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Finding of two new radiolarian associations calibrated with ammonoids in the Vaca Muerta Formation (Late Jurassic–Early Cretaceous), Neuquén Basin, Argentina

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ABSTRACT

An association of ammonoids and radiolarians retrieved from a sedimentary section of the Vaca Muerta Formation at Vega de Escalone, Neuquén Basin, Argentina, was analized under a strict stratigraphic control. Nine ammonoid assemblage biozones were identified, indicating an age span from Early Tithonian to Late Berriasian/earlymost Valanginian for the Vaca Muerta Formation at the studied section. In connection to the ammonoid record, two radiolarian faunas were identified and named J3A1 and J3B1. Fauna J3A1, corresponding to the *Virgatosphinctes andesensis* Biozone, is dominated by nasellarian genera and represents the first Lower Tithonian radiolarian fauna described from the Neuquén Basin. Fauna J3B1, linked to the interval assigned to the *Substeueroceras koeneni* Biozone (Late Tithonian–Early Berriasian), yields abundant representatives of the Pantanellid Family. The presence of *Complexapora kozuri* (Kiessling and Zeiss) and *Loopus primitivus* (Matsuoka and Yao), two important radiolarian primary markers of the Late Jurassic in North America, supports a Late Tithonian age for at least part of the *S. koeneni* Biozone in the studied area. Nor certain Berriasian radiolarian faunas nor elements of the Vallupinae Family were identified so far at the Vega de Escalone section.

1. Introduction

The Jurassic–Cretaceous transition is recorded in Argentina in the marine rocks of the Vaca Muerta Formation, whose deposition was related to a sudden and widespread marine transgression that started in the late Lower Tithonian in the Neuquén Basin (Legarreta and Uliana, 1991). This basin (Fig. 1) is widely known for its nearly uninterrupted sedimentary infill from Late Triassic to Cenozoic times, its large extended outcrops and by the fine quality of its fossil record. All these features have made the Neuquén Basin the source of a great variety of both geological and paleontological studies in former times. Nevertheless, much remains to be described and interpreted to improve our knowledge of this western Gondwana basin.

The radiolaria have proven to be one of the most abundant zooplankton groups in Late Jurassic–Early Cretaceous rocks (Pessagno, 1976, 1977a, b; Pessagno et al., 1984, 1987, 1993; Baumgartner et al., 1995) with important biostratigraphic and taxonomic implications. Representatives of this time interval are well known worldwide but in the Neuquén Basin they were only studied by one of us in a number of articles (Pujana, 1988, 1989, 1991, 1995, 1996a, 1996b, 2000). In this contribution, we present two new radiolarian faunas, one of Early Tithonian (Fauna J3A1), and the other of Late Tithonian to Early Berriasian age (Fauna J3B1). Both are recorded in northern Neuquén province, Argentina and in connection with an accurate ammonoid based biostratigraphic control.

Figured ammonoid specimens are stored at the Paleontological Collection of the University of Buenos Aires, Argentina under numbers CPBA 21240.5, 21560-21563; 21566-21571, and fertile radiolarian slides containing the illustrated specimens are held at the Micropaleontological Collection of the University of Buenos

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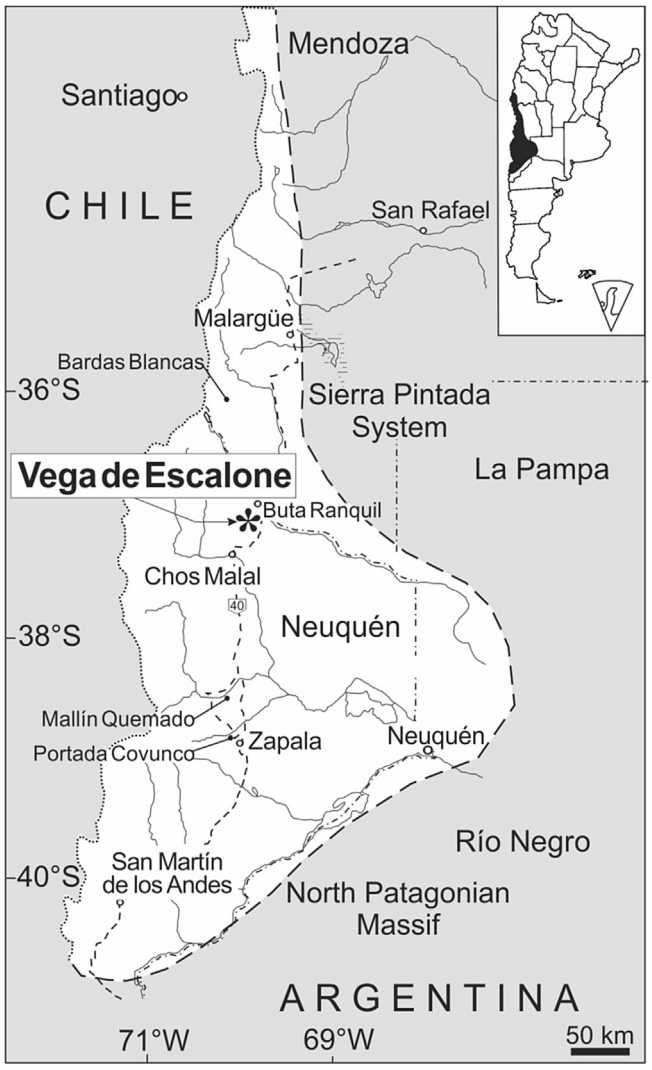

Fig. 1. Neuquén Basin geographic situation in Argentina with indication of the study area.

Aires, Argentina under numbers LM-FCEN N° 3670–3671.

2. Geological setting

2.1. Regional setting

The Neuquén Basin (Fig. 1) is a retroarc basin formed on a convergent continental margin (Legarreta and Uliana, 1996) at the foothill of the Andes. It extends over Chile and west-central Argentina between 33° and 39° southern latitude. During Mesozoic times the basin was limited eastward by the Sierra Pintada System, southeastward by the Patagonian Massif and to the west by a discontinuous active volcanic arc which allowed its communication with the Pacific Ocean (Howell et al., 2005).

The Lower Tithonian–Upper Berriasian marine rocks of the Vaca Muerta Formation (Weaver, 1931; emend. Leanza, 1972) are the result of a sudden marine transgression that, in the studied area (Fig. 2A and B), flooded the earlier continental siliciclastic sediments of the Tordillo Formation. Both lithostratigraphic units integrate the base of the Mendoza Group (Groeber, 1946; emend. Stipanicic et al., 1968).

The Vaca Muerta Formation is characterized by the rhythmic alternation of bituminous dark shales, marls and calcareous beds deposited over an homoclinal carbonate-siliciclastic ramp system dominated by external ramp facies during the Tithonian (Spalletti et al., 2000; Scasso et al., 2002; Kietzmann et al., 2008; Kietzmann and Palma, 2009), which leaded to a more inclined or a distally steepened ramp during the Berriasian (Mitchum and Uliana, 1985; Kietzmann et al., 2008). The prevailing oxygen deficient bottom conditions allowed the excellent preservation of both micro and macrofauna among which ammonoid shells are the most abundantly represented. These environmental conditions also promoted the formation of extended organic-rich facies that turned the Vaca Muerta Formation as the most important hydrocarbon source of the Neuquén Basin (Mitchum and Uliana, 1985; Vergani et al., 2011).

2.2. Fossil locality

The Vega de Escalone section (37° 11′ S; 69° 48′ W) is easily accessible. It is located in the Pampa Tril area (Fig. 2A), 72 km north of Chos Malal City. It can be reached through the intersection of the national road N° 40 with a narrow gravel road situated some kilometers north of the Chihuido del Tril (a Cenozoic basaltic neck). The gravel pathway heads to a small farm inside a marsh (*vega* in Spanish), situated over the eastward boundary of the Yesera del Tromen evaporites. The contact of the Vaca Muerta Formation with the Tordillo Formation can be reached after a 1.5 km walk either through the gravel road or through an old seismic line parallel to it. The analyzed section lies over the eastern flank of the most conspicuous structure in the region, the Yesera del Tromen Anticline (Herrero Ducloux, 1946). Nearby Vaca Muerta Formation outcrops and faunal content have been also studied by Leanza and Hugo (1977), Gulisano and Gutiérrez Pleimling (1994), Spalletti et al. (1999) and Parent et al. (2015).

2.3. Description of the section

In Vega de Escalone the Vaca Muerta Formation is 482 m thick (Fig. 3). The unit starts with thinly laminated microbialite layers and continues upwards with an abundant intercalation of mudstones, wackestones and marls forming massive, laminated and nodular beds. Calcareous nodules up to 1.5 m in diameter are common in the first part of the section, a feature which has also been observed in other areas of the basin (Damborenea and Leanza, 2016). Some tuff layers, siltstones and calcareous sandstones had also been recorded scattered over the column, as well as ferruginous surfaces and thin fibrous calcite layers. The later usually occur parallel to the stratification and are more frequent near the top of the section. These fibrous calcite layers have been formerly observed in many others localities (*e.g.* Leanza, 1973, Leanza et al., 2001), and frequently yield ammonoid and bivalve imprints (*e.g.* Damborenea and Leanza, 2016). Their formation has been recently associated with fluid overpressure episodes during hydrocarbon generation (Rodrigues et al., 2009). The top of the Vaca Muerta Formation in this locality is transitional with the coarser and shallower deposits of the Valanginian Mulichinco Formation.

Ammonoid shells are by far the most abundant fossil invertebrates through all the section, recorded both as three-dimensional internal molds holding neomorfic shell remains, or as detailed imprints. Small gastropods (*e.g. Protohemichenopus*), oysters, epibisated and shallow burrower bivalves are also found (*e.g. Liostrea*, *Huncalotis*, and "*Lucina*"). Vertebrates are usually represented by small disarticulated fish scales and bones; however a Late Tithonian to Early Berriasian crocodile skull from this locality has been recently described (Herrera, 2012; Herrera and Vennari, 2014).