

New Upper Cretaceous Limnocytheridae (Ostracoda, Crustacea) from Argentina

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ABSTRACT: Five new species of ostracods, *Paralimnocythere musacchioi* n. sp., *Paralimnocythere aucamahuevoensis* n. sp., *Wolburgiopsis ballentae* n. sp., *Looneyellopsis multiornata* n. sp. and *Vecticypris punctata* n. sp. are described. The significant number of Limnocytheridae taxa shows the importance of the family in brackish to freshwater Campanian-Maastrichtian sediments of the Allen and Loncoche Formations (Neuquén Basin, Argentina) and provide new paleogeographic and biostratigraphic data of each genera. Our results extend the paleogeographic and biostratigraphic range of the genera. *Looneyellopsis* has a widespread geographic range through Late Cretaceous, and documents affinities with associations from Southern Europe of the same age. *Vecticypris* is the only genus of Timiriaseviinae which is represented, so far, in the uppermost Cretaceous deposits of the Neuquén Basin. A new species of *Wolburgiopsis* confirms the great significance of this genus in the Upper Cretaceous.

Keywords: Neuquén Basin, non marine ostracods, late Campanian-early Maastrichtian, Limnocytherinae, Timiriaseviinae.

INTRODUCTION

The Limnocytheridae Klie 1938 is a worldwide distributed group of ostracods, known from limnic environments at least since the Pennsylvanian (Whatley and Mognilevsky 1996). Two lineages can be recognized on the basis of carapace and appendages morphology: the Timiriaseviinae Mandelstam 1960 and the Limnocytherinae Klie 1938 subfamilies. The Subfamily Timiriaseviinae is characterized by a swollen carapace with brood pouch and the lack of sieve pores. On the other hand, the Subfamily Limnocytherinae has narrower carapaces with sieve pores, and no brooding cavity (Colin and Danielopol 1980, Martens 1995). For a complete discussion about this topic see Sames (2011).

The studies of the fossil Limnocytheridae from Argentina have been scarce and most of them are from Lower Cretaceous deposits (Musacchio 1970; Musacchio and Chebli 1975; Musacchio and Palamarczuk 1975; Ballent et al. 2011). During Late Cretaceous times at least some limnocytherids were a common component of the ostracod associations from this region (Carignano 2012).

From the Loncoche Formation (upper Campanian-lower Maastrichtian, Neuquén Basin), Bertels (1972) referred to a moderately diverse association of ostracods and charophytes; among the ostracods she described the species *Wolburgia? neocretacea*.

Musacchio, in Uliana and Musacchio (1978), defined the genus *Wolburgiopsis* based on *Wolburgia? neocretacea* and assigned to it several species from Cretaceous sediments of Argentina. He also identified a new ostracod "*Gomphocythere? payunensis*" Musacchio 1978 and mentioned the presence of *Timiriasevia?*

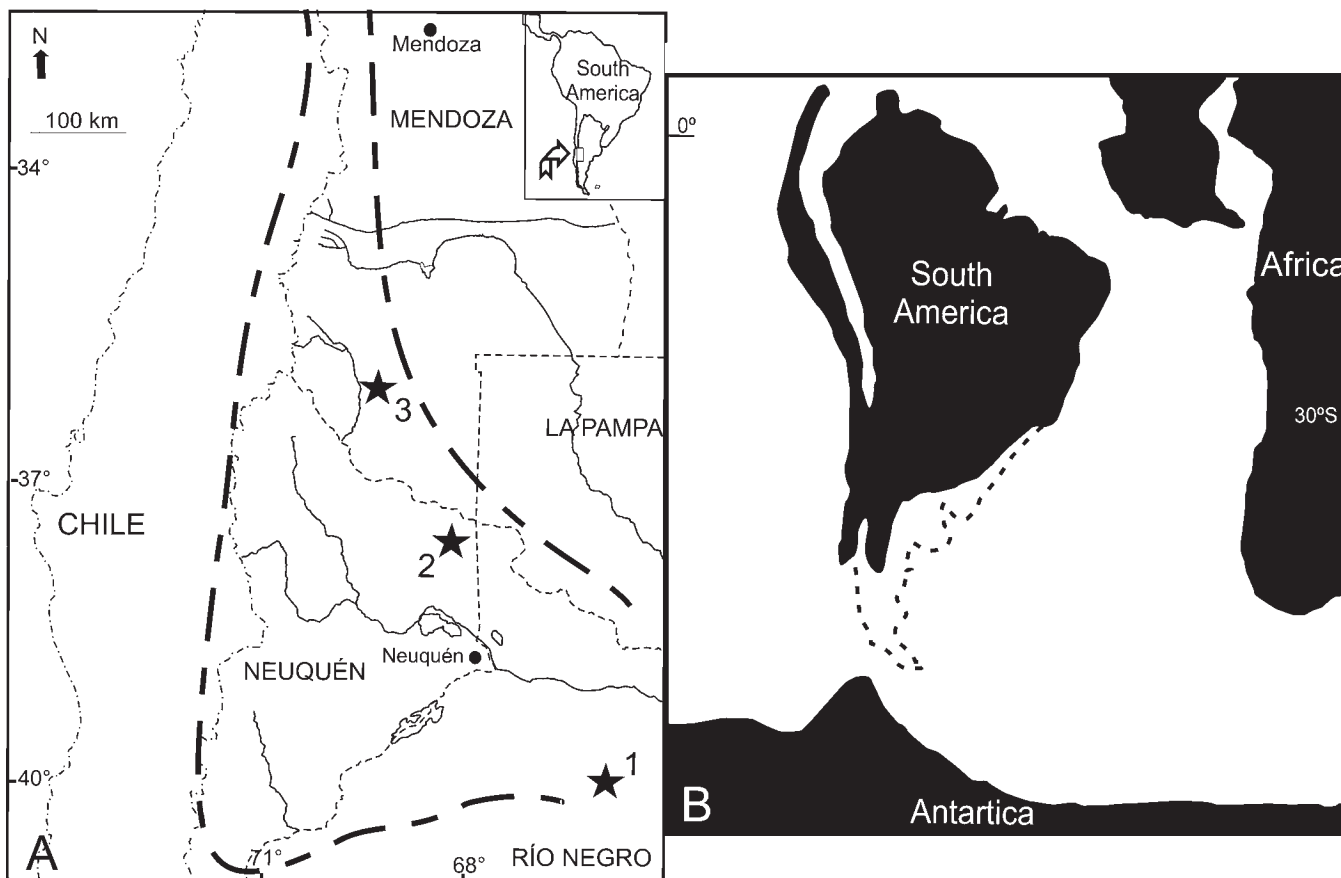
sp. Recently, Musacchio and Vallati (2007) briefly described an association of ostracods, charophytes and seeds from the Plottier Formation (upper Coniacian-lower Santonian, Neuquén Basin), in which they found the species *Paralimnocythere? sp.* Carignano and Varela (2011) studied samples from the Allen Formation (upper Campanian-lower Maastrichtian, Neuquén Basin) from which they recorded the species *Wolburgiopsis neocretacea* (Bertels) and *Vecticypris sp.*

The present paper describes five new species from the Allen and Loncoche formations which were recovered at several locations in Mendoza, Neuquén and Rio Negro provinces from sediments deposited under fresh to brackish water conditions. Of these new species, four belong to the Limnocytherinae and one to the Timiriaseviinae subfamilies. This work aims to provide a clear description of these limnocytherids from the Late Cretaceous of Argentina, taking into account their paleogeographic distributions and relationships with other ostracods, e.g. between species of *Paralimnocythere* from South America.

GEOLOGICAL SETTING AND LOCALITIES

The Neuquén Basin is located in the west-central area of Argentina, between latitude 32° and 41°S. From 37° S, it runs parallel to the Argentine Andes with a north-south orientation up to San Juan province. To the south of 37°S the basin extends eastwards and this is called Neuquén Embayment (Legarreta and Uliana 1991; Leanza et al. 2004) (text-fig. 1A).

The basin was formed during the Triassic period, when large areas of the Andean basement were subject to a considerable extensional regime (Ramos 1999; Legarreta 2002).



TEXT-FIGURE 1

A. Map of the Neuquén Basin (limits with dashed line) and localization of the three sampled sites, 1 Loma Puntuda, Río Negro Province, 2 Auca Mahuevo, Neuquén Province, 3 Ranquil-Có, Mendoza Province. B. Paleogeographic scene during the Maastrichtian (72-65 ma) in South America, dashed lines represents the actual limits of the continent (modified from Vrielynck and Bouysse 2003).

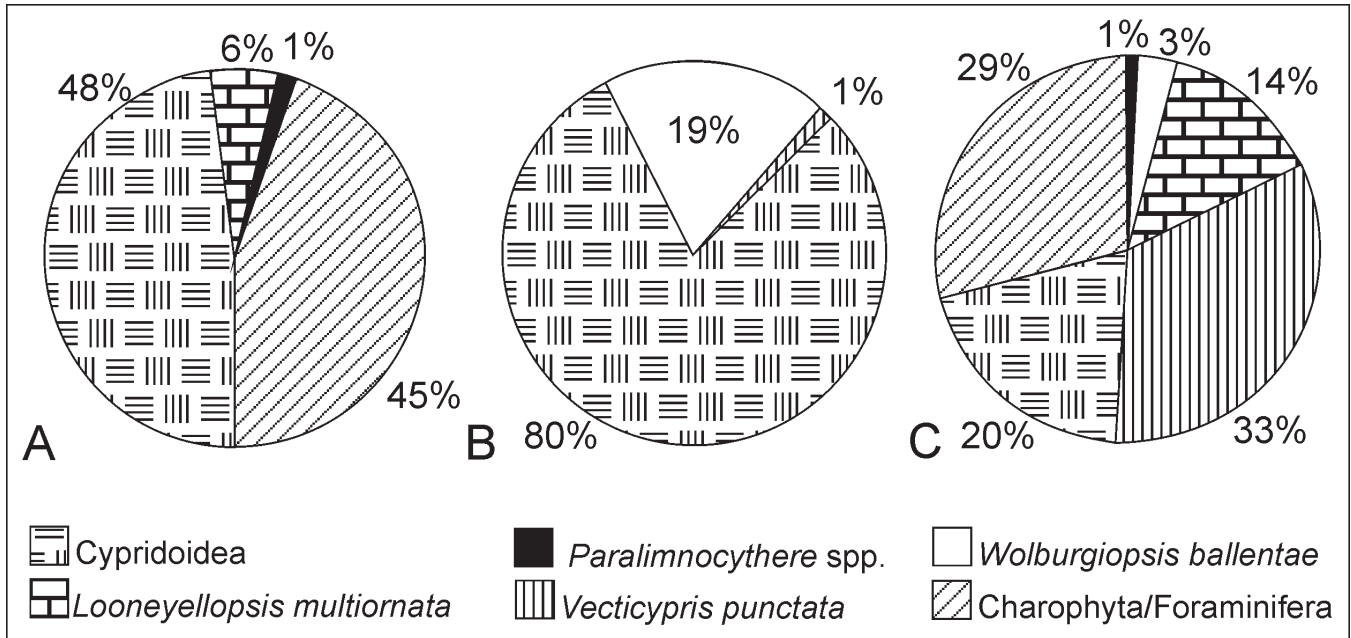
The Neuquén Basin ranges in age from Late Triassic to early Paleocene, and is characterized by a remarkable cyclicity that includes marine and continental siliciclastic, calcareous and evaporitic sediments. These were deposited during different tectonic phases (Howel et al. 2005), the last of which began during the Late Cretaceous, when the basin developed into a foreland basin, and the sediments of the Neuquén and Malargüe Groups were deposited (Tunik et al. 2010).

The Late Cretaceous period was marked by fluctuating climates and sea levels. During the Maastrichtian, extensive areas of South America were flooded by shallow epicontinental seas (text-fig. 1 B). In Argentina, this transgression penetrated deep into the continent, connecting the Colorado and Neuquén Basins, invading wide areas of the southern region and extending northwards through a long stretch of sea (Náñez and Malumián 2008; Benedetto 2010). This transgressive sea, named Kawas Sea, was characterized by flat coasts surrounded by lagoons where fresh and marine conditions alternated; it gradually passed into floodplains and shallow freshwater bodies which were widely vegetated and connected with low energy rivers (Casamiquela 1978).

The Allen Formation (Neuquén and Río Negro provinces) is part of the Malargüe Group. It is considered to be late Campanian-early Maastrichtian based on magnetostratigraphical and micropalaeontological data (Náñez and Concheyro 1997; Dingus et al. 2000). A similar age is given for the Loncoche Formation (northwest of Neuquén and south of Mendoza provinces) based on vertebrate associations (González Riga 1999). Both formations were deposited under brackish to freshwater conditions, in fluvial and lacustrine to marginal marine environments (tidal flats, sabkhas and lagoons) (González Riga and Parras 1998; Parras et al. 1998; Rodríguez 2011).

The samples studied in the present work come from the following three localities:

Auca Mahuevo (Neuquén Province), located approximately between 37°56' S – 68°28' W, is a well-known dinosaur-nesting site (Chiappe and Coria 2004). Here the Allen Formation comprises 38 m of cross-bedded sandstones which pass upwards into a homogeneous sequence of green and yellowish grey mudstones, with some fine-grained sandstone and evaporite beds. The microfossils assemblage includes abundant non marine cypridoid ostracods such as *Neuquenocypris allenensis*



TEXT-FIGURE 2

Relative abundance of ostracods in comparison to Foraminifera and Charophyta in each studied site. A. Allen Formation, Auca Mahuevo, Neuquén Province. B. Allen Formation, Loma Puntuda, Río Negro Province. C. Loncoche Formation, Ranquil-Có, Mendoza Province.

(Angelozzi 1980), ?*Candona bellula* Yang 1982, and *Cypridopsis* sp. The limnocytherids *Looneyellopsis multiornata* n. sp. and *Paralmnocythere aucamahuevoensis* n. sp. are less abundant (text-fig. 2 A). Foraminifers are represented by hyaline forms such as *Protelphidium* sp. and *Patellina subcretacea* Cushman and Alexander 1930, porcellaneous forms like *Quinqueloculina antiqua* Franke 1928 and few agglutinated similar to *Ammobaculites* (Ballent and Carignano 2008; Carignano 2012). The depositional paleoenvironment was interpreted by Carignano and Garrido (2006) as a lagoon with freshwater input, allowing a mixture of the microfauna.

Loma Puntuda (Bajo de Santa Rosa, Río Negro Province), located between 40°1' S – 66°49' W; this section of the Allen Formation is represented by 15 m of fine sandstones and laminated or massive mudstones, and ends with a 30 cm layer of gypsum. The macrofossils are represented by the molluscs *Diplodon* sp. and *Paleoanculosa* sp., vertebrate remains and dinosaur eggshells. The microfossil association is dominated by *Neuquenocypris tenuipunctata* Musacchio and Simeoni 1991, *Ilyocypris riograndensis* Musacchio and Simeoni 1991 and *Wolburgiopsis ballentae* n. sp. (text-fig. 2 B). The bearer levels were deposited in a shallow and low energy freshwater body, close to the coast, e.g. small ponds associated with an estuary (Carignano and Varela 2011).

Ranquil-Có (Mendoza Province), located between 36°12' S – 69°30' W; the Loncoche Formation reaches here 174 m of thickness, and is divided in two units, a lower calcareous-clastic and an upper evaporitic one. González Riga (1999) recorded a large amount of vertebrate remains (fishes, amphibians and reptiles). The microfossils assemblage is composed of abundant charophytes and non-marine ostracods, with *Looneyellopsis*

multiornata n. sp., *Vecticypris punctata* n. sp. and *Candona* sp. as the dominating ostracod species (Carignano 2012) (text-fig. 2 C). The fossiliferous strata were deposited in a shallow, low energy freshwater body, which was subsequently invaded by fluvial channels associated with estuaries (González-Riga 1999).

MATERIAL AND METHODS

Processing followed the standard methodology; the samples were treated for 1-3 hs with water and hydrogen peroxide (10%), then washed through a 63µm sieve with tap water and finally oven dried (30°C). The microfossils were picked under a Nikon SMZ645 stereomicroscope. The selected specimens were mounted on stubs using carbon conductive adhesive tape, gold coated and scanned with a JEOL JSM-6360LV Scanning Electron Microscope at the Servicio de Microscopía Electrónica del Museo de La Plata. The classification for suprageneric categories followed Martin and Davis (2001). Terminology for carapaces descriptions followed Kesling (1951). Measurements are indicated in mm: very small (<0.400); small (0.401-0.500); medium (0.501-0.700); big (0.701-0.900); very big (>0.900). The common abbreviations used are RV (right valve), LV (left valve), H (height), W (wide), and L (length). The figured specimens are deposited in the Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Buenos Aires Province, in the Departamento de Ecología, Universidad Nacional del Comahue, Río Negro Province and in the Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales, Mendoza Province. Abbreviations for repositories are: MLP-MI (Museo de La Plata – Sección Micropaleontología), UNCPMIC (Universidad Nacional del Comahue - Colección de Paleontología-Microfósiles, Bariloche), and IANIGLA-PI

(Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales – Colección de Paleoinvertebrados).

SYSTEMATIC PALEONTOLOGY

Subclass PODOCOPA Müller 1894

Order PODOCOPIDA Sars 1866

Suborder CYTHEROCOPINA Baird 1850

Superfamily CYTHEROIDEA Baird 1850

Family LIMNOCYTHERIDAE Klie 1938

Subfamily LIMNOCYTHERINAE Sars 1925

Genus *Paralimnocythere* Carbonnel 1965

Type species *Paralimnocythere bouleigensis* Carbonnel 1965

Discussion: *Paralimnocythere* Carbonnel 1965 was first described to group those limnocytherids with bifurcated marginal pore-canals and adont hinge. Martens (1992) reviewed this taxon and reassigned several species to *Paralimnocythere*, considering the genus as Miocene to Recent with a Palearctic distribution. Due to the preservation of the specimens studied here, it was not possible to observe the marginal pore canals. There are however, some features present that strongly resemble those of some species of *Paralimnocythere*. These include a posterior squarish and a very acuminate anterior region in dorsal view, the dorsal margin sloping backwards, the presence of tubercles and an alar expansion that modifies the outline of the carapace in dorsal view (see Martens 1992, p. 128).

Paralimnocythere musacchioi Carignano and Cusminsky **n. sp.**

Plate 1, Figures 1-2, 4

Type specimens: Holotype: UNC-PMIC 102, a carapace. Paratypes: IANIGLA-PI 2981, a carapace.

Type Locality and horizon: Allen Formation at Loma Puntuda, Bajo de Santa Rosa, Río Negro province, sample 7. Additional material from the Loncoche Formation at Ranquil-Có, Mendoza province, samples 4, 7, and 9241.

Material: twelve carapaces and two valves.

Etymology: The species is named in honor to Prof. Dr. Eduardo Musacchio, an important Argentinean researcher on mesozoic freshwater ostracods and charophytes of South America.

Diagnosis: a species of *Paralimnocythere* Carbonnel with subtrapezoidal outline, reticulated surface with almost hexagonal fossae and delicate muri, and a smooth posterodorsal tubercle.

Description: small, subtrapezoidal carapace. In lateral view the dorsal margin is straight, faintly sloping backwards and becoming slightly concave close to the posterior region. The posterior margin is rounded, more obliquely in its ventral portion. The ventral margin is concave towards the middle section of the carapace. The anterior margin is widely rounded. The carapace is higher at the anterior region. In dorsal view, the carapace has a lanceolate outline, with a sharpened anterior margin and a squarish posterior one. The LV is larger than the RV, overlapping this one in the dorsal margin. The ventral region of the carapace is expanded by the presence of an alar expansion that modifies the outline in dorsal view. In lateral view, the ornamentation is formed by a mediodorsal sulcus that almost reaches the alar expansion. In front of it, another oblique de-

pression can be seen which begins a little behind the anterior cardinal angle and also reaches the ventral margin. Between this depression and the anterior margin, a vertical lobe is delimited, which barely extends below mid-height. Parallel to the anterior margin a vertical rib can be seen, especially in the holotype. The rest of the ornamentation is represented by a posterodorsal tubercle pointing backwards and a reticulation with almost hexagonal fossae and delicate muri, which covers the lateral surface without preferential arrangement; the anterior region is smooth. The hinge of the RV is formed by two terminal teeth and a median groove. The inner lamella is moderately broad. The rest of the internal features are unknown.

Dimensions: UNC-PMIC 102 H= 0.243mm, W= 0.204mm, L= 0.403mm. IANIGLA-PI 2981 H= 0.266mm, L= 0.433mm.

Stratigraphic and geographical distribution: upper Campanian-lower Maastrichtian, Neuquén Basin, Argentina, outcrops of the Allen Formation at Loma Puntuda, Río Negro Province and of the Loncoche Formation, at Ranquil-Có, Mendoza Province.

Discussion: the present species is similar to *Paralimnocythere* sp. in Musacchio and Vallati (2007, p. 276), from the Upper Cretaceous of Plottier Formation, Mendoza. *Paralimnocythere musacchioi* n. sp. differs in its dorsal margin sloping backwards and in a less swollen alar expansion. *Paralimnocythere aucamahuevoensis* n. sp. has a more sharpened posterior margin, the anterior margin is more expanded, its ornamentation is weaker, with a more open reticulum; moreover, the shape of the alar expansion is different.

Paralimnocythere aucamahuevoensis Carignano and Cusminsky **n. sp.**

Plate 1, Figures 3, 5-7

Paralimnocythere? sp. CARIGNANO and GARRIDO 2006, p. 216 – CARIGNANO 2009, p. 13

Type specimens: Holotype: MLP-MI 1880, a carapace. Paratype: MLP-MI 1881 and 1883, carapaces.

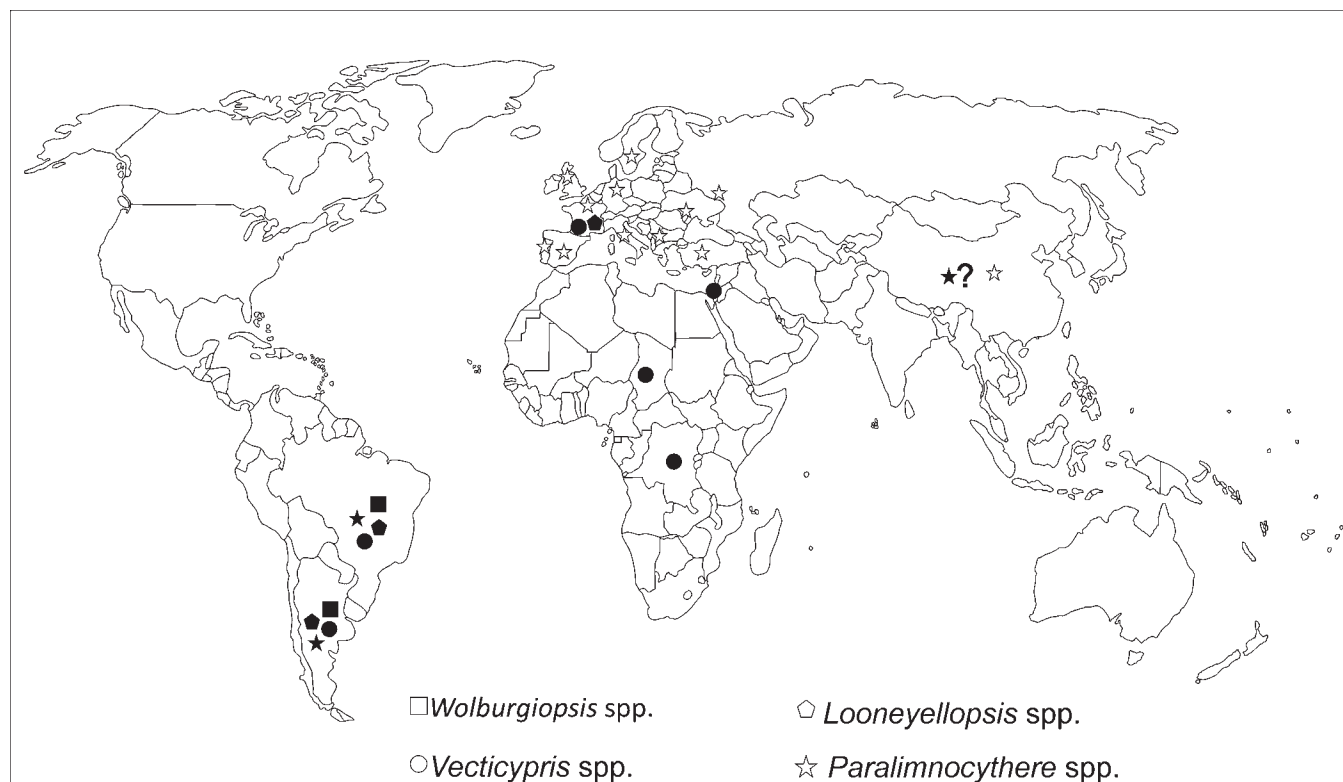
Type Locality and horizon: Allen Formation, Auca Mahuevo site, Neuquén province, Argentina. Sample 5.

Etymology: after Auca Mahuevo, the type locality.

Material: 21 carapaces.

Diagnosis: a species of *Paralimnocythere* Carbonnel ornamented by a posterodorsal tubercle that points backwards and a slender, much extended, s-shaped alar expansion which ends in a small protuberance. Surface ornamentation with thin ribs forming a polygonal reticulum and running parallel at the ventral surface. The dorsal margin of the carapaces is strongly inclined backwards.

Description: medium size, subtrapezoidal carapace. In lateral view, with a strong backward inclination of the dorsal margin and a convexity of the ventral border which is most distinct in the middle. The anterior margin is broadly rounded and more prominent anteroventrally. The posterior margin is dorsally concave and ventrally sloping upwards, thus producing a small tip in its median position. Greatest height at about 2/3rd of carapace length. In dorsal view the carapace is lanceolate, anteriorly very acuminate and with a squarish posterior margin that ends pointed. The LV is slightly larger than the RV, and overlaps the



TEXT-FIGURE 3

Global distribution of the genera *Looneyellopsis*, *Paralimnocythere*, *Vecticypris* and *Wolburgiopsis*. Black symbols are for fossils and white symbols for living species.

latter at about the middle of the dorsal margin. The lateral surface of the valves presents a mediodorsal sulcus, somewhat slanting anteriorly. In front of it there is another depression almost parallel to the anterior margin and up to the half of the height of the carapace. The ornamentation also includes a posterodorsal tubercle that points backwards and a slender, s-shaped, longitudinally arranged alar expansion, with about 1/3 of the length of the carapace. This alar expansion ends in a protuberance. The valves are covered by a delicate polygonal reticulation, finer at the tubercle surface. At the anterior region there is a fine rib that ends at the cardinal angle. The ventral surface is covered by a set of three longitudinally arranged ribs. Abductor muscle scars arranged in a vertical row of four scars (Pl. 1, fig. 7).

Dimensions: MLP-Mi 1880 H=0.287mm, W=0.291mm, L=0.547mm. MLP-Mi 1881 H=0.258mm, W=0.257mm, L=0.547mm. MLP-Mi 1883 H=0.118mm, W=0.095mm, L=0.3mm.

Stratigraphic and geographical distribution: upper Campanian-lower Maastrichtian, Neuquén Basin, Argentina, outcrops of the Allen Formation at Auca Mahuevo, Neuquén Province.

Discussion: *Paralimnocythere aucamahuevoensis* n. sp. strongly resembles some species of *Paralimnocythere* Carbonnel. It differs from *Paralimnocythere? hasuii* Musacchio 2001 (in Dias Brito et al. 2001, p. 257) from the Late Cretaceous of

Brazil, by the absence in the Brazilian species of the tubercles, its swollen alar expansion and an almost horizontal dorsal margin. In comparison with *Paralimnocythere ochridense* (Klie) (in Martens 1992, p. 137) a recent species from Macedonia, the present species shares the general outline of the carapace, especially the squarish posterior border seen in dorsal view and the ornamentation type; but *Paralimnocythere aucamahuevoensis* n. sp. has a sloping dorsal border, its reticulation is wider and more delicate, and the shape of its alar expansion is different.

Genus *Wolburgiopsis* Musacchio 1978

Type species *Wolburgia? neocretacea* Bertels 1972

Discussion: this taxon is assigned to the Limnocytherinae because of the following features: carapace well calcified, with sexual dimorphism, females without brooding pouch, vertical sulcus and antimerodont hinge (Colin and Danielopol 1978, 1980; Danielopol et al. 1989; Martens 1995).

Wolburgiopsis ballentae Carignano and Cusminsky n. sp.

Plate 1, Figures 8-11

Wolburgiopsis neocretacea (Bertels). CARIGNANO and VARELA 2011, p. 174, figs. 4 O-Q.

Type specimens: Holotype: UNC-PMIC 91, a carapace. Paratypes: UNC-PMIC 92 male carapace, UNC-PMIC 93 female carapace, UNC-PMIC 104, LV.

Type Locality and horizon: Allen Formation at Loma Puntuda, Bajo de Santa Rosa, Río Negro Province, sample 7.

Material: 274 carapaces and 62 valves, Allen Formation, Loma Puntuda, Río Negro.

Etymology: The species is named after our beloved Prof. Dr. Sara Ballent, a recognized Argentinean researcher on Mesozoic marine ostracods and foraminifers.

Diagnosis: a species of *Wolburgiopsis* Musacchio with a small, subrectangular and strongly inequivalve carapace, with the larger LV overlapping the RV on the posterior border. Surface of the valves ornamented by rounded fossae and broad muri.

Description: very small carapace with subrectangular outline in lateral view; anterior border rounded, posterior border truncated on its dorsal half and variably expanded on its ventral half; dorsal border straight, slightly sloping backwards; ventral border convex, gently expanded and concave in its posterior third. Outline in dorsal view sub-elliptic, with the anterior border acuminate and the posterior with the edge of the left valve projecting outwards. Two weak sulci are visible on the anterior-dorsal region of the carapace, better seen in dorsal view. Ornamentation represented by a coarse and irregular reticulum of shallow and rounded pits with broad walls; scattered between these pits some sieve pores can be observed (Pl. 1, fig. 8.); the margins of the valves are smooth. Hinge formed in the LV by two terminal sockets and a median bar, RV with two lobulated terminal teeth and a median groove. Inner lamella moderately wide.

The species presents sexual dimorphism: female carapaces slightly inflated laterally at the posterior half, male carapaces display homogeneous width along their length.

Dimensions: UNC-PMIC 91 H= 0.165mm, L=0.335mm. UNC-PMIC 92 W=0.125mm L= 0.365mm. UNC-PMIC 93 W=0.128mm, L= 0.339mm. UNC-PMIC 104 H=0.165mm, L= 0.309mm.

Stratigraphic and geographical distribution: upper Campanian-lower Maastrichtian, Neuquén Basin, Argentina, outcrops of the Allen Formation at Loma Puntuda, Río Negro Province.

Discussion: in contrast to *Wolburgiopsis neoretacea* (Bertels), this new species has a smaller, strongly inequivalve and more subrectangular carapace, with evidence of sexual dimorphism and its ornamentation is smoother, with broad muri and shallow fossae. *Wolburgiopsis vicinalis* Musacchio 1978 from the Upper Cretaceous of Argentina (in Uliana and Musacchio 1978, p. 127) is very similar to *Wolburgiopsis ballentae* n. sp. however, the carapace of the former species is bigger, with rounded margins in dorsal view and a subelliptic rather than subrectangular outline in lateral view.

Genus *Looneyellopsis* Krömmelbein and Weber 1971

Type species *Looneyellopsis brasiliensis* Krömmelbein and Weber 1971

Discussion: this genus was originally described from the Early Cretaceous of Brazil, and also recorded from the Lower Cretaceous La Amarga Formation (Neuquén Basin) (Musacchio 1970). Outside of South America, *Looneyellopsis* has been mentioned by Babinot (2003) from the Campanian of France.

Looneyellopsis multiornata Carignano and Cusminsky n. sp.
Plate 1, Figures 12-16

Type specimens: Holotype: a carapace, MLP-Mi 1885. Paratypes: carapaces MLP-Mi 1886, 1888. Additional material IANIGLA-PI 2982-2983

Type Locality and horizon: Allen Formation, Auca Mahuevo, Neuquén, Argentina, sample 5.

Etymology: referring to the profuse ornamentation of the specimens.

Material: 109 carapaces, Allen Formation, Auca Mahuevo, Neuquén Province, one carapace from the same formation, Loma Puntuda, Río Negro Province, 65 carapaces from the Loncoche Formation, Ranquil-Có, Mendoza Province.

Diagnosis: a species of *Looneyellopsis* with its carapace ornamented by a subcentral tubercle, a large posterodorsal tubercle that points backwards and a small posterior tubercle; a ventral alar expansion carrying three more, less developed tubercles, two vertical lobes near the anterior margin of the carapace, and irregular reticulation along the valves surface.

Description: very small, subtrapezoidal carapace. In lateral view, the dorsal margin is straight, slightly sloping backwards with distinct cardinal angles. The ventral margin is concave, the anterior margin rounded and the posterior margin is obliquely rounded in its ventral part. The greatest height is coincident with the anterior cardinal angle. In dorsal view, the carapace is subelliptic with an anterior acuminate margin and a more rounded posterior margin. The LV is slightly larger than the RV, overlapping it especially at the dorsal and posteroventral margins. The carapace is strongly ornated with a well developed posterodorsal tubercle, protruding from the dorsal border, a less developed anterior one, with more rounded outline and in a subcentral position, and a smaller posterior one located almost at the same height of the anterior tubercle. An alar expansion is developed at the ventral region of the carapace that carries three more small tubercles. The alar expansion is posteriorly curved towards the dorsal margin. All the tubercles are covered by a coarse reticulum, with deep and almost pentagonal fossae (Pl. 1, fig. 16). Near to the anterior margin of the carapace there is a vertical lobe which extends from the dorsal margin to mid-height. Below it, in some specimens there is another vertical less developed lobe. The rest of the carapace is covered by a set of slender ribs forming an irregular reticulum. On the ventral surface the ribs are longitudinally arranged.

Dimensions: MLP-Mi 1885 H=0.197mm, L=0.358mm. MLP-Mi 1886 W=0.16mm, L=0.36mm. MLP-Mi 1888 L= 0.31mm, H=0.15mm. IANIGLA-PI 2982 L=0.338mm, H= 0.178mm. IANIGLA-PI 2983 L=0.39mm, H=0.204mm.

Stratigraphic and geographical distribution: upper Campanian-lower Maastrichtian, Neuquén Basin, Argentina, outcrops of the Allen Formation at Auca Mahuevo, Neuquén Province and at Loma Puntuda, Río Negro Province, outcrops of the Loncoche Formation at Ranquil-Có, Mendoza Province.

Discussion: The species presents some degree of polymorphism; some recovered carapaces are subrectangular in lateral view and narrow in dorsal view, with much more developed tubercles and lobes; the anterior lobe is obliquely projected from the midline to the sides of the carapace in dorsal view. For the

moment, these are included in *Looneyellopsis multiornata* n. sp., considering them as ecophenotypic variations (Pl. 1, fig.15).

Looneyellopsis multiornata n. sp. is very similar to *Looneyellopsis brasiliensis* Krömmelbein and Weber 1971 and *Looneyellopsis chinamuertensis* (Musacchio 1970) two species known in South America, especially considering their carapace outline and the presence of numerous tubercles and an alar expansion. Despite these similarities, *Looneyellopsis brasiliensis* Krömmelbein and Weber 1971 (p. 29) from the Early Cretaceous of Brazil has a longer alar expansion, that can be entirely smooth or with an anterior tubercle. In *Looneyellopsis chinamuertensis*, from the Early Cretaceous of Patagonia, Argentina (Musacchio 1970, p. 306) the number of tubercles is smaller and the posterodorsal ones are connected. The surface of the carapace is in this case, covered by a fine punctuation, which becomes thicker on the posterior and ventral margins.

Subfamily TIMIRIASEVIINAE Mandelstam 1960
Genus *Vecticypris* Keen 1972

Type species *Vecticypris jacksoni* Keen 1972

Discussion: Colin et al. (2000) unified the ancient species of *Metacypris* Brady and Robertson 1870 with a convex dorsal margin under the genus *Vecticypris* Keen. This genus, which was originally described from the Paleogene of northwest Europe, has a hinge with smooth and elongated terminal elements and a short median element, an underdeveloped anterior vestibule and a duplicature with strong selvage and flange (Keen 1972; Colin et al. 2000).

Vecticypris punctata Carignano and Cusminsky n. sp.
Plate 1, Figures 17-21

Vecticypris sp. CARIGNANO and VARELA 2011 p. 174, figs. 4 R-V.

Type specimens: Holotype: RV, UNC-PMIC 99. Paratypes: LV, UNC-PMIC 100. Additional material IANIGLA-PI 2984, carapace, IANIGLA-PI 3027, LV.

Type Locality and horizon: Loma Puntuda, Bajo de Santa Rosa, Río Negro Province, sample 7.

Etymology: The name refers to the punctuation of the valves.

Material: 10 valves and fragments, Allen Formation, Loma Puntuda, Río Negro. 74 carapaces and 13 valves, Loncoche Formation, Ranquil-Có, Mendoza.

Description: a medium sized, subtrapezoidal rounded, equi-valve carapace with thin valves. In lateral view the dorsal margin is strongly convex and sloping to the front. The anterior margin is rounded and ventrally curved. The ventral margin is gently convex. The posterior border is widely rounded. The greatest height is at the middle of the valves. In dorsal view the carapace is subtriangular, with an acuminate anterior margin and a truncated posterior one. The greatest width is behind the half of the valves. In posterior view the carapace is heart shaped. The surface of the valves is densely punctated. On the ventral surface the punctae are arranged parallel to the margins of the valves, giving the appearance of fine striations. Hinge of the RV with an elongated anterior tooth, a smooth median groove and a short posterior tooth. The inner lamella is moderately broad at the anterior margin and narrow posterior, with a

well developed selvage on the LV and a flange on the RV (Pl. 1, figs. 19-20).

Dimensions: UNC-PMIC 99 L= 0.626mm, H= 0.414mm. UNC-PMIC 100 L=0.556mm, H=0.379mm. IANIGLA-PI 2984 W= 0.431 mm, L= 0.608 mm, H= 0.419 mm. IANIGLA-PI 3027 L= 0.621 mm, H= 0.428 mm.

Stratigraphic and geographical distribution: upper Campanian-lower Maastrichtian, Neuquén Basin, Argentina, outcrops of the Allen Formation at Loma Puntuda, Bajo de Santa Rosa, Río Negro Province; outcrops of the Loncoche Formation at Ranquil-Có, Mendoza Province.

Discussion: this new species is comparable with *Vecticypris* cf. *V. polita* (Grékoff 1960) from the Late Cretaceous of Brazil (Dias-Brito et al. 2001, p. 256), with whom it shares the general shape of the carapace; although *Vecticypris punctata* n. sp. is more triangular in dorsal view. *Vecticypris xestoleberiformis* (Colin) from the Cenomanian of France (Colin 1974, p. 184) differs from the present species in the dorsal outline, which is more rounded and in the ornamentation of the valves, less densely pitted. *Metacypris* sp. C in Schäfer 2005 (p. 99) from the early Miocene of Switzerland is very similar in its outline and has also punctated ornamentation of its valves, but in dorsal view is more swollen than *Vecticypris punctata* n. sp.

PALEOBIOGEOGRAPHIC CONSIDERATIONS

The genus *Paralimnocythere* currently inhabits the Palearctic region (Martens 1992; Kulköyliölu 2003; Mischke et al. 2003; Smith and Horne 2004; Mischke et al. 2007). It is known from this region since Miocene, although Martens (1992) refers to a possible record in the Early Cretaceous of China. Musacchio (in Dias-Brito et al. 2001) first mentioned the presence of *Paralimnocythere* in the Cretaceous of South America. Subsequently, Carignano and Garrido (2006) and Musacchio and Vallati (2007) found the genus in the Upper Cretaceous of the Neuquén Basin (text-fig. 3). These findings represent so far the oldest record of the genus, at least until its presence in the Early Cretaceous of China is confirmed.

Wolburgiopsis is an extinct limnocytherid genus represented by seven species, usually recorded from Cretaceous deposits of Argentina and Brazil (Uliana and Musacchio 1978; Gobbo-Rodrigues et al. 1999; Dias-Brito et al. 2001) (text-fig. 3). It is almost always found associated with species of Ilyocyprididae, suggesting similar paleoenvironmental requirements for both genera.

Looneyellopsis is known from lower Cretaceous deposits of Brazil and Argentina (Musacchio 1970; Krömmelbein and Weber 1971; Musacchio et al. 1986; Do Carmo et al. 2004 as *Wolburgiopsis chinamuertensis*). Babinot et al. (1996) recorded the species *Looneyellopsis reticulatus* Babinot 1980 in early Campanian deposits of France, here also associated with Ilyocyprididae; e.g. *Neuquenocypris colloti* (Babinot 1975) (text-fig. 3). The presence of *Looneyellopsis multiornata* n. sp. in the upper Campanian-lower Maastrichtian of Argentina shows additional evidence of the affinities between the Upper Cretaceous non-marine deposits of southern Europe (since the Campanian-Maastrichtian of northern Europe is marine) and South America, as already pointed out by Babinot et al. (1996) and Musacchio (1990; 2001). Particularly, the latter states that the faunal exchange with other regions started in Aptian times and persisted during the Late Cretaceous and early Paleogene

(Musacchio 2001). *Vecticypris* Keen is a fossil genus recorded from the Paleogene of northwest Europe, the Cenomanian of France, Turonian-Santonian of Brazil, Early Cretaceous of Israel and Aptian-Albian of Africa (Colin et al. 2000; Dias-Brito et al. 2001). *Vecticypris punctata* n. sp. represents the first record of this genus for the upper Campanian-lower Maastrichtian of Argentina. (text-fig. 3) The lowest abundance of the Timiriasevinae in the associations studied here is coincident with the paleogeographic scenario prevailing during the later Cretaceous. As already mentioned, the presently recorded limnocytherids genera are also known from the Adamantina Formation (Bauru Group, Brazil), which was considered by Dias-Brito et al. (2001) as Turonian-Santonian in age. Affinities with this formation were already indicated by Dias-Brito et al. (2001), Musacchio 2001, Musacchio and Vallati 2007.

CONCLUSIONS

Five new species of the Family Limnocytheridae are described in the present work. During the Campanian-Maastrichtian the subfamily Limnocytherinae was represented by a group of small ostracods that became important components of the assemblages, while the Timiriasevinae remained as a minor part of them. The presence of *Paralimnocythere musacchioi* n. sp. and *Paralimnocythere aucamahuevoensis* n. sp. along with the species previously described by Musacchio (in Dias-Brito et al. 2001 and in Musacchio and Vallati 2007) provides more data on the paleogeographic and biostratigraphic distribution of the genus *Paralimnocythere*. The finding of *Wolburgiopsis ballentae* n. sp. in the upper Campanian-lower Maastrichtian deposits is a further addition to the high representativeness of *Wolburgiopsis*

PLATE 1

Late Cretaceous Limnocytheridae from Argentina.

Paralimnocythere musacchioi Carignano and Cusminsky, n. sp.

- 1 Carapace, left lateral view, holotype UNC PMIC 102. Allen Formation, Loma Puntuda, Río Negro Province.
- 2 Carapace, left lateral view, Paratype IANIGLA-PI 2981. Loncoche Formation, Ranquil-Có, Mendoza Province.
- 4 Carapace, dorsal view, holotype UNC PMIC 102. Allen Formation, Loma Puntuda, Río Negro Province.

Paralimnocythere aucamahuevoensis Carignano and Cusminsky, n. sp.

- 3 Carapace left lateral view, holotype MLP-MI 1880. Allen Formation, Auca Mahuevo, Neuquén Province.
- 5 Carapace, dorsal view, paratype MLP-MI 1881. Allen Formation, Auca Mahuevo, Neuquén Province.
- 6 Carapace, ventral view, paratype MLP-MI 1881. Allen Formation, Auca Mahuevo, Neuquén Province.
- 7 Juvenile carapace, right lateral view and detail of muscle scar, paratype MLP-MI 1883. Allen Formation, Auca Mahuevo, Neuquén Province.

Wolburgiopsis ballentae Carignano and Cusminsky, n. sp.

- 8 Male carapace, right lateral view and detail of the sieve pores (arrows), holotype UNC-PMIC 91. Allen Formation Loma Puntuda, Río Negro Province.
- 9 Male carapace, dorsal view, paratype UNC-PMIC 92. Allen Formation, Loma Puntuda, Río Negro Province.
- 10 Female carapace, dorsal view, paratype UNC-PMIC 93. Allen Formation, Loma Puntuda, Río Negro Province.

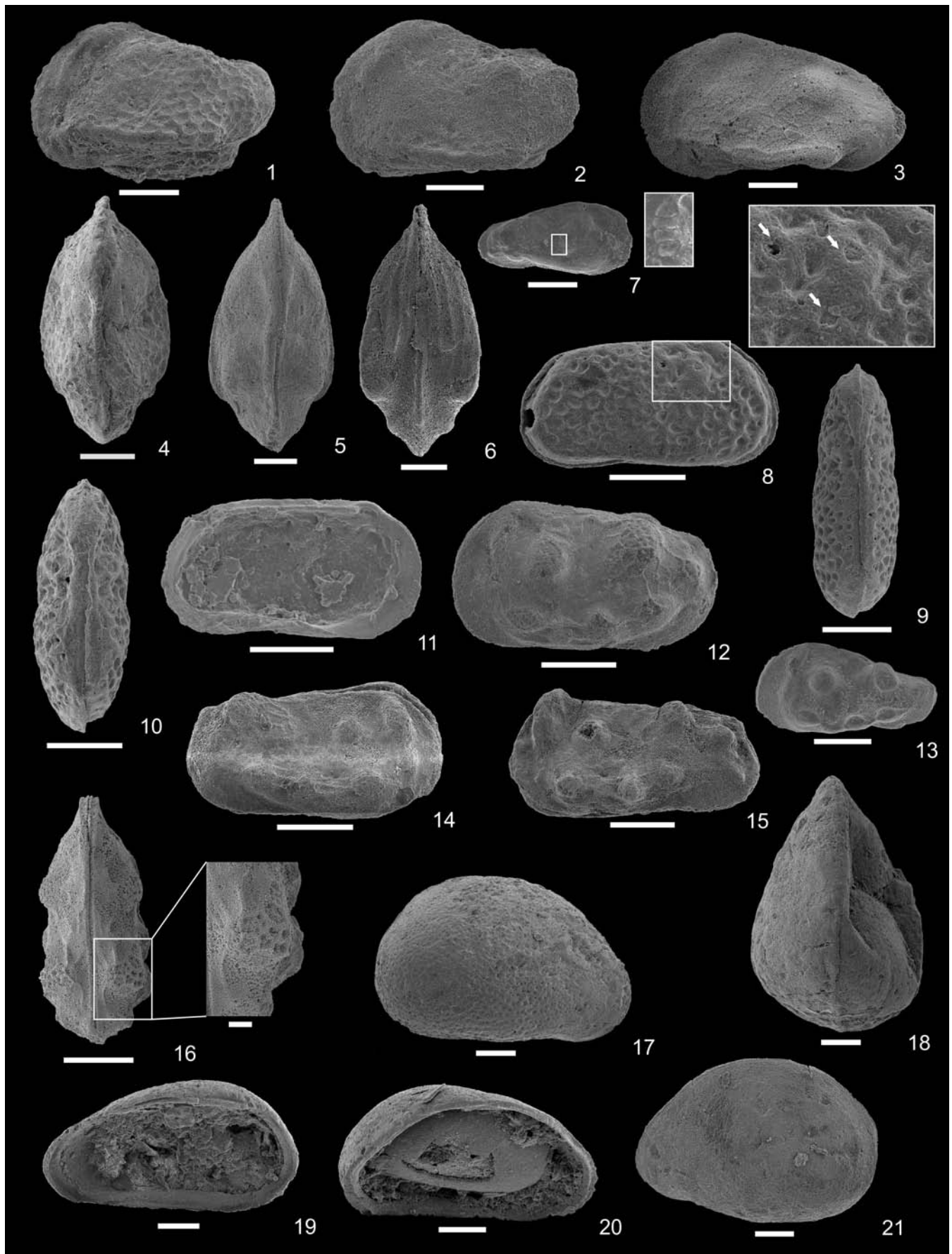
- 11 LV lateral internal view, paratype UNC-PMIC 104. Allen Formation Loma Puntuda, Río Negro Province.

Looneyellopsis multiornata Carignano and Cusminsky, n. sp.

- 12 Carapace left lateral view, holotype MLP-MI 1885. Allen Formation, Auca Mahuevo, Neuquén Province.
- 13 Juvenile carapace, left lateral view, paratype MLP-MI 1888. Allen Formation, Auca Mahuevo, Neuquén Province.
- 14 Carapace right lateral view, paratype IANIGLA-PI 2982. Loncoche Formation, Ranquil-Co, Mendoza Province.
- 15 Carapace, left lateral view, paratype IANIGLA-PI 2983. Loncoche Formation, Ranquil-Co, Mendoza Province.
- 16 Carapace, dorsal view and details of the ornamentation, paratype MLP-MI 1886. Allen Formation, Auca Mahuevo, Neuquén Province.

Vecticypris punctata Carignano and Cusminsky, n. sp.

- 17 RV lateral view holotype UNC-PMIC 99. Allen Formation, Loma Puntuda, Río Negro Province.
- 18 Carapace, dorsal view, IANIGLA-PI. 2984. Loncoche Formation, Ranquil-Có, Mendoza Province
- 19 RV lateral internal view, holotype UNC-PMIC 99. Allen Formation, Loma Puntuda, Río Negro Province.
- 20 LV lateral internal view, paratype UNC-PMIC 100. Allen Formation, Loma Puntuda, Río Negro Province.
- 21 LV lateral view, paratype IANIGLA-PI 3027. Loncoche Formation, Ranquil-Có, Mendoza Province.



in the Late Cretaceous of Argentina. *Looneyellopsis multinotata* n. sp. represents the earliest record of the genus in South America. Its presence in the studied sediments is a new evidence of the affinity between the Campanian-Maastrichtian faunas of South America and the Northern Hemisphere. So far, *Vecticypris punctata* n. sp. is the only representative of the subfamily Timiriaseviinae in the uppermost Cretaceous deposits of the Neuquén Basin. This lack of records could possibly be due to paleoenvironmental conditions. The microfossils associations, together with the macrofauna and the type of sediments encountered in the aforementioned formations, indicate that these Limnocytherids inhabited freshwater to oligohaline environments.

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