



Report on the 5th International Meeting of the IUGS Lower Cretaceous Ammonite Working Group, the Kilian Group (Ankara, Turkey, 31st August 2013)



Stéphane Reboulet^{a,*,1,2}, Ottilia Szives^{b,1,2}, Beatriz Aguirre-Urreta^{c,2}, Ricardo Barragán^{d,2}, Miguel Company^{e,2}, Vyara Idakieva^{f,2}, Marin Ivanov^{f,2}, Mikheil V. Kakabadze^{g,2}, Josep A. Moreno-Bedmar^{d,2}, José Sandoval^{e,2}, Evgenij J. Baraboshkin^{h,3}, Meral K. Çağlar^{i,3}, István Fözy^{b,3}, Celestina González-Arreola^{d,3}, Samer Kenjo^{a,3}, Alexander Lukeneder^{j,3}, Seyed N. Raisossadat^{k,3}, Peter F. Rawson^{l,m,3}, José M. Tavera^{e,3}

^a CNRS-UMR 5276, Laboratoire de Géologie de Lyon: Terre, Planètes, Environnement, Observatoire de Lyon, Université Claude Bernard Lyon 1, Bâtiment Géode, 2 rue Dubois, 69622 Villeurbanne, France

^b Hungarian Natural History Museum, Department of Paleontology, 1088 Ludovika ter 2, H-1431 Budapest, Hungary

^c IDEAN, Instituto de Estudios Andinos Don Pablo Groeber, Departamento de Ciencias Geológicas, Universidad de Buenos Aires, Ciudad Universitaria, Pabellón II, 1428 Buenos Aires, Argentina

^d Departamento de Paleontología, Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Delegación Coyoacán, CP 04510, México, D.F., Mexico

^e Departamento de Estratigrafía y Paleontología, Facultad de Ciencias, Universidad de Granada, Campus de Fuentenueva s/n, 18002 Granada, Spain

^f Sofia University St Kliment Ohridski, Faculty of Geology and Geography, Department of Geology, Paleontology and Fossil Fuels, 15 Tzar Osvoboditel Bd, 1504 Sofia, Bulgaria

^g Djanelidze Institute of Geology, Polytkovskaja St. 5, 0186 Tbilisi, Georgia

^h Geological Faculty, Moscow State University, 119234 Leninskie Gory, Moscow, Russia

ⁱ Ataturk University, Oltu Earth Sciences Faculty, Department of Geology Engineering, 25400 Oltu-Erzurum, Turkey

^j Geological-Palaeontological Department, Natural History Museum, Burgring 7, A-1010 Vienna, Austria

^k Geology Department, Faculty of Science, Birjand University, PO Box 97175/615, Birjand, Iran

^l Centre for Marine and Environmental Sciences, University of Hull, Scarborough Campus, Filey Road, Scarborough YO11 3AZ, United Kingdom

^m Department of Earth Sciences, University College London, Gower Street, London WC1E 6BT, United Kingdom

ARTICLE INFO

Article history:

Received 5 February 2014

Accepted in revised form 3 April 2014

Available online

Keywords:

Kilian Group

Lower Cretaceous

Ammonites

Standard zonation

Boreal

Austral

Central Atlantic zonations

ABSTRACT

The 5th meeting of the IUGS Lower Cretaceous Ammonite Working Group (the Kilian Group) held in Ankara, Turkey, 31st August 2013, discussed the Mediterranean ammonite zonation, and its calibration with different ammonite zonal schemes of the Boreal, Austral and Central Atlantic realms. Concerning the standard zonation, that corresponds to the zonal scheme of the West Mediterranean province, some changes have been made on two stages. For the Valanginian, the *Busnardoites campylotoxus* Zone was abandoned; the upper part of the lower Valanginian is now characterised by the *Neocomites neocomiensiformis* and *Karakaschiceras inostranzewi* zones. For the upper Barremian, the former *Imerites giraudi* Zone is here subdivided into two zones, a lower *I. giraudi* Zone and an upper *Martellites sarasini* Zone. The *I. giraudi* Zone is now subdivided into the *I. giraudi* and *Heteroceras emerici* subzones, previously considered as horizons. The current *M. sarasini* and *Pseudocrioceras waagenoides* subzones correspond to the lower and upper parts of the *M. sarasini* Zone, respectively. The *Anglesites puzosianum* Horizon is kept. The Berriasian, Hauterivian, Aptian and Albion zonal schemes have been discussed but no change was made. The upper Hauterivian zonal scheme of the Georgian (Caucasus) region (East Mediterranean province) has been compared with the standard zonation. Discussions and some attempts at correlations are presented here between the standard zonation and the zonal schemes of different

* Corresponding author. Fax: +33 04 72 43 15 26.

E-mail address: stephane.reboulet@univ-lyon1.fr (S. Reboulet).

¹ Reporters.

² Participants at the meeting.

³ Absents at the meeting but provided written contribution.

palaeobiogeographical provinces: the North-West European area for the Valanginian and Hauterivian, the Argentinean region for the Berriasian, Valanginian and Hauterivian, and the Mexican area for the Valanginian–Hauterivian and Aptian–lower Albian. The report concludes with some proposals for future work.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

The 5th meeting of the IUGS Lower Cretaceous Ammonite Working Group (the Kilian Group) took place on Saturday 31st August 2013 at the Middle East Technical University (METU) at Ankara (Turkey), the day before the 9th International Symposium on the Cretaceous System (1–5 September 2013). The workshop was attended by ten members from seven countries, amongst them reporters (see footnotes 1 and 2). Some colleagues who could not attend submitted contributions that were taken into account during the discussions and their names are added here as a second list of authors (see footnote 3).

Before starting discussion, the chairman recapped briefly the aims of the Kilian Group and the recommendations on the working method evoked during the Lyon (Hoedemaeker et al., 2003) and Vienna (Reboulet et al., 2009) meetings, respectively. According to a remark sent by Lukeneder, it was underlined once again that colleagues who work on Lower Cretaceous stages are encouraged to use consistently the standard zonation (when it is possible) or they should correlate it with their local zonal scheme in order to make easier comparisons of zonal schemes between different studies and to improve communication. Indeed, the Lower Cretaceous standard ammonite zonation established in the Lyon meeting (Hoedemaeker et al., 2003) was adopted in its entirety by Ogg et al. (2004; “A Geological Time Scale 2004”), and the current standard zonal scheme (Reboulet et al., 2011) was also used in the Geological Time Scale 2012 (Ogg et al., 2012). In this last version of the GTS, the work of the Kilian Group was presented and some topics were discussed (Ogg et al., 2012, p. 808–809). The Kilian Group should preserve, as much as possible, the stability of the standard zonation as some changes could be more or less difficult to follow by non-ammonite workers; however, the group has to take into account recent paleontological revisions and must allow the development of the current zonal scheme in the light of new published/submitted data or, at least, results presented in abstracts of symposium.

The Ankara meeting dealt with two topics: 1) the West Mediterranean zonation, which has long been taken as the standard zonation, and 2) the calibration of different ammonite zonal schemes of the Boreal, Austral and Central Atlantic realms with the standard zonation.

2. The standard zonation (West Mediterranean province)

The main decisions previously made by the successive Lower Cretaceous Cephalopod Team (Hoedemaeker et al., 1990, 1993, 1995; Rawson et al., 1999; Hoedemaeker and Rawson, 2000) and the Kilian Group (Hoedemaeker et al., 2003; Reboulet et al., 2006, 2009, 2011) meetings were presented to the meeting. In subsequent discussions some amendments were introduced in the standard zonation for the lower Valanginian and the upper Barremian schemes, and the changes are shown in Table 1a,b. The numbers in the text refer to the numbers in this table. A comparison with the Georgian (Caucasus) zonal scheme (East Mediterranean province) was made for the upper Hauterivian.

2.1. Berriasian

A long discussion was held on the importance of ammonites in relation to current work on the Jurassic–Cretaceous (J/K) boundary

problem. While Wimbledon et al. (2011) regarded ammonites as secondary boundary markers for the J/K event, our meeting concluded that they could provide the primary marker. But the limited number of continuous, non-condensed, ammonitiferous J/K sections in the Tethyan realm is a problem so we suggest the sections described by Arkadiev and Bogdanova (2012) in the Crimea and Vennari et al. (2013) in the High Andes be considered as a possible boundary stratotype. Alternatively, currently published J/K sections from northern East Siberia (Bragin et al. 2013) suggest the possibility of a new, higher position for the boundary relying on ammonite assemblages of Middle/Upper Berriasian age that provide a better correlation between Boreal and Tethyan realms and which appears to fit well with magnetostratigraphic data.

(1 in Table 1a) After a presentation by Szives on ammonite assemblages around the Jurassic–Cretaceous boundary in Hungary (Szives and Fözy, 2013), the Kilian Group discussed the zonal scheme of the Berriasian. Members still considered the *Berriasella jacobi* Zone as the first zone of this stage (Tavera, 1985; Hoedemaeker et al., 1990) and, in terms of ammonites, they agreed to continue placing the base of the Berriasian at the base of this zone (Table 1a).

The introduction of *Delphinella obtusenodosa* as index-species of a new subzone placed in the lower part of the *B. jacobi* Zone was proposed by Ivanov and Idakieva, based on their unpublished work on Bulgarian sections. In South-East France, Le Hégarat (1971, 1973) noted that some species of *Delphinella* are characteristic only of the lower part of the *B. jacobi* Zone in its modern understanding (Hoedemaeker et al., 1990). According to Arkadiev and Bogdanova (2012), *Delphinella* occurs in the lower *Berriasella chomeracensis* Subzone of the *B. jacobi* Zone from the surroundings of Feodosiya in the Eastern Crimea where the only continuous Tithonian–Berriasian sections were studied in detail; however, the lowermost *Delphinella* were found below the first appearance of *B. jacobi* (Guzhikov et al., 2012). Ivanov and Idakieva’s proposal could be supported also by the work of Szives and Fözy (2013), although Hungarian sections are at least partly condensed and therefore cannot be used as an adequate basis for fine biostratigraphic purposes. However, more published data are needed from Bulgaria, Russia or other regions from the Crimea to South-East France before the Kilian Group can consider a change to the current zonation. This point will be discussed during the next meeting, as the Jurassic–Cretaceous boundary problem could be restricted to the placement of the lower boundary of the Berriasian stage. The Kilian Group encouraged Ivanov and Idakieva to publish their data. It is also recommended the study of sections in Mexico, Argentina, Bulgaria and Russia which may be used as key areas for the Berriasian stage.

2.2. Valanginian

Miguel Company presented a new zonation for the lower Valanginian in the Betic Cordillera, based on the analysis of the stratigraphic distribution of more than 10,000 ammonites collected bed-by-bed during several years in some fifteen sections in the Caravaca-Cehegín region in South-East Spain (Company and Tavera, 2013). These authors proposed the following biostratigraphic units, from bottom to top: the “*Thurmanniceras*” *pertransiens* Zone (subdivided into a lower “T.” *pertransiens* Subzone and an upper

Table 1a

Ammonite standard zonation of the Berriasian–Hauterivian stages (West Mediterranean province); the bold numbers refer to the numbers in the text.

STAGES	ZONES	SUBZONES	HORIZONS
HAUTERIVIAN	Upper	<i>Pseudothurmannia picteti</i>	
		<i>Pseudothurmannia catulloi</i>	
		<i>"P. ohmi"</i>	
		<i>Spathicrioceras seitzi</i>	
		<i>Crioceratites krenkeli</i>	
		<i>Binelliceras binelli</i>	
		<i>B. balearis</i>	
	Lower	<i>Plesiospitidiscus ligatus</i>	<i>Subsaynella begudensis</i> <i>Cruasicerus cruasense</i> <i>Olcostephanus (Olcostephanus) variegatus</i>
		<i>Subsaynella sayni</i>	
		<i>Lyticoceras nodosoplicatum</i>	
		<i>Crioceratites loryi</i>	
		<i>Olcostephanus (Jeannoticeras) jeannoti</i>	
		<i>C. loryi</i>	
VALANGINIAN	Upper	<i>Acanthodiscus radiatus</i>	<i>Breistrofferella castellanensis</i>
		<i>Criosarasinella furcillata</i>	
		<i>Teschenites callidiscus</i>	
		<i>C. furcillata</i>	
		<i>Neocomites peregrinus</i>	
		<i>Olcostephanus (Olcostephanus) nicklesi</i>	
	Lower	<i>N. peregrinus</i>	
		<i>Saynoceras verrucosum</i>	
		<i>Karakaschicerus pronecostatum</i>	
		<i>S. verrucosum</i>	
		<i>Karakaschicerus inostranzewi</i> (4)	
		<i>Neocomites platycostatus</i> (4)	
BERRIASIAN	Upper	<i>K. inostranzewi</i> (4)	
		<i>Neocomites neocomiensiformis</i> (3)	
		<i>"Thurmanniceras" pertransiens</i> (2)	
	Middle	<i>Thurmanniceras otopeta</i>	
		<i>Tirmovella alpillensis</i>	
		<i>Berriasella picteti</i>	
		<i>Malbosiceras paramimounum</i>	
	Lower	<i>Dalmasiceras dalmasi</i>	
		<i>Berriasella privasensis</i>	
		<i>Subthurmannia subalpina</i>	
		<i>Berriasella jacobi</i> (1)	

Neolissoceras salinarium Subzone); the *Neocomites neocomiensiformis* Zone (with the *Baronnites hirsutus* Subzone below and the *Valanginites dolioliformis* Subzone above); and the *Karakaschicerus inostranzewi* Zone (subdivided into the *K. inostranzewi* Subzone and the *Saynoceras contestanum* Subzone). The Kilian Group then discussed the possibility of introducing some of these biostratigraphic units into the standard zonation (Table 1a).

(2 in Table 1a) Most authors (see the synonymy list in Klein, 2005, p. 279–280) have considered that the *pertransiens* species belongs to *Thurmanniceras*; however, this species should be attributed to *Tirmovella* according to Hoedemaeker (1982), Gayte (1984) and Bulot (1995). Company and Tavera (2013) preferred the combination "*Thurmanniceras*" *pertransiens*, the inverted commas added to indicate that this species awaits revision (in preparation, Company and Tavera; Kenjo and Reboulet).

The subdivision of the "*Thurmanniceras*" *pertransiens* Zone into two subzones was not accepted as the first appearance of *Neolissoceras (Vergolicerus) salinarium* seems to occur in different stratigraphic positions between South-East Spain and South-East France. Indeed, *N. (V.) salinarium* appears in the lowermost part of the "*T.*" *pertransiens* Zone in the Vergol section (Drôme, SE France;

Kenjo's written contribution, PhD thesis in preparation) and not in its upper part as observed in the Betic Cordillera.

(3 in Table 1a) After discussion, the *Neocomites neocomiensiformis* Zone of Company and Tavera (2013) was accepted in the zonal scheme of the Mediterranean region. Reboulet (1996) demonstrated that the lectotype of *Hoplites neocomiensiformis* Uhlig (refigured by Vašíček, 1975) belongs to a faunal assemblage of the upper part of the lower Valanginian and suggested that this specimen could be interpreted as the inner whorls of a macroconch of *Busnardoites campylotoxus*. In their study of *Teschenites*, Busnardo et al. (2003) considered that "*neocomiensiformis*" belongs to the genus *Busnardoites*. For Klein (2005), this generic attribution is doubtful. This species has been misinterpreted by nearly all ammonite workers; the synonymy made by Klein (2005) shows that numerous specimens identified as *Busnardoites? neocomiensiformis* should correspond to *Teschenites robustus*. More recently, Főzy et al. (2010) figured a well-preserved specimen of *B. neocomiensiformis*. For Company, "*neocomiensiformis*" belongs to *Neocomites* and he emphasized that some "true" specimens of *N. neocomiensiformis* have been identified as *B. campylotoxus* (Company, 1987, pl. 11, figs. 12, 13; Vašíček, 1995, pl. 1, fig. 1; Reboulet, 1996, pl. 3, fig. 1), as *Busnardoites roberti* (Bulot, 1995,

pl. 11, figs. 1, 2?), or as “*Thurmanniceras*” *pertransiens* (Faraoni et al., 1997, pl. 3, fig. 11). Taking into account this synonymy list, the palaeobiogeographic distribution of *N. neocomiensiformis* is: South-East Spain (Company, 1987; Company and Tavera 2013), South-East France (Bulot, 1995; Reboulet, 1996), Central Italy (Faraoni et al. 1997), the Czech Republic (Uhlig, 1902), Slovakia (Vašíček, 1995, 2010), and Hungary (Főzy et al., 2010).

Reboulet underlined that the *Neocomites neocomiensiformis* Zone proposed by Company and Tavera (2013) corresponds, in terms of stratigraphic interval, to the *Olcostephanus stephanophorus* Zone of Bulot and Thieuloy (1995) who subdivided this unit into the *Baronnites hirsutus*, *Busnardoites subcampylotoxus* and *Busnardoites campylotoxus* subzones. Indeed, in both these zonal schemes, the lower boundary of the *N. neocomiensiformis* and *O. stephanophorus* zones is correlated with the lower boundary of the *B. hirsutus* Subzone, and their upper boundary is defined by the base of the *Karakaschiceras inostranzewi* Zone. The First Appearance Datum (FAD) of *O. stephanophorus* and *B. hirsutus* is placed at the same level by Bulot et al. (1993) and Bulot and Thieuloy (1995); for Company and Tavera (2013), *B. hirsutus* and *N. neocomiensiformis* appear in the same level. Company preferred to choose *N. neocomiensiformis* as index-species of this zone because *O. stephanophorus* has a restricted palaeobiogeographic distribution (France and Spain, Bulot, 1990; Klein, 2005). Company considered that the specimen figured by Fatmi and Rawson, 1993, (figs. 3 n–o), does not belong to *O. stephanophorus* and its identification is relatively difficult (sphaeroconic morphology often flattened by compaction). The proposal of Company and Tavera (2013) to subdivide the *N. neocomiensiformis* Zone into a lower *B. hirsutus* Subzone and an upper *Valanginites dolioliformis* Subzone has not been kept; more data are needed in order to find an agreement as Bulot and Thieuloy (1995) suggested a different subdivision (see above) for this stratigraphic interval.

(4 in Table 1a) Company and Tavera (2013) suggested introducing the *Karakaschiceras inostranzewi* Zone in the standard zonation. This stratigraphic interval corresponds to the *Karakaschiceras biassalense* Subzone *sensu* Bulot and Thieuloy (1993) who defined the base by the appearance of the index-species (see also Cotillon, 1971, pp. 36 and 39, who recognized a *Biassalensis* Horizon with his “*Leopoldia*” *biassalensis* and “*Leopoldia*” *inostranzewi* at the base). Later, Bulot (1995) preferred to use *K. inostranzewi* as index-species taking into account that it is difficult to distinguish *K. biassalense* from *Karakaschiceras pronecostatum* when specimens are fragmented, and *K. inostranzewi* is abundant on the platform and not rare in the Vocontian Basin. The base of the *K. inostranzewi* Zone is defined by the appearance of the index-species (Bulot, 1995); this author stressed that on the Provence platform the zone begins with the “*Karakaschiceras* beds” (Formation 7 *sensu* Cotillon, 1971) and includes the “Petite Luma-chelle” Formation (Formation 9 *sensu* Cotillon, 1971). According to Bulot (1995) and Bulot and Thieuloy (1995), *K. inostranzewi*, *K. biassalense* and *Saynoceras fuhri* appear at the same level. Company and Tavera (2013) underlined that the holotype of *K. inostranzewi* comes from Mangush (recently – village of Prokh-ladnoe), while the holotype of *K. biassalense* comes from Biassala (recently – village of Verkhorechie) (Karakasch, 1889), where the holotype of *Neohoploceras karakaschi* has been found. These authors found this last species in the upper part of the *Saynoceras verrucosum* Zone. Moreover, they never identified “true” *K. biassalense* in the *K. inostranzewi* Zone and they considered that many of the specimens interpreted as *K. pronecostatum* could correspond to *K. biassalense*. The *K. inostranzewi* Zone has been subdivided into a *K. inostranzewi* Subzone below (according to Company and Tavera’s proposal) and a *Neocomites platycostatus* Subzone above; this latter was introduced in the standard zonation as a horizon during the Lyon meeting (Hoedemaeker et al., 2003).

The stratigraphic interval of the *Karakaschiceras inostranzewi* Zone is not exactly equivalent to the interval of the *Karakaschiceras biassalense* Subzone *sensu* Hoedemaeker et al. (2003) adopted during the Lyon meeting (Table 2). Indeed, the *K. biassalense* Subzone was subdivided into the *Saynoceras fuhri* and *Neocomites platycostatus* horizons at that meeting. These had first been defined by Atrops and Reboulet (1995a,b; see also Reboulet, 1996 and Reboulet and Atrops, 1999). Consequently, the base of the *K. biassalense* Subzone *sensu* Hoedemaeker et al. (2003) did not begin with the FAD of the index-species but with the FAD of *S. fuhri*. As only a short explanation was given in the Kilian Group’s Lyon report (Hoedemaeker et al., 2003, p. 90) about the introduction of these units in the standard zonation, some confusion could exist about the conception and the use of the *K. biassalense* Subzone (its base defined by the appearance of *K. biassalense* versus that of *S. fuhri*). In order to avoid such confusion it is preferable to choose *K. inostranzewi* as the index-species that characterises an interval between its first appearance and the FAD of *Saynoceras verrucosum*, the index-species of the overlying zone.

2.3. Hauterivian

Kakabadze proposed a correlation for the upper Hauterivian zonal scheme of the Georgian (Caucasus) region (East Mediterranean) with the standard zonation (Table 3). Concerning the “*Pseudothurmannia ohmi*” Zone, he preferred to use *Pseudothurmannia mortilleti* as index-species taking into account that *P. ohmi* is not present in Georgia (Kakabadze, 1981, 2008; Kakabadze et al., 2005). The *P. mortilleti* Zone is subdivided into the *P. mortilleti* and *Pseudothurmannia simionescui* subzones and a horizon of “*Crioceratites* sp.”. Kakabadze correlated the base of the *P. mortilleti* (Sub-)Zone with the base of the “*P. ohmi*” (Sub-)Zone and the *P. simionescui* Subzone would correspond to the *Pseudothurmannia catulloi* Subzone (Kakabadze, 2008). However, Company suggested that the base of the *P. mortilleti* Subzone should be correlated with the base of the *P. catulloi* Subzone, for two reasons. Firstly, for Company et al. (2003, 2008, this meeting), *P. mortilleti* (Pictet and de Loriol) is a senior synonym of *P. catulloi* (Parona) and the *P. catulloi* Subzone of Hoedemaeker (1995) is equivalent of the *P. mortilleti* Subzone of Company et al. (2003). For Hoedemaeker and Leereveld (1995), Klein et al. (2007) and Kakabadze (2008, this work), *P. mortilleti* is not conspecific with *P. catulloi*. Secondly, Company evoked the possibility that the stratigraphic interval corresponding to the “*P. ohmi*” Subzone is condensed or not represented in the Georgia area.

2.4. Barremian

(5 in Table 1b) Idakieva and Ivanov (2013) proposed a zonal scheme for the uppermost part of the Barremian. They suggested a subdivision of the interval corresponding to the *Imerites giraudi* Zone *sensu* Reboulet et al. (2009, 2011) into two zones: a lower *I. giraudi* Zone and an upper *Martellites sarasini* Zone, defined by the FAD of their index-species (Table 1b). Their proposal marks a return to the standard zonation proposed at the Neuchâtel meeting (Reboulet et al., 2006) and they agreed with Vermeulen who considered *M. sarasini* as index-species of a zone (see his comment and the references in Reboulet et al., 2009). The *I. giraudi* and *M. sarasini* zones are widely recognizable, e.g., in France, Spain, Bulgaria, Romania, North Caucasus, Georgia, West Turkmenistan, and Iran (Persian Kopet Dag) (Aguirre-Urreta and Klinger, 1986; Delanoy, 1995, 1997a,b; Aguado et al., 1997; Ropolo et al., 2000; Kakabadze and Kotetishvili, 2003; Kakabadze et al., 2004; Klein et al., 2007; Ivanov and Idakieva, 2009, 2013; Raisossadat, this work and in Zahedipour et al., 2014). In the previous zonal scheme (Bert et al., 2008; Reboulet et al., 2009, 2011), the *I. giraudi* Zone represented *de facto* a “superzone”, while the index species occupied only the lowermost part of the zone. In the upper part

Table 1b

Ammonite standard zonation of the Barremian–Albian stages (West Mediterranean province); the bold numbers refer to the numbers in the text.

STAGES		ZONES	SUBZONES	HORIZONS
ALBIAN	Upper	<i>Arrhaphoceras briacensis</i>		
		<i>Mortoniceras perinflatum</i>		
		<i>Mortoniceras rostratum</i>		
		<i>Mortoniceras fallax</i>		
		<i>Mortoniceras inflatum</i>		
		<i>Mortoniceras pricei</i>		
		<i>Dipoloceras cristatum</i>		
	Middle (7)	<i>Euhoplites lautus</i>		
		<i>Euhoplites loricatus</i>		
		<i>Hoplites dentatus</i>		
Lower (7)	<i>Douvilleiceras mammillatum</i>	<i>Hoplites spathi</i>		
	<i>Leymeriella tardefurcata</i>	<i>Lyelliceras lyelli</i>		
APTIAN	Upper	<i>Hypacanthoplites jacobi</i>	<i>Lyelliceras pseudolyelli</i>	
		<i>Acanthohoplites nolani</i>		
		<i>Parahoplites melchioris</i>		
		<i>Epicheloniceras martini</i>		
		<i>Epicheloniceras buxtorfi</i>		
	Lower	<i>Dufrenoyia furcata</i> (6)	<i>Epicheloniceras gracile</i>	
		<i>Deshayesites deshaysi</i> (6)	<i>Epicheloniceras debile</i>	
		<i>Deshayesites forbesi</i> (6)	<i>Dufrenoyia dufrenoyi</i>	
		<i>Deshayesites oglanlensis</i> (6)	<i>D. furcata</i>	
			<i>Deshayesites grandis</i>	
			<i>Roloboceras hambrovi</i>	
		<i>Deshayesites luppovi</i>		
BARREMIAN	Upper	<i>Martelites sarasini</i> (5)	<i>Pseudocrioceras waagenoides</i>	
			<i>M. sarasini</i>	
		<i>Imerites giraudi</i> (5)	<i>Heteroceras emerici</i> (5)	
			<i>I. giraudi</i> (5)	
		<i>Gerhardtia sartousiana</i>	<i>Hemihoplites feraudianus</i>	
			<i>Gerhardtia provincialis</i>	
			<i>G. sartousiana</i>	
		<i>Toxancyloceras vandenheckii</i>	<i>Barrancyloceras barremense</i>	
		<i>T. vandenheckii</i>		
	Lower	<i>Moutoniceras moutonianum</i>		<i>Heinzia caicedi</i>
				<i>Coronites darsi</i>
		<i>Kotetishvilia compressissima</i>		<i>Subtorcapella defayae</i>
				<i>Heinzia communis</i>
		<i>Nicklesia pulchella</i>		<i>Nicklesia didayana</i>
		<i>Kotetishvilia nicklesi</i>		<i>Holcodiscus fallax</i>
<i>Taveraidiscus hugii auctorum</i>		<i>Psilotissotia colombiana</i>		
	<i>T. hugii auctorum</i>			

of the upper Barremian, there are three distinct and important faunal turnovers: the FAD of the genus *Imerites* with the index species *I. giraudi*; the mass development of the genera *Martelites* and *Colchidites* with the FAD of *M. sarasini*; and the appearance of the genus

Pseudocrioceras with its index species *Pseudocrioceras waagenoides*. Although the first occurrence of the genus *Martelites* takes place in the *I. giraudi* Zone and *Heteroceras* is always represented in the *M. sarasini* Zone, the ammonite assemblages of these two zones are rather

Table 2Correlations of the *Karakaschiceras biassalense* Horizon/Subzone with the *Karakaschiceras inostranzewi* Zone.

Substage	Atrops and Reboulet (1995 a,b) Reboulet and Atrops (1999)		Kilian group Lyon meeting 2002 (Hoedemaeker et al., 2003)		¹⁾ Bulot and Thieuloy (1995) ²⁾ Company and Tavera (2013)
Lower Valanginian <i>p.p.</i>	<i>B. campylotoxus</i> Zone <i>p.p.</i>	<i>N. platycostatus</i> Horizon	<i>B. campylotoxus</i> Zone <i>p.p.</i>	<i>K. biassalense</i> Subzone	<i>N. platycostatus</i> Horizon
		<i>K. biassalense</i> Horizon			<i>K. inostranzewi</i> Zone ¹⁻²
		<i>S. fuhri</i> Horizon			<i>N. neocomiensiformis</i> Zone ² <i>p.p.</i>

different, since they are clearly dominated by different taxa (*Heteroceras* in the *I. giraudi* Zone and *Martelites* in the *M. sarasini* Zone). After a discussion, the Kilian Group agreed to adopt this change and also to subdivide the *I. giraudi* Zone into the *I. giraudi* and *Heteroceras emerici* subzones, previously considered as horizons (Reboulet et al., 2006, 2009, 2011). But Kakabadze considered that subdivision of the *I. giraudi* Zone into two biostratigraphical units (as subzones or horizons) is not possible in Georgia and probably in many Tethyan regions and therefore there is still no fundamental argument to consider these horizons as subzones. The *M. sarasini* and *P. waagenoides* subzones (Reboulet et al., 2009, 2011) correspond to the lower and upper parts of the *M. sarasini* Zone, respectively. As the species *P. waagenoides* has a facies-controlled distribution, the rank of a subzone is kept. The *Anglesites puzosianum* Horizon, introduced (as the *Leptoceratoides puzosianum* Horizon) in the zonal scheme during the Neuchâtel meeting (Reboulet et al., 2006), is kept; this index-species is the type species of the genus *Anglesites* defined by Delany and Busnardo (2007).

2.5. Aptian

(6 in Table 1b) Taking into account the written contributions of Çağlar and Raisossadat, a short discussion was held on some (sub-) zones of this stage (Table 1b). They recognized the *Deshayesites forbesi* (named *Deshayesites weissi* Zone in their work) and *Deshayesites deshayesi* zones in Turkey (Çağlar et al., 2013). The identification of their *Deshayesites* cf. *luppovi* remains uncertain, but if confirmed, the *Deshayesites oglanlensis* Zone could be partly recognized in this area as *D. luppovi* is the index-species of a subzone in the upper part of this zone (up to now, this index-species has only been recognized in Spain and France; see references in Reboulet et al., 2011).

Raisossadat disagreed with Moreno-Bedmar's conception of some *Deshayesites* species (cf. their intraspecific variability, more particularly on the dimorphism of *Deshayesites deshayesi*, see discussion in Reboulet et al., 2011, p. 789). Moreno-Bedmar replied

that he is revising *D. deshayesi* and so this issue will be discussed at the next meeting. Raisossadat approved the subdivision of the *Dufrenoyia furcata* Zone into the *D. furcata* and *Dufrenoyia dufrenoyi* subzones adopted during the Dijon meeting (Reboulet et al., 2011), and he underlined that *D. furcata* is more abundant than *D. dufrenoyi* (García-Mondéjar et al., 2009; Raisossadat, 2011).

2.6. Albian

(7 in Table 1b) The upper Albian zonation was significantly improved during the Dijon meeting (Reboulet et al., 2011). However, it appears that the zonal scheme for the lower and middle Albian is not satisfactory (Table 1b). Members of the Kilian Group underlined the necessity to have new data/results; they encouraged the participation of experts at future Kilian Group meetings in order to improve the zonation and also to have an agreement on the Aptian/Albian boundary.

3. Boreal, Austral and Central Atlantic zonal schemes and their correlations with the standard zonation (West Mediterranean region)

The Kilian Group encouraged the development of zonations for different palaeobiogeographical provinces and the possibility to correlate them with the West Mediterranean zonation, which has long been taken as the standard zonation. Some attempts of correlations are proposed here and they will be further discussed during the next meeting when it is hoped that experts on these different provinces will attend.

3.1. Valanginian–Hauterivian of the Boreal Realm

Baraboshkin sent a set of tables (without explanatory text) showing correlations of the Mediterranean region with the Mountain Crimea, North Caucasus, Russian platform and Western Siberia for the

Table 3

Correlations of the upper Hauterivian zonal scheme of the Georgian (Caucasus) region (East Mediterranean province) and the standard zonation (West Mediterranean province).

SUBSTAGE	Standard zonation (Reboulet et al., 2009, 2011)		Georgia (Kakabadze's proposal)	
Upper Hauterivian	ZONES	SUBZONES/horizons (h)	ZONES	SUBZONES/horizon (h)
	« <i>Pseudothurmannia ohmi</i> »	<i>Pseudothurmannia picteti</i>	<i>Pseudothurmannia mortilleti</i>	«? <i>Crioceratites</i> sp.» (h)
		<i>Pseudothurmannia catulloi</i>		<i>Pseudothurmannia simionescui</i>
		« <i>P. ohmi</i> »		<i>P. mortilleti</i>
	<i>Balearites balearis</i>	<i>Spathicrioceras seitzii</i>	<i>B. balearis</i>	
		<i>Crioceratites krenkeli</i>		
		<i>Binelliceras binelli</i>		
		<i>B. balearis</i>		
	<i>Plesiospitidiscus ligatus</i>		<i>Speetoniceris inversum</i>	
	<i>Subsaynella sayni</i>	<i>Subsaynella begudensis</i> (h)		
		<i>Cruasiceris cruasense</i> (h)		

Hauterivian. According to this author for the North Caucasus (Baraboshkin, 2004, 2008) and to Kakabadze for Georgia and adjacent regions of the Caucasus (Table 3; see also Kakabadze, 1981, 2008), the base of the *Speetonicer* *inversum* Zone in those regions correlates with the base of the *Subsajnella sayni* Zone. However, for Rawson (written contribution; Table 4, see below; Kemper et al., 1981; Rawson 1995, 2007) and Reboulet (see Sr-isotope correlations, McArthur et al., 2007), the base of *S. inversum* Zone of the North-West European Province should be correlated with the base of the *Lyticoceras nodosoplicatum* Zone.

Rawson sent a detailed written contribution (presented briefly by Aguirre-Urreta) including a table correlating the zonal schemes of the North-West European and West Mediterranean provinces for the Valanginian and Hauterivian stages. Subsequently, Rawson has modified the table to take into account some points discussed during the meeting. It should be stressed that the correlations presented below (levels 1–12; Table 4) are based purely on the ammonite evidence, which is the primary concern of the Kilian

Group. Reboulet agreed with some of Rawson's proposals but noted that combining paleontological data with Sr-isotope correlations (for details see McArthur et al., 2007) suggests some alternative correlations, particularly at the Valanginian/Hauterivian boundary where isotope evidence suggests that the base of the *Endemoceras amblygonium* Zone may correlate with the uppermost part of the *Criosarasinella furcillata* Zone (McArthur et al., 2007). This issue will be further discussed during the next meeting.

3.1.1. Valanginian correlations (Table 4)

The North-West European Valanginian zonation is based on the North German (Lower Saxony Basin) sequences: the Speeton (Eastern England) sequence is thin and very incomplete. The historical development of the zonation shown here in Table 4 was discussed in detail by Rawson (1995).

Level 1. Strata across the Jurassic/Cretaceous boundary in North Germany are non-marine. *Platylenticeras* is the first ammonite to appear after the transition from non-marine to marine. Its origin

Table 4

Correlation of the Valanginian and Hauterivian zonal schemes of the North-West European and West Mediterranean provinces. Note that in the right hand column solid lines indicate confident correlation with the standard zonation, dashed lines indicate provisional correlation and dash-and-dot lines indicate no clear correlation is possible at present.

	WEST MEDITERRANEAN PROVINCE			NORTH-WEST EUROPEAN PROVINCE	
	ZONES	SUBZONES/Horizons		ZONES	
UPPER HAUTERIVIAN	BA. <i>Taveraidiscus hughii</i> Auct. [pars]		12 →	<i>Craspedodiscus variabilis</i>	<i>Craspedodiscus discoidalatus</i>
	" <i>Pseudothurmannia ohmi</i> "			<i>Simbirskites marginatus</i>	
	<i>Balearites balearis</i>			<i>Craspedodiscus gottschei</i>	
	<i>Plesiospitidiscus ligatus</i>		11 →	<i>Milanowskia speetonensis</i> / <i>Milanowskia staffi</i>	
	<i>Subsajnella sayni</i>		10 →		
LOWER HAUTERIVIAN	<i>Lyticoceras nodosoplicatum</i>	<i>Olcostephanus</i> (O.) <i>variegatus</i> Horizon	9 →	<i>Speetonicer</i> <i>inversum</i>	
	<i>Crioceratites loryi</i>	<i>Olcostephanus</i> (<i>Jeannoticer</i>) <i>jeannoti</i>	8 →	<i>Endemoceras regale</i>	
		<i>C. loryi</i>		<i>Endemoceras noricum</i>	
	<i>Acanthodiscus radiatus</i>		7 →	<i>Endemoceras amblygonium</i>	
UPPER VALANGINIAN	<i>Criosarasinella furcillata</i>	<i>Teschenites callidiscus</i>	6 →	<i>Olcostephanus</i> (O.) <i>densicostatus</i>	
		<i>C. furcillata</i>	5 ←	<i>Stoicoceras tuberculata</i>	
	<i>Neocomites peregrinus</i>	<i>Olcostephanus</i> (O.) <i>nicklesi</i>		<i>Dichotomites bidichotomoides</i>	
		<i>N. peregrinus</i>	4 →	<i>Dichotomites tryptichoides</i>	
	<i>Saynoceras verrucosum</i>	<i>Karakaschiceras pronecostatum</i>		<i>Dichotomites crassus</i>	
LOWER VALANGINIAN		<i>S. verrucosum</i>		<i>Prodichotomites polytomus</i>	
	<i>Karakaschiceras inostranzewi</i>	<i>Neocomites platycostatus</i>	3 →	<i>Prodichotomites hollwedensis</i>	
		<i>K. inostranzewi</i>	2 →	<i>Polyptychites hapkei</i>	
	<i>Neocomites neocomiensiformis</i>			<i>Polyptychites clarkei</i>	
UPPER BER.	" <i>Thurmanniceras</i> " <i>pertrsansiens</i>			<i>Polyptychites multicostatus</i>	
				<i>Polyptychites pavlowi</i>	
UPPER BER.	<i>Subthurmannia boissieri</i> [pars]	<i>Thurmanniceras otopeta</i>	1 ←	<i>Platylenticeras involutum</i>	
				<i>Platylenticeras heteropleurum</i>	
				<i>Platylenticeras robustum</i>	
				[non-marine]	

BER. - Berriasian; BA. - Barremian

remains uncertain but the Lower Saxony Basin appears to be where the main evolutionary radiation took place (Kemper et al., 1981, p. 278) and the French forms were regarded by Thieuloy (1977a) as of “boreal” origin. French *Platylenticeras* occurring very high in the *Thurmanniceras otopeta* Subzone (Thieuloy, 1977a) appear to be close to early *Platylenticeras* in the German sequence (Kemper et al., 1981, p. 305); so the lowest part of the German *Platylenticeras robustum* Zone is placed in the Berriasian in the correlation table.

Level 2. The lower part of the *Prodichotomites hollwedensis* Zone includes large sphaeroidal *Olcostephanus* of the *Olcostephanus (Olcostephanus) guebhardi* group (Kemper et al., 1981, pl. 35, figs 1, 2; Bulot, 1990, p. 87). In France, Bulot and Thieuloy (1995, p. 19) noted that *O. (O.) guebhardi* reached its acme in the *Karakaschiceras inostranzewi* Zone and therefore they correlated this with the lower *P. hollwedensis* Zone. This is supported by the correlations that can be made between faunas in level 3, just above.

Level 3. This is a very important interval when significant migrations took place in both directions and reflects a significant sea-level rise. In the upper part of the North German *Prodichotomites hollwedensis* Zone, *Saynoceras verrucosum*, *Valanginites* spp. and *Karakaschiceras* spp. appear (see Kemper et al., 1981; Kemper, 1992 for illustration of species) and provide a close tie with the base of the *S. verrucosum* Zone. *Karakaschiceras* migrated as far west as Eastern England where it is preserved only in a “remanié” horizon. There was also migration of boreal ammonites from North Germany to adjacent Tethyan areas: for example, Vašíček and Michalík (2002) record *Prodichotomites complanatus* in the *S. verrucosum* Zone of the Outer Carpathians; Avram (1988) recorded *Polyptychites laticosta* from the same zone in the East Carpathians, while Thieuloy (1977a) figured several polyptychitids from the *S. verrucosum* Zone of South-East France (see also Kemper et al., 1981, p. 305).

Level 4. *Neocomites peregrinus* was first described from the *Dichotomites crassus* Zone but is now known in the Mediterranean region where it forms the index species of the *N. peregrinus* (Sub-)Zone (Reboulet and Atrops, 1999). It clearly originated in the latter area.

Level 5. *Stoicoceras* (= *Dicostella*) is a neocomitid that first appears in the *Dichotomites bidichotomoides* Zone in North Germany, where it probably evolved. It provides the index species for the overlying *Stoicoceras tuberculata* Zone. The very rare French examples of *Stoicoceras* are mainly of the later, *S. tuberculata* group [*Dicostella pitrei* Busnardo, *Dicostella houdardi* (Roman)]: the only well-horizoned specimens were recorded by Thieuloy (1977b, fig. 9) from just above the base of his *Teschenites callidiscus* Zone, i.e., just above the base of the *Criosarasinella furcillata* (Sub-)Zone of the current biozonation (see also McArthur et al., 2007).

Level 6. *Stoicoceras* was replaced in North Germany by an influx of *Olcostephanus* of the *Olcostephanus densicostatus* group (characterising the “Astierien Schichten”). Although *O. densicostatus* ranges across the Valanginian/Hauterivian boundary in France, the *O. densicostatus* Zone is correlated here solely with the *Teschenites callidiscus* Subzone as suggested by Rawson et al. (1999) (see McArthur et al., 2007; see Level 7 below).

3.1.2. Hauterivian correlations (Table 4)

The modern zonation is based mainly on the Speeton Clay (Eastern England) succession, as reviewed by Rawson (1995). The zonation essentially applies across the whole of North-West Europe, though with minor differences between England and Germany: in North Germany *Milanowskia staffi* is used as alternative to *Milanowskia speetonensis* and *Craspedodiscus discofalcatus* as an alternative to *Simbirskites marginatus* and *Craspedodiscus variabilis*, reflecting differences in the abundance of the various index species.

Level 7. In North Germany, *Olcostephanus* was abruptly replaced by a neocomitid genus that is endemic to North-West Europe, *Endemoceras*. The first appearance of *Endemoceras* is generally taken

to mark the base of the Hauterivian, which would limit the *Olcostephanus densicostatus* Zone to the highest Valanginian. The limited field evidence suggests that *Acanthodiscus* first appears in Germany at about the middle of the *Endemoceras amblygonium* Zone and continues into the *Endemoceras noricum* Zone (Kemper et al., 1981, p. 302) which could indicate that the base of the Hauterivian should be placed within the *E. amblygonium* Zone. But Bulot et al. (1993, p. 39) regarded the German forms as comparable with *Acanthodiscus* from the middle of the *Acanthodiscus radiatus* Zone as they have a characteristically broad siphonal band; so the ammonite evidence suggests that the base of the Hauterivian is still best placed at about the base of the *E. amblygonium* Zone (strontium data suggest that the base of the *E. amblygonium* Zone may correlate to the uppermost part of the *Criosarasinella furcillata* Zone; McArthur et al., 2007). *Acanthodiscus* did not reach Eastern England (Speeton Clay), where the *E. amblygonium* and *E. noricum* zones are very condensed.

Level 8. The *Endemoceras regale* Zone faunas are better developed at Speeton than in North Germany and include the distinctive Tethyan olcostephanids *Olcostephanus sayni* (= *Olcostephanus subflosus* Spath) and *Olcostephanus (Jeannoticeras) jeannoti* in the upper part of the *E. regale* Zone (Kemper et al., 1981; Doyle, 1989). These provide a firm tie with the *Olcostephanus (J.) jeannoti* Horizon.

Level 9. *Spitidiscus pavlowi* occurs at the very top of the *Endemoceras regale* Zone. Bulot (1995, p. 134) noted that the group of French forms that *S. pavlowi* probably belongs to occur in the upper *Crioceratites loryi* Zone [*Olcostephanus (Jeannoticeras) jeannoti* Horizon] and extreme base of the overlying *Lyticoceras nodosoplicatum* Zone. Such a correlation is supported by the record from the base of the *Speetoniceratites inversum* Zone, immediately above the *S. pavlowi* bed, of a single *Olcostephanus (Olcostephanus) variegatus* (= *Olcostephanus cf. singularis* in Doyle, 1989), index species of the *O. (O.) variegatus* Horizon at the base of the *C. loryi* Zone in France. Thus the base of the *S. inversum* Zone is correlated here with the base of the *L. nodosoplicatum* Zone.

Level 10. *Crioceratites* of the *nolani/duvali* group appear commonly in the highest part of the *Speetoniceratites inversum* Zone in both England and Germany (e.g., Kemper et al., 1981, pl. 34, figs 3, 4; Kemper, 1992, pls 55–57; Kakabadze and Hoedemaeker, 2010). These indicate a correlation with the middle part of the *Subsaynella sayni* Zone, where *Crioceratites duvali* is most abundant (Bulot et al., 1993, tab. 10). This would indicate that the base of the immediately overlying *Milanowskia speetonensis* Zone correlates with the mid to upper part of the *S. sayni* Zone.

Levels 8–10 are closely spaced and reflect successive pulses of a major mid Hauterivian sea-level rise, though unlike in the mid Valanginian event there is no evidence of boreal ammonites (simbirskitids) migrating southward from here.

Level 11. There is a second *Spitidiscus* level in the middle of the *Milanowskia speetonensis* Zone at Speeton, where the type species, *Spitidiscus rotula*, occurs. This suggests a correlation with the base of the *Plesiospitidiscus ligatus* Zone, where Bulot (1995, p. 134) recorded *Spitidiscus* of the *rotula* group. This is the only horizon in the *M. speetonensis* to *Craspedodiscus variabilis* zones that provides a clue for correlation, though it should be stressed that exposure of these zones at Speeton is intermittent while there are no good German sections now visible. But the fauna appears dominated by boreal simbirskitid ammonites. Fragments of *Crioceratites* occur scattered through the upper Hauterivian but remain poorly known.

Level 12. *Crioceratites (Paracrioceratites) spathi* occurs at the base of the *Craspedodiscus variabilis* Zone at Speeton, which appears to correlate with about the middle of the German *Craspedodiscus discofalcatus* Zone (Kemper et al., 1981). Because *C. (P.) spathi* bears looped ribs characteristic of the Tethyan “*Emericeras*” *emerici* group, Kemper et al. (1981) took its appearance to mark the approximate base of the Barremian at Speeton. However, it is now apparent that such forms may appear earlier in both the Mediterranean area and North Germany

(e.g., Kakabadze and Hoedemaeker, 2010), so the exact position of the boundary remains uncertain. Above the *C. variabilis*/*C. discofalcatus* zones, the lower Barremian ammonite faunas are almost exclusively crioceratitid in both England and North Germany (Rawson and Mutterlose, 1983; Kakabadze and Hoedemaeker, 2010).

3.2. Berriasian, Valanginian and Hauterivian of the Austral province

Concerning the Berriasian of the Austral province, Aguirre-Urreta reported new research centred on exposures of Tithonian–Berriasian age in the Neuquén Basin which have improved the Argentine zonal scheme and its correlation with the Mediterranean zones (Vennari et al., 2013). Three assemblage zones have been identified. The first zone of *Substeueroceras koeneni* includes species of *Substeueroceras*, *Parodontoceras*, *Blanfordiceras*, *Berriasella*, *Aulacosphinctes*, *Pectinatites* (?), *Himalayites*, “*Spiticer*” and *Schaireria*. Traditionally ascribed to the upper Tithonian, it may reach the lowest Berriasian and is correlated with the final part of the *Durangites* Zone and the base of the *Berriasella jacobii* Zone of the Mediterranean Region. The *Argentiniceras noduliferum* assemblage Zone includes several species of *Argentiniceras*, representatives of *Groebericeras*, *Frenguelligeras*, *Berriasella*, “*Thurmanniceras*”; and some relict *Substeueroceras*. It may correspond to the “second faunistic renovation” of Tavera et al. (1986) and is correlated with the upper part of the *B. jacobii* and the *Subthurmannia occitanica* zones, spanning the lower and middle Berriasian. Finally, the *Spiticer* *damesi* assemblage Zone typically includes several species of *Spiticer* and *Cuyanicer*, along with representatives of *Neocosmoceras*, *Neocomites*, “*Thurmanniceras*” and *Blanfordiceras*. These late Berriasian ammonite genera are well known from the Tethys (Le Hégarat, 1973) and may be correlated with the *Subthurmannia boissieri* Zone of the upper Berriasian.

Aguirre-Urreta and Rawson proposed a synthetic table showing correlations between the Valanginian–Hauterivian zonation of the Neuquén Basin (Argentina) and the West Mediterranean zonal scheme (Table 5). The Argentine zonal scheme is based on Aguirre-Urreta and Rawson (1997) with subsequent modifications following their monographic description of many of the faunas; the modifications are summarised in Aguirre-Urreta et al. (2005) and Aguirre-Urreta and Rawson (2012). There were 10 significant faunal turnovers in the Neuquén Basin (Rawson, 2007), initially reflecting an alternation of neocomitid and olcostephanid genera, then of desmoceratid and crioceratitid forms. Many of the taxa are endemic to the basin, while others represent widely-distributed Tethyan genera. As in North-West Europe, the main immigration horizons reflect the “global” mid Valanginian and mid Hauterivian sea-level rises.

Level 1. The *Olcostephanus* (*Olcostephanus*) *atherstoni* Subzone is characterised by abundant *O. (O.) atherstoni*, which appears close to *Olcostephanus* (*Olcostephanus*) *gubhardi* (Bulot in Aguirre-Urreta and Rawson, 1997). In South-East France, the latter reaches its acme in the *Karakaschiceras inostranzewi* Zone (Bulot and Thieuloy, 1995, p. 19).

Level 2. The sudden appearance of *Karakaschiceras* and *Neohoploceras* at the base of the *Karakaschiceras attenuatus* Subzone is taken to represent the mid Valanginian sea-level rise that also caused the northward spread of the same two genera, which corresponds with the base of the *Saynoceras verrucosum* Zone. The *Karakaschiceras*/*Neohoploceras* faunas of the *K. attenuatus* Subzone (Aguirre-Urreta, 1998) indicate a correlation with the *S. verrucosum* to *Neocomites peregrinus* subzones in France.

Level 3. The *Viluceras permolestus* Subzone is characterised by the endemic olcostephanid *Viluceras* but a few evolute *Olcostephanus* occur in the upper half of the subzone to “provide a tentative link with the *Olcostephanus* (*Olcostephanus*) *nicklesi* Subzone” (Aguirre-Urreta and Rawson, 1999), which is characterised by evolute *Olcostephanus*.

Level 4. The base of the *Holcoptychites neuquensis* Zone lies at about the base of the Hauterivian because: (a) early *Holcoptychites*

appear very close to early *Spitidiscus* from the lowest Hauterivian in Europe (Aguirre-Urreta and Rawson, 2003, p. 595); (b) rare *Oosterella* occur either side of the boundary in both areas (Aguirre-Urreta and Rawson, 2003, p. 607).

Level 5. *Olcostephanus* (*Jeannoticeras*) occurs in the *Olcostephanus* (*Olcostephanus*) *laticosta* Subzone, suggesting a correlation with the *Olcostephanus* (*Jeannoticeras*) *jeannoti* Subzone (Aguirre-Urreta and Rawson, 2001).

Level 6. Very rare *Olcostephanus* (*Olcostephanus*) *variegatus* occur in the upper half of the *Hoplitocrioceras giovinei* Subzone suggesting a link with the *O. (O.) variegatus* Horizon (Aguirre-Urreta and Rawson, 2001).

Level 7. The appearance of *Spitidiscus* in Argentina marks the base of the *Spitidiscus riccardii* Zone, which is characterised by *Spitidiscus kilipiae* and *S. riccardii* (Rawson and Aguirre-Urreta, 2012). These forms were originally considered to compare with specimens from the *L. nodosoplicatum* Zone in France (Aguirre-Urreta and Rawson, 1997; Bulot in Rawson, 1999). But as a result of the olcostephanid records from levels 5 and 6, coupled with evidence from nanofossil correlations, Aguirre-Urreta et al. (2005, 2007) and Rawson (2007) correlated the *S. riccardii* Zone with part of the *Subsajnella sayni* Zone, where *Spitidiscus* still occurs.

Level 8. *Crioceratites* species from the *Crioceratites schlagintweitii* Zone are virtually indistinguishable from *Crioceratites* in the *Subsajnella sayni*-*Plesiospitidiscus ligatus* zones.

Level 9. *Sabaudiella riverorum* is the index species of the *S. riverorum* Zone, recently proposed for beds that had previously not yielded ammonites so had been included in the upper part of the *Paraspiticeras groeberi* Zone. After reviewing the occurrence of *Sabaudiella* in Europe, Aguirre-Urreta and Rawson (2012) provisionally correlated the *S. riverorum* Zone with the highest part of the “*Pseudothurmannia ohmi*” and the lower part of the overlying *Taveraidiscus hugii* zones. The *S. riverorum* Zone thus spans the Hauterivian/Barremian boundary.

3.3. Valanginian–Hauterivian and Aptian–lower Albian of the Central Atlantic province

Moreno-Bedmar and Barragán talked about the upper Valanginian–lower Hauterivian ammonoid record (written contribution of González-Arreola, Moreno-Bedmar and Barragán) and the preliminary ammonite zonation for the Aptian–lower Albian (Barragán, Moreno-Bedmar and González-Arreola) of Mexico, respectively. These contributors underlined the abundance of endemic Mexican species and genera that makes the use of the West Mediterranean standard zonation very difficult. Thus, they propose to establish a proper ammonite zonation for Mexico that allows correlations with the West Mediterranean standard zonal scheme; a first scheme has been made for the Aptian (Moreno-Bedmar et al., 2013; this meeting). Their preliminary results have not been integrated in this report as, according to these authors, more research is needed before the next Kilian Group meeting. Due to the strong endemism of ammonoids in this region, they suggested recognizing the Central Atlantic domain as a new faunal province for which the ammonite zonation could ultimately also be applied to coeval rocks from the southern United States, countries in Central America, and probably countries in the northern part of South America.

4. Future work

The Kilian Group considered that the *Berriasella jacobii*, “*Thurmanniceras*” *pertransiens*, *Acanthodiscus radiatus*, *Taveraidiscus hugii* and *Deshayesites oganlensis* zones should be kept as the first zones of the Berriasian, Valanginian, Hauterivian, Barremian and Aptian

Table 5

Correlation of the Valanginian and Hauterivian zonal schemes of the Neuquén Basin (Argentina) and the West Mediterranean province. Note that in the right hand columns solid lines indicate confident correlation with the standard zonation and dashed lines indicate provisional correlation.

	WEST MEDITERRANEAN PROVINCE		NEUQUEN BASIN	
	ZONES	SUBZONES/Horizon	ZONES	SUBZONES
BA.	<i>Taveraidiscus hughii</i> Auct. [pars]			
UPPER HAUTERIVIAN	" <i>Pseudothurmannia ohmi</i> "		9 →	<i>Sabaudiella riverorum</i> <i>Paraspticerus groeberi</i>
	<i>Balearites balearis</i>			<i>Crioceratites diamantensis</i>
	<i>Plesiosptidiscus ligatus</i>			<i>Crioceratites schlagintweiti</i>
	<i>Subsaynella sayni</i>		8 →	<i>Sptidiscus riccardii</i> <i>Weavericeras vacaensis</i>
LOWER HAUTERIVIAN	<i>Lyticoceras nodosoplicatum</i>		7 →	<i>Hoplitocrioceras gentilii</i> <i>Hop. giovinei</i>
	<i>Crioceratites loryi</i>	<i>Olcostephanus (O.) variegatus</i> Horizon <i>O. (Jeannoticeras) jeannoti</i> <i>C. loryi</i>	6 →	<i>Holcoptychites neuquensis</i> <i>Olcostephanus (O.) laticosta</i> <i>Hol. agrioensis</i> <i>Hol. neuquensis</i>
	<i>Acanthodiscus radiatus</i>		5 →	<i>Decliveites crassicostatus</i> <i>Chacantuceras ornatum</i> <i>P. angulatiformis</i> <i>Viluceras permolestus</i>
			4 →	<i>Pseudofavrella angulatiformis</i>
UPPER VALANGINIAN	<i>Criosarasinnella furcillata</i>	<i>Teschenites callidiscus</i> <i>C. furcillata</i>	3 →	<i>Olcostephanus (O.) atherstoni</i> <i>Karakaschiceras attenuatus</i>
	<i>Neocomites peregrinus</i>	<i>Olcostephanus (O.) nicklesi</i> <i>N. peregrinus</i>		
	<i>Saynoceras verrucosum</i>	<i>Karakaschiceras pronecostatum</i> <i>S. verrucosum</i>		
			2 →	<i>O. (O.) atherstoni</i>
LOWER VAL.	<i>Karakaschiceras inostranzewi</i>	<i>Neocomites platycostatus</i> <i>K. inostranzewi</i>	1 →	<i>Lissonia riveroi</i> <i>Neocomites wichmanni</i>
	<i>Neocomites neocomiensisformis</i>			
	" <i>Thurmanniceras</i> " <i>pertransiens</i>			

VAL. - Valanginian; BA. - Barremian

stages, respectively. The members hope that the basal zone of the Albian will be agreed at the next meeting.

The group encouraged new proposals on the Berriasian and lower–middle Albian zonations; it is emphasized that the presence of experts during the meeting is essential to achieve this.

The Group agreed to create a website, hosted under the website of the Subcommission on Cretaceous Stratigraphy of the IUGS International Commission on Stratigraphy. The chairman will initiate and animate the website and he proposed the assistance of Dr Alex Lukeneder, who subsequently agreed.

The chairman also requested the help of some members to develop the discussion on each Lower Cretaceous stage, considering their ammonite zonal schemes and boundaries. This could include the following points: to establish the state of the art; to underline the agreements established within the Kilian Group; to report the outstanding problems; to make some research proposals; to make recommendations, in terms of ammonites, on the definition of the stages and substages boundaries; and to make recommendations for GSSPs. The persons responsible are: Aguirre-

Urreta and Szives for the Berriasian, Reboulet for the Valanginian, Lukeneder for the Hauterivian, Company for the Barremian, Moreno-Bedmar for the Aptian, and Szives for the Albian. This approach will be useful to animate and complete the debate during the meetings and also to maintain an activity of the group between successive meetings. It should be also appropriate to promote a closer collaboration with the Stage Working Groups of the Cretaceous Subcommission. Various works not directly in the scope of the Berriasian Working Group, are in progress (in Bulgaria, Argentina, Mexico and France) and some integrated works are fully completed (Arkadiev and Bogdanova, 2012; Guzhikov et al., 2012; Vennari et al., 2013) on the topic related to the Tithonian–Berriasian boundary. We encourage the Berriasian Working Group to pay attention to these integrated works and let them be fully discussed by our scientific community before reaching a decision on the Jurassic/Cretaceous boundary.

The next meeting of the Kilian Group will probably be associated with the next Cretaceous Symposium, the location and date of which are still to be announced.

Acknowledgements

Sincere thanks are extended to Ismail Ömer Yilmaz and Mehmet Eldegez for the local organization of the Kilian Group meeting. The authors are grateful to reviewers and Marcin Machalski, associate editor of Cretaceous Research, for their constructive comments.

References

- Aguado, R., Company, M., Sandoval, J., Tavera, J.M., 1997. Biostratigraphic events at the Barremian/Aptian boundary in the Betic Cordillera, southern Spain. *Cretaceous Research* 18, 309–329.
- Aguirre-Urreta, M.B., 1998. The ammonites *Karakaschiceras* and *Neohoploceras* (Valanginian Neocomitidae) from the Neuquen Basin, West-Central Argentina. *Journal of Paleontology* 72, 39–59.
- Aguirre-Urreta, M.B., Klinger, H.G., 1986. Upper Barremian Heteroceratinae (Cephalopoda, Ammonoidea) from Patagonia and Zululand, with comments on the systematics of the subfamily. *Annals of the South African Museum* 96, 315–358.
- Aguirre-Urreta, M.B., Mourgues, F.A., Rawson, P.F., Bulot, L.G., Jaillard, E., 2007. The Lower Cretaceous Chañarillo and Neuquén Andean basins: ammonoid biostratigraphy and correlations. *Geological Journal* 42, 143–173.
- Aguirre-Urreta, M.B., Rawson, P.F., 1997. The ammonite sequence in the Agrio Formation (Lower Cretaceous), Neuquén Basin, Argentina. *Geological Magazine* 134, 449–458.
- Aguirre-Urreta, M.B., Rawson, P.F., 1999. Lower Cretaceous ammonites from the Neuquén Basin, Argentina: *Viluceras*, a new Valanginian subgenus of *Olcostephanus*. *Cretaceous Research* 20, 343–357.
- Aguirre-Urreta, M.B., Rawson, P.F., 2001. Lower Cretaceous ammonites from the Neuquén Basin, Argentina: a Hauterivian *Olcostephanus* fauna. *Cretaceous Research* 22, 763–778.
- Aguirre-Urreta, M.B., Rawson, P.F., 2003. Lower Cretaceous ammonites from the Neuquén Basin, Argentina: the Hauterivian genus *Holcoptychites*. *Cretaceous Research* 24, 589–613.
- Aguirre-Urreta, M.B., Rawson, P.F., 2012. Lower Cretaceous ammonites from the Neuquén Basin, Argentina: A new heteromorph fauna from the uppermost Agrio Formation. *Cretaceous Research* 35, 208–216.
- Aguirre-Urreta, M.B., Rawson, P.F., Concheyro, G.A., Bown, P.R., Ottone, E.G., 2005. Lower Cretaceous (Berriasian–Aptian) biostratigraphy of the Neuquén Basin. In: Veiga, G.D., et al. (Eds.), *The Neuquén Basin: A Case Study in Sequence Stratigraphy and Basin Dynamics*, Geological Society, London, Special Publication 252, pp. 57–81.
- Arkadiev, V.V., Bogdanova, T.N., 2012. Cephalopods (Ammonites). In: Arkadiev, V.V., Bogdanova, T.N., Guzhikov, A.Y., Lobacheva, S.V., Myshkina, N.V., Platonov, E.S., Savelyeva, Y.N., Shurekova, O.V., Yanin, B.T. (Eds.), *Berriasian Stage of the Mountain Crimea*. Saint-Petersburg: LEMA 472 (in Russian with English abstract).
- Atrops, F., Reboulet, S., 1995a. Le Valanginien–Hauterivien basal du bassin vocontien et de la bordure provençale: zonation et corrélations. *Comptes Rendus de l'Académie des Sciences de Paris* 320, 985–992.
- Atrops, F., Reboulet, S., 1995b. *Neolissoceras* (*Carinites*), nouveau sous-genre d'ammonites du Valanginien du bassin vocontien (SE de la France). *Comptes Rendus de l'Académie des Sciences de Paris* 321, 1203–1210.
- Avram, E., 1988. The Early Cretaceous (Berriasian–Barremian) ammonite assemblages in Romania. In: Wiedmann, J., Kullman, J. (Eds.), *Cephalopods – Present and Past*. Schweizerbart'sche Verlags, Stuttgart, pp. 607–619.
- Baraboshkin, E.Yu., 2004. Boreal–Tethyan correlation of Lower Cretaceous Ammonite scales. *Moscow University. Geology Bulletin* 59 (6), 9–20.
- Baraboshkin, E.Yu., 2008. Paleotraits, their characteristics and stratigraphic significance. *Bulletin of Moscow Society of Naturalists, Section of Geology*, Moscow 83 (5), 89–98.
- Bert, D., Delanoy, G., Bersac, S., 2008. Nouveaux biohorizons et propositions pour le découpage biozonale ammonitique du Barrémien supérieur du Sud-Est de la France. *Carnets de Géologie/Notebooks on Geology*, Brest, Article 2008/03 (CG2008_A03): 18 p.
- Bragin, V.Yu., Dzyuba, O.S., Kazansky, A.Yu., Shurygin, B.N., 2013. New data on the magnetostratigraphy of the Jurassic–Cretaceous boundary interval, Nordvik Peninsula (northern East Siberia). *Russian Geology and Geophysics (Geologiya i Geofizika)* 54 (3), 335–348 (438–455).
- Bulot, L.G., 1990. Evolution des *Olcostephaninae* (Ammonitina, Cephalopoda) dans le contexte paléo-biogéographique du Crétacé inférieur (Valanginien–Hauterivien) du Sud-Est de la France. *Diplôme Etude Supérieure*, Université de Bourgogne, 177 p. (Unpublished).
- Bulot, L.G., 1995. Les formations à ammonites du Crétacé inférieur dans le SE de la France (Berriasien–Hauterivien): biostratigraphie, paléontologie et cycles sédimentaires. *Thèse du Muséum National d'Histoire Naturelle*, 374 p. (Unpublished).
- Bulot, L.G., Thieuloy, J.-P., 1993. Implications chronostratigraphiques de la révision de l'échelle biostratigraphique du Valanginien supérieur et de l'Hauterivien du Sud-Est de la France. *Comptes rendus de l'Académie des Sciences de Paris* 317, 387–394.
- Bulot, L.G., Thieuloy, J.-P., 1995. Les biohorizons du Valanginien du Sud-Est de la France: un outil fondamental pour les corrélations au sein de la Téthys occidentale. *Géologie Alpine, Mémoire H.S. 20* (1994), 15–41.
- Bulot, L.G., Thieuloy, J.-P., Blanc, E., Klein, J., 1993. Le cadre stratigraphique du Valanginien supérieur et de l'Hauterivien du Sud-Est de la France: Définition de biochronozones et caractérisation de nouveaux biohorizons. *Geologie Alpine* 68 (1992), 13–56.
- Busnardo, R., Charollais, J., Weidmann, M., Clavel, B., 2003. Le Crétacé inférieur de la Veveyse de Châtel (Ultraschelvétique des Préalpes externes; canton de Fribourg, Suisse). *Revue de Paléobiologie* 22, 1–174.
- Çağlar, M.K., Kalkan, E., Raisosadat, S.N., Özer, Ç., Bilici, Ö., 2013. Planktonic foraminifera and ammonite contents for the Valanginiyen–Aptian (Lower Cretaceous) of Eastern Anatolian, Olur-Erzurum, Turkey, 3rd International Conference on the Palaeontology of South East-Asia (ICPSEA3), Malaysia. Program and Abstracts, p. 56.
- Company, M., 1987. Los ammonites del Valanginiense del sector oriental de las Cordilleras Béticas (SE de España). Tesis doctoral. Universidad de Granada, 294 p.
- Company, M., Sandoval, J., Tavera, J.M., 2003. Ammonite biostratigraphy of the uppermost Hauterivian in the Betic Cordillera (SE Spain). *Geobios* 36, 685–694.
- Company, M., Sandoval, J., Tavera, J.M., Aoutem, M., Ettachfini, M., 2008. Barremian ammonite faunas from the western High Atlas, Morocco – biostratigraphy and palaeobiogeography. *Cretaceous Research* 29, 9–26.
- Company, M., Tavera, J.M., 2013. Lower Valanginian ammonite biostratigraphy in the Betic Cordillera (southeastern Spain) new data, pp. 118–119, 9th International Symposium on the Cretaceous System, Ankara, 1–5 September 2013, abstract book.
- Cotillon, P., 1971. Le Crétacé inférieur de l'arc subalpin de Castellane entre l'Asse et le Var, stratigraphie et sédimentologie. *Mémoire du Bureau de Recherche Géologique et Minière* 68, 1–243.
- Delanoy, G., 1995. Les zones à Feraudianus, Giraudi et Sarasini du Barrémien supérieur de la région stratotypique d'Angles-Barrême-Castellane (Sud-Est de la France). *Géologie Alpine, Mémoire H.S. 20* (1994), 279–319.
- Delanoy, G., 1997a. Biostratigraphie haute résolution du Barrémien supérieur du Sud-Est de la France. *Comptes Rendus de l'Académie des Sciences de Paris* 325, 689–694.
- Delanoy, G., 1997b. Biostratigraphie des faunes d'Ammonites à la limite Barrémien–Aptien dans la région d'Angles-Barrême-Castellane. Etude particulière de la famille des Heteroceratina Spath, 1922 (Ancyloceratina, Ammonoidea). *Annales du Muséum d'Histoire Naturelle de Nice* 12, 1–270.
- Delanoy, G., Busnardo, R., 2007. *Anglesites gen. nov.* (Ammonoidea, Ancyloceratina), un nouveau genre d'ammonites hétéromorphes du Barrémien supérieur du Sud-Est de la France. *Geobios* 40, 801–807.
- Doyle, J.C., 1989. The stratigraphy of a late Lower Hauterivian horizon in the Speeton Clay formation (Lower Cretaceous) of East Yorkshire. *Proceedings of the Geologists' Association* 100, 175–182.
- Faraoni, P., Flore, D., Marini, A., Pallini, G., Pezzoni, N., 1997. Valanginian and early Hauterivian ammonite successions in the Mt Catria group (Central Apennines) and in the Lessini Mts (Southern Alps), Italy. *Palaeopelagos* 7, 59–100.
- Fatmi, A.N., Rawson, P.F., 1993. The first Early Cretaceous ammonite faunas from Baluchistan. *Cretaceous Research* 14, 91–100.
- Fözy, I., Janssen, N.M.M., Price, G.D., Knauer, J., Pálffy, J., 2010. Integrated isotope and biostratigraphy of a Lower Cretaceous section from the Bakony Mountains (Transdanubian Range, Hungary): A new Tethyan record of the Weissert event. *Cretaceous Research* 31, 525–545.
- García-Mondéjar, J., Owen, H.G., Raisosadat, N., Millán, M.I., Fernández-Mendiola, P.A., 2009. The Early Aptian of Aralar (northern Spain): stratigraphy, sedimentology, ammonite biozonation, and OAE1. *Cretaceous Research* 30, 434–464.
- Gayte, D., 1984. Le Valanginien et l'Hauterivien de la bordure cévenole méridionale. *Biostratigraphie, paléontologie, sédimentologie*. Thèse de l'Université Claude Bernard Lyon 1, 147 p. (Unpublished).
- Guzhikov, A.Yu., Arkad'ev, V.V., Baraboshkin, E.Yu., Bagaeva, M.I., Piskunov, V.K., Rud'ko, S.V., Perminov, V.A., Manikin, A.G., 2012. New Sedimentological, Bio-, and Magnetostratigraphic Data on the Jurassic–Cretaceous Boundary Interval of Eastern Crimea (Feodosiya). *Stratigraphy and Geological Correlation* 20 (3), 261–294.
- Hoedemaeker, P.J., 1982. Ammonite biostratigraphy of the uppermost Tithonian, Berriasian, and lower Valanginian along the Río Argos (Caravaca, SE Spain). *Scripta Geologica* 65, 1–81.
- Hoedemaeker, P.J., 1995. Ammonite distribution around the Hauterivian–Barremian boundary along the Río Argos (Caravaca, SE Spain). *Géologie Alpine, Mémoire H.S. 20* (1994), 219–277.
- Hoedemaeker, P.J., Bulot, L. (reporters), Avram, E., Busnardo, R., Company, M., Delanoy, G., Kakabadze, M., Kotetishvili, E., Krishna, J., Kvantaliani, I., Latil, J.L., Memmi, L., Rawson, P.F., Sandoval, J., Tavera, J.M., Thieuloy, J.P., Thomel, G., Vašíček, Z., Vermeulen, J., 1990. Preliminary Ammonite zonation for the Lower Cretaceous of the Mediterranean region. *Géologie Alpine* 66, 123–127.
- Hoedemaeker, P.J., Cecca, F. (reporters), Avram, E., Company, M., Delanoy, G., Erba, E., Ettachfini, M., Faraoni, P., Kakabadze, M., Landra, G., Marini, A., Memmi, L., Pallini, G., Rawson, P.F., Ropolo, P., Sandoval, J., Tavera, J.M., Vašíček, Z., 1995. Report on the 3rd International Workshop on the Standard Lower Cretaceous Ammonite Zonation of the Mediterranean Region. *Memorie Descrittive della Carta Geologica d'Italia* 51, 213–215.
- Hoedemaeker, P.J., Company, M. (reporters), Aguirre-Urreta, M.B., Avram, E., Bogdanova, T.N., Bujtor, L., Bulot, L., Cecca, F., Delanoy, G., Ettachfini, M., Memmi, L., Owen, H.G., Rawson, P.F., Sandoval, J., Tavera, J.M., Thieuloy, J.P., Tovbina, S.Z., Vašíček, Z., 1993. Ammonite zonation for the Lower Cretaceous of the Mediterranean region; basis for the stratigraphic correlation within ICGP-Project 262. *Revista Espanola de Paleontología* 8, 117–120.
- Hoedemaeker, P.J., Leereveld, H., 1995. Biostratigraphy and sequence stratigraphy of the Berriasian–lowest Aptian (Lower Cretaceous) of the Río Argos succession, Caravaca, SE Spain. *Cretaceous Research* 16, 195–230.

- Hoedemaeker, Ph.J., (Chair), Rawson, P.F., (Vice Chair), 2000. Report on the 5th International Workshop of the Lower Cretaceous Cephalopod Team (Vienna, 5 September 2000). *Cretaceous Research* 21, 857–860.
- Hoedemaeker, Ph.J., Reboulet, S., (reporters), Aguirre-Urreta, M.B., Alsen, P., Aoutem, M., Atrops, F., Barragan, R., Company, M., González Arreola, C., Klein, J., Lukeneder, A., Ploch, I., Raisossadat, N., Rawson, P.F., Ropolo, P., Vašíček, Z., Vermeulen, J., Wipich M.G.E., 2003. Report on the 1st International Workshop of the IUGS Lower Cretaceous Ammonite Working Group, the “Kilian Group” (Lyon, 11 July 2002). *Cretaceous Research* 24, 89–94, and erratum (p. 805).
- Idakieva, V., Ivanov, M., 2013. New ammonite data for the biostratigraphy of the Upper Barremian in North Bulgaria, 9th International Symposium on the Cretaceous System, Ankara, 1–5 September 2013, abstract book, p. 118.
- Ivanov, M., Idakieva, V., 2009. Upper Barremian ammonite biostratigraphy in Central-North and Northeastern Bulgaria. *Proceedings of National Conference Geosciences 2009*, Bulgarian Geological Society, Sofia, pp. 55–56 (in Bulgarian).
- Ivanov, M., Idakieva, V., 2013. Lower Aptian ammonite biostratigraphy and potential for further studies of OAE1a in Bulgaria. In: Skelton, P.W., Granier, B., Moullade, M. (Eds.), *Spatial patterns of change in Aptian carbonate platforms and related events*. *Cretaceous Research* 39, 47–69.
- Kakabadze, M.V., 1981. Ancyloceratids of the South of the USSR and their stratigraphical significance. *Proceedings of A. Janelidze Geological Institute of Georgian Academy of Sciences*, New Series 71, 1–197 (in Russian with English abstract).
- Kakabadze, M.V., 2008. New data on biostratigraphy of Upper Hauterivian deposits of Georgia. *Proceedings of A. Janelidze Institute of Geology of Georgia*, New Series 124, 161–167 (in Russian with English abstract).
- Kakabadze, M.V., Hoedemaeker, Ph.J., 2010. New data on Early Cretaceous (Hauterivian–Barremian) heteromorph ammonites from northern Germany. *Scripta Geologica* 140, 1–168.
- Kakabadze, M.V., Hoedemaeker, Ph. J., Bogdanova, T.N., Sharikadze, M.Z., 2004. On the Barremian–Early Albian biogeography (by ammonites) of Colombia. In: Donovan, S.K. (Ed.), *Early Cretaceous ammonites from Colombia*. *Scripta Geologica* 128, 515–558.
- Kakabadze, M.V., Kotetishvili, E.V., 2003. On the biostratigraphy of the Upper Barremian of Georgia. *Bulletin of Moscow Society of Naturalists, Series Geology* 78, 36–45 (in Russian).
- Kakabadze, M.V., Kvantaliani, I.V., Kotetishvili, E.V., Sharikadze, M.Z., Tsirekidze, L.R., 2005. Stratigraphy of the Lower Cretaceous deposits of Georgia. In: Topchishvili, M.V. (Ed.), *Atlas of Early Cretaceous Fauna of Georgia*. *Proceedings of A. Janelidze Institute of Geology of Georgia*, New Series 120, 7–84 (in Russian).
- Karakasch, N., 1889. Über einige Neocomablagerungen in der Krim. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe* 98, 428–438.
- Kemper, E., 1992. Die tiefe Unterkreide im Vechte-Dinkel-Gebiet (westliches Niedersächsisches Becken). Mit einem paläobotanischen Beitrag von J. van der Burgh, 95 p.
- Kemper, E., Rawson, P.F., Thieuloy, J.-P., 1981. Ammonites of Tethyan ancestry in the early Lower Cretaceous of north-west Europe. *Palaeontology* 24, 251–311.
- Klein, J., 2005. Lower Cretaceous Ammonites I, Perisphinctaceae 1: Himalayitidae, Olcostephanidae, Holcodiscidae, Neocomitidae, Oosterellidae. In: Rieggraf, W. (Ed.), *Fossilium Catalogus I: Animalia*. Backhuys Publishers, Leiden part 139, 484 p.
- Klein, J., Busnardo, R., Company, M., Delanoy, G., Kakabadze, M., Reboulet, S., Ropolo, P., Vašíček, Z., Vermeulen, J., 2007. Lower Cretaceous Ammonites III. Bochianitoidea, Protancyloceratoidea, Ancyloceratoidea, Ptychoceratoidea. In: Rieggraf, W. (Ed.), *Fossilium Catalogus I: Animalia*. Pars 144. Backhuys Publishers, Leiden, The Netherlands, 381 p.
- Le Hégarat, G., 1971. Perisphinctidae et Berriassellidae de la limite Jurassique–Crétacé. *Genres nouveaux et révision critique de quelques définitions taxonomiques antérieures*. *Comptes Rendus des Séances de l'Académie des Sciences de Paris* 273, 850–853.
- Le Hégarat, G., 1973. Le Berriasien du sud-est de la France. *Documents des Laboratoires de Géologie, Faculté des Sciences, Lyon* 43 (1971), 1–576.
- McArthur, J.M., Janssen, N.M.M., Reboulet, S., Leng, M.J., Thirlwall, M.F., van de Schootbrugge, B., 2007. Palaeotemperatures, polar ice-volume, and isotope stratigraphy (Mg/Ca, $\delta^{18}\text{O}$, $\delta^{13}\text{C}$, $^{87}\text{Sr}/^{86}\text{Sr}$): The Early Cretaceous (Berriasian, Valanginian, Hauterivian). *Palaeogeography, Palaeoclimatology, Palaeoecology* 248, 391–430.
- Moreno-Bedmar, J.A., Barragán Manzo, R., Company Sempere, M., Bulot, L.G., 2013. Aptian (lower Cretaceous) ammonite biostratigraphy of the Francisco Zarco Dam stratigraphic section (Durango State, northeast Mexico). *Journal of South American Earth Sciences* 42, 150–158.
- Ogg, J.G., Agterberg, F.P., Gradstein, F.M., 2004. The Cretaceous Period. In: Gradstein, F.M., Ogg, J.G., Smith, A.G. (Eds.), *A Geologic Time Scale 2004*, pp. 344–383.
- Ogg, J.G., Hinnov, L.A., Huang, C., 2012. Chapter 27. Cretaceous. In: Gradstein, F.M., Ogg, J.G., Schmitz, M.D., Ogg, G.B. (Eds.), *The Geologic Time Scale 2012*, Vol. 2. Elsevier, pp. 793–853.
- Raisossadat, S.N., 2011. The Early Aptian (Early Cretaceous) ammonites from the Aralar Mountains, Basque–Cantabrian Basin, Northern Spain. *Carnets de Géologie/Notebooks on Geology*, Memoir 2011/02 (CG2011_M02), 163–201.
- Rawson, P.F., 1995. The “Boreal” Early Cretaceous (Pre-Aptian) ammonite sequences of NW Europe and their correlation with the western Mediterranean faunas. *Memorie Descrittive della Carta Geologica d'Italia* 51, 121–130.
- Rawson, P.F., 1999. Long-distance correlations in the Valanginian–Hauterivian: Argentina–Western Mediterranean–NW Europe. In: Rawson, P.F., Hoedemaeker, Ph.J. (Eds.), *Proceedings of the 4th meeting of the Lower Cretaceous Cephalopod Working Group*, IGCP Project 362, *Scripta Geologica*, Special Issue 3, pp. 151–158.
- Rawson, P.F., 2007. Global relationships of Argentine (Neuquén Basin) Early Cretaceous ammonite faunas. *Geological Journal* 42, 175–183.
- Rawson, P.F., Aguirre-Urreta, M.B., 2012. Lower Cretaceous ammonites from the Neuquén Basin, Argentina: The Hauterivian genus *Spitidiscus*. *Cretaceous Research* 33, 97–105.
- Rawson, P.F., Hoedemaeker, Ph.J., (reporters), Aguirre-Urreta, M.B., Avram, E., Ettachfini, M., Kelly, S.R.A., Klein, J., Kotetishvili, E., Owen, H.G., Ropolo, P., Thomson, M.R.A., Wipich M., Vašíček, Z., 1999. Report on the 4th International Workshop of the Lower Cretaceous Cephalopod Team (IGCP-Project 362). *Scripta Geologica*, Special Issue 3, 3–13.
- Rawson, P.F., Mutterlose, J., 1983. Stratigraphy of the Lower B and basal Cement Beds (Barremian) of the Speeton Clay, Yorkshire, England. *Proceedings of the Geologists' Association* 94, 133–146.
- Reboulet, S., 1996. L'évolution des ammonites du Valanginien–Hauterivien inférieur du bassin vocontien et de la plate-forme provençale (Sud-Est de la France): relations avec la stratigraphie séquentielle et implications biostratigraphiques. *Documents des Laboratoires de Géologie de Lyon* 137 (1995), 371 p.
- Reboulet, S., Atrops, F., 1999. Comments and proposals about the Valanginian–Lower Hauterivian ammonite zonation of south-east France. *Eclogae geologicae Helvetiae* 92, 183–197.
- Reboulet, S., Hoedemaeker, Ph.J., (reporters), Aguirre-Urreta, M.B., Alsen, P., Atrops, F., Baraboshkin, E.Y., Company, M., Delanoy, G., Dutour, Y., Klein, J., Latil, J.L., Lukeneder, A., Mitta, V., Mourgues, F.A., Ploch, I., Raisossadat, N., Ropolo, P., Sandoval, J., Tavera, J.M., Vašíček, Z., Vermeulen, J., 2006. Report on the 2nd international meeting of the IUGS Lower Cretaceous ammonite working group, the “Kilian Group” (Neuchâtel, Switzerland, 8 September 2005). *Cretaceous Research* 27, 712–715.
- Reboulet, S., Klein, J. (reporters), Barragán, R., Company, M., González-Arreola, C., Lukeneder, A., Raisossadat, S.N., Sandoval, J., Szives, O., Tavera, J.M., Vašíček, Z., Vermeulen, J., 2009. Report on the 3rd International Meeting of the IUGS Lower Cretaceous Ammonite Working Group, the “Kilian Group” (Vienna, Austria, 15th April 2008). *Cretaceous Research* 30, 496–502.
- Reboulet, S., Rawson, P.F., Moreno-Bedmar, J.A. (reporters), Aguirre-Urreta, M.B., Barragán, R., Bogomolov, Y., Company, M., González-Arreola, C., Idakieva Stoyanova, V., Lukeneder, A., Matron, B., Mitta, V., Randrianaly, H., Vašíček, Z., Baraboshkin, E.J., Bert, D., Bersac, S., Bogdanova, T.N., Bulot, L.G., Latil, J.-L., Mikhailova, I.A., Ropolo, P., Szives, O., 2011. Report on the 4th International Meeting of the IUGS Lower Cretaceous Ammonite Working Group, the “Kilian Group” (Dijon, France, 30th August 2010). *Cretaceous Research* 32, 786–793.
- Ropolo, P., Conte, G., Gonnert, R., Masse, J.-P., Moullade, M., 2000. Les faunes d'Ammonites du Barrémien supérieur/Aptien inférieur (Bédoulien) dans la région stratotypique de Cassis-La Bédoule (SE France): état des connaissances et propositions pour une zonation par Ammonites du Bédoulien-type. *Géologie Méditerranéenne* 25 (1998), 167–175.
- Szives, O., Fözy, I., 2013. Systematic descriptions of Early Cretaceous ammonites of the carbonate formations of the Gerecse Mountains, Hungary. In: Fözy, I. (Ed.), *Late Jurassic–Early Cretaceous fauna, biostratigraphy, facies and deformation history of the carbonate formations in the Gerecse and Pilis Mountains (Transdanubian Range, Hungary)*. Institute of Geosciences, University of Szeged, GeoLittera Publishing House, pp. 293–342.
- Tavera, J.M., 1985. Los ammonites del Tithónico superior-Berriasiense de la Zona Subbética. *Universidad de Granada*, 381 p.
- Tavera, J.M., Checa, A., Olóriz, F., Company, M., 1986. Mediterranean ammonites and the Jurassic–Cretaceous boundary in Southern Spain (Subbetic Zone). *Acta Geologica Hungarica* 29, 151–159.
- Thieuloy, J.-P., 1977a. Les ammonites boréales des formations Néocomiennes du sud-est Français (Province Subméditerranéenne). *Geobios* 10, 395–461.
- Thieuloy, J.-P., 1977b. La zone à *Callidiscus* du Valanginien supérieur vocontien (Sud-Est de la France). *Lithostratigraphie, ammonitofaune, limite Valanginien–Hauterivien, corrélations*. *Géologie Alpine* 53, 83–143.
- Uhlig, V., 1902. Über die Cephalopodenfauna der Teschner und Grodischer Schichten. *Denkschriften der Kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe* 72, 1–87.
- Vašíček, Z., 1975. Zur Revision der Ammoniten von den Oberen Těšín-Schichten (Valendis-Stufe). *Sborník Geologických Věd. Paleontologie* 17, 71–103.
- Vašíček, Z., 1995. Lower Cretaceous ammonite biostratigraphy in the Western Carpathians (The Czech and Slovak Republics). *Géologie Alpine, Mémoire H.S.* 20 (1994), 169–189.
- Vašíček, Z., 2010. Early Cretaceous ammonites from the Butkov Quarry (Manín Unit, Central Western Carpathians, Slovakia). *Acta Geologica Polonica* 60, 393–415.
- Vašíček, Z., Michalík, J., 2002. Boreal elements in the Lower Cretaceous ammonite associations of the West Carpathian Tethyan sector. In: Michalík, J. (Ed.), *Tethyan/Boreal Cretaceous correlation*. VEDA, Bratislava, pp. 115–136.
- Vennari, V.V., Lescano, M., Naipauer, M., Aguirre-Urreta, B., Concheyro, A., Schaltegger, U., Armstrong, R., Pimentel, M., Ramos, V.A., 2013. New constraints on the Jurassic–Cretaceous boundary in the High Andes using high-precision U–Pb data (in press). *Gondwana Research*. <http://dx.doi.org/10.1016/j.gr.2013.07.005>.
- Wimbleton, W.A.P., Casellato, C.E., Reháková, D., Bulot, L.G., Erba, E., Gardin, S., Verreussel, R.M.C.H., Munsterman, D.K., Hunt, C.O., 2011. Fixing a basal Berriasian and Jurassic/Cretaceous (J/K) boundary—is there perhaps some light at the end of the tunnel? *Rivista Italiana di Paleontologia e Stratigrafia* 117 (2), 295–307.
- Zahedipour, R., Raisossadat, S.N., Khazaei, A.R., Babazadeh, S.A., 2014. Biostratigraphy of the base of Sarcheshmeh Formation based on ammonites at south east Shirvan area, Kopet Dag. *Proceedings of 32nd National and 1st International Geoscience Congress Fundamental Geology*, Geological Survey of Iran, Mashhad, Iran [English Abstract], 16–19 Feb. 2014, pp. 121–125.