Journal of South American Earth Sciences 84 (2018) 444–447

Contents lists available at ScienceDirect

Journal of South American Earth Sciences

journal homepage: www.elsevier.com/locate/jsames

Comment on "Tethyan calpionellids in the Neuquén Basin (Argentine Andes), their significance in defining the Jurassic/Cretaceous boundary and pathways for Tethyan-Eastern Pacific connections" by R. López-Martínez, B. Aguirre-Urreta, M. Lescano, A. Concheyro, V. Vennari and V. Ramos

Diego A. Kietzmann [a, b, *], María Paula Iglesia Llanos [a, b]

[a] Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Departamento de Ciencias Geológicas, Ciudad Universitaria, Pabellón II, Intendente Güiraldes 2160, C1428EHA Ciudad Autónoma de Buenos Aires, Argentina
[b] CONICET-Universidad de Buenos Aires, Instituto de Geociencias Básicas, Ambientales y Aplicadas de Buenos Aires (IGeBA), Argentina

ARTICLE INFO

Article history:
Received 8 August 2017
Received in revised form
19 September 2017
Accepted 3 October 2017
Available online 7 October 2017

1. Introduction

In this contribution, López-Martínez et al. (2017) state that they achieved to define the position of the Jurassic- Cretaceous (J-K) boundary from the finding of Tethyan calpionellids in the Vaca Muerta Formation at Las Loicas section, Neuquén Basin. The authors analyzed ten samples in a reduced interval of the Vaca Muerta Formation where the boundary would lie.

Las Loicas section represents a basinal section of c. 270 m with large covered intervals (c. 90 m) bearing ammonites of the Lower Tithonian *Virgatosphinctes mendozanus* Zone to at least the Upper Berriasian *Spiticeras damesi* Zone (Aguirre-Urreta et al., 2014). The upper part is covered.

We do consider that the data presented by López-Martínez et al. are important for the discussion on the J-K boundary in Argentina, provided that the knowledge of calpionellids in the Neuquén basin is very poor. The aim of this Comment is to better explain some data derived from previous biostratigraphic and magnetostratigraphic studies (i.e. Fernández Carmona and Riccardi, 1999, Kietzmann et al., 2011a; Kietzmann, 2017; Iglesia Llanos et al., 2017) that López-Martínez et al. (2017) failed to interpret correctly.

2. Clarifications on previous works

In the section *Comments of previous calpionellid records* López-Martínez et al. questioned some previous age assignments. These authors point out that Kietzmann et al. (2011a) assigned a late Early Tithonian age for the *Windhauseniceras internispinosum* ammonite Zone which is in fact early Late Tithonian. Such difference in the age assignment responds simply to the changes introduced by Riccardi et al. (2011) with respect to Riccardi (2008a,b) in the biostratigraphic schemes (Fig. 1). In the same discussion, López-Martínez et al. interpreted that Kietzmann et al. (2011a) reported the *Boneti* Subzone of the *Chitinoidella* Zone, based on the presence of the genus *Chitinoidella* close the J-K boundary. However, López-Martínez et al. do not mention that Kietzmann et al. (2011a) clearly stated that "the occurrence of large forms of *Calpionella alpina* Lorenz, *Crassicollaria* sp. and *Tintinnopsella* sp. in association with ammonites of the Late Tithonian (*Corongoceras alternans* and lowermost *Substeueroceras koeneni* Zones (Fernández Carmona et al., 1996) rule out the correlation of this level with the *Chitinoidella* Zone".

Most recently, Kietzmann (2017) reported seven known species of Chitinoidellidae and four known species of Calpionellidae in the Neuquén basin. He found the first Chitinoidellidae within the *Virgatosphinctes mendozanus* ammonite Zone, the first occurrence (FO) of *Chitinoidella boneti* at the base of the *Windhauseniceras internispinosum* ammonite Zone, and the FO of hyaline calpionellids at the base of the *Corongoceras alternans* ammonite Zone. Hence, Kietzmann (2017) identified the *Chitinoidella* Zone within the *Virgatosphinctes mendozanus* and the *Windhauseniceras internispinosum* ammonite Zones, restricting the *Boneti* Subzone to the *Windhauseniceras internispinosum* Zone (Fig. 2a), without extending it up to the *Corongoceras alternans* and *Substeueroceras koeneni* ammonite Zones. In this regard, López-Martínez et al. in Fig. 4 reported the *Chitinoidella* Zone at the lowermost part of the

* Corresponding author. Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Departamento de Ciencias Geológicas, Ciudad Universitaria, Pabellón II, Intendente Güiraldes 2160, C1428EHA Ciudad Autónoma de Buenos Aires, Argentina.

https://doi.org/10.1016/j.jsames.2017.10.002

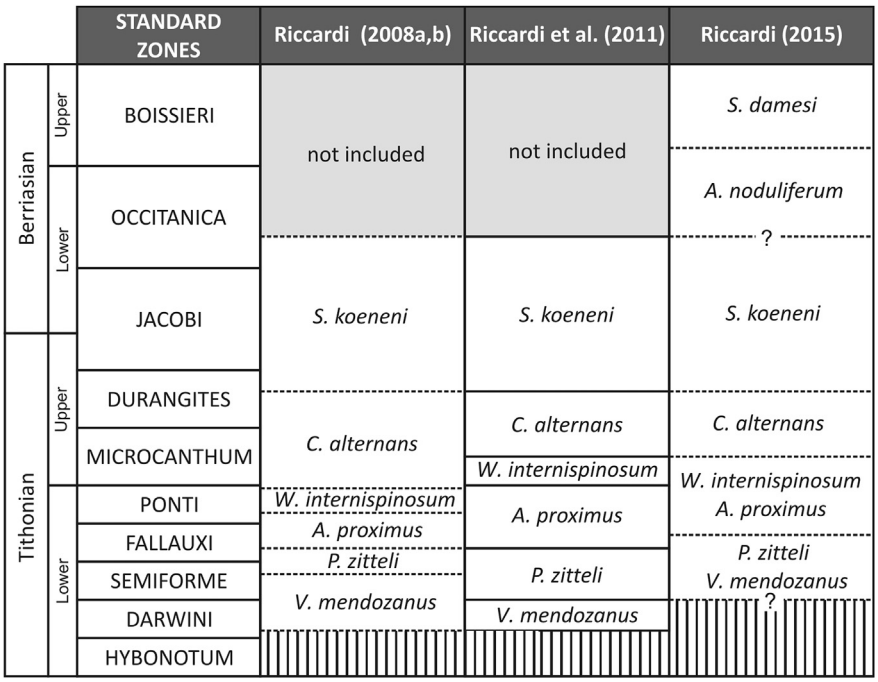

Fig. 1. Andean ammonite zones and their correlation with the standard Tethyan zones according to Riccardi (2008a, b) Riccardi et al. (2011) and Riccardi (2015). Note the different position of the *Windhauseniceras internipinosum* Zone in Riccardi (2008a, b) and Riccardi et al. (2011).

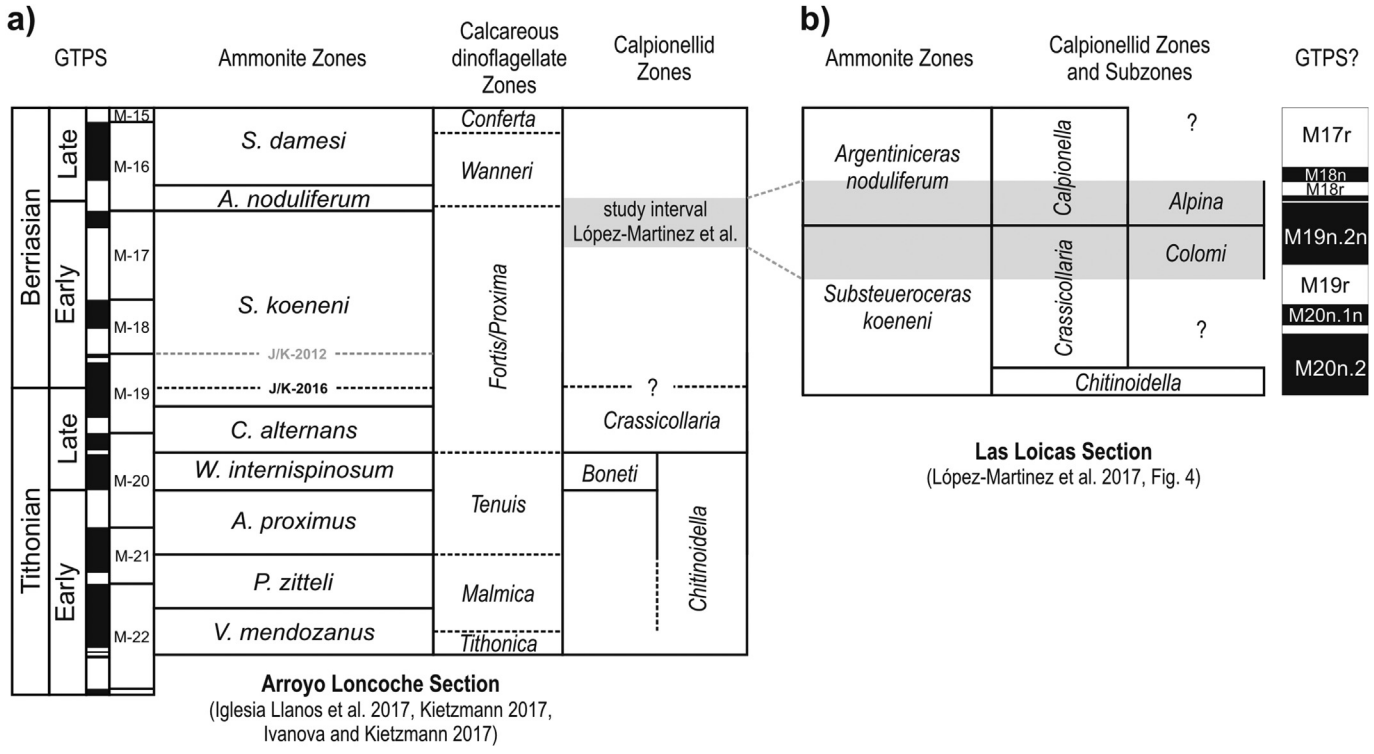

Fig. 2. a) Andean ammonite zones calibrated by magnetostratigraphy and cyclostratigraphy (Kietzmann et al., 2015; Iglesia Llanos et al., 2017), and their correlation with calcareous dinoflagellate cysts and calpionellids zones (Ivanova and Kietzmann, 2017; Kietzmann, 2017) in the Arroyo Loncoche section. b) Calpionellids zones and correlation with the GTPS? in Las Loicas section according to López-Martínez et al. (2017). Note that the *Alpina* Subzone in the Tethys bears a normal polarity (M-19n), while the *Argentiniceras noduliferum* Zone comprises only one reverse polarity. Therefore, we interpreted that the *Argentiniceras noduliferum* Zone correlated with M16r (Upper Berriasian).

Substeueroceras koeneni ammonite Zone, although they clearly state that did not find chitinoidellids in the studied Las Loicas section. Anyway, the position of the *Chitinoidella* Zone alleged by López-Martínez et al. is different from that interpreted by Kietzmann (Fig. 2a), which makes it an interesting topic for further studies.

López-Martínez et al. claim that the chronostratigraphic position of the *Argentiniceras noduliferum* ammonite Zone in Kietzmann (2017) is Lower Berriasian. However, this author interpreted the

Argentiniceras noduliferum Zone as Upper Berriasian taking into consideration the biostratigraphy (Riccardi, 2015), cyclostratigraphy (Kietzmann et al., 2011b, 2015) and magnetostratigraphy (Iglesia Llanos et al., 2017). The misinterpretation pointed out by López-Martínez et al. in the age of the *Argentiniceras noduliferum* Zone derives from confusing the age ranges assigned by Kietzmann (2017) to the calpionellids with those of the ammonite zone (Fig. 2a). In this respect, the author reported the younger chitinoidellids at the very base of the *Argentiniceras noduliferum* Zone, and thus the younger stratigraphic chitinoidellids record would be uppermost Lower Berriasian, which does not imply that he interprets the *Argentiniceras noduliferum* Zone as Lower Berriasian (Fig. 2).

In the *Discussion* section, López-Martínez et al. also commented on the paper by Iglesia Llanos et al. (2017). They pointed out that their calpionellid biozonation differs in age from the classic Tethyan standards, since the base of the *Calpionella* Zone is placed in the Late Tithonian instead of the base of Berriasian. In the first place, the calpionellid biozonation is shown as a complementary part in a figure which puts together the biostratigraphy, magnetostratigraphy and cyclostratigraphy of the Vaca Muerta Formation which make up the core of the paper (Iglesia Llanos et al., 2017). Secondly, the biozonation that was used in that paper was taken from González Tomassini et al. (2015) as indicated in the caption, who used the 2012 scale proposed by the International Commission of Stratigraphy and not that from 2016 because it was the only one available at that time. The usage of the 2012 scale accounts for the differences in age put forward by López-Martínez et al. (2017). In Iglesia Llanos et al., it is clearly explained the two likely positions of the J-K boundary according to the Berriasian Working Group 2012 and 2016, respectively, the latter placing it at the base of the *Calpionella* Zone within the M19n.2n polarity subzone (see page 192: third paragraph; and page 203: section 7; Fig. 9).

3. Further comments

It is in fact well-known, that the study of calpionellids in the Neuquén Basin needs a thorough revision which involves as many sections as possible before establishing that the Tethyan bioevents were also recorded in Argentina. López-Martínez et al. presented the association of *C. alpina*, *Cr. parvula, Cr. colomi, Cr. massutiniana*, *Cr. brevis, T. remanei*, and *T. carpathica* which make up the Colomi Subzone of the *Crassicollaria* Zone, whereas *C. alpina* and *Cr. massutiniana* conform the *Alpina* Subzone of the *Calpionella* Zone (Fig. 2b). Several reported species of their *Colomi* Subzone (e.g., *Cr. massutiniana, Cr. brevis, C. alpina, Cr. parvula* and *T. carpathica*) were identified in the *Calpionella* Zone (e.g., Manivit et al., 1986; Altiner and Özkan, 1991; Bucur, 1992; Boorová et al., 1999), and *Cr. colomi*, which López-Martínez allege that indicates the *Colomi* Subzone, has also been found in the Early Berriasian *Alpina* Subzone (e.g., Reháková et al., 1996; 2011, Lakova, 1993; Lakova et al., 2007). This implies that the upper *Crassicollaria* Zone from López-Martínez et al. could actually belong to the lower *Calpionella* Zone as well. López-Martínez et al. asserted to have found the "explosion" of *Calpionella alpina* in sample LL7 (this event would be recognized for the first time in the Neuquén Basin, and therefore should be illustrated). Even assuming the synchronicity of this "explosion" with the Tethys, in order to demonstrate that this acme has in fact taken place, the study of more than one stratigraphic section with the corresponding statistics should be mandatory. This is a requisite to rule out that such "explosion" could have been the result of mechanical concentration. On the other hand, López-Martínez objected that Kietzmann (2017) reported some species found in the Tehtys at older stratigraphic levels. It looks like the authors did the same when identified some species that in the Tethys are reported in older positions such as *T. remanei* and *Cr. massutiniana* (Grün and Blau, 1997; Lakova et al., 1999; Reháková et al., 2009; Lakova and Petrova, 2013).

Remarkably, López-Martínez et al. have not taken into account that there already exists a magnetostratigraphic study in the Loicas section performed by Iglesia Llanos in 2013 together with Aguirre-Urreta and Ramos that so far, has not been published. We consider it unfortunate that those authors did not compare the polarities sequence obtained by Iglesia Llanos with the international magnetostratigraphic scale they used (Fig. 2b), for such discussion would have provided important input to their contribution. For instance, López-Martínez et al. in Fig. 1, showed that the *Alpina* Subzone in the base of the *Argentiniceras noduliferum* Zone marks the beginning of the Berriasian, and according to the proposal of the Berriasian Working Group 2016, the J-K boundary falls in the middle of the normal subpolarity zone M19n.2n (Ogg et al., 2016). However, the magnetostratigraphic studies derived from three sections of the Vaca Muerta Formation indicate that the *Argentiniceras noduliferum* Zone begins and comprises a dominant reverse polarity (e.g., Amigo et al., 2015; Iglesia Llanos et al., 2017) interpreted by Iglesia Llanos et al. (2017) as the subpolarity Zone M-16r (Fig. 2a). According to the cyclostratigraphic and magnetostratigraphic data in Iglesia Llanos et al. (2017) moreover, the J-K boundary is located at the lower part of the *Substeueroceras koeneni* Zone which, in Las Loicas section, corresponds to a covered interval of c. 90 m comprising the *Corongoceras alternans* Zone and the lower half of the *Substeueroceras koeneni* Zone (Aguirre Urreta et al., 2014). Additionally, recent data published by Ivanova and Kietzmann (2017) suggest the correlation of the *Argentiniceras noduliferum* ammonite Zone with the uppermost part of *Stomiosphaerina proxima* and the lower part of *Stomiosphaera wanneri* calcareous dinoflagellate Zones, which would indicate a Late Berriasian age (Fig. 2a). More recently, Vennari et al. (2017) reported the FOs of *N. kamptneri minor* and *N. steinmannii steinmannii* at the lower part of the *Substeueroceras koeneni* Zone (uppermost M19n Subchron, see Svobodová and Košták, 2016; Ogg et al., 2016; Grabowski et al., 2017), which is in agreement with our data (see Fig. 2; Kietzmann et al., 2015; Iglesia Llanos et al., 2017).

The combination of biostratigraphic (Riccardi, 2015; Kietzmann, 2017; Ivanova and Kietzmann, 2017), cyclostratigrahic (Kietzmann et al., 2011b, 2015) and magnetostratigraphic (Amigo et al., 2015; Iglesia Llanos et al., 2017) data suggests an Early Berriasian age for the upper part of the *Substeueroceras koeneni* Zone. The calpionellid association reported in López-Martínez et al. is also consistent with this interpretation, based on the fact that similar associations were reported in the Tethys for this time.

References

Aguirre Urreta, M.B., Vennari, V., Naipauer, M., Lescano, M., Concheyro, A., Ramos, V.A., 2014. Bioestratigrafía y geocronología de alta resolución de la Formación Vaca Muerta, cuenca Neuquina. In: IX Congreso de Exploración y Desarrollo de Hidrocarburos, Mendoza.

Altiner, D., Özkan, S., 1991. Calpionellid zonation in North-western Anatolia (Turkey) and calibration of the stratigraphic ranges of some benthic foraminifera at the Jurassic-Cretaceous Boundary. Geol. Rom. 27, 215–235.

Amigo, J., Iglesia-Llanos, M.P., Kietzmann, D.A., 2015. Magnetostratigraphy of the Vaca Muerta Formation in Puerta Curaco Section. LATINMAG, Maresias, Neuquén Basin, Argentina.

Boorová, D., Lobitzer, H., Skupien, P., Vašiček, Z., 1999. Biostratigraphy and Facies of Upper Jurassic-Lower Cretaceous pelagic carbonate sediments (Oberalm-, Schrambach- and Roßfeld-Formation) in the Northern Calcareous Alps, South of Salzburg. Abh. Geol. Bundesanst. 56 (2), 273–318.

Bucur, I.I., 1992. Calpionellids and calcispheres from the Upper Jurassic-Lower Cretaceous deposits in the Resita-Moldova Noua zone, Southern Carpathians, Romania. Cretac. Res. 13, 565–576.

Fernández Carmona, J., Riccardi, A.C., 1999. Primer reporte de Calpionélidos calcáreos del Cretácico inferior —Berriasiano de la Provincia del Tethys en la República Argentina: Conexión Tethys-Pacífico. Bol. do Simp. sobre Cretaceo do Bras. 465–466.

Fernández Carmona, J., Álvarez, P.P., Aguirre-Urreta, M.B., 1996. Calpionélidos calcáreos y grupos *incertae sedis* en la Formación Vaca Muerta (Tithoniano superior), alta cordillera mendocina, Argentina. In: 13º Congreso Geológico Argentino y 3º Congreso de Exploración de Hidrocarburos, Actas, vol. 5, p. 225. Mendoza.

González Tomassini, F., Kietzmann, D.A., Fantín, M.A., Crousse, L.C., Reinjenstein, H.M., 2015. Estratigrafía y análisis de facies de la Formación Vaca Muerta en el área de El Trapial. Cuenca Neuquina, Argentina, Petrotecnia 2015/2, pp. 78–89.

Grabowski, J., Haas, J., Stoykova, K., Wierzbowski, H., Brański, P., 2017. Environmental changes around the Jurassic/Cretaceous transition: New nannofossil, chemostratigraphic and stable isotope data from the Lókút section (Transdanubian Range, Hungary. Sediment. Geol. 360, 54–72.

Grün, B., Blau, J., 1997. New aspects of calpionellid biochronology: proposal for a revised calpionellid zonal and subzonal division. Rev. Paléobiologie 16, 197–214.

Iglesia Llanos, M.P., Kietzmann, D.A., Kohan Martínez, M., Palma, R., 2017. Magnetostratigraphy of the Upper Jurassic–Lower Cretaceous from Argentina: implications for the J-K boundary in the Neuquén Basin. Cretac. Res. 70, 189–538.

Ivanova, D.K., Kietzmann, D.A., 2017. Calcareous dinoflagellate cysts from the Tithonian - Valanginian Vaca Muerta Formation in the southern Mendoza area of the Neuquén Basin, Argentina. J. S. Am. Earth Sci. 77, 150–169.

Kietzmann, D.A., 2017. Chitinoidellids from the early Tithonian–early Valanginian Vaca Muerta Formation in the Northern Neuquén Basin, Argentina. J. S. Am. Earth Sci. 76, 152–164.

Kietzmann, D.A., Blau, J., Riccardi, A.C., Palma, R.M., 2011a. An interesting finding of chitinoidellids (Clapionellidea Bonet) in the Jurassic-Cretaceous boundary of the Neuquén Basin. In: XVIII Congreso Geológico Argentino, Actas: pp. 1480-1481, Neuquén.

Kietzmann, D.A., Martín-Chivelet, J., Palma, R.M., López-Gómez, J., Lescano, M., Concheyro, A., 2011b. Evidence of precessional and eccentricity orbital cycles in a Tithonian source rock: the mid-outer carbonate ramp of the Vaca Muerta Formation, Northern Neuquén Basin, Argentina. AAPG Bull. 95, 1456–1474.

Kietzmann, D.A., Palma, R.M., Iglesia Llanos, M.P., 2015. Cyclostratigraphy of an orbitally-driven Tithonian-Valanginian carbonate ramp succession, Southern Mendoza, Argentina: implications for the Jurassic-Cretaceous boundary in the Neuquén Basin. Sediment. Geol. 315, 29–46.

Lakova, I., 1993. Middle Tithonian to Berriasian praecalpionellid and calpionellid zonation of the Western Balkanides, Bulgaria. Geol. Balc. 23, 3–24.

Lakova, I., Petrova, S., 2013. Towards a standard Tithonian to Valanginian calpionellid zonation of the Tethyan Realm. Acta Geol. Pol. 63, 201–221.

Lakova, I., Stoykova, K., Ivanova, D., 1999. Calpionellid, nannofossil and calcareous dinocyst bioevents and integrated biochronology of the Tithonian to Valanginian in the Western Balkanides, Bulgaria. Geol. Carpathica 50, 151–158.

Lakova, I., Tchoumatchenco, P., Ivanova, D., Koleva-Rekalova, E., 2007. Callovian to Lower Cretaceous pelagic carbonates in the West Balkan Mountain (Komshtitsa and Barlya sections): integrated biostratigraphy and microfacies. Geol. Balc. 36, 81–89.

López-Martínez, R., Aguirre-Urreta, B., Lescano, M., Concheyro, A., Vennari, V., Ramos, V.A., 2017. Tethyan calpionellids in the Neuquén Basin (Argentine Andes), their significance in defining the Jurassic/Cretaceous boundary and pathways for Tethyan-Eastern Pacific connections. J. S. Am. Earth Sci. 78, 116–125.

Manivit, H., Azéma, J., Galbrun, B., De Wever, P., 1986. Biostratigraphic study of calpionellids and nannofossils in the Tethyan realm (Spain, Sicily, SE France) in Late Jurassic and Berriasian Time: a correlation with magnetostratigraphic results. Acta Geol. Hung. 29 (1–2), 105–123.

Ogg, J.G., Ogg, G.M., Gradstein, F.M., 2016. A Concise Geologic Time Scale. Elsevier, Amsterdam, 243 p.

Reháková, D., Michalík, J., Ožvoldová, L., 1996. New microbiostratigraphical data from several Lower Cretaceous pelagic sequences of the Northern Calcareous Alps, Austria (preliminary results). Geologisch-Paläontologische Mittl. Innsbr. 4, 57–81.

Reháková, D., Halásová, E., Lukeneder, A., 2009. The Jurassic-Cretaceous boundary in the Gresten Klippenbelt (Nutzhof, lower Austria): implications for micro-and nannofacies analysis. Ann. des Naturhistorischen Mus. Wien 110 A, 345–381.

Reháková, D., Matyja, B.A., Wierzbowski, A., Schlögl, J., Keobicki, M., Barski, M., 2011. Stratigraphy and microfacies of the Jurassic and lowermost Cretaceous of the Veliky Kamenets section (Pieniny Klippen Belt, Carpathians, Western Ukraine). Vol. Jurassica IX 61–104.

Riccardi, A.C., 2008a. El Jurásico de la Argentina y sus amonites. Rev. la Asoc. Geol. Argent. 63, 625–643.

Riccardi, A.C., 2008b. The marine Jurassic of Argentina: a biostratigraphic framework. Episodes 31, 326–335.

Riccardi, A., 2015. Remarks on the Tithonian-Berriasian ammonite biostratigraphy of west central Argentina. Vol. Jurassica 13, 23–52.

Riccardi, A.C., Damborenea, S.E., Manceñido, M.O., Leanza, H.A., 2011. Megainvertebrados jurásicos y su importancia geobiológica. In: Leanza, H.A., Arregui, C., Carbone, O., Danieli, J.C., Vallés, J.M. (Eds.), Geología y Recursos Naturales de la Provincia del Neuquén. Asociación Geológica Argentina, Buenos Aires, pp. 441–464.

Svobodová, A., Košták, M., 2016. Calcareous nannofossils of the Jurassic/Cretaceous boundary strata in the Puerto Escano section (southern Spain)—biostratigraphy and palaeoecology. Geol. Carpath. 67, 223–238.

Vennari, V.V., Lescano, M., Aguirre-Urreta, B., Concheyro, A., Fantín, M., Vallejos, M.D., Depine, G., Sagasti, G., Ambrosio, A., 2017. Avances en la Bioestratigrafía de alta resolución de la Formación vaca Muerta: amonites y nanofósiles calcáreos integrando datos de subsuelo y afloramientos. XX Congreso Geológico Argentino, San Miguel de Tucumán, Argentina, pp. 168–172.