

## JK2018: International Meeting around the Jurassic/Cretaceous Boundary – Chairperson's Report

Bruno GRANIER<sup>1</sup>

The JK2018 meeting was held from the 5<sup>th</sup> to the 7<sup>th</sup> of December 2018 at the “Muséum d’Histoire Naturelle de Genève” (Switzerland). It was intended to bring together people with interests in the transition period of the latest Jurassic to the earliest Cretaceous times, *i.e.*, a ca. 20 Ma interval of time spanning the Tithonian – Berriasian (Volgian – Ryazanian) – Valanginian interval (eventually overlapping slightly its lower and upper boundaries) in the Tethys area, as well as in the Panthalassa, Boreal and Austral regions. It was also intended to feature disciplines covering the many aspects of stratigraphy (litho-, bio-, magneto-, chemo-, cyclo-, sequence), as well as sedimentology, paleontology, paleogeography and global tectonics, at all scales, from the SEM – Scanning Electron Microscopy – to basin analyses.

### IN SHORT, AND IN NUMBERS

This meeting was organized by Prof. Bruno Granier (Chairperson) and Swiss colleagues: Prof. Rossana Martini, Dr Lionel Cavin, Prof. Jean J. Charollais, Dr Christian Meister, Dr Eric Monteil, Dr André Piuze, and Prof. Andreas Strasser. In addition to the organizing committee, a panel of some 30 international members constituted the scientific committee. The meeting was placed under the aegis of or benefited from the partnership of some 15 national or international scientific partners: Asociación Paleontológica Argentina (APA), Association Paléontologique et Évolutive Libanaise (APEL), Association Paléontologique Française (APF), Carnets de Géologie, Comité Suisse de Stratigraphie (strati.CH), International Association of Sedimentologists (IAS), International Subcommission on Stratigraphic Classification (ISSC), International Research Group on Ostracoda (IRGO), Меловая комиссия МСК (Russian “Cretaceous Commission”), Юрская комиссия МСК (Russian “Jurassic Commission”), Sociedad Española de Paleontología (SEP), Società Paleontologica Italiana (SPI), Societatea Paleontologilor din România (SPR), Society for Sedimentary Geology (SEPM), “Stratigraphy, Sedimentology and Palaeontology (SSP) – European Geosciences Union (EGU)”, and The Paleontological Society. 176 authors and coauthors, of which 74 registrants (Fig. 1) from 25 countries [Africa: Algeria, Morocco; Americas: Argentina, Chile, USA; Asia: China, Iraq, Japan, Jordan, Lebanon, Qatar, Thailand, Turkey; Europe: Denmark, France, Germany, Italy, Netherlands (the), Poland, Romania, Russian Federation, Slovenia, Spain, Switzerland, United Kingdom] contributed 59 oral presentations or posters: 6 keynotes, 33 regular presentations, and 25 posters including 5 to supplement regular presentations or keynotes. As such the meeting achieved its goals and the organizers have received congratulations from all sides, including from the bureau of the International Commission on Stratigraphy. A language-edited version of the abstract volume was published a few weeks after the meeting ended (Granier, 2019a), and a Virtual Special Issue dedicated to the Jurassic – Cretaceous Transition is in preparation (some papers are already available: Granier, 2019b; Granier & Clavel, 2019; Mircescu *et al.*, 2019; Schlagintweit *et al.*, 2019a, b; Scott, 2019; Skupien & Doupovcová, 2019; in press: Aurell *et al.*, 2019, or under review).

In the recent past, there were very few opportunities for a broad group of people working on the Jurassic or on the Cretaceous to meet and have a fair, unbiased, and open discussion on the Jurassic/Cretaceous System boundary; the most signifi-

---

<sup>1</sup> Département des Sciences de la Terre et de l’Univers, Faculté des Sciences et Techniques, Université de Bretagne Occidentale, CS 93837, 29238 Brest, France; bgranier@univ-brest.fr.



**Fig. 1. Group photo on the last day (December 7, 2018), photo Peter Schuchert**

1. Mikhail A. Rogov, 2. Luis O'Dogherty, 3. Thierry Adatte, 4. Atsushi Matsuoka, 5. Andreas Strasser, 6. Xin Li, 7. Camille Frau, 8. Mohamed El Ouali, 9. Maria Bolivar, 10. Peter O. Baumgartner, 11. Christian Salazar, 12. Susanne Feist-Burkhardt, 13. Jean J. Charollais, 14. Marco Chiari, 15. Mohamed Benzaggagh, 16. Raymond Énay, 17. Mathieu Martinez, 18. Špela Goričan, 19. Haiyan Tong, 20. Ian Roger Sharp, 21. Simon Kelly, 22. André Piuze, 23. Dany Azar, 24. Sibelle Maksoud (APEL grant), 25. Bruno R.C. Granier, 26. Jacek Grabowski, 27. Beatriz Aguirre-Urreta, 28. Michał Krobicki, 29. Jolanta Iwanczuk, 30. Cristina Sequero, 31. Sergey Averyanov, 32. Elena V. Shchepetova, 33. Mariarosaria Martino, 34. Evgenij Baraboshkin, 35. Tatiana Baraboshkina, 36. Ioan I. Bucur, 37. Stephan Wohlwend, 38. Iuliana Lazăr, 39. Christian A. Meyer, 40. Helmut J. Weissert, 41. Christophe Ferrante, 42. Ismail Omer Yilmaz, 43. Damian Gerard Lodowski (IAS grant), 44. Dursun Acar, 45. Ignacio Capelli, 46. Christian Meister, 47. Lionel Cavin

cant one took place almost 50 years ago in the 1973 Lyon meeting. The 2018 Geneva meeting was then planned to reopen and broaden the debate in search of a practical solution. On its last day, a survey measured the attendees' preliminary opinions, perceptions and orientations.

## KEYNOTES, REGULAR TALKS AND POSTERS

In both abstracts, figures and slides, the authors were invited to refrain from referring to “the” system boundary and to preferably use the corresponding stage boundary instead. The editor and the scientific committee did not censor any abstract. Therefore, some abstracts still use the label “J/K boundary” when they actually refer to the “Tithonian/Berriasian boundary” without naming it. The vote and the debate that followed reached a different conclusion, *i.e.*, the “Berriasian/Valanginian boundary” could be a more useful system boundary.

The keynote speakers were:

1. Peter O. Baumgartner (on behalf of his coauthors, Špela Goričan, Luis O'Dogherty and Atsushi Matsuoka): “Panthalas-san radiolarite versus pelagic carbonate in Intra-Pangaean basins during the late Jurassic – early Cretaceous transition – paleofertility and ocean circulation”;

2. Raymond Énay: “The Jurassic – Cretaceous is at an impasse: Why not go back to Oppel’s original and historic definition of the Tithonian (1865)?”;
3. Bruno Granier: “Dual biozonation scheme (benthic foraminifera and “calcareous” green algae) over the Jurassic – Cretaceous transition: Another plea to revert the system boundary to its historical Orbigny’s and Oppel’s definition” (Granier, 2019b);
4. Alain Morard: “The new lithostratigraphic table of Switzerland – where do we stand?”;
5. André Strasser: “The Jurassic/Cretaceous boundary interval in the Jura Mountains and the Vocontian Basin: Sedimentological aspects”;
6. Helmut Weissert: “Late Jurassic – early Cretaceous oceanography”.

Most contributions focused on the core of the stratigraphic interval of interest, few extended into its end members: Kimmeridgian (Grabowski *et al.*, Sequero *et al.*) or Hauterivian (Aguirre-Urreta *et al.*, Baraboshkin, Granier, Martinez *et al.*, Martino *et al.*, Salazar & Stinnesbeck, Yilmaz & Tekin). From the geographical point of view, a number of contributions dealt with the wider Tethys Ocean: France, Italy, Romania (Lazăr *et al.*, Mircescu & Bucur), Spain, Switzerland, Turkey (Yilmaz), Ukraine (Grabowski *et al.*, Krobicki), Algeria (Youcef Brahim *et al.*), Morocco (El Ouali *et al.*), Lebanon (Maksoud *et al.*), Iraq (Ahmed *et al.*), Jordan (Makhlouf & Moh’d), Oman (Goričan *et al.*, Wohlwend), Qatar (Sadooni), United Arab Emirates, Florida offshore – USA (Granier), with disparities in the approaches. For instance, oil and gas geologists of the Middle East have selected the top of the Hith Formation to be the top of the Jurassic section (see Sadooni); however, this level falls into the (?) Kimmeridgian – Tithonian interval (see Granier, 2019b). Fewer contributions were on other areas:

1. the Austral Realm: Argentina (Aguirre-Urreta *et al.*, Lena *et al.*, Martinez *et al.*, Ramos), Chile (Salazar & Stinnesbeck);
2. the Boreal Realm: Canada (Schneider *et al.*), Greenland (Kelly *et al.*), Russia (Baraboshkin, Frau *et al.*, Manikin *et al.*, Rogov, Shchepetova *et al.*);
3. the Panthalassa (Baumgartner *et al.*).

Basinal domains where the sedimentary record is supposedly continuous were most represented, as well as fossils characteristic of these environments, such as the ammonites (Aguirre-Urreta *et al.*, Baraboshkin, Frau *et al.*, Kelly *et al.*, Rogov, Salazar & Stinnesbeck), the calpionellids (Benzaggagh, Granier), the radiolarians (Baumgartner *et al.*, Bertinelli *et al.*, Chiari *et al.*, Goričan *et al.*, Li *et al.*, Matsuoka *et al.*, O’Dogherty *et al.*, Yilmaz & Tekin), and the ichnofossils (Baucon *et al.*). However, the sedimentary record is not everywhere continuous as it is reported to be incomplete in SE France (Ferry & Granier, Strasser). That did not impede the BWG to identify potential candidates for the Berriasian GSSP in that same area. Another potential candidate for this GSSP is located in the Bosso valley in Italy (Bertinelli *et al.*, Chiari *et al.*, Li *et al.*, Matsuoka *et al.*). The facies is typically of Maiolica-type, which unfortunately corresponds to deposits having taken place below the Aragonite Compensation Depth. By contrast, fewer contributions dealt with shallow-water environments (Granier, Granier & Clavel, Lazăr *et al.*, Maksoud *et al.*, Martino *et al.*, Mircescu & Bucur, Strasser) and their fossils (foraminifers: Rigaud *et al.*, Schlagintweit *et al.*, 2019a, b, and algae: Granier & Lethiers, 2019), and continental environments (El Ouali *et al.*) and their fossils (Meyer & Belvedere, Tong *et al.*). Paleogeographic approaches and long distance correlations using different “tools” were also presented (Baraboshkin, Baumgartner *et al.*, Benzaggagh, Granier, Goričan *et al.*, Martinez *et al.*, O’Dogherty *et al.*, Rogov, Shchepetova *et al.*). Other disciplinary fields comprised chronostratigraphy (Scott, 2019), including U-Pb dating (Lena *et al.*, Ramos), chemostratigraphy (Grabowski *et al.*, Vickers *et al.*, Weissert, Wohlwend), clay minerals (Schnyder & Deconinck), cyclostratigraphy (Monkenbusch *et al.*, Martinez *et al.*), magnetostratigraphy (Grabowski *et al.*, Manikin *et al.*), sedimentology (Ferry & Granier, Granier), and sequence stratigraphy (Morard, Strasser).

All authors made these three days a very dense, diversified and animated meeting, and a unique opportunity to share opinions on the Jurassic/Cretaceous system boundary.

## TODAY’S SITUATION REGARDING THE J/K BOUNDARY

As highlighted by Ogg and Hinnov (2012), the Jurassic/Cretaceous boundary is the only system boundary of the Phanerozoic that does not have an accepted global definition.

Historically, when Alcide Dessalines d’Orbigny (1850: p. 157) referred to the Neocomian as the first stage of the Cretaceous, he quoted the ammonitic assemblage of its lowermost strata from SE France (not from the Neuchâtel area) that includes *Neocomites neocomiensis* (Orbigny, 1841), *Kilianella roubaudiana* (Orbigny, 1841), *Saynoceras verrucosum* (Orbigny, 1841), all known from the pyritous marls of the today’s Valanginian. Similarly, Carl Albert Oppel (1865) defined the last stage of the Jurassic, *i.e.*, the “Tithonische Etage”, on the basis of the ammonitic assemblage from the Stramberg

Formation, outcrops of which are known to encompass today's Tithonian/Berriasian boundary. According to Zittel (1901: p. 512), "on the basis of their peculiar Cephalopod fauna" Oppel "classified the Tithonian series as an independent group of strata between the Kimmeridge and the Neocomian horizons". That is probably the first use of the term "Tithonian". Later uses of Neocomian and Tithonian led to abandon the first term and to significantly change the definition of the second. The introduction of the Berriasian, Infravalangian and Valangian substages, the persistent use of the Purbeckian as a stage or a facies, erroneous correlations with basinal series, and nationalistic views led to a confusion that still persists today. This historical aspect was further developed by Énay in his keynote.

The Berriasian Working Group (BWG) of the Subcommission on Cretaceous Stratigraphy (SCS) of the International Commission on Stratigraphy (ICS) took the lead – not to say a quasi-monopolistic position – on the Jurassic/Cretaceous boundary definition, and most of its members are convinced that base Berriasian is the sole valid candidate. The BWG has been very active and, in the end, they selected the base of the acme of *Calpionella alpina* to be their primary marker (Wimbledon, 2017). However, in doing so, the BWG has not yet produced a proposal that would meet with approval by all. For instance:

1. short-distance correlations of the base of Berriasian from Tethysian basins into the adjacent carbonate platforms are doomed to fail. As pointed out by Granier (2019b), "Biodiversity is relatively low over the Tithonian – early Berriasian interval in both photozoan and heterozoan microfossil assemblages. Subsequently, it is impossible to distinguish the (upper) Tithonian from the lower Berriasian";
2. the situation is not better when attempting to correlate this level over long distances outside the Tethys Ocean into the Boreal Realm.

According to Premoli Silva (2004), "With the increasing focus on so many alternative (non-biostratigraphic) methods of correlation during the last 10 years it is likely that the marker for the base of the Cretaceous (and the Berriasian?) will be a non-biostratigraphic marker that can be traced from one realm to another and therefore overcome the biogeographic problems". But to be honest, today these goals have not been fully or consistently achieved.

Premoli Silva (2004), who was well aware of the Tethysian – Boreal issue, left the back door open to an alternative. She reminded ICS and SCS people that "Even which stage to place the J/K boundary at is debatable – base of Berriasian to most, but base of Valangian to some" (Premoli Silva, 2004). According to Remane, as early as 1991, "Only if it would appear that a J/K boundary at, or near, the base of the Berriasian cannot be traced into the Boreal realm another solution would have to be adopted". He even suggested that "Other levels should be tested in future". More specifically the alternative he offered is that the J/K boundary could be "placed at the top of the Berriasian", *i.e.*, at the base of the Valangian, in order to maintain a "relative stability of nomenclature" (Remane, 1991).

Regarding the Valangian Working Group (VWG), a Spanish candidate section at Cañada Luenga (Aguado *et al.*, 2000) is ready to go for the polls, a decision which was postponed pending a French candidate, located at Montbrun-les-Bains, that is ready to compete. The primary marker has long been an ammonite, hence the Pertransiens Zone (or Subzone); currently a calpionellid is favored, hence the Calpionellites Zone or Zone E.

## THE RESULTS OF THE SURVEY

We did not discuss any stage boundaries or GSSPs at JK2018, because that is the sole responsibility of the ISC, the SCS, the Subcommission on Jurassic Stratigraphy, and their Working Groups. The survey was focused on the system boundary and potential criteria:

- 1st option, the base of Berriasian (the primary marker is the base of the acme of *Calpionella alpina*, *i.e.*, base of calpionellid Zone B, inside the M19n, as designed by the BWG) got 17% of the votes;
- 2nd option, the base of Valangian (the primary marker is the FAD of *Calpionellites darderi*, *i.e.*, base of calpionellid Zone E, near base of the M14r, as designed by the VWG) got an absolute majority (52%);
- 3rd option, the base of Ryazanian got 7% of the votes;
- 4th option, a Radiolarian marker near base of calpionellid Subzone A2, near base of the M19r (Špela Goričan, personal communication, 12/07/2018), got 21 % of the votes. Note that this option should be ruled out because, at this stage, it is conflicting with the ICS's, SCS's, and BWG's decisions.

During the following discussion, the chairperson offered a voice to everyone, however of those who spoke, most did not vote for the Valangian (and even some did not vote at all). One person stated that "it is too late to change!", which disregarded the scientific data presented during the meeting. A recent example illustrates that change is always possible: The Ge-



Zones	Chronos	Key events
Pertransiens	M13n	
	M13r	
	M14n	
	M14r	6, 7
Boissieri	M15n	
	M15r	
	M16n	
	M16r	
Occitan.	M17n	
	M17r	
Jacobi - Grandis	M18n	1, 3
	M18r	
	M19n.1r	
	M19n.2n	4
Andreaei	M19r	2, 5
	M20n.1n	
	M20n.1r	
Microcanth.	M20n.2n	
	M20r	

**Fig. 2. The various locations of the Tithonian/Berriasian and the Berriasian/Valanginian stage boundaries**

Tithonian/Berriasian placements: **1.** base of Grandis Subzone (Lyon 1963: 1965), **2.** base of Jacobi-Grandis (Lyon-Neuchâtel 1973: 1975), **3.** base of Magnetochrom M18r according to GTS 2012, **4.** base of Zone B (base of an abundance biozone), primary marker of the BWG (Wimbledon, 2017), **5.** Radiolarian turnover  
 Berriasian/Valanginian placements: **6.** base of Pertransiens Subzone, **7.** base of Zone E (a FAD), primary marker of the VWG

lasian was recently shifted into the Pleistocene (hence into the Quaternary). In addition, as pointed out by many attendees, the difficulty to identify a objective marker for the Tithonian/Berriasian boundary has produced an untenable instability over the years (Fig. 2), which should discount this stage boundary to be given the rank of system boundary. In contrast the Berriasian/Valanginian boundary has remained remarkably stable during the same period (Fig. 2).

Geochemical events and properties did not change with the Tithonian but after the Berriasian. The Weissert event marks the dawn of the Cretaceous Oceanic Anoxic Events. Helmut Weissert himself stated that “Oppel was right!” (with the Tithonische = Tithonian + Berriasian) because there is no geochemical break near the Tithonian/Berriasian boundary. The system boundary should be located at a stage boundary between the end of Oppel’s Tithonische and the Weissert event. Only one stage boundary meets this requirement, *i.e.*, the (base) Valanginian.

Everyone would expect a biological crisis to coincide with the system boundary, as is the case for the Cretaceous/Paleocene boundary above and the Triassic/Jurassic boundary below. According to Baumgartner and colleagues, a Radiolarian turnover occurred in the late Tithonian. However, it does not match with the stage boundary (Fig. 2); it is older. Except (?) for the calpionellids with 3 *Crassicolaria* species that disappeared (but could it be qualified to be a turnover?), there are no major breaks in any other group. For instance, Granier (2019b) documents

	Day before yesterday	Yesterday	Today	Tomorrow
Néocomien		Hauterivian	Hauterivian	Hauterivian
		Valanginian	Valanginian	Valanginian
Portlandian (Tithonische Etage)		Berriasian	Berriasian	Berriasian
		Tithonian	Tithonian	Tithonian
Orbigny, Oppel, Toucas, Haug, ...	Kilian	BWG	Énay	

**Fig. 3. Past, present and a possible future view of the Jurassic/Cretaceous system boundary**

no change in the photozoan microfossil assemblage (benthic foraminifers and “calcareous” algae) of the Tethysian carbonate platforms over the late Tithonian – early Berriasian interval. On the opposite, several other fossil groups show a real turnover at or near the Berriasian/Valanginian boundary, starting with ammonites, calpionellids, “calcareous” algae, foraminifers in both photozoan and heterozoan associations, etc.

## CONCLUSION

At the end of the last day further to this open discussion, which was all but “sterile”, it looks like a majority of people would like the option of the base of Valanginian as the J/K boundary to be fully reconsidered, particularly because it looks like it coincides with a biological crisis, it is more stable and also easier to correlate over long distances.

Today the door is wide open for a real reconsideration of the Berriasian/Valanginian boundary as the base of the Cretaceous *sensu* Orbigny, Oppel, Toucas, Énay, and followers (Fig. 3).

**Acknowledgments.** The reporter thanks Robert W. Scott who kindly check the latest version of this manuscript.

## REFERENCES

- AGUADO R., COMPANY M., TAVERA J.M., 2000 – The Berriasian/Valanginian boundary in the Mediterranean region: new data from the Caravaca and Cehegín sections, SE Spain. *Cretaceous Research*, **21**: 1–21.
- AURELL M., BÁDENAS B., CANUDO J.I., CASTANERA D., GARCÍA-PENAS A., GASCA J.M., MARTÍN-CLOSAS C., MOLINER L., MORENO-AZANZA M., ROSALES I., SANTAS L., SEQUERO C., VAL J., 2019 – Kimmeridgian – Berriasian stratigraphy and sedimentary evolution of the central Iberian Rift System (NE Spain). *Cretaceous Research*, in press.
- GRANIER B. (Ed.), 2019a – JK2018 – International Meeting around the Jurassic-Cretaceous Boundary (Geneva, December 5–7, 2018). Abstract volume, Carnets de Géologie, Madrid, Book 2019/01 (CG2019\_B01). <https://doi.org/10.4267/2042/69811>.
- GRANIER B., 2019b – Dual biozonation scheme (benthic foraminifera and “calcareous” green algae) over the Jurassic–Cretaceous transition. Another plea to revert the system boundary to its historical Orbigny’s and Oppel’s definition. *Cretaceous Research*, **93**: 245–274.
- GRANIER B., CLAVEL B., 2019 – Revised dating of the major earliest Cretaceous transgression in S Aquitaine (SW France). *Cretaceous Research*, **99**: 246–254.
- GRANIER B., LETHIERS A., 2019 – *Aloisalthella*, a new genus of fossil Polyphysacean green algae (Chlorophyta, Dasycladales), with notes on the genus *Clypeina* (Michelin, 1845). *Palaeontologia electronica*, in press.
- MIRCESCU C.V., BUCUR I.I., SĂSĂRAN E., PLEȘ G., UNGUREANU R., OPRÎȘA A., 2019 – Facies evolution of the Jurassic-Cretaceous transition in the Eastern Getic Carbonate Platform, Romania: Integration of sequence stratigraphy, biostratigraphy and isotope stratigraphy. *Cretaceous Research*, **99**: 71–75.
- OGG J.G., HINNOV L.A., 2012 – Chapter 27 – Cretaceous. In: The geologic time scale 2012 (Eds F.M. Gradstein, J.G. Ogg): 793–853. Elsevier, Boston.
- OPPEL C.A., 1865 – Die Tithonische Etage. *Zeitschrift der Deutschen geologischen Gesellschaft*, Jahrgang, **17**: 535–558.
- d’ORBIGNY A.D., 1840 – Paléontologie française. Description zoologique et géologique de tous les animaux mollusques et rayonnés fossiles de France. Terrains crétacés. Tome premier, contenant les Céphalopodes. Chez l’auteur, Paris. <https://www.biodiversitylibrary.org/item/73202#page/9/mode/1up>.
- d’ORBIGNY A.D., 1840–1842 – Paléontologie française. Description zoologique et géologique de tous les animaux mollusques et rayonnés fossiles de France. Terrains crétacés. Atlas. Tome premier, contenant les Céphalopodes. Chez l’auteur, Paris. <https://gallica.bnf.fr/ark:/12148/bpt6k9693620h#>.
- d’ORBIGNY A.D., 1850 – Cours élémentaire de paléontologie et de géologie stratigraphiques. Premier volume. Masson, Paris. <https://gallica.bnf.fr/ark:/12148/bpt6k6260677z/f7.item>.
- PREMOLI SILVA I., 2004 – Subcommission on Cretaceous Stratigraphy. Annual Report. In: International Commission on Stratigraphy. Consolidated Annual Report (Eds F.M. Gradstein, J.G. Ogg): 59–66. International Union of Geological Sciences. <http://www.stratigraphy.org/bak/report04.pdf>.
- REMANE J., 1991 – The Jurassic-Cretaceous boundary: problems of definition and procedure. *Cretaceous Research*, **12**, 5: 447–453.
- SCHLAGINTWEIT F., BUCUR I.I., SUDAR M.N., 2019a – *Bispiraloculus serbiacus* gen. et sp. nov., a giant arborescent benthic foraminifer from the Berriasian of Serbia. *Cretaceous Research*, **93**: 98–106.
- SCHLAGINTWEIT F., BUCUR I.I., GRANIER B., KOCH R., 2019b – *Barkerina dobrogiaca* Neagu, 2000, a Valanginian marker taxon from the Northern Neotethysian margin. *Cretaceous Research*, **101**: 76–83.
- SCOTT R.W., 2019 – Jurassic-Cretaceous boundary bioevents and magnetochrons: A stratigraphic experiment. *Cretaceous Research*, **100**: 97–104.
- SKUPIEN P., DOUPOVCOVÁ P., 2019 – Dinoflagellates and calpionellids of the Jurassic–Cretaceous boundary, Outer Western Carpathians (Czech Republic). *Cretaceous Research*, **99**: 209–228.
- WIMBLETON W.A.P., 2017 – Developments in fixing a Tithonian/Berriasian (J/K) boundary. *Volumina Jurassica*, **XV**: 181–186.
- von ZITTEL K.A., 1901 – History of geology and paleontology to the end of the nineteenth century (English translation of Maria M. Ogilvie-Gordon). Walter Scott, London, Charles Scribner’s Sons, New York. <https://archive.org/details/cu31924012130534/page/n551>.