
OSTRACODS AND PALEOAMBIENTAL INFERENCES IN THE PLOTTIER FORMATION (CONIANCIAN - UPPER CRETACEOUS) OF THE BARREALES LAKE, NEUQUÉN

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ABSTRACT: Upper Cretaceous outcrops, at the northeast of Barreales lake, Neuquén, Argentina, has given in the last 20 years a rich vertebrate fauna including dinosaur, reptiles, fish and plants on different sites. In this contribution, rocks of the Plottier Formation at Babilonia Site at Proyecto Dino Geopaleontological Park have given, for the first time, an interesting microfauna composed by ostracods. The ostracofauna recovered is represented by the family Ilyocyprididae with four taxa, *Neuquenocypris calfucurensis* Musacchio, 1973, *Neocyprideis zampalensis* (Angelozzi, 1980), *Neuquenocypris tenuipunctata* Musacchio & Simeoni, 1991 and *Neuquenocypris nahuelniyuensis* Musacchio, 1989 and the family limnocytheridae, with one taxa *Vecticypris* sp. The association of these ostracod indicates a paleoenvironment characterized by a shallow meandering river with low energy, probably an abandoned oxbow lake. Palaeoecological analyses indicate a fresh water with fluctuating oligohaline salinities throughout deposition.

KEY WORDS: Ostracods, Upper Cretaceous, Neuquén, paleoecology Plottier formation, Argentina

Micropaleontological studies on the Neuquén Basin are abundant; mainly from Lower Cretaceous marine outcrops, of Agrío Formation (Concheyro et al., 2009; Simeoni & Musacchio, 1996), Bajada del Agrío Group (Musacchio, 1979; Bertels, 1990; Leanza, 2003), Huitrín Formation, (Simeoni, 1988; Ballent et al., 2006). Some studies includes paleoecological and paleoambiental implications. Upper Cretaceous non-marine ostracod in Patagonia were described mainly form Río Negro and Mendoza provinces (Musacchio, 1989, 2003). Most of them belong to the Allen Formation (Musacchio, 1973; Angelozzi, 1980; Ballent, 1980; Kielbowicz, 1980; Musacchio & Simeoni, 1989, 1991; Ballent & Carignano, 2008; Carignano & Ballent, 2009; Carignano & Varela, 2011).

The rich vertebrate fauna at the continental upper Cretaceous Neuquén Group (Calvo et al., 2011 and references indeed), contrast with the few records of invertebrates. Most of the invertebrates recorded belong to the pelecypod

Diplodon at Cerro Lisandro Formation (Leanza et al., 2004; Salgado et al., 2009; González Riga & Ortiz, 2014), Portezuelo Formation (Calvo, 2006) and Plottier Formation (Leanza & Sanchez, 2001; Calvo et al., 2011; Kihn & Calvo, 2018). The micropaleontological invertebrates is not common in rocks of the Neuquén Group and it is probably that the absence of them is due to the oxygenated environment. The only record of ostracods in the Neuquén Group comes from the Plottier Formation and it is restricted to just one locality, Zampal site, at Mendoza province (Musacchio, 2006; Musacchio & Valleti, 2007). At this site, six ostracods genera were recovered: *Ilyocypris*, *Neuquenocypris*, *Talicyprideinae*, *Paralimnocythere?*, *Wolburgiopsis* and *Neocyprideis*. These species were associated with two taxa of Charophyta, one Lycophitae and three morphological taxa of probable angiospermous affinity. This microfossil assemblages suggest a stable regimen of shallow-water deposits and oligotrophic conditions. At Neuquén province, the record of Upper Cretaceous ostracods is very scarce; just a brief description was made by Kihn & Calvo (2018) from Babilonia dinosaur site, Plottier formation on the north coast of Barreales Lake, Neuquén (Fig. 1). This finding indicates an oligohaline sweet shallow water, probably an abandoned meandering river. The Babilonia site has been worked for more than 10 years looking for dinosaurs; in there, a dissarticulated titanosaurid is being excavated (Calvo et al., 2013, 2014). Moreover, other materials were found such as crocodiles and theropod dinosaur teeth, roots, pelecypods (Calvo et al., 2013). In this paper, we present a detailed description of shells and carapace of the ostracods belonging to the families Ilyocypridae and Limnocytheridae found at Babilonia site, Plottier formation, and make a paleoecological interpretation with discussion about the age of it.

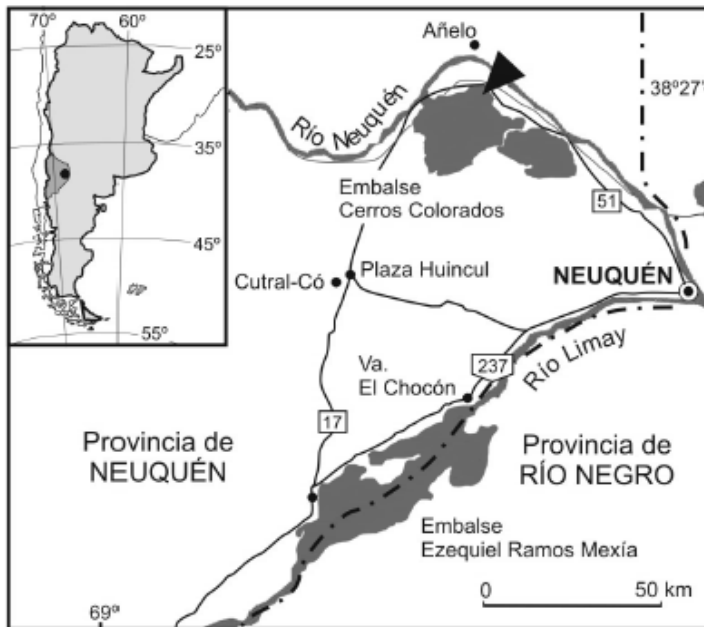


Figure 1. Map showing the Babilonia quarry where the samples were collected (taken from Veralli y Calvo, 2004).

GEOLOGICAL SETTINGS

The Neuquén Group (Digregorio, 1972; Cazau & Uliana, 1973; Legarreta & Gulisano, 1989; Hugo, 2001) includes Río Limay, Río Neuquén and Río Colorado subgroups (Leanza & Hugo, 2001). The material described here comes from continental deposits from the middle of Plottier Formation (Fig. 2).

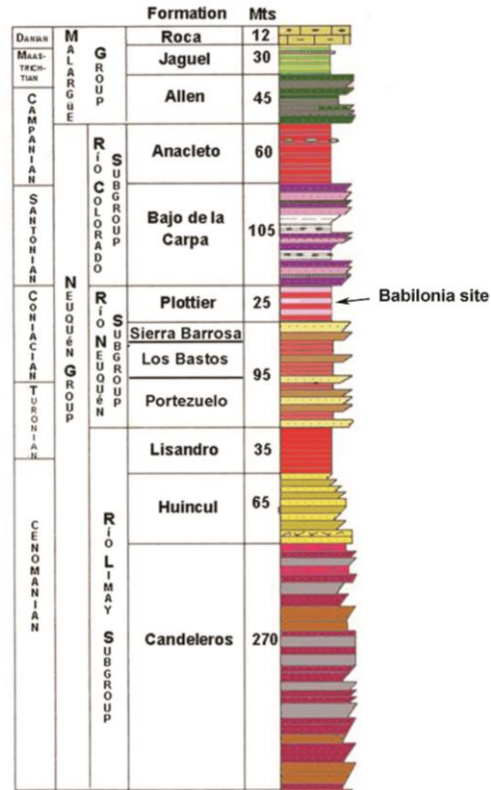


Figure 2. Profile of Neuquén Group (modified from Leanza, 1999; Garrido, 2010).

This formation shows a wide distribution and outcrops on the oriental border of the Neuquén Basin in Neuquén province. In general, the Plottier formation shows red to brown fine sandstones and claystones, with some conglomerates. On the northeast coast of Barreales Lake, the Plottier formation has been interpreted has low energy deposits related to alluvial plains (Cazau & Uliana, 1973; Ramos, 1981). The outcrops occupy a small part of the hill and they have claystones with intercalations of fine sandstones (Sanchez et al., 2000). On the bottom of the formation, sediments were deposited by a low energy fluvial system, as part of a meandering river where the organic remains were trapped in a point bar. There, the fine grained and continuous sedimentation on the floodplain deposits was due to periodically flooding close related to shallow channels. These outcrops were deeply studied by Sanchez et al. (2006) and they suggest on the bottom of

the formation a low sinuosity and ephymeorus fluvial system. On the Babilonia site, on the middle portion of the Formation, ostracod were collected from a 20 centimeters thick green claystone within a fine conglomerate (Fig. 3). The environment was interpreted as a meandering river system in a flattened area of exuberant vegetation, developed in humid climate conditions (Sánchez et al., 2005) and the ostracods were found on the base of ancient channels of abandoned meandering rivers surrounded by humidity paleosols (Calvo et al., 2014). The age of Plottier Formation has been dated as Coniacian – Santonian based on microfossil studies (Musacchio, 2006; Musacchio & Vallati, 2007).

MATERIAL AND METHODS

We analyzed 9 samples from the Babilonia quarry, five of them were fertile for microfossils. Dry samples were processed and disaggregated using 10% hydrogen peroxide, washed through a sieve of 63 µm mesh and dried at room temperature. From the residue, 5 g of material was extracted; all the valves and carapaces were picked and studied under binocular microscope. The taxonomic identification has been discussed previously by Martin & Davis (2001), Bertels (1972), Musacchio (1973, 1989) and Musacchio & Simeoni (1989, 1991), among others. The studied material is deposited at the Geology and Paleontology Museum of the National University of Comahue at Proyecto Dino Geo-Paleontological Park, (MUCPi).

SYSTEMATIC PALEONTOLOGY

Order PODOCOPIIDA Sars, 1866
Suborder CYPRIDOCOPINA Jones, 1901
Superfamily CYPRIDOIDEA Baird, 1845
Family ILYOCYPRIDIDAE Kaufmann, 1900
Genus *Neuquenocypris* Musacchio, 1973

Neuquenocypris calfucurensis Musacchio, 1973
(Fig. 3E)

1973 *Ilyocypris* (*Neuquenocypris*) *calfucurensis* Musacchio, p. 17-20, lám.
1989 *Neuquenocypris calfucurensis* n. comb. Musacchio, p. 835.

Referred material. 3 fragments of the posterior half of the valve, MUCPi 27,28,29.

Distribution. Species originally described for the late Campanian (Anacleto Formation) in Paso Córdoba and near of Vista Alegre, Río Negro and Neuquén province respectively, Argentine, associated with non-marine ostracods and charophyte (Musacchio, 1973; Musacchio & Simeoni, 1989, 1991). It was also found in samples from the Loma Puntuda locality and near the Salitral de Santa Rosa (Eastern sector of the Neuquén Basin), Allen Formation (Carignano & Varela, 2011).

Neocyprideis zampalensis (Angelozzi) 1980
(Fig. 3A)

1978 *Ilyocypris* sp. Musacchio ien Uliana y Musacchio, pág. 119, figs. 1-3.
1980 *Ilyocypris zampalensis* Angelozzi, lám. II, figs. 12-15.
2011 *Neuquenocypris zampalensis* (Angelozzi), Ballent et al. pág. 521

Referred material. 4 adult valves, MUCPi 30, 31, 32, 33.

Dimensions of illustrated examples. L= 0,856 mm, H= 0,480 mm.

Observations. The specimens recovered is very similar to the specimen showed by Angelozzi, (Fig. 15, 1980).

Neuquenocypris tenuipunctata Musacchio & Simeoni, 1991

(Fig. 3C)

1991 *Neuquenocypris tenuipunctata* Musacchio & Simeoni, p. 370-371, figs. 10.1, 10.2, 10.5-10.7.

Dimensions of illustrated examples. L= 0,771 mm, H= 0,435 mm.

Referred material. 5 adult valves and 3 juvenile valves, MUCPi 34, 35, 36, 37, 38 39, 40, 41.

Neuquenocypris nahuelniyuensis Musacchio, 1989

(Fig. 3B)

1989 *Neuquenocypris nahuelniyuensis* Musacchio, p. 386.

Dimensions of illustrated examples. L= 0,653 mm, A= 0,353 mm.

Referred material. 6 valves. MUCPi 42-43-44-45-46-47.

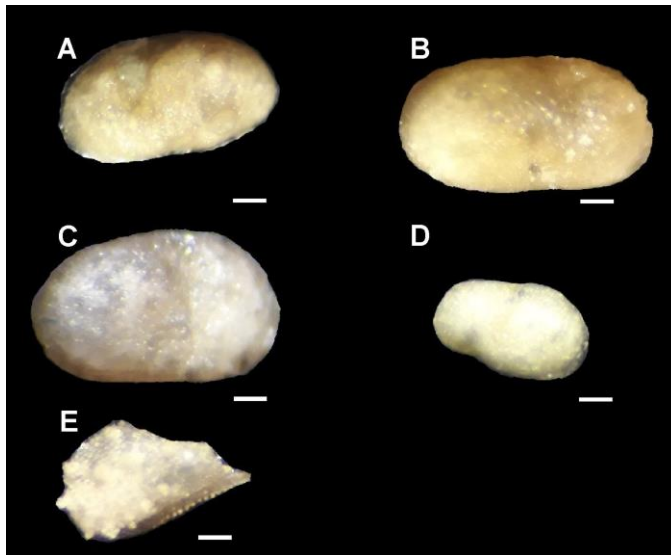


Figure 3. A, *Neocyprideis zampalensis* (Angelozzi) 1980, MUCPi 30 external view RV; B, *Neuquenocypris nahuelniyuensis* Musacchio, 1989, MUCPi 42 external view RV; C, *Neuquenocypris tenuipunctata* Musacchio & Simeoni, 1991, MUCPi 34 external view LV; D, *Vecticypris* sp., MUCPi 48 external view RV; E, *Neuquenocypris calfucurensis* Musacchio, 1973, MUCPi 27 external view, posterior half. Scale: 0.1mm.

Suborder CYTHEROCOPINA Baird, 1850

Superfamily CYTHEROIDEA Baird, 1850

Family LIMNOCYTHERIDAE Klie, 1938

Subfamily TIMIRIASEVIINAE Mandelstam, 1960

Genus *Vecticypris* Keen, 1972

Vecticypris sp.
(Fig. 3D)

Dimensions of illustrated examples. L= 0,626 mm, A= 0,414 mm, a= 0, 231 mm.

Referred material. 2 valves, MUCPi 48-49.

Description. Carapace heart-shaped in posterior view, subtriangular in dorsal view with posterior margin truncated and anterior margin acuminate. In lateral view, the margin of the valve is strongly convex dorsally, rounded anteriorly, slightly convex ventrally, and rounded posteriorly. The maximum height is at the median region. Surface of valves ornamented with a punctuated. In an internal view a narrow calcified internal lamella is on the anterior area. Hinge made in the right valve by an elongated anterior socket, a smooth middle bar. The left valve has a posterior tooth.

DISCUSSION AND CONCLUSIONS

At Babilonia site, several ostracods species have been found; among them the Llyocyprididos are represented by the genus *Neuquenocypris* (Musacchio, 1973). This taxa has been recognized in Argentina from the Aptian to the Paleocene in marine and no-marine rocks; most of times it was found associated to charophytes and other fresh water ostracods (Musacchio & Simeoni, 1991). This genus also have been found at the Upper Cretaceous of Brazil (Días-Brito et al., 2001) and Bolivia (Camoin et al., 1991). Carignano & Varela (2011) described many species of *Neuquenocypris* in rocks of the Allen Formation (Upper Cretaceous) in the Neuquén Basin. Outside of South America the taxa was found in the upper cretaceous of France (Babinot et al., 1996). The new finding of *Neuquenocypris calfucurensis*, *N. zampalensis* y *N. tenuipunctata* allow us to expand both the geographic distribution and the temporal range of these taxas.

All the species described here were only mentioned on rocks of Campanian-Maastrichtian times (Carignano & Varela, 2011; Carignano & Ballent, 2009). Therefore, the ostracods *Neocyprideis zampalensis*, and *Vecticypris* sp., found on the Plottier formation allow to increase the biochron of them up to Coniacian times.

Plottier formation was interpreted as sediments deposited at a low energy in wide alluvial plains (Cazau & Uliana, 1973; Ramos, 1981). On them, small body waters and some paleosols were developed (Garrido, 2000). However, Sánchez et al. (2006) recognized a paleoenvironment composed by floodplain deposits with ephemeral channels developed under climatic changes that produced great fluctuations on the fluvial regime.

On the Babilonia site the fossil record includes cranial materials, caudal and cervical vertebrae, hind and forelimbs, etc. of a disarticulated titanosaurid sauropod; theropod and crocodiles teeth; roots replaced by copper and carbon; pelecypods and ostracods (Calvo et al., 2013; Kihn & Calvo, 2018). All this evidence together with the sedimentological data such as the presence of slickensides, is interpreted as a meandering river such as a fluvio-lacustrine systems and spring-fed wetlands, and wet paleosols. The weather was alternating

from wet to dry seasons with an anoxic environment, probably the high level of a groundwater.

Ostracods recorded at Babilonia site is interpreted as the oligo to mesohaline water from a low energy river in shallow channel. This interpretation is confirmed because the valves of ostracods are complete. The ostracods were found together with pelecypods, *Diplodon* sp. (Kihn & Calvo, 2018), which live in freshwater and brackish water (Carignano & Varela, 2011). These pelecypods are in very well conditions indicating a river of low energy or a small lake. Therefore, all the evidence, based on the paleovertebrate, paleoflora together with this new evidence of ostracods, reaffirm the hypothesis that the paleoenvironment of the Plottier Formation, at this part of the basin, was a wide area with a meandering river, small lakes and wet paleosols. The microfaunistic association and the mollusks found allow inferring a depositional environment corresponding to a shallow fresh to oligohaline low-energy water body for the studied levels of the lower reaches of the Plottier Formation in this sector of the Neuquén Basin; This information allows corroborating the previously proposed hypothesis of the presence in some sectors of abandoned meanders or oxbow.

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