien de plusieurs bassins argentins, dont la Cordillère Orientale, la Famatina et la Precordillera, permettent de reconnaître un groupe de conodontes qui déterminent un nouveau genre, ici appelé *Condorodus n. gen.* Ce genre possède un appareil composé de six éléments récupérés à ce jour : Pa, Pb, Sb1, Sb2, Sc et Sd. Les différences principales entre les éléments P soutiennent la reconnaissance de trois espèces, de la plus ancienne à la plus jeune : *C. diablensis n. gen., n. sp.*, *C. graciellae n. gen., n. sp.* et *C. chilcaensis n. gen., n. sp.*, qui sont apparues dans le Floian supérieur (Ordovicien inférieur) et ont disparu au temps Darriwilien moyen (Ordovicien moyen). La Cordillère Orientale est ici supposée comme le lieu d'origine de la lignée *Condorodus n. gen.* à la fin du Floian, puis ce genre s'est dispersé à travers la marge ouest du Gondwana, atteignant le Precordillera au début du Darriwilien, de là, il aurait pu se disperser dans différentes régions du Gondwana, Perigondwana et Laurentia à la fin du Darriwilien, et donne probablement naissance à des appareils conodontes de morphologie similaire dans l'Ordovicien supérieur.

MOTS CLÉS

Condorodus,
conodontes,
Ordovicien,
Argentine,
genre nouveau,
espèces nouvelles.

INTRODUCTION

Darriwilian strata from the Precordillera provided conodonts that were assigned, in open nomenclature, to *Bryantodina* aff. *B. typicalis* Stauffer, 1935. These forms were briefly described and illustrated for the first time by Lehnert (1995); after that conodont researchers illustrated elements as *B. aff. B. typicalis* for similar conodonts recovered from the Darriwilian Precordilleran carbonates (Ortega *et al.* 2007; Heredia 2012; Mestre 2012). Later, similar conodonts to those assigned to *B. aff. B. typicalis* were recovered from the Suri Formation (Famatinian Range), which were classified as *Jumudontus gananda* Cooper, 1981 by Albanesi & Vaccari (1994).

Only isolated elements were illustrated since the Lehnert (1995) contribution and the apparatus of this conodont taxon remained unknown. The first differentiation of the Pa and Pb elements was proposed by Mestre (2012) for elements retrieved from the *Lenodus pseudoplanus* Conodont Zone at the top of the San Juan Formation (Cerro La Chilca section). Carlorosi (2012) compared conodont elements recovered from Floian and Dapingian strata from the Acoite and Alto del Cóndor formations (Eastern Cordillera) to those elements of “*Bryantodina*” from the Precordillera, noting strong similarities between them.

After several years our conodont collections from the Eastern Cordillera, Famatina and the Precordillera have increased, and include many specimens that we have interpreted as representative of species of a new genus. This study evaluates the taxonomy of the proposed conodont apparatus, and discusses their origin and the possible lineages associated, environment preferences, and the geographical dispersal of this genus from the western margin of Gondwana.

ABBREVIATIONS

Institutional abbreviations

- CIGEOBIO Centro de Investigaciones de la Geósfera y Biósfera, San Juan;
- CML-C Colección Microvertebrados Lillo- Conodontes, Instituto Superior de Correlación Geológica, Yerba Buena, Tucumán;

CONICET

Consejo Nacional de Investigaciones Científicas y Técnicas, Ciudad Autónoma de Buenos Aires;

IIM

Instituto de Investigaciones Mineras, San Juan;

INGEO-MP

Instituto de Geología Emiliano Aparicio – Micropaleontología, Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de San Juan, San Juan;

UCM

Universidad Complutense de Madrid, Madrid;

UNT

Universidad Nacional de Tucumán, Tucumán.

Other abbreviations

- CAI color alteration index;
- SEM scanning electron microscope.

GEOLOGICAL SETTINGS

Lower Paleozoic outcrops in Argentina are well represented in the geological provinces of Eastern Cordillera, Famatinian Range and Precordillera (Fig. 1). The Eastern Cordillera province is characterized by siliciclastic deposits which formed part of a large marine basin, where it is possible to recognize sedimentary environments ranging from shallow to deep platform. This geological province is composed of the Peruvian Eastern Cordillera, Bolivian Eastern, and Central Cordilleras, extending to the south as far as the northern of the part of the Tucumán province in Argentina (Ramos 1999, 2008).

The Famatinian Range was defined by Petersen & Leanza (1953) and is represented in a set of ranges that extend from north to south in the La Rioja and Catamarca provinces (Fig. 1), and exhibit well-developed Ordovician volcanoclastic deposits (Aceñolaza & Toselli 1977; Mángano & Buatois 1997). The Eastern Cordillera and the Famatinian Range are considered part of Gondwana during the Ordovician. On the other hand, the Precordillera shows mainly carbonate, mixed carbonate and siliciclastic deposits during Ordovician times, characterizing different environments, from very shallow

platform to slope (Beresi & Bordonaro 1984; Heredia *et al.* 2017). The Precordillera succession was interpreted by several authors as allochthonous (Laurentian, Benedetto 1993; Astini *et al.* 1995; Thomas & Astini 1996) while other authors supposed it as an autochthonous terrane (Aceñolaza & Toselli 1988; Aceñolaza *et al.* 2002; Finney 2007).

The studied formations and sections from the Eastern Cordillera are the Alto del Cóndor Formation (Los Colorados region) and the Acoite Formation (Espinazo del Diablo section) cropping out in the Jujuy province; and the Santa Gertrudis Formation exposed in the Mojotoro range in the Salta province. The Suri Formation crops out in the Chaschuil region, Famatinian Range (Catamarca province). The Precordilleran studied units were the San Juan and Las Aguaditas formations from the Cerro La Chilca and Las Chacritas river sections (San Juan province) (Fig. 1).

Eastern Cordillera

Espinazo del Diablo section. The studied outcrops are on the western flank of the Espinazo del Diablo range (Fig. 2A), approximately 3 km from El Aguilar Mine. This formation is composed of green shale and dark greenish gray sandstone which develops few beds of dark gray sandstone with abundant carbonate cement. The succession is characterized by sandstone beds that are intensely burrowed on the top, while the base exhibits coquina of fragmented brachiopod shells. The conodont associations recovered from the section have provided biostratigraphic information, documenting the *Trapezognathus diprion* Conodont Zone and the *Baltoniodus* cf. *B. triangularis* Conodont Zone (Fig. 2A) (*sensu* Carlorosi *et al.* 2013). The ED1 sample include: *Baltoniodus* cf. *B. triangularis* (Lindström, 1955); *Condorodus diablensis* n. gen., n. sp., *Drepanodus arcuatus* Pander, 1856, *Drepanoistodus basiovalis* Sergeeva, 1963, *Drepanoistodus forceps* (Lindström, 1955), *Drepanoistodus pitjanti* Cooper, 1981, *Drepanoistodus* sp. A, *Gothodus costulatus* Lindström, 1955, *Oistodus* sp. and *Trapezognathus diprion* (Lindström, 1955).

Los Colorados region. The studied succession includes the Acoite and Alto del Cóndor formations. The uppermost part of the Acoite Formation is almost 300 m thick and is represented by a succession of coarsening-upward and thickening-upward strata that reflects a gradual shallowing-upward evolution from grey-greenish sandstone and green siltstone to thicker grey sandstone including coquinoïd levels with thin and few siltstone beds (Sandy Member of Astini & Waisfeld 1993). The Alto del Cóndor Formation is 120 m thick and is composed by pale yellow sandstone for the lower member, while the upper member comprises green siltstone and red sandstone beds (Fig. 2B).

The conodont association recovered from the Alto del Cóndor Formation includes *Baltoniodus triangularis* (Lindström, 1955), *Baltoniodus* cf. *B. triangularis*, *Condorodus diablensis* n. gen., n. sp., *Drepanodus* sp., *Drepanoistodus basiovalis*, *Drepanoistodus* sp., *Erraticodon patu* Cooper, 1981, *Gothodus costulatus*, *Oistodus* sp., *Trapezognathus diprion*, *T. quadrangulum* Lindström, 1955 and *Triangulodus* sp. The conodont

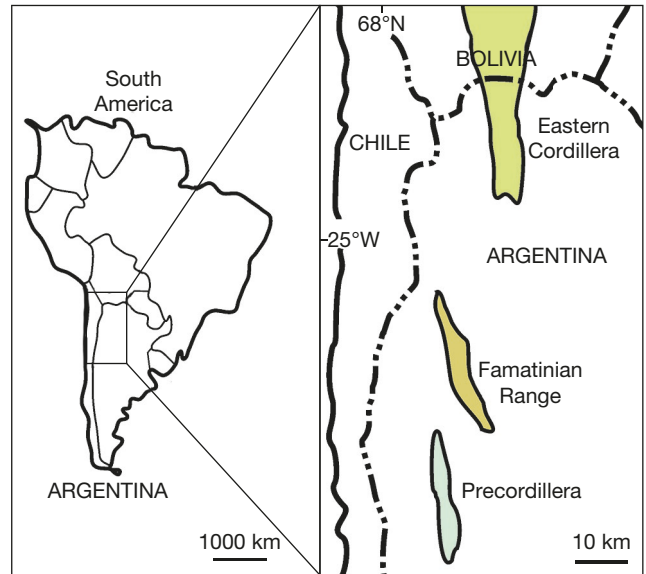


Fig. 1. — Regional location map showing the geological provinces studied in this contribution.

Baltoniodus triangularis records the eponymous zone in the earliest Dapingian (Middle Ordovician) (Carlorosi *et al.* 2013).

Mojotoro Range. The Santa Gertrudis Formation is one of the classical Ordovician units of the Eastern Cordillera; it was defined by Harrington (in Harrington & Leanza 1957), cropping out at the Gallinato and Santa Gertrudis creeks at 14 km northward from Salta City (Fig. 2C). Moya *et al.* (2003) described the Santa Gertrudis Formation as composed of fine-medium slightly micaceous wacke and dark-greenish grey silt, with ripple cross-lamination and weak stratification. On the other hand, Carlorosi *et al.* (2011) characterized this formation as intensively burrowed quartz wacke and grey siltstone strata alternating with fine lenses of limestone. The unit reaches 80 m thickness in the Gallinato Creek, where the Santa Gertrudis Formation is better exposed. It overlies the Lower Ordovician Mojotoro Formation and is covered in turn by modern deposits (Fig. 2C). The conodonts recovered from this unit are *Baltoniodus triangularis*, *B. cooperi* Carlorosi, Sarmiento & Heredia, 2018, *Condorodus graciellae* n. gen., n. sp., *Drepanoistodus* sp., *E. patu*, *Gothodus* sp., *Periodon* aff. *P. flabellum* Lindström, 1955 and *T. quadrangulum*; recording the lower Dapingian (Carlorosi *et al.* 2018).

Famatinian range

Chaschuil region. The Suri Formation was defined by Harrington (1957) in the Rio Cachiyuyo section, La Rioja province. Later, Turner (1967) extended this denomination to siliciclastic successions in the Chaschuil region, Catamarca province. In this area, the Suri Formation is divided in three members (Astini 2003) (Fig. 3). The conodonts recovered came from the middle member, named Loma del Kilómetro (sample LK9), composed of siltstone, calcareous shale and sandstone interbedded with volcanogenic gravitational flows caused by storm episodes. The lower Dapingian conodont

association includes *B. cooperi*, *B. triangularis*, *Condorodus graciellae* n. gen., n. sp. and *E. patu* (Carlorosi *et al.* 2018).

Precordillera

The Lower-Middle Ordovician carbonate succession of the Precordillera is developed along a length of 400 km N-S with a width of 150 km E-W. Several classical localities at the Central and Eastern Precordillera were well studied by several authors (synthesis in Benedetto *et al.* 2007). The Middle Ordovician succession of the San Juan Formation and Las Aguaditas/Los Azules Formation is characterized by carbonate and mixed carbonate/fine siliciclastic deposits (Cañas 1999; Keller 1999; Mestre 2010).

The Ordovician carbonate succession begins with the Lower to Middle Ordovician San Juan Formation, composed mainly of fossiliferous limestone and marly limestone. The San Juan Formation is conformably overlain by grey and black shale and thin- to medium-bedded marly limestone and black shale of the Los Azules or Las Aguaditas formations of Middle to Late Ordovician age (Heredia *et al.* 2011; Mestre & Heredia 2013a, b, 2019a, b; Mestre 2014).

Las Chacritas river section. The Ordovician carbonates exposed in the Las Chacritas river section are composed of grey to dark grey limestone, marls and mixed carbonate/siliciclastic sediments deposited in a ramp setting (Fig. 4A) (Peralta & Baldis 1995; Carrera 1997; Peralta *et al.* 1999a, b; Mestre 2010). The section begins with the Lower to Middle Ordovician San Juan Formation, composed mainly of fossiliferous limestone and marly limestone. Its base is concealed by faulting, but the exposed part is 340 m thick in this section (Keller 1999). The San Juan Formation is conformably overlain by the Las Aguaditas Formation, Middle to Late Ordovician in age, this unit is composed of 70 m of marly limestone, black shale, grainstone and carbonate breccia in its base (Fig. 4A).

The first appearance of *Condorodus chilcaensis* n. gen., n. sp. in this section occurs in the *Lenodus pseudoplanus* Conodont Zone and its last record is in the *Lenodus succicus* Conodont Zone, together with *Ansella jemtlandica* (Löfgren, 1978), *Baltoniodus medius* (Dzik, 1976), *Costiconus ethingtoni* (Fähræus, 1966), *D. basiovalis*, *Drepanodus robustus* (Hadding, 1913), *Dzikodus tablepointensis* (Stouge, 1983), *Erraticodon balticus* (Dzik, 1978), gen. et sp. indet. A, gen. et sp. indet. B., *Histiodela holodentata* Harris, 1962, *Histiodela kristinae* Stouge, 1984, *Kallidontus? galerus* (Albanesi, 1998), *Lenodus pseudoplanus* (Viira, 1972), *Lenodus succicus* (Bergström, 1971), *Parapaltodus simplicissimus* Stouge, 1984, *Paroistodus horridus* Barnes & Poplawski, 1973, *Periodon aculeatus* Hadding, 1913, *Periodon zgiezensis* (Dzik, 1976), *Periodon macrodentatus* (Graves & Ellison, 1941), *Protopanderodus gradatus* Serpagli, 1974, *Protopanderodus graei* (Hamar, 1966) (Heredia 2012; Mestre & Heredia 2013b).

Cerro La Chilca Section. The section begins with the Lower-Middle Ordovician San Juan Formation, which is overlain by the Los Azules Formation of Middle to Late Ordovician age

(Mestre 2010, 2012; Mestre & Heredia 2019a, b) (Fig. 4B). Both formations were sampled for conodonts. The following species were recovered from the upper part of the San Juan Formation: *A. jemtlandica*, *Condorodus chilcaensis* n. gen., n. sp., *Cornuodus longibasis* (Lindström, 1955), *D. arcuatus*, *D. basiovalis*, *Drepanoistodus costatus* (Abaimova, 1971), *Erraticodon cf. balticus* (Dzik, 1978), *Erraticodon hexianensis* An & Ding, 1985, *Fabraeusodus marathonensis* (Bradshaw, 1969), *Juanognathus jaanussoni* Serpagli, 1974, *Lenodus crassus* (Chen & Zhang, 1983), *Lenodus variabilis* (Sergeeva, 1963), *P. simplicissimus*, *Paroistodus originalis* (Sergeeva, 1963), *P. horridus*, *P. macrodentatus*, *Protopanderodus rectus* (Lindström, 1955), *Pteracontiodus cryptodens* Mound, 1965, *Rossodus barnesi* Albanesi, 1998, *Scolopodus oldstockensis* Stouge, 1984, *Semiacontiodus potrerillensis* Albanesi, 1998. This association corresponds to the *Lenodus crassus* Conodont Zone (Mestre & Heredia 2013a, 2019a, b).

The uppermost part of the San Juan Formation and the lower member of Los Azules Formation in Cerro La Chilca section bear Darriwilian conodonts, from the *Lenodus pseudoplanus* Zone, such as: *A. jemtlandica*, *B. medius*, *Condorodus chilcaensis* n. gen., n. sp., *D. basiovalis*, *Drepanoistodus bellburnensis* Stouge, 1984, *D. costatus*, *L. pseudoplanus*, *E. cf. balticus*, *F. marathonensis*, *Histiodela* sp., *H. holodentata*, *H. kristinae*, *Paltodus? jemtlandicus* Löfgren, 1978, *P. simplicissimus*, *P. horridus*, *P. macrodentatus*, *P. gradatus*, *Protopanderodus* sp., *R. barnesi*, *S. oldstockensis* (Mestre 2010, 2012; Mestre & Heredia 2019a, b).

MATERIAL AND METHODS

A total of 230 elements of *Condorodus* n. gen. were recovered from the studied areas and here are assigned to three species described below. The samples were processed using formic acid, the residue was filtered in sieves with mesh of 80 and 100 µm (Stone 1987). The conodont elements retrieved from the different sections exhibit diverse CAI values (Color Alteration Index, Epstein *et al.* 1977). In the Espinazo del Diablo and Los Colorados sections the CAI of the elements are 1½-2; the elements recovered from Santa Gertrudis and Suri formations show a range of CAI value of 4-5 and still it is possible to observe the white matter in the cusp and denticles. In the Precordillera sections the recovered elements have a range of CAI values between 2 and 3.

The specimens show good preservation; mainly the P elements which are more numerous and complete. While the S elements are few and fragmented, with a more deteriorated appearance, these elements conform to the *Condorodus* n. gen. apparatus proposed here.

The conodont elements are housed in collections of Conodonts of the INGEO at the Universidad Nacional de San Juan, under the code -MP, and in the Collection of Microvertebrates Lillo – Conodonts under the code CML-C in the INSUGEO-CONICET-UNT. All photographic illustrations (Figs 5-9) are SEM digital photomicrographs taken in the National Centre of Electronic Microscopy, Complutense University

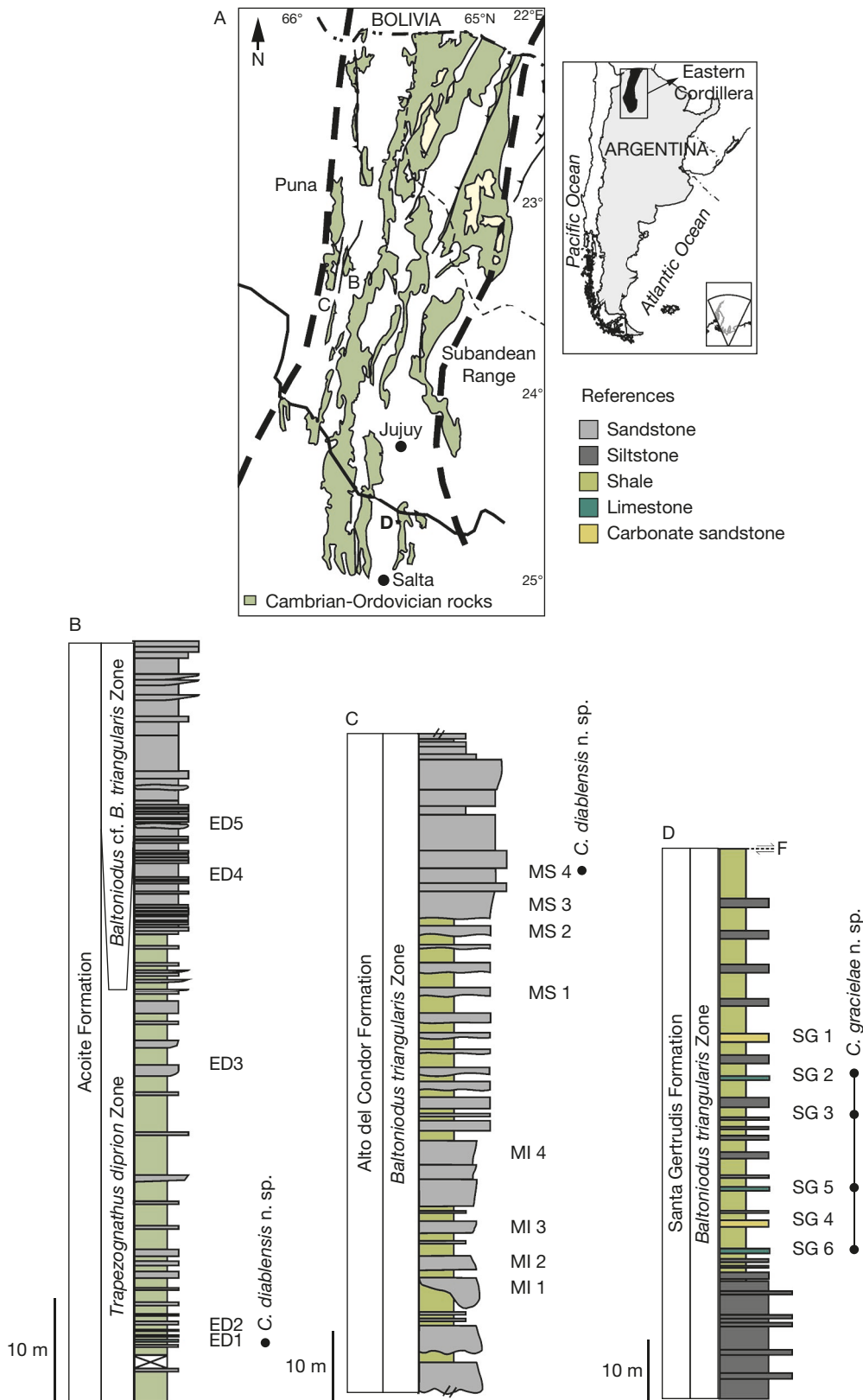


FIG. 2. — **A**, Location map showing the Eastern Cordillera geological province in NW Argentina; **B-D**, the letters indicate the study areas with their respective stratigraphic columns and the vertical distribution of the *Condorodus* n. gen.: **B**, Acoite Formation at the Espinazo del Diablo section, Jujuy province, *Condorodus diablensis* n. gen., n. sp.; **C**, Alto del Condor Formation at Los Colorados region, Jujuy province, *Condorodus diablensis* n. gen., n. sp.; **D**, Santa Gertrudis Formation at the Mojotoro range, Salta province, *Condorodus gracietae* n. gen., n. sp.

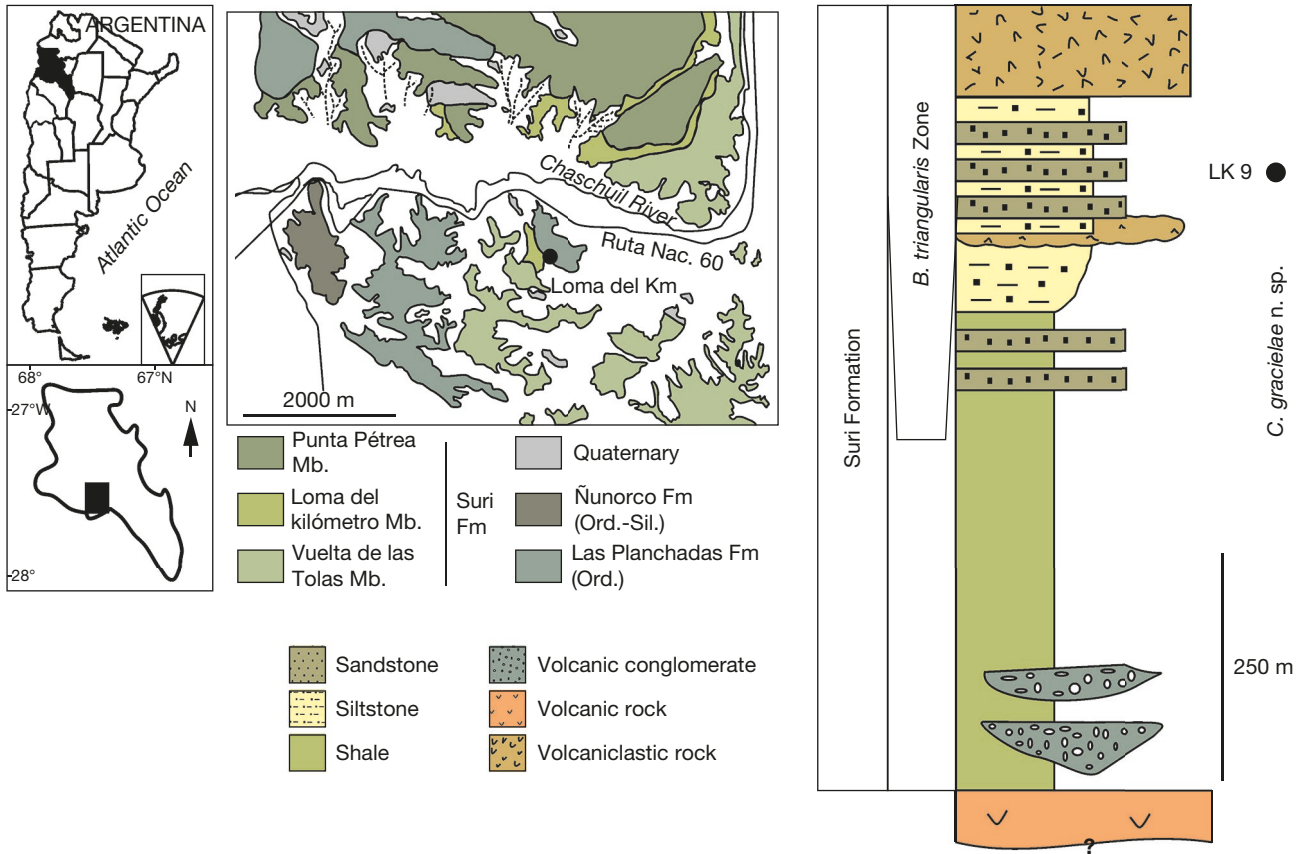


FIG. 3. — Location map showing the Famatinian Range geological province with the studied area, stratigraphic column and level of occurrence of *Condorodus gracielae* n. gen., n. sp. at the Suri Formation, Chaschuil section, Catamarca province.

of Madrid, Spain and in the SEM laboratory of IIM (Instituto de Investigaciones Mineras – Facultad de Ingeniería), Universidad Nacional de San Juan, Argentina.

SYSTEMATIC PALEONTOLOGY

The conventional notation system of Sweet (1981, 1988), which labels the spatial positions M, S and P, from the anterior extremity to the posterior of the multielemental apparatus, was used in the descriptions of taxa. Corresponding subpositions of the symmetry were also considered, and do not necessarily reflect location within the oral cavity of the conodont animal.

Phylum CONODONTA Pander, 1856
Class CONODONTA Pander, 1856

Genus *Condorodus* n. gen.
(Figs 5-9)

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TYPE SPECIES. — *Condorodus chilcaensis* n. sp.; Precordillera; lower to middle Darriwilian - Middle Ordovician.

DIAGNOSIS. — The apparatus of *Condorodus* n. gen. is composed by six element locations identified so far: two carminate P elements, two different teriopedeate Sb elements, one dolabrate Sc and one digyrate Sd element. No M or Sa elements were recovered yet.

The new and diagnostic feature of this genus is that both P elements (Pa and Pb) have carminate morphology, representing until now the first genus to have this structural plan that appears in the Lower and early Middle Ordovician. These carminate P elements are strongly laterally compressed with well-defined cusp, the anterior and posterior processes are well developed and carry variable number of denticles. Their cusps have a well-marked keel with striae as ornamentation. The denticles are fused at the base and free apically, showing striae on the surface. The Pa element is longer than the Pb element and has a greater number of denticles. The basal cavity of moderate size is located immediately beneath the cusp with basal margin slightly expanded laterally.

The S transition series is represented by ramiform elements that include Sb1 modified teriopedeate, Sb2 teriopedeate, Sc dolabrate and Sd digyrate elements. All the elements present a long cusp with a well-marked rib and longitudinal striae. The processes have denticles in a variable number and size, with striae on their surfaces.

ETYMOLOGY. — The genus name “*Condorodus*” refers to the emblematic bird of the Los Andes Cordillera “cóndor” and “odus” (et. gr. tooth) “Cóndor tooth”.

SPECIES INCLUDED. — *Condorodus chilcaensis* n. gen., n. sp., *Condorodus gracielae* n. gen., n. sp., *Condorodus diablensis* n. gen., n. sp.

STRATIGRAPHIC AND GEOGRAPHICAL OCCURRENCE. — Lower and Middle Ordovician of the Eastern Cordillera, Famatinian Range

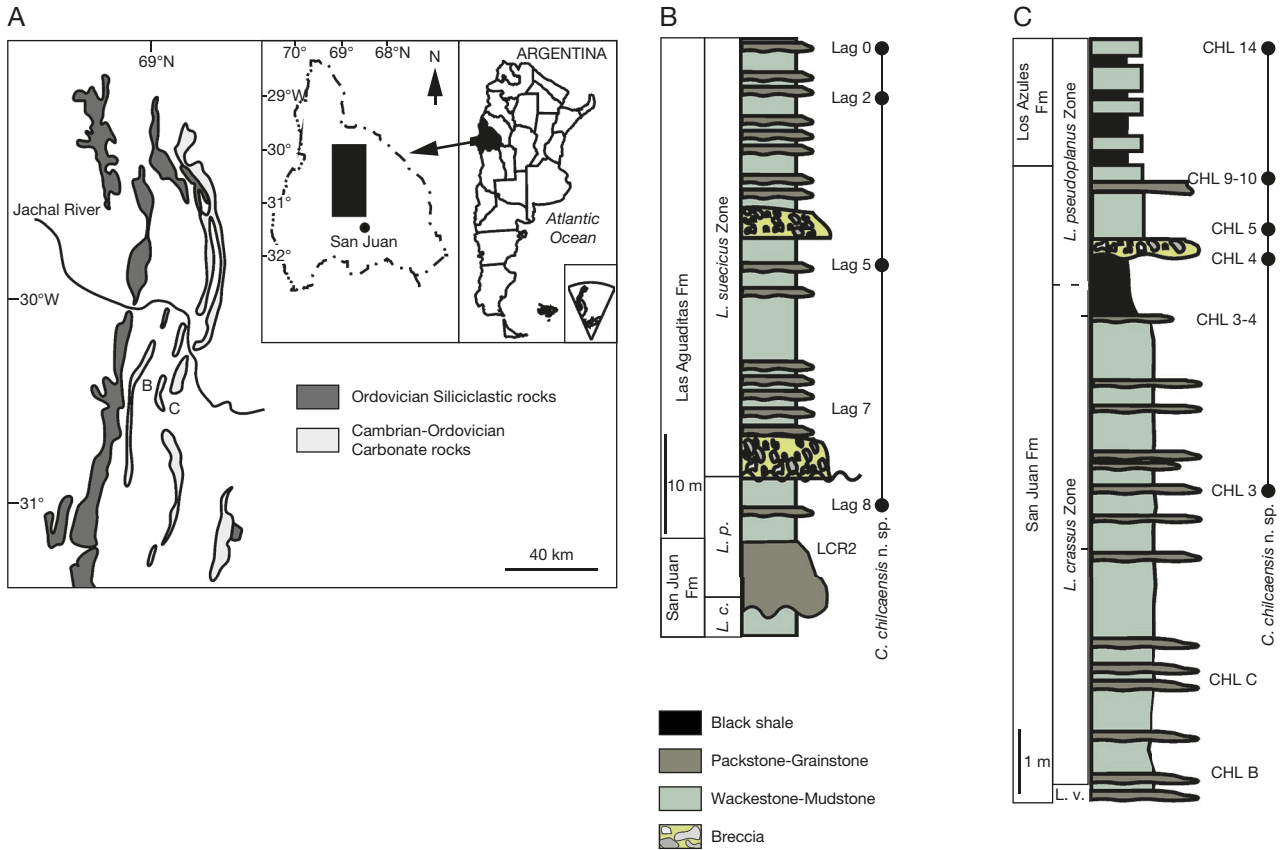


FIG. 4. — **A**, Location map showing the Precordillera geological province; **B**, **C**, the study areas with their respective stratigraphic columns and the vertical distribution of the *Condorodus chilcaensis* n. gen., n. sp.: **B**, San Juan and Las Aguaditas formations at the Las Chacritas river section, San Juan province; **C**, San Juan and Los Azules formations at the Cerro La Chilca section, San Juan province.

and Precordillera. Upper Floian (*Trapezognathus diprion* Zone) to Dapingian (*Baltoniodus triangularis* Zone) in the Eastern Cordillera and Famatinian Range (Carlorosi *et al.* 2013, 2017). Lower to middle Darriwilian (*Lenodus crassus* – *L. suecicus* zones) Central Precordillera of San Juan (Heredia & Mestre 2011, 2013; Mestre 2012; Mestre & Heredia 2013a, b, 2019a, b; Heredia *et al.* 2017). South America - Argentina.

REMARKS

The *Condorodus* n. gen. apparatus was interpreted and reconstructed from the conodont association recovered from the LK9 sample (Suri Formation - Famatinian Range) which provided conodont elements only from three different genera and four species. Three of these species were previously studied in detail by Carlorosi *et al.* (2013, 2018) and Heredia *et al.* (2013) and are well-known, they are: *Baltoniodus cooperi*, *Baltoniodus triangularis* and *Erraticodon patu*. Consequently, the low diversity in this sample, allowed identified the elements that conform the apparatus of *Condorodus* n. gen. The carminate P elements were recognized easily due to their abundance and size, conversely, the S elements were difficult to recognize because they are small, fragmented, and scarce. The other morphologies recovered could not be attributed to M or Sa elements in the Suri Formation, or in any other area where this new genus was recorded. The *Condorodus* n. gen. apparatus reconstruction obtained from the Suri Formation, allowed comparison with similar

conodont elements recovered from Ordovician strata of the Eastern Cordillera and Precordillera.

Condorodus chilcaensis n. gen., n. sp. has been selected as type species of the genus, because its apparatus is better preserved and represented than those of *C. diablensis* n. gen., n. sp. and *C. graciellae* n. gen., n. sp. The P elements of each species present differences mainly in their denticular pattern as well as in their basal margins. The S elements recovered from the Precordillera (Darriwilian) are bigger than those recovered from the Suri, Santa Gertrudis and Alto del Cóndor formations (Dapingian). The *C. chilcaensis* n. gen., n. sp. S elements have robust denticles and cusps and the angle between processes are different in comparison to *C. graciellae* n. gen., n. sp. S elements.

The relation of P elements recovered from the samples is greater than the S elements. The ratio between P and S elements is displayed in Table 3.

Condorodus chilcaensis n. gen., n. sp.
(Figs 5A-F; 8A-H; 9A-D)

urn:lsid:zoobank.org:act:541113AE-03DD-44FD-8560-CA7FB1D8B88B

P elements

“*Bryantodina*” aff. *typicalis* Stauffer, 1935, Lehnert 1995: 75, pl. 10: 7, pl. 11: 3-4, pl. 13: 3. — Ortega *et al.* 2007: fig. 6: V. — Mestre 2012:

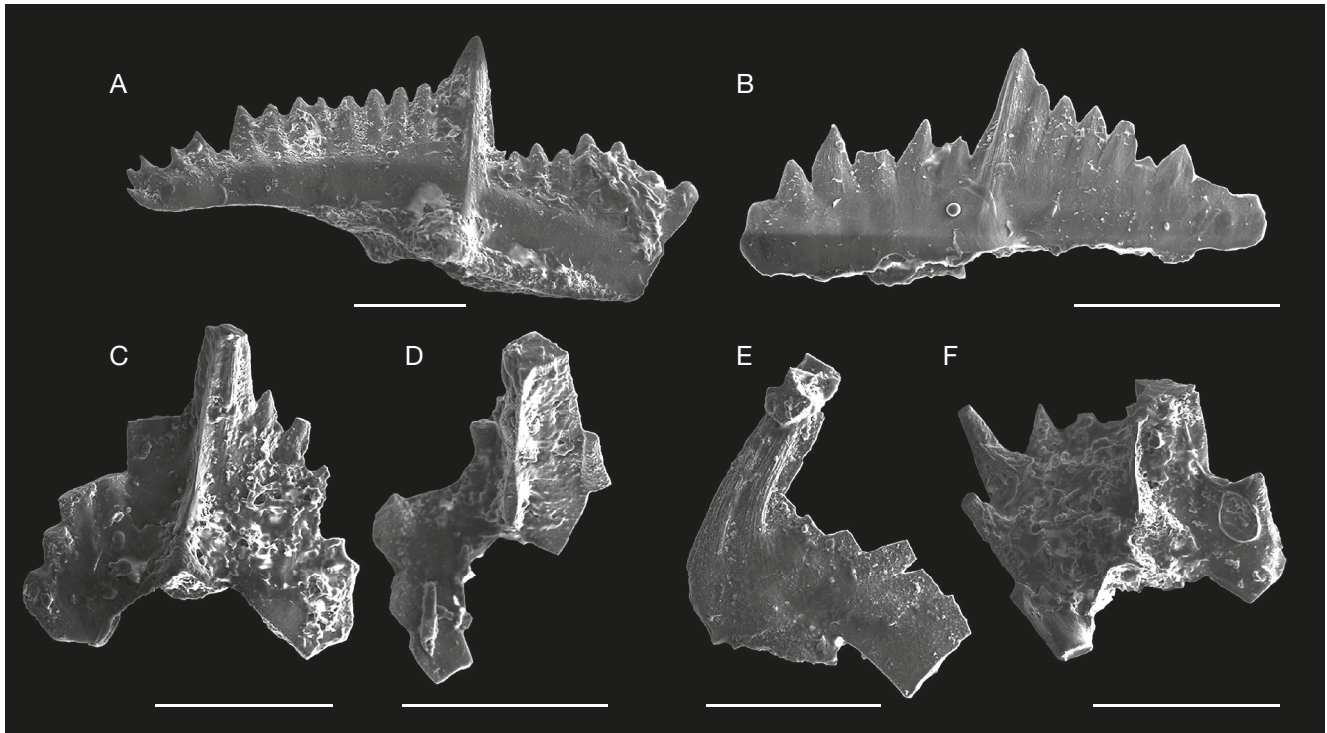


FIG. 5. — **A-F**, Scanning electron microphotographs of *Condorodus chilcaensis* n. gen., n. sp. All specimens recovered from the *Lenodus pseudoplanus* Zone, from the Cerro La Chilca section (**A-E**) and from Las Chacritas river section (**F**): **A**, Pa element (holotype), inner lateral view, CHL4 sample, INGENO MP 1003(4); **B**, Pb element, inner lateral view, CHL 9-10 sample, 1047(4); **C**, Sb1 element, posterior view, Lag 8 sample, CML-C 3410(21); **D**, Sb2 element, posterior view, Lag 8 sample, CML-C 3410(22); **E**, Sc element, lateral view, Lag 8 sample, CML-C 3410(24); **F**, Sd element, posterior view, Lag 8 sample, CML-C 3410(23). Scale bars: 0.1 mm.

fig. 5: 1-3. — Serra *et al.* 2013: fig. 3: 24. — Voldman *et al.* 2013: fig. 2: 24. — Mango *et al.* 2018: fig. 2: 5. — Serra *et al.* 2020: fig. 4: 7.

S elements

Microzarkodina cf. *M. ozarkodella* Lindström, 1971 — Mestre 2012: 191, fig. 4: 14.

Microzarkodina ozarkodella Lindström, 1971; Serra *et al.* 2013, fig. 2: 9. — Feltes *et al.* 2013, fig. 4: 9.

Microzarkodina hagetiana Stouge & Bagnoli, 1990 — Serra *et al.* 2013: fig. 2: 10. — Serra *et al.* 2013: fig. 4: 10. — Mango *et al.* 2018: fig. 2: 12. — Serra *et al.* 2020: fig. 5: 1-3.

TYPE MATERIAL. — **Holotype**. Pa element, CHL4 sample, INGENO-MP 1003(4), (Fig. 5A).

Paratypes. Pb element, CHL 9-10 sample, INGENO-MP 1047(4); Sb1 element, Lag 8 sample, CML-C 3410(21); Sb2 element, Lag 8 sample, CML-C 3410(22); Sc element, Lag 8 sample, CML-C 3410(24); Sd element, Lag 8 sample, CML-C 3410(23), (Fig. 5B-F).

MATERIAL EXAMINED. — 68 specimens were recovered from the Cerro La Chilca section, San Juan Formation, from the *L. crassus* and *L. pseudoplanus* zones; and from the Las Chacritas river section, Las Aguaditas Formation from the *L. crassus* to *L. suecicus* zones. See Table 3.

DIAGNOSIS. — This species is characterized by a denticular pattern in its P elements where the first two or three denticles close to the cusp of the anterior process are lower than the rest. In addition, the basal cavity of both elements P is wide and extends to both processes.

ETYMOLOGY. — The denomination of this species is related to the provenance of these elements, Cerro La Chilca section, Central Precordillera of San Juan, Argentina.

TYPE LOCALITY. — San Juan and Los Azules formations, Cerro La Chilca section, Precordillera, Argentina (Fig. 4B).

TYPE HORIZON. — Sampled level CHL4 from the San Juan Formation, Cerro La Chilca section, Central Precordillera, 1.10 m from the top of the section. Collection A. Mestre PhD thesis (2010), Instituto de Investigaciones Mineras, housed in the INGENO, Universidad Nacional de San Juan (INGEO-MP) (A. Mestre collector).

DESCRIPTION

Pa element

Carminate, the cusp is erect with keeled margins and a costa on its inner side. The posterior process is longer and the aboral margin is higher than the anterior process. The posterior process is directed slightly downward distally and carries up to fifteen denticles; the first denticle is completely fused to the cusp, all denticles are subequal in size, slightly compressed and fused in the basal part, distal ones are smaller and seem to be rudimentary. The anterior process is straight and carries up to ten denticles, two or three denticles immediately anterior to the cusp are shorter than the others (Figs 5A; 8B, E, G, H; 9A). The basal cavity is deep and extends under both processes, becomes narrower distally. The Pa element shows a well-developed asymmetrical expansion of the basal cavity. On the inner side of the element the expansion of the basal cavity is directly below the cusp, while the outer side of the element exhibits an expansion towards the posterior process (Fig. 9A, C1, C2).

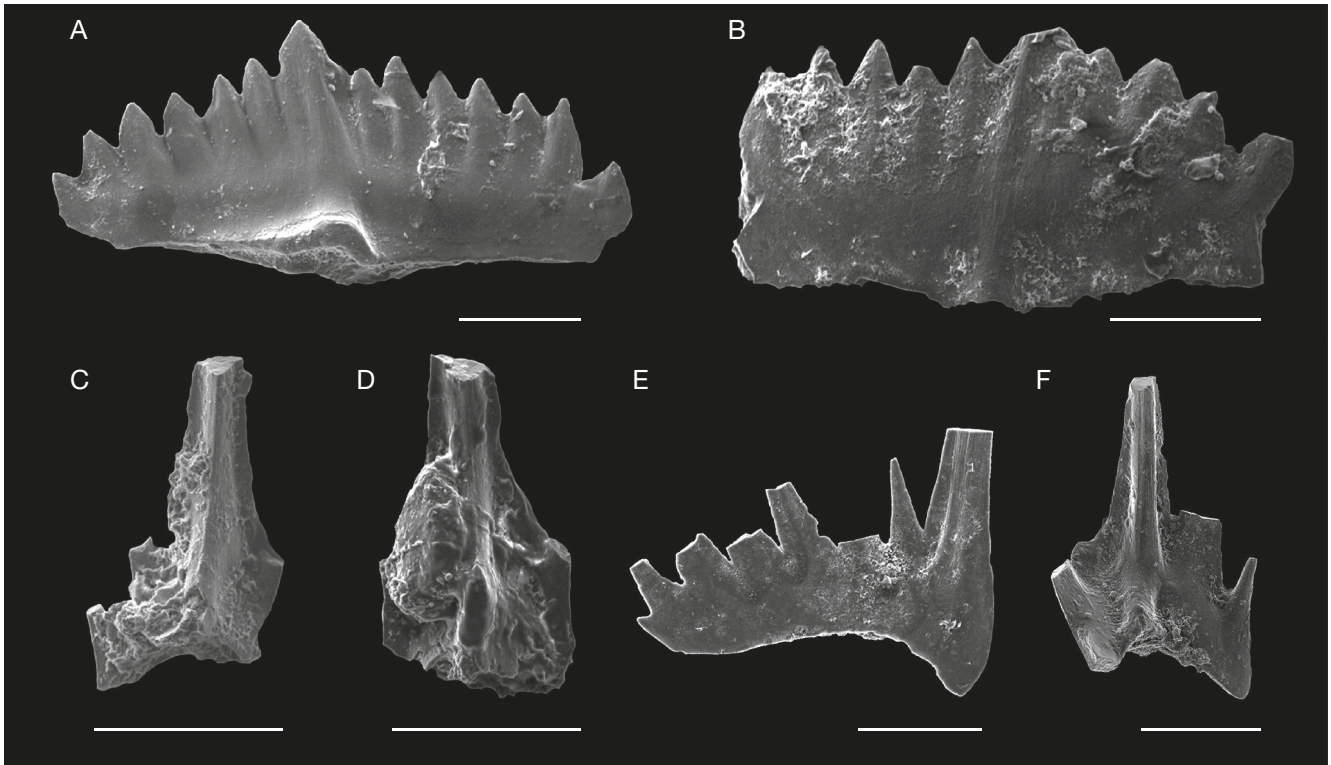


FIG. 6. — **A-F**, Scanning electron microphotographs of *Condorodus gracielae* n. gen., n. sp. All specimens recovered from the *Baltoniodus triangularis* Zone, from the Santa Gertrudis Formation, Mojotoro Range, Salta province (**A, E-F**) and from the Suri Formation in the Chaschuil region, Famatinian Range, Catamarca province (**B-D**): **A**, Pa element (holotype), inner lateral view, SG2 sample, CML-C 7110(1); **B**, Pb element, outer lateral view, LK9 sample, CML-C 4011(1); **C**, Sb1 element, posterior view, LK9 sample, CML-C 4013(1); **D**, Sb2 element, posterior view, LK9 sample, CML-C 4014(1); **E**, Sc element, lateral view, SG2 sample, CML-C 7114(1); **F**, Sd element, posterior view, SG3 sample, CML-C 7122(1). Scale bars: 0.1 mm.

Pb element

This carminate element shows fewer denticles than the Pa element on both processes. The cusp is slightly reclined, having a well-developed costa in the inner side. The anterior and posterior processes are straight, developing a blade shape with the cusp in the middle part. On the anterior process, the first denticles are shorter than the rest, as in the Pa element, generally carries up to eight subtriangular and fused denticles; progressively increasing in size distally. On the posterior process the first denticle is fused to the cusp, and has up to seven denticles that decrease in size distally (Figs 5B; 8B, F; 9B). The basal cavity is deep and extends as grooves below the element, also develops small expansion to the inner side of the element (Fig. 9B, D1, D2).

S elements

The recovered ramiform elements are all asymmetrical showing longitudinal striae and they present a well-marked rib on the posterior side of the cusp.

Sb1 element

Modified tertiopodate element with erect cusp and small basal cavity. On the outer posterior side of the cusp, there is a rib that extends beyond the base, developing a short adenticulate posterior process that ends in a keel (Figs 5C; 8A, D). Each lateral process presents a different denticulate pattern. The latero-anterior process exhibits free and spaced triangular

denticles, the first one bigger than the rest, then decreasing in size towards the end of the process. The latero-posterior process has several quadrangular and fused denticles, the first denticle is bigger than the rest decreasing their sizes until the end in a short and gently rounded denticle. On the inner face of the cusp is a diagnostic well-marked longitudinal costa with striae (Figs 5; 8A, D).

Sb2 element

Tertiopodate element with erect cusp that shows square cross section and sharp margins, a strong rib on the posterior side of the cusp develops a short posterior process with a small and rudimentary denticle. The antero-lateral process is directed downward carrying five denticles, a small fragment of the posterior-lateral process is evident and seems to be similar but straight. First denticles on each process are fused to the cusp (Fig. 5D).

Sc element

Dolabrate element. The cusp is reclined, elongated and compressed laterally with sharp edges, the inner-lateral margin is weakly rounded, furrowed and striate. The posterior process is long with a wide base and carries up to eight denticles, the first one is fused to the cusp, all are rectangular, reclined and the distal are bigger. Complete element surface presents the diagnostic striae which are more visible on a wide costa in the middle part of the cusp (Fig. 5E).

Sd element

Digyrate element with erect cusp, and a short posterior adenticulate process. Two lateral asymmetrical processes, one is almost straight while the other curves downward strongly in a typical digyrate form, this latter one is the longer. The denticle pattern in each lateral process is different. The shorter lateral process shows subtriangular denticles; the other one presents more denticles which are triangular and spaced, the first denticle is fused to the cusp, the third is bigger than the others denticles. Despite the preservation of the elements, it is possible to observe the typical striae on the surface of the elements (Fig. 5F).

REMARKS

Lehnert (1995) and Mestre (2012) described P elements of *Condorodus* n. gen. as belonging to the genus *Bryantodina* Stauffer, 1935. A close comparison to those elements described in this contribution allows to dismiss these elements as part of the genus *Bryantodina*. The main differences between these genera are the carminate element in Pb position and the development of striae ornamentation on the cusp and denticles in *Condorodus* n. gen.

Several authors have inferred the presence of *Microzarkodina* cf. *ozarkodella*, *M. hagetiana* and *M. ozarkodella* in some sections of Precordillera based on the record of Sa elements only (see list of synonyms). Through of an analysis of the conodont collections studied by Mestre (2012), Feltes *et al.* (2013), Serra *et al.* (2013, 2020) and Mango *et al.* (2018), was evident that this S element of *Microzarkodina* appears to be unfailingly associated with the carminate P elements assigned here to the *Condorodus* n. gen. apparatus. A comparison between the S elements of “*Microzarkodina*” and those assigned to *Condorodus* n. gen., confirm that these do not correspond to symmetric Sa elements of *Microzarkodina*, reassigning them to asymmetric elements included here as Sb1, Sb2 and Sd elements of the multielemental apparatus of *Condorodus* n. gen. (Figs 5C, E; 8A, D). Another consideration about the characteristics of these elements that support our interpretation is the presence of striae on the cusp and denticles that are absent in the genus *Microzarkodina*.

In the Cerro La Chilca section, Mestre (2012) described for the first time a possible apparatus of the *Microzarkodina* cf. *ozarkodella* associated with the elements of “*Bryantodina*” aff. *typicalis*. Those materials were re-examined for the present contribution, including all S elements as belonging to the apparatus of the *Condorodus* n. gen. Recently, Serra *et al.* (2020), for the same section, illustrated three different asymmetrical elements as Sa elements of *M. hagetiana*, but none of these correspond to an alate element, even more, one of this element possess tertiopeodate morphology with development of three denticulate processes (Serra *et al.* 2020: fig. 5C), this element is interpreted here as Sb2 element of *Condorodus chilcaensis* n. gen., n. sp. and the others as Sb1 element (Serra *et al.* 2020: fig. 5A) and Sd element (Serra *et al.* 2020: fig. 5B).

Feltes *et al.* (2013), Serra *et al.* (2013, 2020) and Mango *et al.* (2018) lack the complete apparatus reconstruction of the Darriwilian species of *Microzarkodina*, only illustrated specimens interpreted as Sa elements. These authors proposed

that the variation in the angle between the lateral processes of the Sa element could be used for differentiating between *M. hagetiana* and *M. ozarkodella*, basing their Darriwilian conodont biostratigraphic proposal on this weak taxonomic interpretation. Löfgren & Tolmacheva (2008) recognized the P element as the major element used to distinguish between species of *Microzarkodina* and observed that the variation in the angle in Sa element can be considerable even within single species. Based on these observations, we consider that the record of the Darriwilian species of *Microzarkodina* is poorly supported in Precordillera since all specimens previously assigned to the different species of this genus are interpreted as belonging to the apparatus of *Condorodus* n. gen. in the present contribution.

Stratigraphic and geographical occurrence

San Juan and Las Aguaditas formations at Cerro La Chilca section and Las Chacritas river sections from the Central Precordillera. Lower to middle Darriwilian, *L. crassus*, *L. pseudoplanus* and *L. suecicus* zones.

Condorodus graciellae n. gen., n. sp. (Figs 6A-F; 8I-R; 9E-H)

urn:lsid:zoobank.org:act:9270C1A0-969F-418A-9E35-A43BEF23B043

P elements

Jumudontus gananda (Cooper, 1981), Albanesi & Vaccari 1994: 136-137, pl. 2: 13, 14.

Bryantodina typicalis (Stauffer, 1935), Moya *et al.* 2003: 21, fig. 12: 1.

Bryantodina cf. *typicalis* Stauffer, 1935, Albanesi *et al.* 2007: 12, fig. 3: J, R.

S elements

2003 *Plectodina* sp. A — Moya *et al.* 2003: 21, fig. 12: 2.

TYPE MATERIAL. — **Holotype**. Pa element, SG2 sample, CML-C 7110(1), (Fig. 6A).

Paratypes. Pb element, LK9 sample, CML-C 4011(1); Sb1 element, LK9 sample, CML-C 4013(1); Sb2 element, LK9 sample, CML-C 4014(1); Sc element, SG2 sample, CML-C 7114(1); Sd element, SG3 sample, CML-C 7122(1), (Fig. 6B-F).

MATERIAL EXAMINED. — 127 specimens were recovered from Famatinian Range, Suri Formation and Mojotoro Range, Santa Gertrudis Formation from the *Baltoniodus triangularis* Zone. See Table 3.

DIAGNOSIS. — *Condorodus graciellae* n. gen., n. sp. is characterized by P elements with processes having denticles subequal and erect, and with similar size to the cusp. Besides, they have an isolated denticle at the distal end of the anterior process, very evident when it is preserved. The basal cavity has an intermediate width compared to the other two species.

ETYMOLOGY. — In honor to Dr Graciela Sarmiento who described for the first time the conodont association from the Santa Gertrudis Formation.

TYPE LOCALITY. — Suri Formation, Chaschuil section, Famatinian Range, Argentina (Fig. 3).

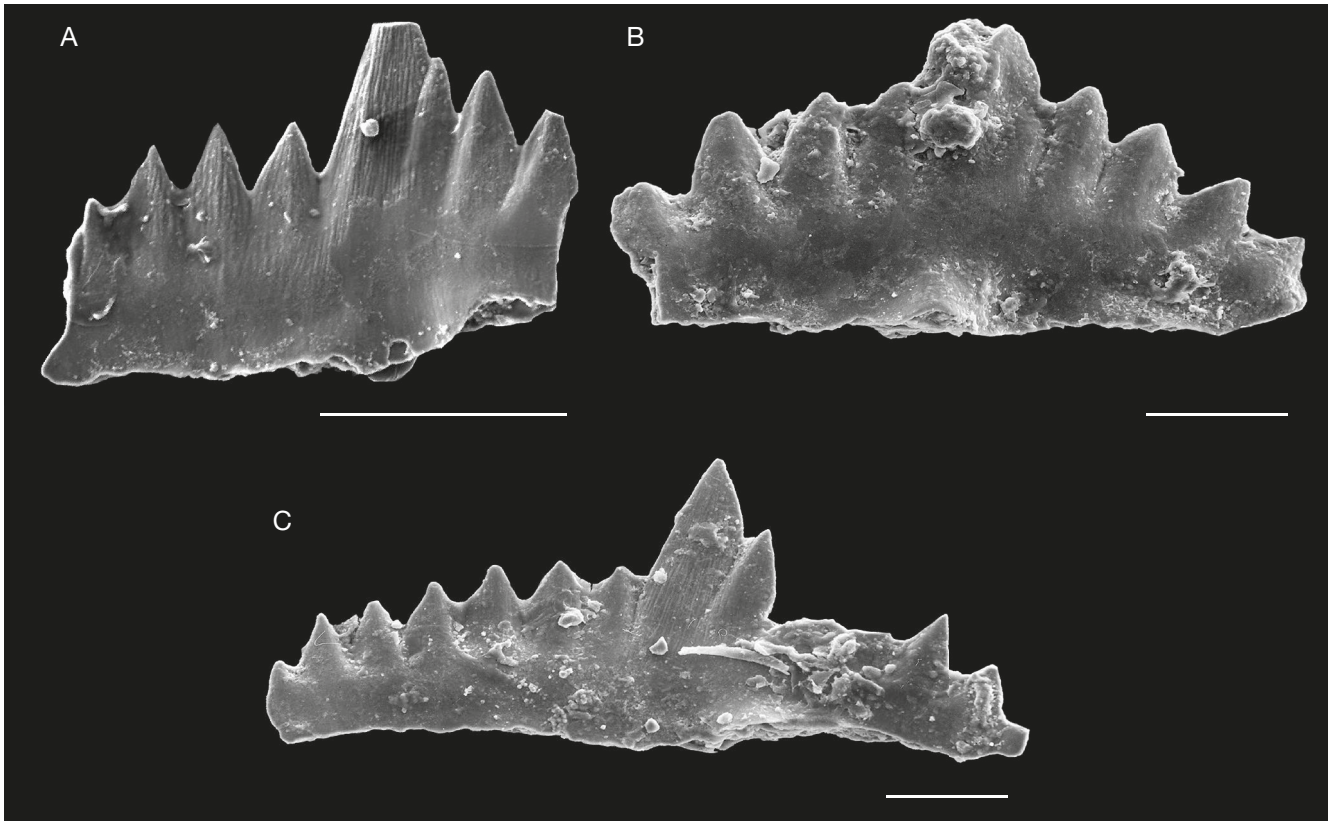


FIG. 7. — **A–C**, Scanning electron microphotographs of *Condorodus diablensis* n. gen., n. sp. All specimens recovered from the *Trapezognathus diprion* and *Baltoniodus triangularis* zones: **A**, from the Acoite Formation at the Espinazo del Diablo section, Jujuy province; **B**, **C**, from the Alto del Cóndor Formation at Los Colorados region, Jujuy province: **A**, Pa element (holotype), outer lateral view, ED1 sample, CML-C 5004(1); **B**, Pb element, inner lateral view, MS4 sample, CML-C 5092(2); **C**, Pa element, outer lateral view, MS4 sample, CML-C 5080(1). Scale bars: 0.1 mm.

TYPE HORIZON. — Sampled level LK9 from the Suri Formation, Chaschuil section, approximately 750 meters from the base of the section, see Figure 3. Collection Lillo-Microvertebrates/Conodonts (CML-C) (J. Carlorosi, collector).

DESCRIPTION

Pa element

Carminate, the processes comprise a narrow bar with numerous subtriangular denticles on it. The anterior process is longer than the posterior one and has eight to ten subtriangular denticles decreasing in height distally. The first denticle of the posterior process is completely fused to the cusp and carries from seven to nine denticles with the same pattern as the anterior process. The Pa elements from Famatina are shorter and more robust than those from Santa Gertrudis, and have the distalmost denticle of the anterior process bigger and isolated (Figs 6A; 8I, M, P, R; 9E). The Pa element developed an asymmetrical expansion of the basal cavity. On the inner side of the element the expansion of the basal cavity is directly below the cusp, while on the outer side the expansion is slightly towards the posterior process (Fig. 9E, G1, G2).

Pb element

This carminate element is shorter and more robust than the Pa element and their processes carry fewer denticles. The

posterior process carries five to seven denticles while the anterior process has four to seven denticles that are tilted in the opposite direction than those on the Pa. The processes bar is well developed mainly in the Famatinian specimens. The cusp is triangular in cross section with a strong keel and straight anterior and posterior processes. The denticles decrease in size towards the distal end of the processes and an independent denticle is at the end of the anterior process (Figs 6B; 8K, N, Q; 9F). The basal cavity is deep and extends as grooves from the cusp to the processes, the basal margins are laterally slightly expanded. The basal cavity in the Pb element is less developed than in the Pa element (Fig. 9F, H1, H2).

S elements

The recovered elements are smaller and delicate compared with the S elements of *C. chilcaensis* n. gen., n. sp. from the Precordillera.

Sb1 element

Modified teriopede. The cusp is elongate with subtriangular cross section with sharp lateral margins. The inner face of the cusp has a well-marked rib that develops a short posterior process that ends in a keel. One of the lateral process is developed inward and downward and has two denticles, one is big and the other is almost triangular. The other process is fragmented (Fig. 6C).

Sb2 element

Tertiopodate. The preservation of the Sb2 element is not good, but it is possible to observe a sub-rounded and long cusp with two thin and asymmetric lateral processes. A well-marked rib in the inner face of the cusp develops a posterior process. On the latero-posterior process a denticle of rounded cross section is evident (Fig. 6D).

Sc element

Dolabrate. It has a laterally compressed cusp with sharp anterior and posterior lateral margins; the anterior margin extends in a wide sub-rounded keel and the posterior one extends in a long posterior process that carry seven to nine denticles. The first denticle is triangular, not fused to the cusp; the denticles are reclined and ending with a small rudimentary denticle. The bar of the posterior process is shorter than those from the Precordillera and moderately arched (Fig. 6E; 8L, O).

Sd element

Digryate. This element shows an erect cusp. The inner face of the cusp carries a sharp rib that extends in an adenticulate short process. Two lateral processes develop asymmetrically from the cusp. One of the lateral process is straight and carries two denticles; one is big and quadrangular and the other is small and subtriangular. The other lateral process curves downward and has two sub-rounded denticles. On the element it is possible to observe the striae on the surface (Figs 6F; 8J1-J2).

REMARKS

All elements of the *C. graciellae* n. gen., n. sp. apparatus were recognized, only few morphologic variations compared to the P elements of the *C. diablensis* n. gen., n. sp. and *C. chilcaensis* n. gen., n. sp. are observed, such as the denticle patterns on the processes and the basal cavity of the P elements. However, the S elements of *C. graciellae* n. gen., n. sp. show strong differences from those from the Precordillera, the size and width of the processes are smaller and narrower in *C. graciellae* n. gen., n. sp. than *C. chilcaensis* n. gen., n. sp., also the cusps are thinner and have sharp lateral margins in *C. graciellae* n. gen., n. sp.

Condorodus graciellae n. gen., n. sp. was recovered from clastic deposits from the Suri Formation, that outcrops in the Famatinian Range, and from the Santa Gertrudis Formation that crops out in the Mojotoro Range in the Eastern Cordillera. All the elements are similar, and these common features allow us to consider them as a single species. Furthermore, previous studies on the conodont associations recovered from these formations suggest that there is a strong link between them; sharing almost the same conodont species and recording the *Baltoniodus cooperi* subzone which is present only in these two places (Carlorosi *et al.* 2018). Nevertheless, we have recognized affinity between the P elements of Santa Gertrudis to those of the Alto del Cóndor Formation in the Eastern Cordillera (*C. diablensis* n. gen., n. sp.), on the other hand the P elements of the Suri Formation are similar to those of the Precordillera (*C. chilcaensis* n. gen., n. sp.).

The only conodont report from the Suri Formation was made by Albanesi & Vaccari (1994), recording the *Baltoniodus navis* Conodont Zone; in this conodont assemblage the authors illustrated a broken P element assigned to *Jumudontus gananda* Cooper, 1981 (Cooper 1981: 136, pl. 2, figs 13, 14), a detailed analysis of this specimen allows us to assign it here to *C. graciellae* n. gen., n. sp.

Upper Darriwilian conodonts were mentioned by Moya *et al.* (2003) in the Santa Gertrudis Formation, including a Pa of *Bryantodina typicalis* and Sa elements of *Plectodina* sp. A (Moya *et al.* 2003: 64; pl. 12; figs 1, 2) which are comparable to the Pa and Sb1 elements of *Condorodus graciellae* n. gen., n. sp. The Santa Gertrudis Formation was recently studied and reassigned as lower Dapingian after the record of the *B. triangularis* Zone (Carlorosi *et al.* 2018).

Albanesi *et al.* (2007) recovered a conodont association from the Capillas Formation that crops out at the Sierra Subandinas and was assigned a late Darriwilian age. These authors assigned two carminate Pa elements to *Bryantodina* cf. *typicalis* (Albanesi *et al.* 2007: text, fig. 3J, R). We have compared them with the *Condorodus* n. gen. P elements, and these can be reassigned to a Pa element and a Pb element of *C. graciellae* n. gen., n. sp. (Albanesi *et al.* 2007: text, fig. 3J; specimen- as Pa element and R specimen- as Pb element). The conodont fauna described by Albanesi *et al.* (2007) has a similar composition to that of Santa Gertrudis Formation and records probably the *Baltoniodus triangularis* Zone.

Stratigraphic and geographical occurrence

Santa Gertrudis Formation, Mojotoro Range, Salta province and Suri Formation, Famatinian Range, Catamarca province, Argentina. Lower Dapingian (Middle Ordovician). *Baltoniodus triangularis* Zone/*Baltoniodus cooperi* subzone.

Condorodus diablensis n. gen., n. sp.
(Figs 7A-C; 8S; 9I-L)

urn:lsid:zoobank.org:act:12749B57-8FCC-4CF3-A5E2-6653C6F2E3ED

TYPE MATERIAL. — **Holotype.** Pa element, ED1 sample, CML-C 5004(1) (Fig. 7A).

Paratype. Pb element, MS4 sample, CML-C 5092(2) (Fig. 7B).

MATERIAL EXAMINED. — 35 specimens were recovered from the Acoite Formation, Espinazo del Diablo, from the *Trapezognathus diprion* Zone and Alto del Condor Formation, Los Colorados, from the *Baltoniodus triangularis* Zone. See Table 3.

DIAGNOSIS. — The P carminate elements are small compared to those of *C. chilcaensis* n. gen., n. sp. and *C. graciellae* n. gen., n. sp. The Pa elements are characterized by having a well-developed cusp and low subtriangular denticles on the processes, the first denticle of the posterior process is almost the same length as the cusp and is partially fused to it. The Pb elements are robust and the cusps are more difficult to differentiate from the rest of the denticles which are decreasing in size distally. The basal cavity is narrow and closes towards the ends of the processes in both elements.

ETYMOLOGY. — The *diablensis* designation refers to the Espinazo del Diablo locality.

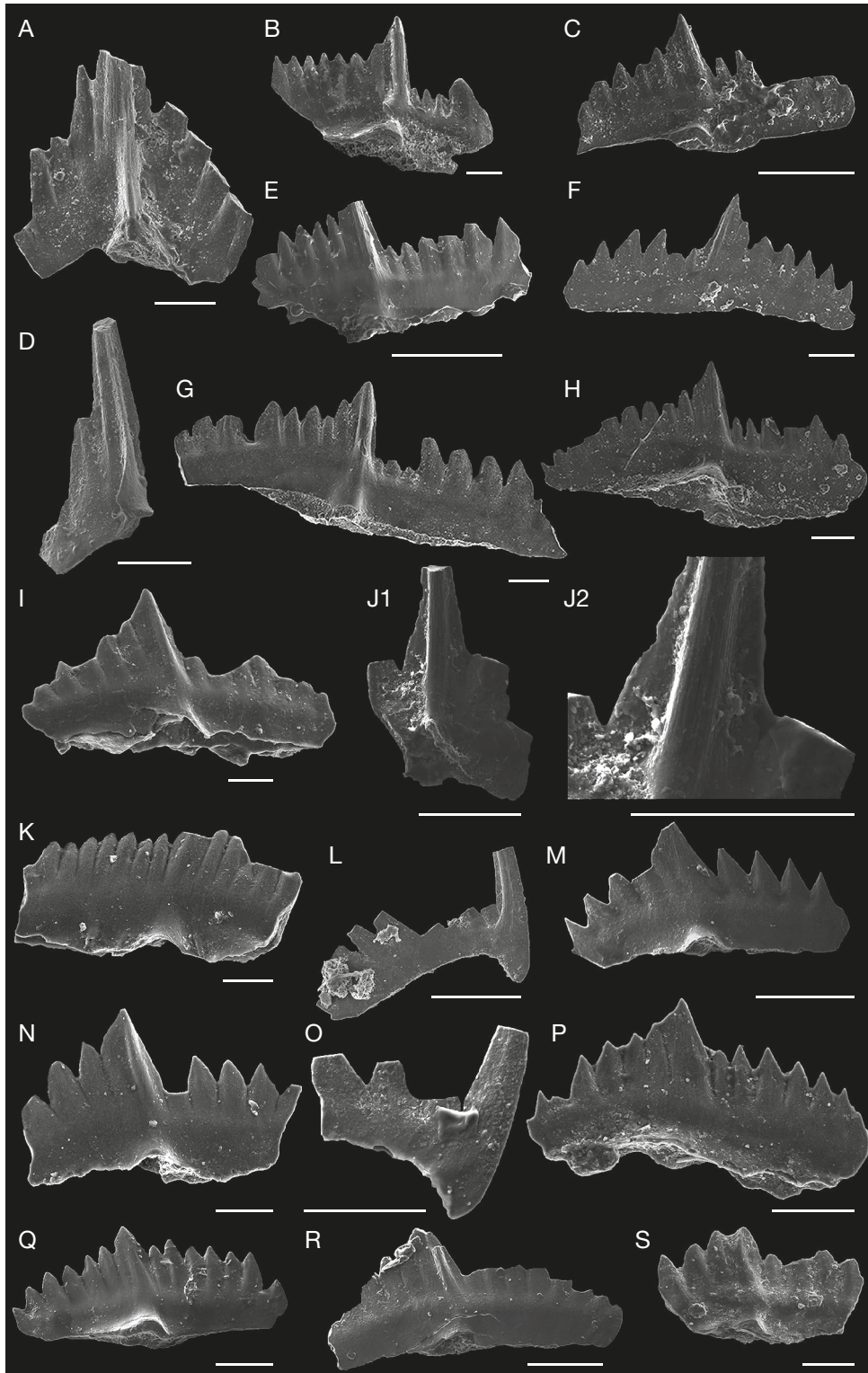


FIG. 8. — Scanning electron microphotographs: **A-H**, *Condorodus chilcaensis* n. gen., n. sp. from the Cerro La Chilca section (**A, D, F-H**) and from the Las Chacritas river section (**B, C, E**), *Lenodus pseudoplanus* Conodont Zone: **A, D**, Sb1 elements, posterior views, sample CHL4, INGEO-MP-1003(5-6); **B, E**, Pa elements, inner lateral views, Lag 8 sample, INGEO MP 3410(1-2); **C**, Pb element, inner lateral view, Lag 8 sample, INGEO MP 3410(12); **F**, Pb element, inner lateral view, sample CHL4, INGEO-MP-1003(2); **G**, Pa element, inner lateral view, sample CHL4, INGEO-MP-1003(1); **H**, Pa element, inner lateral view, sample CHL4, INGEO-MP-1003(3); **I-R**, *Condorodus graciellae* n. gen., n. sp. from the Santa Gertrudis Formation, Mojoroto Range, Salta Province (**I-L, N-P**) and from the Suri Formation, Famatinian Range, Catamarca province; *Baltoniodus triangularis* Zone and *B. cooperi* subzones (**M, Q, R**): **I**, Pa element, outer lateral view, sample SG3, CML-C 7117(1); **J1, J2**, Sd element, posterior view and cusp longitudinal striae detail, sample SG2, CML-C 7115(1); **K**, Pb element, inner lateral view, sample SG5, CML-C 7124(1); **L, O**, Sc element, inner lateral view, sample SG2, CML-C 7114(2-3); **M, S**, Pa elements, inner lateral views, sample LK9, CML-C 4010(2-3); **N**, Pb element, inner lateral view, sample SG5, CML-C 7124(2); **P**, Pa element, inner lateral view, sample SG5, CML-C 7123(1); **Q**, Pb element, inner lateral view, sample LK9, CML-C 4011(5); **R**, *Condorodus diablensis* n. gen., n. sp. from the Alto del Cóndor Formation at Los Colorados region, Jujuy province, Pb element, inner lateral view, Sample MS4, CML-C 5092(1). Scale bars: 0.1 mm.

TYPE LOCALITY. — Acoite Formation, Espinazo del Diablo section, Eastern Cordillera, Argentina (Fig. 3B).

TYPE HORIZON. — Sampled level ED1 from the Acoite Formation, Espinazo del Diablo section, from approximately 8 meters above the base of the section. Collection Lillo Microvertebrates/Conodonts (CML-C) (J. Carlorosi, collector).

STRATIGRAPHIC AND GEOGRAPHICAL OCCURRENCE. — ED1 sample, Espinazo del Diablo section and MS4 sample, Los Colorados region, Jujuy province. Upper Floian – Lower Dapingian (Lower/Middle Ordovician), from the *Trapezognathus diprion* to *Baltoniodus triangularis* zones.

DESCRIPTION

Pa element

The cusp is triangular with sharp margins and has an arrow shape. The anterior process is straight and longer than the posterior. Both processes carry up to seven subtriangular and equal sized denticles. The first denticle of the posterior process is tall and fused to the cusp in the base and free apically (Figs 7A, C; 9I). The basal cavity is below the cusp and extends under both processes like grooves (Fig. 9I, K1, K2).

Pb element

Element with a small cusp, similar in size and height to the denticles, only differentiated by the presence of the basal cavity below it. Both processes carry up to four or six subrounded denticles (Figs 7B; 8S; 9J). The Pb element is shorter, and the bar of the processes is wider than in the Pa element. The first denticle of the posterior process is completely fused to the cusp. The basal cavity extends below both processes and the basal sheath presents a similar morphology to that of the Pa element (Fig. 9J, L1, L2).

REMARKS

The morphological characters described of *C. diablensis* n. gen., n. sp. are based mainly on the conodont collection from the Alto del Cóndor Formation (Los Colorados region), recovered from lower Dapingian strata, *Baltoniodus triangularis* Zone (Carlorosi *et al.* 2013). However, the oldest element was retrieved from the ED1 sample of the Acoite Formation, cropping out in the Espinazo del Diablo section, late Floian in age by the record of the *Trapezognathus diprion* Zone (Carlorosi 2011, 2012).

The subequal length of the anterior and posterior processes in the carminate P elements; almost the same number of denticles in the Pa and Pb elements (acquiring a shape similar to a fan) where some of these are blunt and others pointed; and the undulations on both sides of the basal cavity of triangular in shape, unlike the other species where they are rounded and widened, are the main characteristics of *C. diablensis* n. gen., n. sp. that allow us to distinguish it from the other species of the *Condorodus* n. gen.

In the retrieved material we have not recovered S or M elements assignable to this species. Moreover, the P elements recovered are small, and S and M elements probably could be even smaller, and they could have been lost in the laboratory process.

SUPRAGENERIC CLASSIFICATION: COMPARISON AND DISCUSSION

The apparatus architecture of *Condorodus* n. gen. is composed of carminate Pa and Pb, modified tertiopedate Sb1, tertiopedate Sb2, dolabrate Sc and digyrate Sd (Figs 5-9) elements. This architecture represents an innovation compared to the conodont apparatuses of the Lower and early Middle Ordovician, since both Pa and Pb positions are occupied by carminate elements. Despite the observation that the composition of the apparatus of *Condorodus* n. gen. is still incomplete, the particular morphologies of its P elements and the S elements associated with them lead us to erect this new genus. Based on the diagnostic morphology of the P elements, we have tried to place the genus within a higher taxonomic classification, but given its architecture, it is difficult to assign it accurately. To carry out this analysis, the three most used taxonomic classifications of conodonts have been compared, taking into account their different classification criteria.

According to the classification proposed by Clark *et al.* (1981) *Condorodus* n. gen. could be related to the superfamily Prioniodontacea Bassler, 1925, family Cyrtoniodontidae Hass, 1959 that includes genera defined by apparatuses with P elements carminate, angulate, digyrate, segminate or pastinate; M elements dolabrate, digyrate, geniculate or coniform; S transition series from dolabrate to digyrate or tertiopedate to alate elements; basal cavity well developed, extending along most of underside of all elements. The Cyrtoniodontidae family is composed of six genera (*sensu* Clark *et al.* 1981); but comparing mainly the elements P and some S elements, only *Bryantodina* Stauffer, 1935 and *Plectodina* Stauffer, 1935 present a similar composition of their apparatuses compared to *Condorodus* n. gen. The genus *Bryantodina* and the species *B. typicalis* was defined by Stauffer (1935); later, Webers (1966) described five elements that could represent the apparatus of *Bryantodina typicalis*, the Pa and Pb elements, and S elements forming a transition series. The M element was not identified (Webers 1966: 50; pl. t; figs 4-7). Later, Bauer (1994) defined *Bryantodina aequalis* with a quinquemembrate or seximembrate apparatus including a possible dolabrate M element. The species of *Condorodus* n. gen. have a certain similarity with the basal species *B. typicalis* in their morphology of carminate Pa element, tertiopedate Sb and dolabrate Sc, but differs in their Pb and Sd which are present in *C. chilcaensis* n. gen., n. sp. and *C. graciellae* n. gen., n. sp., as well as our not having found an M element. Due to this, the elements described here were not included as part of the genus *Bryantodina*; besides that, *C. diablensis* n. gen., n. sp. appears in the upper Floian whereas that the genus *Bryantodina* appears in the middle Darriwilian. The other genus similar to *Condorodus* n. gen. is *Plectodina* Stauffer, 1935; the apparatus was reconstructed by Sweet & Bergström (1972), consisting of carminate to angulate or pastinate P elements, M dolabrate or digyrate, and S elements from dolabrate or bipennate through digyrate to alate. Basal cavity shallow and narrow in all elements, extending under all the processes.

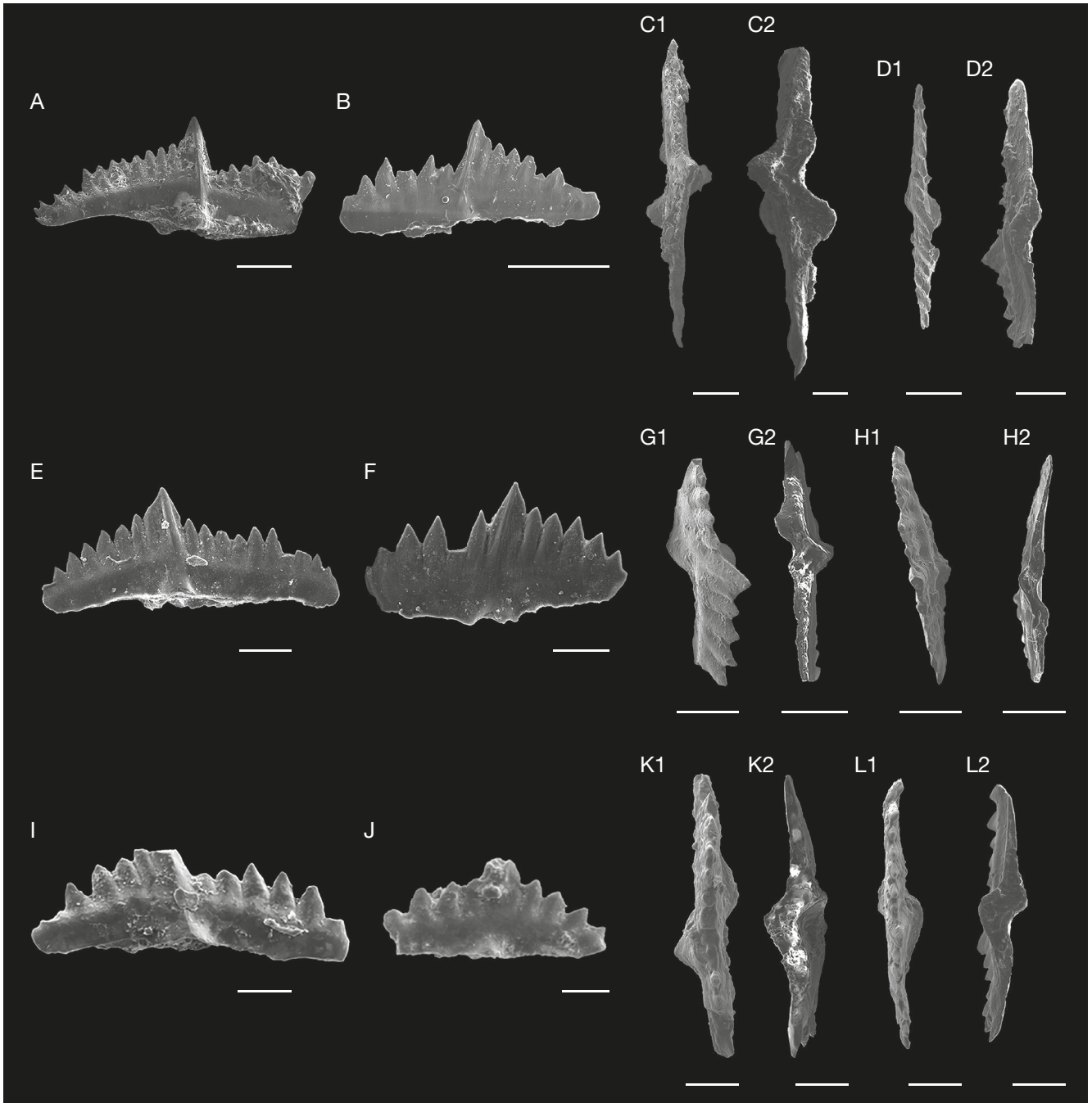


FIG. 9. — Scanning electron microphotographs of P elements in lateral, oral and aboral views of *Condorodus diablensis* n. gen., n. sp., *C. gracietae* n. gen., n. sp. and *C. chilcaensis* n. gen., n. sp.: **A-D**, *Condorodus chilcaensis* n. gen., n. sp. specimens recovered from the *Lenodus pseudoplanus* Zone: **A**, Pa element, inner lateral view, CHL4 sample, INGEO MP 1003(4); **B**, Pb element, inner lateral view, INGEO MP 1047(5); **C1, C2**, Pa element oral and aboral views; **D1, D2**, Pb element, oral and aboral views; **E-H**, *Condorodus gracietae* n. gen., n. sp. specimens recovered from the *Baltoniodus triangularis* Zone: **E**, Pa element, inner lateral view, SG2 sample, CML-C 7110(1); **F**, Pb element, inner lateral view, SG2 sample, CML-C 7111(1); **G1, G2**, Pa element, oral and aboral views; **H1, H2**, Pb element, oral and aboral views. **I-L**, *Condorodus diablensis* n. gen., n. sp. specimens recovered from the *B. triangularis* Zone: **I**, Pa element, inner lateral view, MS4 sample, CML-C 5080(2); **J**, Pb element, inner lateral view, MS4 sample, CML-C 5092(2); **K1, K2**, Pa element, oral and aboral views; **L1, L2**, Pb element, oral and aboral views. Scale bars: 0.1 mm.

According to this classification, *Condorodus* n. gen. could have a closer taxonomic relationship with the genus *Bryantodina*, and we could suggest that *Condorodus* n. gen. would have given rise to this genus; or be at the base of the family Cyrtionodontidae (*sensu* Clark *et al.* 1981) (Table 1).

Sweet (1988), introduced some modifications to the higher taxonomy of Clark *et al.* (1981), and, following that, we postulate that *Condorodus* n. gen. could be included in the order Prioniodontida Dzik, 1976 (conodonts with P positions occupied by pastinate, pectiniform elements or their platformed equivalent). Sweet (1988) inserted the new family

TABLE 1. — Comparison of the possible phylogenetic relationships of *Condorodus* n. gen. based on its carminate P elements according to the taxonomic classifications of Clark *et al.* (1981), Sweet (1988), and Dzik (1991).

Taxonomic classifications	Clark <i>et al.</i> (1981)	Sweet (1988)	Dzik (1991)
–	Phylum Conodonta Eichenberg, 1930	Phylum Conodonta Pander, 1856	Class Conodonta Pander, 1956
–	Class Conodonta Eichenberg, 1930	Class Conodonti Branson, 1938	
–	Order Conodontophorida Eichenberg, 1930	Order Prioniodontida Dzik, 1976	–
–	Superfamily Prioniodontacea Bassler, 1925	–	–
–	–	Family Plectodinidae Sweet, 1988	–
–	–	Genus <i>Plectodina</i> Stauffer, 1935;	
–	–	? <i>Tangshanodus</i> An, 1983	
–	Family Cyrtoniodontidae Hass, 1959	Family Cyrtoniodontidae Hass, 1959	–
–	Genus <i>Bryantodina</i> Stauffer, 1935;	Genus ? <i>Bryantodina</i> Stauffer, 1935;	
–	<i>Plectodina</i> Stauffer, 1935	<i>Phragmodus</i> Branson & Mehl, 1933	
–	–	Order Ozarkodinida Dzik, 1976	Order Ozarkodinida Dzik, 1976
–	–	–	Suborder Plectodinina Dzik, 1991
–	–	–	Superfamily Chirognathacea Branson & Mehl, 1944
–	–	Family Spathognathodontidae Hass, 1959	Family Plectodinidae Sweet, 1988
–	–	Genus <i>Ozarkodina</i> Branson & Mehl, 1933;	Genus <i>Plectodina</i> Stauffer, 1935;
–	–	?“ <i>Plectodina</i> ”;	<i>Microzarkodina</i> Lindström, 1971;
–	–	<i>Yaoxianognathus</i> An, 1983	<i>Yaoxianognathus</i> An, 1985;
Possible phylogenetic relationships of <i>Condorodus</i> n. gen.	Possible closer taxonomic relationship with <i>Bryantodina</i> , we suggest that <i>Condorodus</i> n. gen. would have given rise to this genus; or be at the base of the family Cyrtoniodontidae.	Possible greater affinity with the “ <i>Plectodina</i> ” group and with <i>Yaoxianognathus</i> . It could be suggesting that <i>Condorodus</i> n. gen. gave rise to the basal Ozarkodinids in the Upper Ordovician.	Possible would be at the base of the Order Ozarkodinida, and perhaps it is phylogenetically related to the genera <i>Plectodina</i> , <i>Bryantodina</i> and <i>Yaoxianognathus</i> .

Plectodinidae that includes conodonts with a pastinate element in the Pa position, an angulate pectiniform element in Pb, a dolabrate or bipennate element in M, and alate, digyrate, and bipennate ramiform elements in the Sa, Sb, and Sc positions respectively. Some of the included genera are: *Plectodina* Stauffer, 1935; and ?*Tangshanodus* An, 1983; and in the family Cyrtoniodontidae, the genera ?*Bryantodina* and *Phragmodus* Branson & Mehl, 1933. Sweet (1988) used the order Ozarkodinida established by Dzik (1976) to apparatuses with P positions occupied by carminate and angulate pectiniform elements or their platformed analogues; and within the family Spathognathodontidae Hass, 1959 incorporated genera such as: *Ozarkodina* Branson & Mehl, 1933; “*Plectodina*” (genus for species without pastinate P elements) and *Yaoxianognathus* An, 1985, among others. According to this classification, *Condorodus* n. gen. would present a greater affinity with the group created by Sweet (1988) as “*Plectodina*” and with *Yaoxianognathus*, given its carminate P elements, even without the presence of an M element so far, and it could be suggested that *Condorodus* n. gen. could have given rise to the basal Ozarkodinids of the Upper Ordovician (Table 1).

Recently, Zhen (2019) carried out a rearrangement within the Cyrtoniodontidae family of Sweet (1988) classification, including: *Bryantodina*, *Phragmodus*, *Tangshanodus* An in An *et al.* 1983 and *Protophragmodus* Zhen, 2019. This author also included *Plectodina*, *Yaoxianognathus* and *Tasmanognathus* Burret, 1979 in the family Plectodinidae. All these genera exhibit a carminate Pa element like *Condorodus* n. gen., but only *Yaoxianognathus* has similar S elements (Sc and Sd), representing possibly a major affinity with *Condorodus* n. gen. Additionally, Zhen (2019) presented a phylogenetic analysis, based on six diagnostic characters of genera included in the Cyrtoniodontidae family plus the “*Plectodina*” group that are possibly related to *Condorodus* n. gen. Beyond its superior taxonomic category, we could suggest that *Condorodus* n. gen. would be the basal group or their common ancestor (Zhen 2019: 4; fig. 2).

Finally, according to Dzik’s (1991) classification, *Condorodus* n. gen. defined in this contribution would be linked to the order Ozarkodinida Dzik, 1976; that includes genera with apparatuses with biramous P elements (carminate, angulate). That author also introduced a suborder Plectodinina

Dzik, 1991 which includes M elements with proclined cusp. The superfamily Chirognathacea Branson & Mehl, 1944, characterized by the presence of biramous lo-pl elements (dolabrate Sb and Sc elements) incorporates the family Plectodinidae Sweet, 1988; and lumps together the genera *Plectodina*, *Microzarkodina*, *Yaoxianognathus* and *Bryantodina* among others (Dzik 1991).

In accordance with the classification of Dzik (1991), the *Condorodus* n. gen. would be within the order Ozarkodinida, possibly in its base, and perhaps phylogenetically related to the genera *Plectodina*, *Bryantodina* and *Yaoxianognathus* (Table 1).

Plectodina aff. *flexa* (Rhodes, 1953), in the Dapingian of Sudetes (Kaczawa Mts., Poland) was recorded by Dzik (1990). He proposed the basal species of *Microzarkodina* as possible ancestors of the ozarkodinids. On the other hand, a recent study of Zhen (2019) mentioned a new species of *Plectodina* from upper Floian from the Horn Siltstone Valley in the Amadeus Basin, central Australia. Both species could represent the first known species of that genus to have carminate Pa and pastinate Pb elements. Taking into account the architecture of the *Condorodus* n. gen. in which both P elements are carminate and whose most basal species (*C. diablensis* n. gen., n. sp.) has the first appearance in the upper Floian (*Trapezognathus diprion* Zone), lets us to suggest that *Condorodus* n. gen. could be the original of these primitive forms of *Plectodina*, as well as the rest of the ozarkodinids, despite not having the M element yet. The Pb element seems to be the one that has undergone the major modifications throughout the Ordovician Period, probably from carminate to angulated or pastinate in the different descendant genera.

Despite the close similarity of *Condorodus* n. gen. with different known families and genera, we avoid including this new genus in a family or other upper taxonomic category due to the fact that its apparatus remains incompletely known. Therefore, future studies will be necessary to confirm the accurate taxonomic affinity of the *Condorodus* n. gen.

EVOLUTIONARY TRENDS

The taxonomic analysis of the recovered elements allows us to recognize an evolutionary pattern among the species of the *Condorodus* n. gen. This evolutionary trend is represented by progressive changes in the P elements, from basal species *Condorodus diablensis* n. gen., n. sp. (late Floian - lowermost Dapingian), followed by the intermediate species *Condorodus graciellae* n. gen., n. sp. (Dapingian) and finally the late species *Condorodus chilcaensis* n. gen., n. sp. (middle Darriwilian).

The main differences among the P elements of the three species of *Condorodus* n. gen. are: the elongation of the processes and increasing number of denticles on both processes, the progressive expansion of the basal cavity of the Pa element and the reduction of the basal cavity in Pb element, as well as a gradual variation of the inclination of the cusp, in the Pa element from proclined to erect, and in the Pb element from erect to proclined. More detailed differences of P elements are shown in Figure 9 and Table 2.

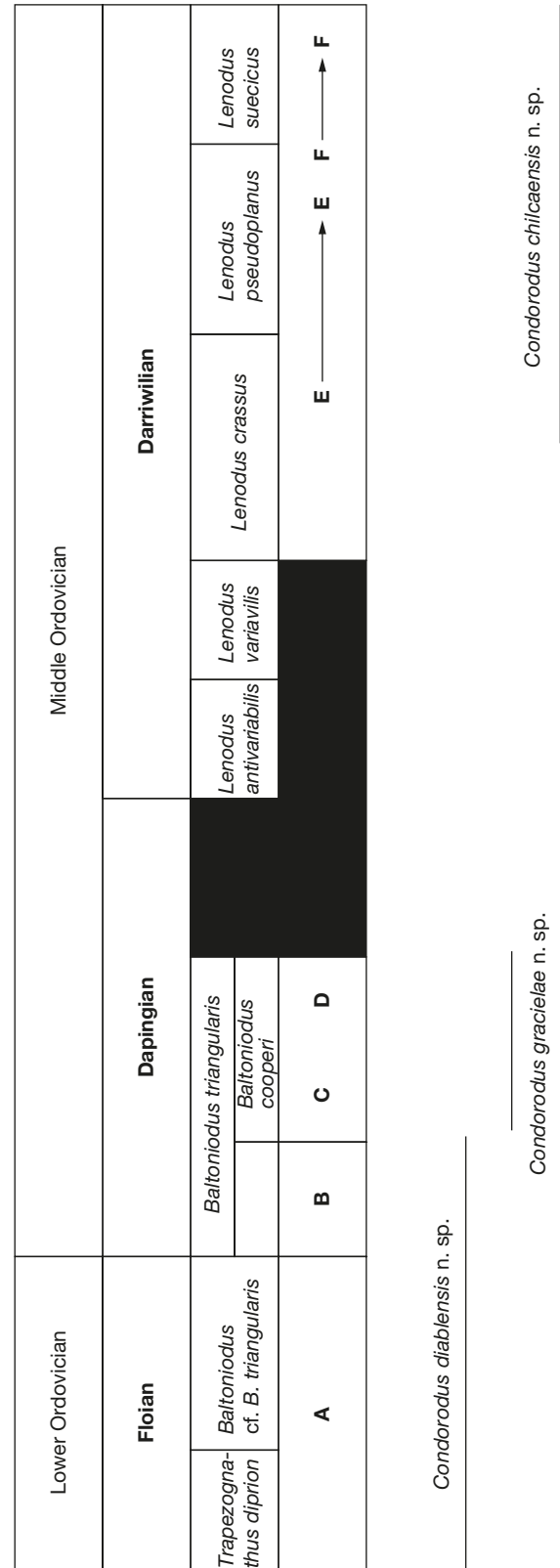


FIG. 10. — Ordovician conodont biostratigraphic chart with vertical distribution of *Condorodus* n. gen. in Argentina. The letters correspond to the studied areas where each species of *Condorodus* n. gen. was recorded: **A**, Espinazo del Diablo section, Acoite Formation; **B**, Los Colorados region, Alto del Cóndor Formation; **C**, Mojotoro Range, Santa Gertrudis Formation; **D**, Famatinian Range, Suri Formation; **E**, Cerro La Chilca section, San Juan/Los Azules formations; **F**, Las Chacritas river section, San Juan/Las Aguaditas formations.

TABLE 2. — Chart of comparison between the diagnostic morphologic features of the P elements of *Condorodus* n. gen. species.

Species	Evolutionary features
<i>Condorodus chilcaensis</i> n. gen., n. sp.	<p>Pa element The posterior process carries up to fifteen and the anterior process carry up to eight denticles, the first denticle on the posterior process is completely fused to the cusp. The two or three denticles closer the cusp on the anterior process are lower than those denticles on the anterior process. The cusp is normally two times as wide or more the width of denticles. The element shows a well-developed subrounded asymmetrical expansion of the basal cavity.</p> <p>Pb element The posterior process carries up to six and the anterior process carry up to eight denticles, the first denticle on the posterior process is fused to the cusp, which is procline and normally 1.5 as wide the width of denticles. The basal cavity shows a less development with a small expansion to the inner side.</p>
<i>Condorodus graciellae</i> n. gen., n. sp.	<p>Pa element The posterior process carries up to nine and the anterior process carries up to twelve denticles, the first denticle on the posterior process is fused to the cusp. All denticles are equivalent in size and height. The cusp is normally 1.5 as wide or less the width of denticles. The element shows the development of an asymmetrical subtriangular expansion of the basal cavity.</p> <p>Pb element The posterior and anterior processes carry up to seven denticles same in size in both processes. The cusp is well differentiable from the denticles with a strong keel in both sides of the cusp. The basal cavity is conspicuous.</p>
<i>Condorodus diablensis</i> n. gen., n. sp.	<p>Pa element The posterior and anterior processes carry up to seven denticles, the first denticle on the posterior process is partially fused to the cusp. All denticles are equal in size and height. The cusp exhibited the same width of the denticles. The element shows a less development of the asymmetrical subtriangular expansion of the basal cavity.</p> <p>Pb element The processes are the same length and both carry up four or six denticles, similar in size and height to the cusp. The basal cavity is similar to the Pa element.</p>

PALEO GEOGRAPHY AND BIOSTRATIGRAPHICAL DISPERSAL OF THE CONDORODUS SPECIES

The oldest specimens of *Condorodus* n. gen., represented by the species *C. diablensis* n. gen., n. sp., appear in the late Floian, in the *T. diprion* Zone (Carlorosi 2011, 2012), which was recovered from the siliciclastic Acoite Formation at the Espinazo del Diablo section. *Condorodus diablensis* n. gen., n. sp. also was found in the Los Colorados section but from lower Dapingian siliciclastic strata assigned to the *B. triangularis* Zone (Carlorosi 2012; Carolosi *et al.* 2013). The subsequent species, *C. graciellae* n. gen., n. sp., exhibits a geographical dispersal southward to the Mojotoro range (south of the Eastern Cordillera), reaching the volcanoclastic Famatinian Range during Dapingian time in the late *B. triangularis* Zone (*B. cooperi* subzone). Finally, *C. chilcaensis* n. gen., n. sp. arrived to the mixed carbonate Precordilleran San Juan Formation during Darriwilian time, being poorly represented in the *L. crassus* Zone, compared to the major number of elements recovered from the *L. pseudoplanus* Zone (Fig. 10). The increase in the population of *C. chilcaensis* n. gen., n. sp. probably was associated to a change in the environment or to the rise of the GOBE (Webby *et al.* 2004; Harper 2006; Stigall *et al.* 2017, 2019).

Several paleontological studies provided evidence supporting that both the Central Andean Basin and the Puna-Famatinian Basin were centers of evolutionary radiation (“centers of origin”) of several brachiopod species (Harper *et al.* 2013; Benedetto 2018), from which new taxa probably spread to neighbor-

ing areas (Sánchez & Benedetto 2004; Muñoz & Benedetto 2016; Benedetto & Muñoz 2017). The brachiopod genus *Athiella* seems to have followed the same dispersal pathway as the genus *Condorodus* n. gen. *Athiella* also originated in the Central Andean Basin during the late Floian, with the species *A. zarelai* and *A. coloradensis*, moving to Famatina during the Dapingian represented by *A. famatiniana* and arriving in the Precordillera with *A. argentina* in the Darriwilian (Benedetto 2018). The migration pathway similarity may have been responding to similar environment preferences (fine siliciclastic environments) or the opening of connections between these sedimentary basins.

The strata of the Eastern Cordillera, Famatina and Precordillera that yielded *Condorodus* n. gen. are characterized by fine siliciclastic to mixed carbonate deposits that developed in shallow environments below wave action (Astini 2003; Mestre 2011; Carolosi *et al.* 2013; Mestre *et al.* 2013), suggesting that *Condorodus* n. gen. had preferences for shallow muddy settings. Zhen (2019) proposed that those genera with carminate or angulate P elements were likely restricted to shallow-water settings, similar to the habitats preferred by *Condorodus* n. gen. Taking into account this concept, *Condorodus* n. gen. probably would have migrated to other regions of Gondwana, China and Laurentia during late Darriwilian times, where mixed carbonate shallow environments were present, possibly giving rise to younger genera such as *Plectodina*, *Bryantodina*, and *Yaoxianognathus* during the Late Ordovician (Dzik 1991; Jing *et al.* 2017; Zhen 2019).

TABLE 3. — Table showing the types of specimens recovered from each sample studied together with their repository number, locality and conodont biozone from where they were retrieved, for each of the *Condorodus* n. gen. species.

	Sample	Specimen types	Location	Conodont Zone	Total	
<i>Condorodus diablensis</i> n. gen., n. sp.	ED1	1Pa CML-C 5004(1)	Espinazo del Diablo section/Acoite Formation	<i>Trapezognathus diprion</i> Zone	1	
	MS4	21Pa CML-C 5080(1-21) 11Pb CML-C 5092(1-11) 2P CML-C 5095(1-2)	Los Colorados section/Alto del Condor Formation	<i>Baltoniodus triangularis</i> Zone	34	
<i>Condorodus graciellae</i> n. gen., n. sp.	LK9	6Pa CML-C 4010(1-5) 4Pb CML-C 4011(1-5) 1Sb1 CML-C 4013(1) 1Sb2 CML-C 4014(1)	Famatinian Basin/Suri Formation	<i>B. triangularis</i> Zone	12	
	SG2	22Pa CML-C 7110(1-21) 7Pb CML-C 7111(1-7) 1Sb1 CML-C 7112(1) 3Sc CML-C 7114(1-3) 1Sd CML-C 7115(1)	Mojotoro Range/Santa Gertrudis Formation	<i>B. triangularis</i> Zone	34	
	SG3	21Pa CML-C 7117(1-21) 14Pb CML-C 7118(1-14) 1Sc CML-C 7121(1) 1Sd CML-C 7122(1)	Mojotoro Range/Santa Gertrudis Formation	<i>B. triangularis</i> Zone	37	
	SG5	19Pa CML-C 7123(1-19) 10Pb CML-C 7124(1-10)	Mojotoro Range/Santa Gertrudis Formation	<i>B. triangularis</i> Zone	29	
	SG6	2Pa CML-C 7129(1-2)	Mojotoro Range/Santa Gertrudis Formation	<i>B. triangularis</i> Zone	2	
	SG7	8Pa CML-C 7136(1-8) 4Pb CML-C 7137(1-4) 1Sc CML-C 7140(1)	Mojotoro Range/Santa Gertrudis Formation	<i>B. triangularis</i> Zone	13	
	<i>Condorodus chilcaensis</i> n. gen., n. sp.	CHL3	1P INGEO-MP 1076(1)	Cerro La Chilca section/San Juan Formation	<i>Lenodus crassus</i> Zone	1
CHL4		9Pa INGEO-MP 1003(1-9) 5Pb INGEO-MP 1003(10-14) 2Sb1 INGEO-MP 1012(1-2) 1Sc INGEO-MP 1012(1)	Cerro La Chilca section/San Juan Formation	<i>L. pseudoplanus</i> Zone	17	
CHL5		1Pa INGEO-MP 1022(1)	Cerro La Chilca section/San Juan Formation	<i>L. pseudoplanus</i> Zone	1	
CHL6		2Pa INGEO-MP 1032(1-2) 1Pb INGEO-MP 1032(1) 2Sb1 INGEO-MP 1038(1-2)	Cerro La Chilca section/San Juan Formation	<i>L. pseudoplanus</i> Zone	5	
CHL9-10		3Pa INGEO-MP 1047(1-3) 2Pb INGEO-MP 1047(4-5) 1Sb1 INGEO-MP 1052(1) 1Sd INGEO-MP 1052(2)	Cerro La Chilca section/San Juan Formation	<i>L. pseudoplanus</i> Zone	7	
CHL14		1P INGEO-MP 1064(1)	Cerro La Chilca section/Los Azules Formation	<i>L. pseudoplanus</i> Zone	1	
Lag8		11Pa CML-C 3410(1-11) 9Pb CML-C 3410(12-20) 1Sb1 CML-C 3410(21) 1Sb2 CML-C 3410(22) 1Sd CML-C 3410(23) 2Sc CML-C 3410(24-26) 5P CML-C 3410(27-31)	Las Chacritas river section/ Las Aguaditas Formation	<i>L. pseudoplanus</i> Zone	30	
Lag5		3P CML-C 3411(1-3)	Las Chacritas river section/ Las Aguaditas Formation	<i>L. suecicus</i> Zone	3	
Lag2		1Sb1 CML-C 3412(1)	Las Chacritas river section/ Las Aguaditas Formation	<i>L. suecicus</i> Zone	1	
Lag0		2P CML-C 3413(1-2)	Las Chacritas river section/ Las Aguaditas Formation	<i>L. suecicus</i> Zone	2	
General total		—	—	—	—	230

CONCLUSIONS

We propose a new conodont genus *Condorodus* n. gen., whose apparatus contains at least six elements type: two carminate P elements, two terriopedate Sb elements, one dolabrate Sc element and one digyrate Sd element. No M or Sa elements were recovered yet. Three species are recognized, based mainly on differences of the P elements, they are: *C. diablensis* n. gen., n. sp., *C. graciellae* n. gen., n. sp. and *C. chilcaensis* n. gen., n. sp. The morphological analysis of these differences

allows inferring an evolutionary trend from the oldest species *C. diablensis* n. gen., n. sp. (late Floian), to the intermediate species *C. graciellae* n. gen., n. sp. (early Dapingian) and the youngest *C. chilcaensis* n. gen., n. sp. (early-middle Darriwilian). Its geographical and chronological distribution suggests that this genus would have originated in the Central Andean Basin (Eastern Cordillera) in late Floian, moving later to Famatina in early Dapingian and from there reached the Precordillera during the early Darriwilian, suggesting that there were connections between these three basins through these time intervals.

It is also possible to suggest, based on the architecture of the apparatus, environmental preferences, and dispersal that this new genus could be in the base of the Cyrtoniodontidae family (of Clark *et al.* 1981 classification) or the Ozarkodinids (based on the classifications of Sweet 1988 and Dzik 1991), or given rise to morphologically similar apparatuses of basal species belonging to the genera *Plectodina*, *Bryantodina* and *Yaioxianognathus* in the Late Ordovician.

Acknowledgements

This contribution was supported by CONICET through the grant PIP 2014 0058CO. Authors wish to thank to G. Sarmiento (UCM, Madrid, España) for the assistance in this paper and our technician M. González (IIM, CONICET, San Juan, Argentina) for her work at lab. We would like to thank to the associate editor, Annalisa Ferretti, the anonymous reviewer and Dr John Repetski for sparing the time for writing so many detailed and useful comments. This is a contribution to the International Geoscience Program (IGCP) Project 653 – The onset of the Great Ordovician Biodiversification Event.

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*Submitted on 8 October 2020;
accepted on 15 June 2021;
published on 5 October 2022.*