The literature on Triassic, Jurassic and earliest Cretaceous dinoflagellate cysts: supplement 4

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ABSTRACT

Since the publication of four compilations issued between 2012 and 2019, 93 further published contributions on Triassic, Jurassic and earliest Cretaceous (Berriasian) dinoflagellate cysts from Africa, North America, South America, the Arctic, Australasia, East Europe, West Europe, the Middle East and Russia have been discovered in the literature, or were issued in the last 12 months (i.e. between February 2018 and January 2019). Of these, 55 were published during 2018 and 2019, making this period a very productive one. These studies are mostly on the Late Triassic and Early Jurassic of Europe. All the 93 items are listed herein with digital object identifier (doi) numbers where available, as well as a description of each item as a string of keywords. Publications on West Europe comprise 31.2% of the total, and items on Africa, the Arctic, Australasia, East Europe and Russia are also significant (15.1%, 6.5%, 7.5%, 9.7% and 14.0% respectively). The least well-represented regions are North America, South America and the Middle East (2.2%, 1.1% and 1.1% respectively).

KEYWORDS dinoflagellate cysts; earliest Cretaceous (Berriasian); Jurassic; literature analysis and compilation; Triassic; worldwide

1. Introduction

The literature on Triassic to earliest Cretaceous (Berriasian) dinoflagellate cysts is extensive, and was listed and reviewed by Riding (2012, 2013, 2014, 2019). These four papers cited 1347, 94, 89 and 266 publications respectively, with each citation followed by keywords detailing the scope of each of the 1796 studies. The reviews provided by Riding (2014, 2019) were substantially more interpretive than those in Riding (2012, 2013); the former two papers reviewed and summarised each of the major publications listed. During the 12 months since the completion of Riding (2019), i.e. between February 2018 and January 2019, the author has compiled a further 93 relevant articles. Of these, 55 are recently published papers; the other 38 were previously overlooked. Thirty of the 93 items are considered to be of substantial scientific significance. The total of 55 articles published between February 2018 and January 2019 makes this one of the most productive periods on this topic in recent years.

The 93 articles are largely on the Late Triassic and Early Jurassic of Europe (Tables 1, 2), and are listed in Appendix 1 of the Supplementary data. Papers on West Europe are most numerous (29), and comprise 31.2% of the overall total (Table 1). By contrast, Riding (2012, 2013, 2014, 2019) noted a substantial bias towards the Late Jurassic of Europe. Publications on Africa, the Arctic, Australasia, East Europe and Russia are also numerous (15.1%, 6.5%, 7.5%, 9.7% and 14.0% respectively; Table 1). Finally, relatively low proportions of articles are on North America, South America and the Middle East (2.2%, 1.1% and 1.1% respectively; Table 1). In this compliation, six formally unpublished PhD theses are listed (e.g. Ruckwied 2009, Baranyi 2018, Correia 2018); these are all freely available online and the respective web addresses are quoted.

2. Regional review and synthesis

In this section, brief commentaries/reviews of selected articles from the 93 publications listed in Appendix 1 of the Supplementary data are presented. These items are from nine of the 14 geographical subdivisions in Riding (2019). In the present compilation, there are no relevant single-region publications from Central America, Antarctica, Southeast Asia, China and the Indian subcontinent. Each contribution in Appendix 1 of the Supplementary data is referred to at least one of these 14 regions; furthermore, ‘multi-region’ and ‘no geographical focus’ are also options (Table 1).

The publication by Mangerud et al. (2019) is a good example of the latter two categories. This article is a global synthesis of the available literature on Triassic dinoflagellate cysts; it reviewed data from Arabia, the present Arctic region, Europe, Oceania and South America. It is clear that, with the exception of *Sahulidinium ottii* in one well in offshore Australia, dinoflagellate cyst body fossils first appeared during the Late Triassic. The Norian–Rhaetian genus *Rhaetogonyaulax* appears to be a cosmopolitan pioneer taxon. There was migration into many formerly land-locked regions during the Rhaetian, and most Triassic dinoflagellate cyst taxa became extinct at the end-Triassic event. Other examples of ‘multi-region’ and ‘no geographical focus’ papers include Boersma et al. (1987), Lindstrom et al. (2017), Londeix (2018) and Penaud et al. (2018). All dinoflagellate cysts and other palynomorph taxa at and below species level mentioned in this paper are listed in Appendix 2 of the Supplementary data with full author citations.

2.1. Africa

This compilation includes 14 single-region contributions from East and North Africa, including five that are deemed especially significant (Appendix 1 of the Supplementary data). The highlights of this research are outlined in the next two subsections.

2.1.1. East Africa

In this synthesis, four single-region contributions on Ethiopia and Tanzania in East Africa are considered. Msaky (2008) is a thesis on the Bajocian to Cenomanian palynology of coastal Tanzania, and is available online. The thesis was published as Msaky (2011a, 2011b), and these major publications were reviewed by Riding (2019).

The palynofloras of the Pindiro Group (Triassic to Lower Jurassic) of southern Tanzania were studied by Hudson and Nicholas (2014). These authors reported the dinoflagellate cysts *Dapcodinium priscum, Sahulidinium ottii, Scriniocassis* sp. cf. *S. weberi* and *Sverdrupiella* sp. from the Mbuo Formation (Hudson and Nicholas 2014, p. 59). This assemblage was interpreted as being Late Triassic in age. The presence of *Dapcodinium priscum* and *Sverdrupiella* sp. is consistent with this age determination. However, *Sahulidinium ottii* and *Scriniocassis* sp. cf. *S. weberi* are indicative of the Middle Triassic and the late Pliensbachian to Aalenian respectively (Helby et al. 1987, Riding and Thomas 1992). If confirmed, this report would be the first record of *Sahulidinium ottii* since this species was first described by Stover & Helby (1987). *Nannoceratopsis pellucida* was recorded from the Mihambia Formation by Hudson and Nicholas (2014, p. 65). The Mihambia Formation was interpreted as being Toarcian to Aalenian in age. Either the interpreted age, or the identification of *Nannoceratopsis pellucida* appears to be erroneous because the range base of this species in both hemispheres is Bathonian (Riding et al. 1985, Riding et al. 2010). It should be noted that the 'probable reworked dinoflagellate' figured by Hudson and Nicholas (2014, fig. 3.5M) is an indeterminate palynomorph, and has no demonstrable dinoflagellate affinity.

Smelror et al. (2018) is a relatively short paper on the Upper Jurassic and Lower Cretaceous palynostratigraphy of the Kipatimu, Mitole, Nalwehe and Kihuluhulu formations of the onshore Mandawa Basin in southeastern coastal Tanzania. The authors concluded that the four formations span the Oxfordian–Tithonian to Aptian–Albian interval. Jurassic and earliest Cretaceous dinoflagellate cysts were recorded only from the Mitole Formation, and these were interpreted as being of Oxfordian to Berriasian age. They include *Canningia reticulata, Circulodinium distinctum, Cribroperidinium* spp., *Dingodinium jurassicum, Kaiwaradinium scruttinum* and *Systematophora areolata*. This assemblage is significantly reminiscent of the Late Jurassic and Early Cretaceous of Gondwana (Helby et al. 1987, Riding et al. 2010). Sample WP232-5-14 from the Mitole Formation contains a marine palynoflora reminiscent to the *Dingodinium jurassicum-Kilwacysta* assemblage of Schrank (2005), and is indicative of a correlation with the *Trigonia smeei* Bed of Tendaguru Hill in southeastern Tanzania.

2.1.2. North Africa

Ten single-region contributions on North Africa are included herein. Nine of the articles are on northern Egyptian material, which reflects the intense hydrocarbon exploration and production activity in this region. One contribution (Jaydawi et al. 2016) is a study of Moroccan material.

Aboul Ela and Tahoun (2010) documented the stratigraphical palynology of the Middle Jurassic to Lower Cretaceous (Bathonian–Callovian to Albian) of the Mango-1 and Til-1 offshore wells, northern Sinai, Egypt. Based on 174 samples of ditch cuttings, the authors established 11 informal dinoflagellate cyst zones which were correlated with other successions in Egypt and surrounding Tethyan areas. Five of these zones cover the Bathonian–Callovian to ?Berriasian interval. A major depositional hiatus between the late Kimmeridgian and the ?Berriasian was identified, and was attributed to a major sea-level fall associated with the Cimmerian orogenic event (Aboul Ela and Tahoun 2010, figs 2, 3). The samples yielded diverse and rich marine and terrestrial palynofloras. This paper focuses entirely on biostratigraphy, and the ranges of all the palynomorphs were given in non-quantitative range charts (Aboul Ela and Tahoun 2010, p. 90–98). The Jurassic dinoflagellate cyst associations appear to be substantially similar in content and distribution to their European counterparts; for example *Cribroperidinium*? *longicorne, Ctenidodinium continuum, Gonyaulacysta jurassica, Korystocysta pachyderma* and *Systematophora areolata* were recorded.

Ied and Ibrahim (2010) studied the Jurassic and Early Cretaceous palynology of the Almaz-1 well in northern Egypt. This contribution focused mostly on miospores, but some dinoflagellate cysts were recorded from the Bajocian–Callovian to the Barremian. These include *Ctenidodinium sellwoodii, Gonyaulacysta jurassica, Pareodinia ceratophora* and *Systematophora penicillata* (see Ied and Ibrahim 2010, p. 10). A very similar biostratigraphical paper on the Middle Jurassic to Early Cretaceous (Callovian–Albian) of the Kabrit-1 well drilled west of Cairo in northeastern Egypt was published by Ied and Lashin (2016). They recorded dinoflagellate cysts from the entire succession examined, including *Cribroperidinium* spp., *Dichadogonyaulax*? *pannea, Gonyaulacysta jurassica, Lithodinia jurassica, Pareodinia prolongata* and *Systematophora areolata* (see Ied and Lashin 2016, fig. 2). This assemblage is similar to floras from eastern North America and Europe.

Tahoun et al. (2012) undertook a study of the Middle Jurassic to Upper Cretaceous succession of the Alamein-IX well in northern Egypt. In this study, zone 5, which comprises the Masajid Formation, was interpreted as being of Callovian to possibly Kimmeridgian age (Tahoun et al. 2012, p. 68, fig. 3). This interpretation was based on the presence of *Acanthaulax* sp. cf. *A. crispa*, *Amphorulacysta*? *dodekovae, Epiplosphaera reticulospinosa, Lithodinia jurassica, Meiourogonyaulax reticulata* and *Sentusidinium* spp. This assemblage appears to be somewhat biostratigraphically ambiguous; however, the presence of *Amphorulacysta*? *dodekovae* and *Epiplosphaera reticulospinosa* strongly suggests a late Oxfordian to early Kimmeridgian age (Feist-Burkhardt and Wille 1992, fig. 2).

Gentzis et al. (2018) published a study on the petroleum prospectivity of the Matruh Basin, North Western Desert, Egypt. The dinoflagellate cysts *Ctenidodinium sellwoodii, Korystocysta gochtii, Mancodinium semitabulatum, Nannoceratopsis gracilis Rhynchodiniopsis cladophora* and *Systematophora penicillata* were recorded from the Wadi Natrun, Khattatba and Masajid formations. The two discrete intervals represented by these formations were interpreted as being of Toarcian–Aalenian and ?late Bathonian–Oxfordian (Gentzis et al. 2018, fig. 4). Some photographs were presented, although the images of *Nannoceratopsis gracilis* (Gentzis et al. 2018, pl. 1/1, 2) are not clearly of that species.

The stratigraphical palynology of the Middle and Upper Jurassic (Bathonian–Oxfordian) strata of the South Sallum well, North Western Desert, Egypt was studied by Mostafa et al. (2018). This interval yielded relatively diverse dinoflagellate cyst asssociations, and these were comprehensively illustrated (Mostafa et al. 2018, pls 2–5). Two dinoflagellate cyst biozones were recognised. These are the *Dichadogonyaulax sellwoodii – Wanaea acollaris – Wanaea digitata* Assemblage Zone, interpreted as Bathonian–Callovian in age, and the *Amphorula dodekovae* Interval Zone which was deemed to be Callovian–Oxfordian. Note that the species *Amphorula dodekovae* is now questionably accommodated in *Amphorulacysta*? (see Williams and Fensome 2016, p. 139). Included in the *Dichadogonyaulax sellwoodii – Wanaea acollaris – Wanaea digitata* Assemblage Zone were *Ctenidodinium ornatum, Impletosphaeridium varispinosum, Korystocysta* spp., *Mendicodinium groenlandicum, Pareodinia prolongata* and *Wanaea digitata*. By comparison with Europe, this interval is most likely to be entirely Callovian in age (e.g. Poulsen and Riding 2003). The index taxon for the *Amphorula dodekovae* Interval Zone was first described from the Kimmeridgian and its range was determined as late Oxfordian to early Kimmeridgian (Zotto et al. 1987; Feist-Burkhardt and Wille 1992, fig. 2). Mostafa et al. (2018) interpreted this biozone as being of Callovian–Oxfordian age. However the presence of *Amphorulacysta*? *dodekovae, Compositosphaeridium*? *polonicum, Endoscrinium galeritum, Gonyaulacysta jurassica* and *Neuffenia willei* is strongly suggestive that it is entirely of Oxfordian age (Riding 1984a, Riding and Thomas 1992). The biostratigraphical significance of selected Berriasian dinoflagellate cysts from northern Egypt was discussed in a review paper by Tahoun and Ied (2018). Sparse and low diversity dinoflagellate cyst associations were recorded from the Tithonian to Albian strata penetrated by the Minqar-IX well, northern Egypt by Mahmoud et al. (2019).

The paper by Jaydawi et al. (2016) is a major and well-illustrated contribution on the Callovian to Kimmeridgian dinoflagellate cyst biostratigraphy of the petroliferous Essaouira Basin in the Marrakesh–Safi region of central-western Morocco. These authors examined three boreholes. An early Callovian assemblage which includes *Ctenidodinium combazii, Ctenidodinium cornigerum* and *Impletosphaeridium varispinosum* was encountered in the MKL-110 borehole. Further material was studied from the NDK-2 and NDK-3 boreholes. A rich late Callovian flora containing *Ctenidodinium continuum, Ctenidodinium ornatum* and *Wanaea thysanota* was recovered in the latter borehole. The NDK-2 well yielded established marker species such as *Cribroperidinium*? *longicorne, Egmontodinium polyplacophorum, Gonyaulacysta centriconnata, Scriniodinium crystallinum, Systematophora areolata* and *Trichodinium scarburghense*, indicative of the interval from the Callovian–Oxfordian transition to the Kimmeridgian.

2.2. Sub-Arctic North America

The only relevant single-region publication on sub-Arctic North America issued between February 2018 and January 2019 is that by Dodsworth and Eldrett (2018). These authors recorded the reworking of low numbers of *Chytroeisphaeridia chytroeides*, ?*Gonyaulacysta jurassica*, ?*Rhynchodiniopsis cladophora* and *Scriniodinium* spp. into the Upper Cretaceous (Cenomanian–Turonian) Bridge Creek Member (Greenhorn Formation) near Pueblo, Colorado, USA. These Middle to Late Jurassic forms are part of an extensive suite of allochthonous palynomorphs of Carboniferous to middle Cretaceous age (Dodsworth and Eldrett 2018, p. 9, 10).

Additionally, one older single-region contribution was also discovered. This is by van Helden (1987), and comprises a short article in a newsletter designed to encourage research on the Jurassic palynology of Alberta and Saskatchewan in western Canada. This author reported that the Nordegg, Poker Chip and Rock Creek formations of Alberta, and the Shaunavon and Vanguard formations in Saskatchewan contain abundant and diverse Jurassic dinoflagellate cyst assemblages. It was noted that detailed study of these floras would help the understanding of both the biostratigraphy and palaeoecology of the region. Van Helden (1987) expressed surprise that the palynology of these lithostratigraphical units had not been studied by contemporary palynologists in Canada, and recommended that this open field of research be advanced.

2.3. South America

Only one publication is included here on South America. This is Olivera et al. (2018), which is a report of the pollen grain *Shanbeipollenites proxireticulatus* from the Vaca Muerta Formation of the Neuquén Basin, Argentina and its associated palynomorphs, including dinoflagellate cysts. *Shanbeipollenites proxireticulatus* was previously reported from the Upper Jurassic of Tanzania (Schrank 2004). The material in this study was interpreted as being of ?Berriasian–Valanginian age based on the overall palynoflora which includes *Meiourogonyaulax bulloidea, Sentusidinium villersense* and *Systematophora penicillata* (Olivera et al. 2018, figs 4, 5).

2.4. The Arctic

Six recent single-region contributions from the Arctic are considered in this subsection. Four of these are from Arctic Russia, one of which (Nikitenko et al. 2018a) is considered to be especially significant (Appendix 1 of the Supplementary data).

The Lower Jurassic through Upper Cretaceous (Hettangian–Turonian) biostratigraphy and lithostratigraphy of the New Siberian Islands and adjacent areas of continental Arctic Siberia was studied by Nikitenko et al. (2017), who defined three depositional series with important reference sections. These strata have been substantially deformed. Despite the substantial structural complications, however, Nikitenko et al. (2017) demonstrated the applicability of these successions for correlation in the continental shelf east of the Laptev Sea and in the west of the East Siberian Sea. These authors used ammonites, bivalves, foraminifera, miospores and ostracods, in addition to dinoflagellate cysts. Nikitenko et al. (2018b) is a closely related study and involves an investigation of the same sections that were studied by Nikitenko et al. (2017). Nikitenko et al. (2018b) comprises a detailed examination of the micropalaeontology (dinoflagellate cysts, foraminifera, miospores and ostracods) and Hettangian and Pliensbachian organic geochemistry of the Hettangian to Turonian reference sections of the New Siberian Islands. A scheme of Boreal standard biozones was erected that have regional applicability in northern Siberia. Kashirtsev et al. (2018) involves a study based on organic geochemistry on the Oxfordian to Valanginian succession of the Nordvik Peninsula, western Anabar Bay, Arctic Russia. A comprehensive biostratigraphy has been developed for this succession including seven dinoflagellate cyst zones (Kashirtsev et al. 2018, fig. 2).

By far the most significant publication on the Arctic region in this review is that by Nikitenko et al. (2018a). This work details the biostratigraphy, geochemistry ($\delta^{13}C_{TOC}$), palaeoecology and sedimentology of the Middle Jurassic to Lower Cretaceous (Bathonian–Valanginian) succession of the Olenek section in the Anabar-Lena region of Arctic Russia. The emphasis is on the uppermost Jurassic and Lower Cretaceous (Tithonian [=Volgian] to Valanginian) Buolkalakh and Iaedaes formations (Nikitenko et al. 2018a, fig. 3). Detailed range data was gathered for ammonites, dinoflagellate cysts, foraminifera and miospores (Nikitenko et al. 2018a, figs 6–9). Five 'dinocyst local zones' were recognised: 1 – the *Cometodinium whitei, Epiplosphaera gochtii, Gonyaulacysta eisenackii* 'dinocyst local zone'; 2 – the *Bourkidinium* sp. 'dinocyst local zone'; 3 – the *Gochteodinia villosa* 'dinocyst local zone'; 4 – the *Batioladinium varigranosum, Occisucysta tentorium* 'dinocyst local zone'; and 5 – the *Cyclonephelium cuculliforme, Batioladinium reticulatum* 'dinocyst local zone' (Nikitenko et al. 2018a, fig. 7). Numbers 1 to 4 of these 'zones' cover the ?uppermost

Kimmeridgian–Lower Volgian to uppermost Tithonian/Volgian–lower Boreal Berriasian interval. The ages of the five 'dinocyst local zones' from the Olenek section were calibrated to the current geological time scale via correlations with 11 coeval studies throughout the northern and southern hemispheres (Nikitenko et al. 2018a, fig. 11).

The only other single-region publications on the Arctic reviewed herein are those by Felix and Burbridge (1977) and Rismyhr et al. (2018). Felix and Burbridge (1977) established a new species of pteridophytic spore, *Ricciisporites umbonatus*, from the Upper Triassic (Carnian–Norian) of the Sverdrup Basin, Arctic Canada. This comprehensive study and it included details of the associated palynomorphs, including common occurrences of the dinoflagellate cysts *Sverdrupiella baccata*, *Sverdrupiella manicata, Sverdrupiella ornaticingulata, Sverdrupiella septentrionalis* and *Sverdrupiella usitata* in the borehole successions that were examined. Dinoflagellate cysts proved absent in the outcrop samples that were studied (Felix and Burbridge 1977, table 1). *Sverdrupiella usitata* is the most prominent species throughout the boreholes sections studied. The genus *Sverdrupiella* is therefore highly characteristic of the Norian of boreholes drilled in the Canadian Arctic (Bujak and Fisher 1976).

Rismyhr et al. (2018) provided a major study of the palynology, sedimentology and sequence stratigraphy of the Carnian to Callovian strata of western central Spitsbergen, Svalbard. Ten composite assemblage zones (CAZs) were established, of which the six for the Norian to Callovian interval are based on dinoflagellate cysts (Rismyhr et al. 2018, fig. 3). The principal focus of this study was the Knorringfjellet Formation (Wilhelmøya Subgroup), in which three sequences were identified. Sequence 1 is Norian, and is characterised by the *Rhaetogonyaulax arctica* and *Heibergella* spp. CAZs. *Nannoceratopsis senex* gives its name to a Toarcian CAZ which is equivalent to Sequence 2. The Brentskardhaugen Bed is a highly condensed deposit of late Toarcian–early Aalenian age. It is assigned to the *Phallocysta eumekes* CAZ, and was assigned to Sequence 2 by Rismyhr et al. (2018).

2.5. Australasia

Seven single-region contributions from Australasia are listed in Appendix 1 of the Supplementary data in this review. Zhang Wangping & Grant-Mackie (2001) described the palynology of the Late Triassic and Early Jurassic (Norian–Sinemurian) of New Zealand. This paper is chiefly on miospores, although the authors also reported undifferentiated acritarchs and dinoflagellate cysts from various lithostratigraphical units of the Hokonui Hills and southwestern Kawhia.

The remaining six single-region studies are from Australia. Jones & Nicoll (1984) and Dixon et al. (2012) are short papers on the Late Triassic (Carnian–Norian) of the North West Shelf of Australia. Both mention dinoflagellate cysts briefly. Dixon et al. (2012) worked on the Upper Mungaroo Formation from the offshore Carnarvon Basin. These authors recorded *Dapcodinium* spp. from marginal marine to tidally influenced facies, and *Hebecysta balmei* and *Rhaetogonyaulax* spp. from open-marine settings. The paper by Paumard et al. (2018) is also on material from the North West Shelf of Australia. In this multidisciplinary study the authors examined the sedimentary architecture and sediment partitioning in the Barrow Group (Tithonian–Valanginian) of the Northern Carnarvon Basin. Offshore well data were integrated to establish a seismic stratigraphy of this economically important unit. The authors related seven third-order seismic sequences to the eustatic and tectonic history of the depocentre, and calibrated these sequences using the *Pseudoceratium iehiense* to *Systematophora areolata* dinoflagellate cyst zones of Helby et al. (1987).

However, the most significant Australasian contribution listed herein is by Wainman et al. (2018a). This paper is on the latest Jurasssic (Tithonian) palynology of the Indy 3 well in the western Surat Basin, Queensland, southeastern Australia. These authors discovered low-diversity dinoflagellate cysts and colonial algae in the Walloon Coal Measures (Injune Creek Group). The Walloon Coal Measures were previously believed to be entirely nonmarine. The study showed that either a brief marine transgression is represented by this unit, or that these planktonic palynomorphs were freshwater forms and thus represent a rare report of pre-Cretaceous nonmarine dinoflagellate cysts. These records are coincident with an interval of high global sea level hence the former scenario appears to be the best explanation. The new dinoflagellate cyst species described by Wainman et al. (2018a) are *Moorodinium crispa* and *Skuadinium fusum*, and they also described the colonial alga *Palambages pariunta* as new. *Moorodinium crispa* and *Skuadinium fusum* are small, thin-walled proximate cysts from a thin (ca. 2 m) unit interpreted as a possible upper estuarine deposit (Wainman et al. 2018a, pls 1, 2). This interpretation, together with the high dominance and low species richness nature of the assemblage, is consistent with a freshwater setting. Wainman et al. (2018a) provided the palynological basis for a wider study of the Middle–Upper Jurassic Walloon Coal Measures of the Surat Basin (Wainman and McCabe 2018, Wainman et al. 2018b).

2.6. East Europe

None of the nations generally considered to comprise this region are in the Arctic Circle, so the prefix 'sub-Arctic' is superfluous in this case. Nine single-region items concerning Bulgaria, Hungary, Poland and Slovakia in East Europe are listed in Appendix 1 of the Supplementary data. Two of these publications are deemed to have substantial significance.

Three multi-authored papers written in Bulgarian detail the Jurassic (Sinemurian–Tithonian) lithostratigraphy of northeastern Bulgaria (Sapunov et al. 1985, 1986a, 1986b). Specifically, the Dobrič, Drinovo, Esenica, Ginci, Javorec, Kalojan, Ozirovo, Polaten, Provadija, Sultanci and Tiča formations were considered in this set of contributions, all in the same journal. The material studied is from numerous deep, continuously cored, boreholes drilled as part of a partially successful petroleum exploration campaign throughout northern Bulgaria. In Sapunov et al. (1985), the four formations considered are treated separately in ascending stratigraphical order. By contrast in Sapunov et al. (1986a, 1986b), the lithostratigraphy was described borehole-by-borehole. Throughout each of these three papers, integrated biostratigraphy based on brachiopods, calpionellids, molluscs and palynomorphs was included. Selected occurrences of dinoflagellate cysts, especially in Sapunov et al. (1986a), were provided by the late Lilia Dodekova, who was one of the co-authors. No photographs or range charts were provided.

The paper by Bóna (1995) is a major work on the Upper Triassic palynostratigraphy of a large coal-bearing basin around Pécs, in the Mecsek Mountains of southern Hungary. Only 'dinoflagellate indet.' was recovered from the lowermost Mecsek Coal formations (Rhaetian) (Bóna 1995, table 2; pl. 8/17). This specimen is very poorly-preserved, but appears to be referable to *Rhaetogonyaulax rhaetica*. This author also reported questionable specimens of *Hystrichosphaeridium magnum* from the Karolinavölgy Sandstone and the lowermost Mecsek Coal formations, which are of Norian and Rhaetian age respectively (Bóna 1995, table 2; pl. 8/16; pl. 9/2, 3, 6). The original authorship of the spinose species *Hystrichosphaeridium magnum* was not provided by Bóna (1995) and was not located by the present author. Only one of the two specimens illustrated of *Hystrichosphaeridium magnum* appears to have possible dinoflagellate cyst affinity (Bóna 1995, pl. 8/16). This specimen is a chorate form with an apparent apical archaeopyle and may be refereable to *Beaumontella*.

As part of an unpublished, PhD thesis mainly focussed on miospores from southwestern England, Hungary and the southwestern USA, Baranyi (2018) analysed borehole material from the the Veszprém Marl Formation (Carnian) of the southern Transdanubian Range, western Hungary and recorded 'dinocyst indet.' and *Heibergella* sp. (see Baranyi 2018, pl. 12/10, 11). These records are within the Carnian Pluvial Episode, and are highly unusual in that most Triassic dinoflagellate cyst occurrences are Norian–Rhaetian (Mangerud et al. 2019, fig. 2).

The dissertation by Ruckwied (2009) on the palynology of the Rhaetian and Hettangian strata of the northwestern Tethyan Realm of Hungary and northern Slovakia aimed to investigate biostratigraphy, palaeoclimate and palaeoecology. The principal thrust of this contribution is on miospores. However Ruckwied (2009) reported *Dapcodinium priscum* and *Rhaetogonyaulax rhaetica* from the Rhaetian and Hettangian of the Furkaska section in the Tatra Mountains of northern Slovakia (see also Ruckwied and Götz 2009). Ruckwied (2009) did not record dinoflagellate cysts from the successions investigated in Hungary.

The prominent Hungarian palynologist Mária Sütőné Szentai produced a compilation of all the genera and species of Silurian to Holocene organic-walled microplankton reported from Hungary since 1957 (Sütőné Szentai 2018). This compendium was an alphabetical listing of all published post-Silurian records of palynomorphs excluding miospores. By far the largest section of this book is on dinoflagellate cysts (Sütőné Szentai 2018, p. 11–111). Every species recorded from Hungary is included; the holotype and the stratigraphical range are also given. The main papers on Triassic and Early Jurassic dinoflagellate cysts from Hungary included in this compilation are Bóna (1995), Bucefalo Palliani et al. (1997) and Baranyi et al. (2016).

2.7. Sub-Arctic West Europe

A total of 29 single-region contributions on the Triassic, Jurassic and earliest Cretaceous of sub-Arctic West Europe are covered in this review, and 12 of these are considered to be considerably impactful (Appendix 1 of the Supplementary data). This section is subdivided into three subsections based on the stratigraphical coverage of the items.

2.7.1. Triassic and Early Jurassic

Seven articles summarised here are focused on the Triassic and Early Jurassic interval. The paper by Karle (1984) involves a detailed study of the palynology of the Triassic–Jurassic boundary at Fonsjoch, western Austria. This author recorded *Rhaetogonyaulax rhaetica* from the Rhaetian. This species is especially common in the middle and upper Rhaetian, and the range top is immediately below a prominent limestone bed which underlies the Pre-Planorbis Beds at the Triassic–Jurassic transition (Karle 1984, fig. 3).

The published PhD dissertation by Holstein (2004) details the palynofacies, palynology and sequence stratigraphy of the Kössen Beds (Upper Triassic, Norian–Rhaetian) of the Eiberg and Mörtlbachgraben sections in the Northern Calcareous Alps of northern Austria. The palynofloras are dominated by miospores, but the dinoflagellate cysts *Dapcodinium priscum* and *Rhaetogonyaulax rhaetica* were recognised. This author asserted that *Dapcodinium priscum* preferred high-energy, shallow-water settings, and *Rhaetogonyaulax rhaetica* had a preference for deep-water, low-energy palaeoenvironments.

A wide-ranging and multidisciplinary study on the Triassic–Jurassic boundary by Lindström et al. (2017) includes descriptions of palynofloras from several localities in Austria, Denmark, England and Germany. The range top of the last, last common and last consistent occurrences (LO, LCO and LCON respectively) of *Rhaetogonyaulax rhaetica* were used as a reliable regional markers. The LCO and LCON of this prominent and cosmopolitan species are consistently within, or immediately below and above, the extinction phase in the late Rhaetian. However, *Rhaetogonyaulax rhaetica* apparently became extinct (LO) during the post-extinction phase in Austria and England (Lindström et al. 2017, fig. 12).

Juncal et al. (2018) involves a multidisciplinary study of the Permian and Triassic of the Paris Basin in central France. These authors reported *Dapcodinium priscum* and *Rhaetogonyaulax rhaetica* from the uppermost Rhaetian of the Sancerre-Couy 1 borehole, within their SC-4 assemblage. Schneebeli-Hermann et al. (2018) provided a very detailed study of the palynology of the Norian, Rhaetian and Sinemurian strata of northern Switzerland, distinguishing five informal palynomorph associations. The main emphasis was on miospores, but nine dinoflagellate cyst taxa were recognised from the Rhaetian and Sinemurian (Schneebeli-Hermann et al. 2018, figs 2, 5). These include *Beaumontella langii, Dapcodinium priscum, Rhaetogonyaulax rhaetica* and ?*Suessia swabiana*; the greatest dinoflagellate cyst diversity is in the Rhaetian (Schneebeli-Hermann et al. 2018, figs 2, 5).

As part of a major multidisciplinary paper on the cores recovered by the Schandelah Scientific Drilling Project in northern Germany, van de Schootbrugge et al. (2018) investigated the palynology of an important Rhaetian to Toarcian succession. Full details of the palynomorphs recovered were not given, but these authors illustrated major bioevents and figured significant dinoflagellate cyst, miospore taxa (van de Schootbrugge et al. 2018, fig. 3, pl. 1). The authors recognised the Early Jurassic *Dapcodinium priscum, Liasidium variabile* and *Nannoceratopsis* dinoflagellate cyst zones.

Several contributions on the Early Jurassic palynology of the Lusitanian Basin in western Portugal were published recently by Vânia Correia and her co-authors (Appendix 1 of the Supplementary data). These are all associated with the author's PhD thesis (Correia 2018), and the most significant is Correia et al. (2018). This paper is on the palynostratigraphy of the Lower Jurassic strata of this important Iberian depocentre. Correia et al. (2018) documented the Sinemurian to Toarcian palynomorph biostratigraphy based on six localities, with the principal emphasis being on dinoflagellate cysts. The Sinemurian proved devoid of dinoflagellate cysts. By contrast the Pliensbachian and Toarcian are characterised by the presence of the genera *Luehndea, Mancodinium, Mendicodinium, Nannoceratopsis* and *Scriniocassis*. *Luehndea* was apparently made extinct by the Toarcian Oceanic Anoxic Event (T-OAE). This event proved substantially more intense in the Lusitanian Basin than elsewhere in southern Europe, and the recovery of phytoplankton was protracted in this basin. Correia et al. (2018) proposed a biozonation for the late Pliensbachian and Toarcian, comprising the *Luehndea spinosa* and *Mendicodinium microscabratum* dinoflagellate cyst zones. The zones were subdivided into subzones (Correia et al. 2018, fig. 15).

2.7.2. Middle Jurassic

In this subsection, four items focused on the Middle Jurassic are documented. A major study on the palynology of the Middle Jurassic Ravenscar Group, from the Cleveland Basin, northeastern Yorkshire, northern England, was undertaken by Hogg (1993). This unpublished PhD thesis focussed on outcrops of the Cloughton, Scarborough, Scalby and Cornbrash formations (Bajocian–Bathonian) in the Scarborough area of North Yorkshire. The emphasis was on miospores, but diverse dinoflagellate cyst floras were also recovered and 30 genera were recognised (Hogg 1993, p. 121–137, fig. 4.6, pls 17–23). Three new species were informally introduced. Furthermore, *Ambonosphaera calloviana* and *Tabulodinium senarium* were reported from the UK for the first time. Hogg (1993) determined that much of the Long Nab Member of the Scalby Formation is of latest Bathonian (*Clydoniceras discus* ammonite zone) age. This work refined the biostratigraphical results of Riding and Wright (1989), who reported a Bathonian (undifferentiated) age. Hogg (1993, p. 179–190) discussed the dinoflagellate cyst biostratigraphy of the Scarborough and Scalby formations in some detail, comparing his results with previous studies such as those by Riding and Wright (1989) and Gowland and Riding (1991). The sequence stratigraphy of the successions investigated was also analysed.

Powell et al. (2018, appendix B) documented the palynology of two samples from the Kellaways Sand Member (Lower Callovian) of Burythorpe Sand Quarry, North Yorkshire, UK. Sample 2 was relatively rich in dinoflagellate cysts and five specimens were illustrated (Powell et al. 2018, fig. 12).

The early Mesozoic phytoplankton radiation was investigated by Wiggan et al. (2018). The coccolithophores and dinoflagellates radiated substantially during the Bajocian (~170–168 Ma). Wiggan et al. (2018) described and interpreted a dominance of the genus *Dissiliodinium* in the mid-latitudes, followed by the explosive evolutionary expansion of the dinoflagellate family Gonyaulacaceae. The latter phenomenon was viewed as being strongly influenced by increases in sea level and changes in ocean gateways, and possibly related to the Mesozoic Marine Revolution. The key dinoflagellate cyst data in Wiggan et al. (2018) were from an important borehole succession in southern Germany initially published by Wiggan et al. (2017).

Correia et al. (2019) presents part of the senior author's PhD study (Correia 2018), providing an account of the palynostratigraphy of the Cabo Mondego and Póvoa de Lomba formations (uppermost Toarcian–Bathonian) at Cabo Mondego and São Gião in the northern Lusitanian Basin. The succession at Cabo Mondego includes the Global Stratotype Section and Point (GSSP) for the Bajocian. The samples from Cabo Mondego were by far the most palynologically productive. Here the uppermost Toarcian to lowermost Bajocian succession produced low diversity dinoflagellate cyst associations dominated by *Nannoceratopsis*. Within the *Witchellia laeviuscula* ammonite zone, the assemblages become markedly more diverse, reflecting the intra-Bajocian global evolutionary explosion of dinoflagellates. This predominantly involved the family Gonyaulacaceae, and was apparently strongly linked to sea-level rise (Wiggan et al. 2017, 2018). The upper part of the Lower Bajocian and much of the Upper Bajocian were not sampled by Correia et al. (2019, fig. 2); however the trend of increasing dinoflagellate cyst diversity continued through the Bajocian–Bathonian transition. It is clear from Correia et al. (2019) that the Middle Jurassic dinoflagellate cyst species richnesses in the Arctic region and the Boreal Realm are substantially higher than in southern Europe. This may be because more northerly palaeolatitudes were a phytoplankton-diversity hotspot during the Mesozoic, that the the recovery from the Toarcian Oceanic Anoxic Event (T-OAE) was more protracted in the Iberian region, or that regional palaeogeographical factors controlled dinoflagellate diversity in the Lusitanian Basin.

2.7.3. Middle Jurassic to Early Cretaceous inclusive

In this subsection, the six remaining substantial papers exclusively on West Europe are discussed. The works involved range from the Middle Jurassic to Early Cretaceous. Heunisch and Luppold (2018) present an important study of the Middle Jurassic to earliest Cretaceous (Callovian–Berriasian) micropalaeontological biostratigraphy of two boreholes drilled in the Lower Saxony Basin of northern Germany. It is a technical report with the micropalaeontology of selected intervals in the Eulenflucht-1 and Wendhausen-6 boreholes described one-by-one. In the palynology subsections, age-diagnostic dinoflagellate cysts such as *Compositosphaeridium*? *polonicum, Dingodinium tuberosum, Gonyaulacysta jurassica, Hystrichosphaerina*? *orbifera, Muderongia simplex* subsp. *microperforata, Nannoceratopsis pellucida, Pareodinia brevicornuta, Systematophora areolata* and *Systematophora penicillata* are mentioned (Heunisch and Luppold 2018, pl. 3).

An overview of the Middle Jurassic to Early Cretaceous (Bathonian–Barremian) basin evolution in the Central Graben area of the North Sea (representing the Danish, Dutch and German sectors) was presented by Verreussel et al. (2018). This study was entirely based on the correlations of wells that have been analysed for palynology (Verreussel et al. 2018, fig. 2). These authors recognised four intervals that they termed tectonostratigraphical megasequences (TMS). Each TMS represents a distinct phase of basin evolution; for example TMS-1 reflects the onset of basin rifting and the rift climax occurred during this phase. It was characterised by thick mud deposition.

A study focussed on the Oxfordian/Kimmeridgian boundary beds in the Flodigarry Shale Member (Staffin Bay Formation) of the Isle of Skye, northwestern Scotland, was undertaken by Barski (2018). This unit is notable because it includes a proposed Global Stratotype Section and Point (GSSP) for the base of the Kimmeridgian. Barski (2018) studied seven samples from the *Ringsteadia pseudocordata* and *Pictonia baylei* ammonite zones, and presented quantitative data (Barski 2018, table 1). The author recognised a eutrophication event in the lowermost Kimmeridgian. Furthermore, Barski (2018) noted that the range bases of sparse *Emmetrocysta sarjeantii, Perisseiasphaeridium pannosum* and *Senoniasphaera jurassica* can be used as markers for the base of the Kimmeridgian.

Turner et al. (2018) is a major study by on the comprehensive stratigraphy of the Upper Jurassic and Lower Cretaceous of the Arctic and Europe, and it included palynological analysis of the Kimmeridgian to Berriasian of the Norwegian Continental Shelf. These authors integrated carbon isotope, cyclostratigraphical, dinoflagellate cyst and gamma ray data to effect interregional correlations throughout this important interval. Turner et al. (2018, fig. 2) calibrated the palynological data from the Barents and North seas to the the current geological time scale using ammonite-dated dinoflagellate cyst studies such as Riding and Thomas (1992) and Poulsen and Riding (2003).

Schneider et al. (2018) undertook a detailed study of the micropalaeontology and palynology of the Jurassic–Cretaceous transition (Tithonian–Berriasian) in the Lower Saxony Basin of northern Germany. This study is based mainly on miospores, but the authors noted the regional correlative significance of the range bases of *Batioladinium pomum, Cantulodinium speciosum, Muderongia simplex* subsp. *microperforata, Muderongia simplex* and *Pseudoceratium pelliferum* in the Berriasian (Schneider et al. 2018, fig. 2).

Stanley Duxbury continued his extensive research into dinoflagellate cysts from the Lower Cretaceous of the North Sea and surrounding areas that began with Duxbury (1977). Duxbury (2018) is a major study of the Berriasian to lower Hauterivian marine palynostratigraphy of the Speeton Clay and Valhall formations of the Central North Sea and northeastern England based on 1131 samples. The biozonation of Duxbury (2001) is substantially refined. Duxbury (2018) is dominated by a systematic section with taxonomic novelties including one new genus and 21 new species.

2.8. The Middle East

The one single-region contribution on the Middle East herein is the article by Eshet (1990). This author studied the Permian and Triassic successions of 11 boreholes drilled throughout Israel. Eshet (1990) erected seven interval zones for the Early Permian to Late Triassic. Only one dinoflagellate cyst zone, the *Rhaetogonyaulax rhaetica* Zone (VII; Norian–Rhaetian), was established. The base of this zone was defined by the range bases of post-Carnian miospores, and the top by the range top of *Rhaetogonyaulax rhaetica* and other dinoflagellate cysts (i.e. *Heibergella asymmetrica, Noricysta fimbriata, Suessia swabiana* and *Sverdrupiella* spp.). Two distinct palynofacies are present in this zone, one with dinoflagellate cysts and the other devoid of these marine palynomorphs. The *Rhaetogonyaulax rhaetica* Zone is restricted to the coastal plain in the extreme west of Israel; elsewhere the Norian–Rhaetian has been cut out by a regional unconformity. Its reference section is within the Shefaiym Formation, between 4860 m and 4495 m in the Ga’ash 2 Borehole, northwestern Israel (Cousminer 1981; Eshet 1990, fig. 1). The age interpretation of Norian–Rhaetian is based on the ranges of the dinoflagellate cysts *Rhaetogonyaulax rhaetica* and *Suessia swabiana* (see Visscher & Brugman 1981) and foraminifera.

2.9. Sub-Arctic Russia

Twelve single-region articles on sub-Arctic Russia are compiled in this review, six of which are deemed to be highly significant (Appendix 1 of the Supplementary data). Three of these are on sub-Arctic West Russia, i.e. west of the Ural Mountains, and the remaining nine are on southwestern Russia. The most significant of these contributions are detailed below in two subsections.

2.9.1. Sub-Arctic West Russia

The unpublished PhD thesis by Smith (1999), available online, details the palynostratigraphy of the Tithonian (Volgian) to Valanginian strata of the important Volgian lectostratotype successions at Gorodische and Kashpir, near Ulyanovsk, southwestern Russia. The key findings were later incorporated into Harding et al. (2011). Another noteworthy article based on the Upper Kimmeridgian and Tithonian strata of Gorodische is Pestchevitskaya (2018). This author focussed on the distinctive camocavate dinoflagellate cyst genus *Dingodinium*. The genus was emended, with the archaeopyle interpreted as of combination type (apical/anterior intercalary), and the tabulation partiform (Pestchevitskaya 2018, fig. 2). Pestchevitskaya (2018) thus placed *Dingodinium* into the family Cladopyxiaceae. She compiled the Middle Jurassic to the latest Cretaceous stratigraphical ranges of the genus worldwide, and discussed the morphologies of 12 species of *Dingodinium* (Pestchevitskaya 2018, figs 1, 3). Pestchevitskaya (2018) identified *Dingodinium albertii*, *Dingodinium jurassicum* and *Dingodinium tuberosum* from Gorodische, and established the new species *Dingodinium nequeas*. In another publication Dzyuba et al. (2018) discussed the ranges of dinoflagellate cysts, mainly identified only at the generic level, from the Tithonian–Berriasian (Volgian–Ryazanian) of a fossiliferous succession exposed on the banks of the Maurynya River in the Northern Ural Mountains of West Siberia.

2.9.2. Southwestern Russia (the Caspian Sea, the Caucasus Mountains and Crimea)

The discussion of articles on the Caspian Sea, the Caucasus Mountains and Crimea is placed in the subsection on sub-Arctic Russia herein for purely geographical and pragmatic reasons. This strategy has absolutely no political significance whatsoever.

The remaining nine items from sub-Arctic Russia, all recently published, are based on material from southwestern Russia. Arkadiev et al. (2018) is a biostratigraphical and magnetostratigraphical synthesis of the Jurassic–Cretaceous boundary beds of the Crimean

Mountains. Tithonian and Berriasian strata are well-developed and highly fossiliferous throughout this region. The authors summarised research on ammonites, calpionellids, dinoflagellate cysts, foraminifera and ostracods from Tithonian to lowermost Valanginian strata across Crimea, and correlated these fossil records with magnetostratigraphy. Two subdivisions based on dinoflagellate cysts were recognised. These are the 'beds with *Amphorula expirata'* (now *Amphorulacysta*? *expirata*) and the 'beds with *Phoberocysta neocomica'* of latest Tithonian–earliest Berriasian and earliest Berriasian–latest Berriasian age respectively. The range bases of *Ctenidodinium elegantulum*, *Phoberocysta neocomica* and *Spiniferites* spp. define the boundary between these two informal biozones; these bioevents are within the *Tirnovella occitanica* ammonite zone (Arkadiev et al. 2018, fig. 21).

The short paper by Goryacheva and Ruban (2018) is on the Pliensbachian and Toarcian palynology of the Sjuk River valley in the northwestern Caucasus, where the authors identified *Nannoceratopsis senex*. Another short article by Goryacheva et al. (2018) is on the palynology of a sandstone representing a reportedly deep marine setting in the upper part of the Bagovskaja Formation from the River Belaja, south of Guzeripl in the northern Arkhyz-Guzereplskaja area, Western Caucasus region. This unit is Toarcian in age, based on ammonites recovered from its lowermost beds. Goryacheva et al. (2018) reported a dinoflagellate cyst assemblage dominated by *Nannoceratopsis*. The most abundant species is *Nannoceratopsis spiculata*. Less common forms include *Nannoceratopsis plegas, Nannoceratopsis senex, Phallocysta eumekes* and *Susadinium faustum.* Goryacheva et al. (2018) interpreted this association as being of late Toarcian age.

Mitta et al. (2017) provided an integrated palaeontological study of the Middle Jurassic (Bajocian–Bathonian) of the Bolshoi Zelenchuk River Basin in the Northern Caucasus region. Samples were collected from the uppermost Bajocian and lowermost Bathonian (*Parkinsonia parkinsoni* and *Zigzagiceras zigzag* ammonite zones) part of the Djangura Formation from localities 8, 11, 12 and 25 of Mitta et al. (2017, fig. 2). The authors examined ammonites, dinoflagellate cysts, foraminifera, miospores and ostracods from this succession. The five productive samples yielded moderately diverse dinoflagellate cyst associations. Prominent species recorded throughout include *Aldorfia aldorfensis, Chytroeisphaeridia chytroeides, Ctenidodinium sellwoodii, Korystocysta gochtii, Meiourogonyaulax caytonensis, Nannoceratopsis gracilis, Nannoceratopsis spiculata* and *Valensiella ovulum*. Mitta et al. (2017) recognised two informal zones. The uppermost Bajocian was termed 'beds with *Rynchodiniopsis*? *regalis'*, the nominate species being confined to this interval. The most prominent dinoflagellate cysts are *Ctenidodinium* *sellwoodii* and *Dissiliodinium* spp. The presence of *Acanthaulax* aff. *crispa* (as *Cribroperidinium* aff. *crispum*) is indicative of the late Bajocian (Wiggan et al. 2017). However, Mitta et al. (2017) also recorded *Nannoceratopsis dictyambonis* from this interval. This species, characteristic of the latest Toarcian to early Bajocian interval (Riding 1984a, 1984b; Wiggan et al. 2017), may thus be reworked. The overlying lowermost Bathonian was assigned to 'beds with *Ctenidodinium sellwoodii'*, named after one of the dominant species. The dinoflagellate cysts of this interval are substantially similar to those from the underlying interval. Only six range bases were observed in the 'beds with *Ctenidodinium sellwoodii'*, including that of *Ctenidodinium continuum*.

Mitta et al. (2018) is a companion paper to that of Mitta et al. (2017). The former is an important biostratigraphical study of the Upper Bajocian Djangura Formation from the banks of the Kyafar River, a tributary of the Bolshoi Zelenchuk River, Karachay-Cherkessia, Northern Caucasus, southwestern Russia. The material is all from the *Rarecostites subarietis* ammonite subzone of the *Parkinsonia parkinsoni* ammonite zone. Ten samples were examined, and all yielded substantial proportions of dinoflagellate cysts in relatively diverse associations (Mitta et al. 2018, fig. 6). The samples are dominated by *Dissiliodinium* spp. Furthermore, the following species were found throughout: *Aldorfia aldorfensis; Chytroeisphaeridia chytroeides; Ctenidodinium continuum; Ctenidodinium sellwoodii; Durotrigia daveyi; Korystocysta* spp.; *Meiourogonyaulax caytonensis; Meiourogonyaulax valensii; Nannoceratopsis gracilis; Nannoceratopsis senex; Nannoceratopsis spiculata; Pareodinia ceratophora; Pareodinia prolongata; Rhynchodiniopsis*? *regalis; Sentusidinium* spp.; *Tubotuberella* spp.; and *Valensiella ovulum*. The following are also present, but rather less consistently: *Endoscrinium galeritum*; *Kalyptea stegasta*; *Leptodinium* sp.; *Nannoceratopsis dictyambonis; Nannoceratopsis raunsgaardii; Pareodinia halosa; Phallocysta elongata;* and *Wanaea acollaris* (see Mitta et al. 2018, fig. 6, pl. V). The authors assigned the entire succession that they studied to the 'beds with *Meiourogonyaulax valensii, Rhynchodiniopsis*? *regalis'* (Mitta et al. 2018, fig. 7). Many of the dinoflagellate cyst taxa recovered by Mitta et al. (2018) are entirely consistent with the latest Bajocian age determined by ammonites and other fossils. These marker taxa include *Aldorfia aldorfensis, Ctenidodinium continuum, Ctenidodinium sellwoodii, Dissiliodinium* spp., *Durotrigia daveyi, Kalyptea stegasta*, *Korystocysta* spp., *Leptodinium* sp., *Meiourogonyaulax caytonensis, Meiourogonyaulax valensii, Rhynchodiniopsis*? *regalis, Tubotuberella* spp. and *Wanaea acollaris* (see for example Riding and Thomas 1992, Wiggan et al 2017).

As in Mitta et al. (2017), Mitta et al. (2018), identified apparent reworking of dinoflagellate cysts. The diversity of the species involved is considerable, comprising *Nannoceratopsis dictyambonis, Nannoceratopsis raunsgaardii, Nannoceratopsis gracilis, Nannoceratopsis senex* and *Phallocysta elongata*. The presence of these taxa is clearly stratigraphically incompatible with a latest Bajocian age and reflects stratigraphical recycling of Upper Pliensbachian to Early Bajocian strata. The range bases of *Nannoceratopsis gracilis* and *Nannoceratopsis senex* are late Pliensbachian, and these species are common throughout the Toarcian and earliest Bajocian interval (e.g. Morgenroth 1970, Poulsen 1996, Riding et al. 1999, Correia et al. 2018, Correia et al. 2019). The allochthonous species with the shortest ranges are *Nannoceratopsis dictyambonis* and *Phallocysta elongata*, forms that are characteristic of the latest Toarcian to earliest Bajocian (Riding 1984b, 1994).

The earliest Cretaceous (Berriasian) dinoflagellate cysts from the Uruh section in the North Caucasus, southwestern Russia were reported in a short contribution in Russian by Shurekova (2018). The article is well-illustrated and a semiquantitative range chart was presented (Shurekova, 2018, p. 283–285). The author distinguished the *Phoberocysta neocomica* and *Systematophora* cf. *palmula* dinoflagellate cyst zones which are broadly equivalent to the *Tirnovella occitanica* and *Fauriella boissieri* ammonite zones. The species *Systematophora palmula* is now known as *Palaecysta palmula.*

3. Conclusions

In a literature search from February 2018 to January 2019, 55 new publications pertaining to Triassic to earliest Cretaceous dinoflagellate cysts were discovered, and are compiled herein together with 38 older items which were not covered by Riding (2012, 2013, 2014, 2019). These 93 papers are based on material from Africa, North America, South America, the Arctic, Australasia, East Europe, West Europe, the Middle East and Russia. Thirty of them are deemed herein to be significantly impactful and are asterisked in Appendix 1 of the Supplementary data. All 93 contributions are listed in Appendix 1 of the Supplementary data, and most are on the Late Triassic and Early Jurassic of Europe (Tables 1, 2). This may be due to substantial recent interest in the Triassic–Jurassic transition, and the situation differs from previous compilations which demonstrated greater focus on the Late Jurassic of Europe (Riding 2012, 2013, 2014, 2019). Papers based on West Europe comprise 31.2% of the total, and publications on Africa, the Arctic, Australasia, East Europe and Russia are also significant (15.1%, 6.5%. 7.5%, 9.7% and 14.0% respectively). The least well-represented regions are North America, South America and the Middle East (2.2%, 1.1% and 1.1% respectively; Table 1).

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Display material captions:

Table 1. A breakdown of the 93 publications on Triassic to earliest Cretaceous dinoflagellate cysts compiled herein, based on the nine relevant geographical regions (i.e. Africa, North America, South America, the Arctic, Australasia, East Europe, West Europe, the Middle East and Russia) and the initial letter of the family name of the first author. The number in the geographical region cell refers to the number of relevant published items on that area alone. An ellipsis (…) indicates a zero return for that particular parameter.

Table 2. A breakdown of of the 93 publications on Triassic to earliest Cretaceous (Berriasian) dinoflagellate cysts compiled herein, subdivided into Triassic, Early Jurassic, Middle Jurassic, Late Jurassic, Jurassic–Cretaceous transition, investigations comprising three or more of the previous intervals and studies with no stratigraphical focus, and reworking. Some latitude and pragmatism is used in this compilation; for example, if a publication is on the Berriasian and Valanginian it is classified as covering the Jurassic–Cretaceous transition. One item may be counted twice (e.g. if it spans the Oxfordian to Berriasian), but not three times. An ellipsis (…) indicates a zero return for that particular parameter.

SUPPLEMENTARY DATA

Appendix 1. List of Literature

Ninety-three contributions on Triassic to earliest Cretaceous dinoflagellate cysts issued after the publication of Riding (2012, 2013, 2014, 2019), together with papers encountered after these compilations were made, are listed in alphabetical/chronological order below. The reference citation format used is much the same as in Riding (2013, 2014, 2019), which was slightly modified from Riding (2012). Digital object identifier (doi) numbers are included where these are available. The 30 papers which are deemed to be of major significance are asterisked. The language in which a paper was written in is indicated if it is not in English. A synthesis of the scope of each item is given as a string of keywords in parentheses after each citation. These keywords attempt to comprehensively summarise the principal subject matter, age range, major geographical region(s) and country/countries. A distinction is made between publications that present new data (‘primary data’), and those that compile, review or summarise existing datasets (‘compilation’). A significant number of abstracts are listed here; these are denoted by the word ‘summary’ in the keyword string. If the author(s) have included photographs, occurrence charts and a zonal breakdown, these are indicated respectively in the keywords. For the purpose of this work, the world is subdivided into 14 major geographical regions. These are Africa, Central America, North America, South America, Antarctica, the Arctic, Southeast Asia, Australasia, China, East Europe, West Europe, the Indian subcontinent, the Middle East and Russia (Table 1). The regional assignments of any disputed territories, for example of Crimea, are merely for internal consistency and geographical pragmatism, and have no political significance whatsoever.

A

*ABOUL ELA, N.M., and TAHOUN, S.S. 2010. Dinoflagellate cyst stratigraphy of the subsurface Middle–Upper Jurassic/Lower Cretaceous sequence in North Sinai, Egypt. *Fifth International Conference on the Geology of the Tethys Realm, 2nd–7th January 2010, South Valley University, Quena, Luxor, Egypt*, 85–115.
(acritarchs; biostratigraphy; biozonation; calcareous nannofossils; correlation; eustasy; foraminifera; foraminiferal test linings; fungal spores; hiatus; lithostratigraphy; pollen-spores; tectonics; primary data; occurrence charts; photographs; Middle Jurassic–Early Cretaceous [Bathonian–Albian]; North Africa [Mango-1 and Til-1 wells, offshore northern Sinai Basin, Egypt])

*ARKADIEV, V., GUZHIKOV, A., BARABOSHKIN, E., SAVELIEVA, J., FEODOROVA, A., SHUREKOVA, O., PLATONOV, E., and MANIKIN, A. 2018.

Biostratigraphy and magnetostratigraphy of the upper Tithonian–Berriasian of the Crimean Mountains. *Cretaceous Research*, 87: 5–41 (doi: 10.1016/j.cretres.2017.07.011). (acritarchs; ammonites; belemnites; biostratigraphy; brachiopods; calpionellids; correlation; foraminifera; magnetostratigraphy; ostracods; prasinophytes; stratigraphical synthesis; Tethyan palaeogeography; primary data; photographs; latest Jurassic–Early Cretaceous [Tithonian–Valanginian]; sub-Arctic Russia [Crimean Mountains from Feodosiya to Sevastopol, Crimea, southwestern Russia)

ARKADIEV, V.V., BARABOSHKIN E.Yu., GUZHIKOV, A.Yu., BARABOSHKIN, E.E., SHUREKOVA, O.V., and SAVELIEVA, Yu.N. 2018. Tirnovella occitanica zone (Berriasian) of the Eastern Crimea. *In*: Baraboshkin E.Yu., Lipnitskaya, T.A., and Guzhikov, A.Yu. (editors). *Cretaceous system of Russia and near abroad: problems of stratigraphy and paleogeography*. Proceedings of the Ninth All-Russian Conference, Belgorod State National Research University, Belgorod, September 17th–21st, 2018. Polyterra Publishing House, Belgorod, ISBN 978-5-98242-250-7, 32–38 (in Russian with an English abstract). (ammonites; biostratigraphy; biozonation; magnetostratigraphy; ostracods; pollen-spores; *Tirnovella occitanica* zone; summary; earliest Cretaceous [Berriasian]; sub-Arctic Russia [Zavodskaya Balka section, eastern Crimea, southwestern Russia])

B

BARABOSHKIN, E.Yu., SHTUN, S.Yu., GUZHIKOV, A.Yu., KUZNETZOV, A.B., FEODOROVA, A.A., SHUREKOVA, O.V., and SMIRNOV, M.V. 2018. Sedimentology and stratigraphy of the Jurassic-Cretaceous boundary interval of the carbonate ramp of the Northern Caspian. *In*: Baraboshkin E.Yu., Lipnitskaya, T.A., and Guzhikov, A.Yu. (editors). *Cretaceous system of Russia and near abroad: problems of stratigraphy and paleogeography*. Proceedings of the Ninth All-Russian Conference, Belgorod State National Research University, Belgorod, September 17th–21st, 2018. Polyterra Publishing House, Belgorod, ISBN 978-5-98242-250-7, 54–58 (in Russian with an English abstract). (biostratigraphy; correlation; palaeoecology; palaeomagnetism; sedimentology; stable isotopes; summary; latest Jurassic–earliest Cretaceous [Tithonian–Berriasian]; sub-Arctic Russia [the Khvalynskaya-5 and Sarmatskaya-3 wells, northern Caspian Sea, offshore southwestern Russia])

BARANYI, V. 2018. *Vegetation dynamics during the Late Triassic (Carnian–Norian): Response to climate and environmental changes inferred from palynology*. Unpublished PhD thesis, University of Oslo, Norway, 164 p., ISSN 1501-7710 (available online at: https://www.duo.uio.no/handle/10852/61940).
(biostratigraphy; carbon isotope analysis; clay mineralogy; correlation; floral evolutionary history; Carnian Pluvial Episode; Mid-Norian Climate Shift; lithostratigraphy [the Chinle and Veszprém Marl formations and the Mercian Mudstone Group]; palaeoclimatology; palaeoecology; Sub-Boreal and Tethyas realms; taphonomy; terrestrial ecosystems; Late Triassic [Carnian–Norian]; multi-region: sub-Arctic North America [Petrified Forest National Park, Arizona, southwestern USA]; East Europe [southern Transdanubian Range, western Hungary]; sub-Arctic West Europe [Wessex Basin, southwestern England])

*BARSKI, M. 2018. Dinoflagellate cyst assemblages across the Oxfordian/Kimmeridgian boundary (Upper Jurassic) at Flodigarry, Staffin Bay, Isle of Skye, Scotland - a proposed GSSP for the base of the Kimmeridgian. *Volumina Jurassica*, 16: 51–62 (doi: not available in Oct 18).
(ammonites; biostratigraphy; bloom of zygnemataceous chlorophycean alga [?*Spirogyra*]; correlation; eutrophication event [“green tide”]; lithostratigraphy [Flodigarry Shale Member, Staffin Bay Formation]; palynofacies; proposed Global Stratotype Section and Point (GSSP); primary data; quantitative occurrence chart; photographs; Late Jurassic [Oxfordian–Kimmeridgian]; sub-Arctic West Europe [foreshore sections at Flodigarry, Trotternish Peninsula, Isle of Skye, northwestern Scotland])

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region: East Europe [Poland]; sub-Arctic West Europe [Denmark; England, France, Germany])

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(acritarchs; ammonite biozones; biostratigraphy; biozonation; correlation; diversity; foraminiferal test linings; geochemistry; lithostratigraphy; palaeobiology; palaeoecology; palaeogeography; palynomorph fluorescence; petroleum geology; pollen-spores; prasinophytes; provincialism; regional geology; tectonic history; thermal alteration index [TAI]; Toarcian Oceanic Anoxic Event [T-OAE]; primary data; occurrence charts; photographs; Early–Middle Jurassic [Sinemurian–Callovian]; sub-Arctic West Europe [Lusitanian Basin, western-central Portugal])

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(ammonites; biostratigraphy; diversity; evolutionary radiation; Global Stratotype Section and Point (GSSP); Mesozoic Marine Revolution; summary; Early–Middle Jurassic [Toarcian–Bajocian]; sub-Arctic West Europe [Cabo Mondego, Lusitanian Basin, western-central Portugal])

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(ammonite biozones; biostratigraphy; diversity; summary; occurrence chart; photographs; Early Jurassic [Sinemurian–Toarcian]; sub-Arctic West Europe [Brenha, Fonte Coberta,

Maria Pares, Peniche, São Pedro de Moel and Val das Fontes, Lusitanian Basin, western central Portugal])

CORREIA, V.F., RIDING, J.B., DUARTE, L.V., FERNANDES, P., and PEREIA, Z. 2018. Lower Jurassic dinoflagellate cysts throughout the Toarcian Oceanic Anoxic Event (T-OAE) in the Lusitanian Basin, Portugal. *In*: Silva, R.L., Duarte, L.V., and Sêco, S. (editors). *Second International Workshop on the Toarcian Oceanic Anoxic Event, Coimbra, Portugal, September 6–9, 2018*. Abstracts Volume, 33–34. ISBN: 978-989-98914-6-3. (abundances; diversity; palaeoecology; palaeogeography; recovery; Toarcian Oceanic Anoxic Event (T-OAE); summary; photographs; Early Jurassic [Pliensbachian–Toarcian]; sub-Arctic West Europe [Fonte Coberta, Maria Pares, Peniche, Lusitanian Basin, western central Portugal])

*CORREIA, V.F., RIDING, J.B., DUARTE, L.V., FERNANDES, P., and PEREIRA, Z. 2018. The Early Jurassic palynostratigraphy of the Lusitanian Basin, western Portugal. *Geobios,* 51(6): 537–557 (doi: 10.1016/j.geobios.2018.03.001). (acritarchs; ammonite biozones; biostratigraphy; biozonation; diversity; foraminiferal test linings; pollen-spores; prasinophytes; regional geology; Toarcian Oceanic Anoxic Event (T-OAE); primary data; occurrence charts; photographs; Early Jurassic [Sinemurian–Toarcian]; sub-Arctic West Europe [Brenha, Fonte Coberta, Maria Pares, Peniche, São Pedro de Moel and Val das Fontes, Lusitanian Basin, western central Portugal])

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(biostratigraphy; biozonation; chemostratigraphy; correlation; Global Stratotype Section and Point (GSSP); lithostratigraphy [Bridge Creek Member, Greenhorn Formation]; pollen-spores; reworking; primary data; occurrence chart; photographs; reworked Middle and Late Jurassic [undifferentiated] into the Late Cretaceous [Cenomanian–Turonian]; sub-Arctic North America [Rock Canyon anticline outcrop, west of Pueblo, Colorado, USA])

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photographs; Early Cretaceous [Berriasian–Hauterivian]; sub-Arctic West Europe [Blocks 14/26a and 20/01, Golden Eagle Field, Outer Moray Firth, Central North Sea; coastal outcrops at Speeton, Filey Bay, North Yorkshire, northeastern England])

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(biostratigraphy; geochemistry; hydrocarbon generation potential; Khattatba and Masajid formations; petroleum geology; pollen-spores; reservoir and source rocks; Rock-Eval pyrolysis; total organic carbon [TOC]; vitrinite reflectance; Wadi Natrun Formation; primary data; photographs; Early–Late Jurassic [Toarcian–Oxfordian]; North Africa [Matruh Basin, North Western Desert, northern Egypt])

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pollen-spores; vertebrate migration; vertebrate palaeontology; primary data; latest Jurassic [Tithonian]; East Africa [Aleltu River Valley, north of Addis Ababa, Ethiopia])

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(biostratigraphy; *Nannoceratopsis senex*; palaeoclimate; palaeovegetation; pollen-spores; sandstones; primary data; photographs; Early Jurassic [Pliensbachian–Toarcian]; sub-Arctic Russia [Sjuk River valley, north of the Dakh Crystalline Massif, Republic of Adygeja, northwestern Caucasus])

*GORYACHEVA, A.A., ZORINA, S.O., RUBAN, D.A., ESKIN, A.A., NIKASHIN, K.I., GALIULLIN, B.M., MOROZOV, V.P., MIKHAILENKO, A.V., NAZARENKO, O.V., and ZAYATS, P.P. 2018. New palynological data for Toarcian (Lower Jurassic) deep-marine sandstones of the Western Caucasus, southwestern Russia. *Geologos*, 24(2): 127–136 (doi: 10.2478/logos-2018-0012).
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(ammonite and belemnite zones; biostratigraphy; calcareous nannofossils; correlation; *Ctenidodinium combazii*; Jurassic reworking; Lower Saxony Basin; *Nannoceratopsis plegas*; *Nannoceratopsis triceras*; taxonomy; *Wanaea acollaris*; primary data; occurrence charts;

photographs; Early Jurassic–Early Cretaceous [Early and Middle Jurassic reworking into Barremian–Aptian]; sub-Arctic West Europe [Ahlum 1 Borehole and the Otto Gott Clay Pit, east of Hannover, northern Germany])

*HEUNISCH, C., and LUPPOLD, F.W. 2018. 3. Mitteljura bis Unterkreide in den Bohrungen Eulenflucht 1 und Wendhausen 6 – litho- und biostratigraphische Ergebnisse [Middle Jurassic to Lower Cretaceous in the Eulenflucht 1 and Wendhausen 6 boreholes – litho- and biostratigraphical results]. *In*: Fischer, K., Herrendorf, G., Heunisch, C., Luppold, F.W., Meinsen, J., Possin, W., Schwarz, C., and Thomas, M. Neue Erkenntnisse zu Quartär, Jura und Unterkreide in Niedersachsen [New results on the Quaternary, Jurassic and Lower Cretaceous in Lower Saxony]. *GeoBerichte*, 31: 40–85. Landesamt fur Bergbau, Energie und Geologie (LBEG), Hannover, Germany, ISSN 1864-6891 and 1864-7529 (in German). (acritarchs; biostratigraphy; calcareous nannofossils; core photographs; foraminifera; freshwater algae; lithostratigraphy; ostracods; prasinophytes; trace fossils; Wealden type facies; primary data; occurrence chart; photographs; Middle Jurassic–earliest Cretaceous [Callovian–Berriasian]; sub-Arctic West Europe [the Eulenflucht-1 and Wendhausen-6 boreholes, Lower Saxony Basin, northern Germany])

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(basin evolution; biofacies; correlation; evaporites; foraminifera; lithostratigraphy; palaeoecology; petroleum geology; Mandawa Basin; Mbuo, Mihambia and Nondwa formations; ostracods; palaeoecology; palaeogeography; Pindiro Group; pollen-spores; regional geology; reworking; sedimentology; tectonic rifting of Gondwana; compilation; photographs; Late Triassic–Middle Jurassic [undifferentiated]; East Africa [southern coastal Tanzania])

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(biostratigraphy; biozonation; Kabrit-1 well; lithostratigraphy; palaeoecology; palaeogeography; pollen-spores; provincialism; primary data; occurrence charts; photographs; Middle Jurassic–Early Cretaceous [Callovian–Albian]; North Africa [south of Bitter Lake, north Eastern Desert, northeastern Egypt])

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(biostratigraphy; petroleum geology; regional geology; primary data; occurrence charts; photographs; Middle–Late Jurassic [Callovian–Kimmeridgian]; North Africa [boreholes MKL-110, NDK-2 and NDK-3, Essaouira Basin, central western Morocco])

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(acritarchs; biostratigraphy; biozonation; *Dapcodinium priscum*; depositional environments/facies analysis; lithostratigraphy; *Plaesiodicton mosellanum*; pollen-spores; regional geology; *Rhaetogonyaulax rhaetica*; sedimentology; sequence stratigraphy; well-log analysis; primary data; non-quantitative occurrence chart; photographs; Permian

[undifferentiated] and Middle–Late Triassic [Ladinian–Rhaetian]; sub-Arctic West Europe [Sancerre-Couy-1 borehole, Paris Basin, near Nevers, central France])

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(acritarchs; ammonite [*Psiloceras planorbis*]; biostratigraphy; biozonation; lithostratigraphy; Northern Limestone Alps; palaeoecology; pollen-spores; *Rhaetogonyaulax rhaetica*; primary data; semi-quantitative occurrence chart; photographs; latest Triassic–earliest Jurassic [Rhaetian–Hettangian]; sub-Arctic West Europe [Fonsjoch, western Austria])

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(ammonites; biostratigraphy; eustasy; foraminifera; lithostratigraphy; macrofossils; molecular biomarkers; organic geochemistry; ostracods; palaeobathymetry; palaeoecology; palaeoceanography; pollen-spores; prasinophytes; radiolaria; sedimentology; source rock potential; trace fossils; primary data; Late Jurassic–Early Cretaceous [Oxfordian–Valanginian]; Arctic Russia [outcrops A32 and 33, Cape Urdyuk-Khaya, Nordvik Peninsula, western Anabar Bay, Laptev Sea])

L

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(acritarchs; ammonite zonation; biostratigraphy; Central Atlantic Magmatic Province [CAMP]; correlation; end-Triassic mass extinction; eustasy; geochemistry ($\delta^{13}C_{TOC}$); geochronology; hiatuses; lithostratigraphy; methane release; pollen-spores; prasinophytes; *Rhaetogonyaulax rhaetica*; sedimentology; seismic activity; Triassic–Jurassic boundary; primary data; occurrence charts; latest Triassic–earliest Jurassic [Rhaetian–Hettangian]; multi-region: North America [New York Canyon, Nevada, USA]; South America [Pucara Basin, Peru]; sub-Arctic West Europe [Austria, Denmark, England, Germany])

LONDEIX, L. 2018. Quantitative biostratigraphical ranges of some late Cenozoic species of the dinoflagellate genus *Spiniferites* and taxonomic considerations. *Palynology,* 42 Supplement 1: 203–220 (doi: 10.1080/01916122.2018.1465740).
(*Achomosphaera*; databases; generic genome; *Gonyaulax spinifera* complex; index of stratigraphical abundance [ISA]; morphology; motile dinoflagellates; palaeoecology; phylogeny; quantitative biostratigraphy; *Spiniferites*; compilation; occurrence charts; photographs; Late Jurassic [Oxfordian]–Holocene; no specific geographical focus)

M

MAHMOUD, M.S., DEAF, A.S., TAMAM, M.A., and KHALAF, M.M. 2019. Revised (miospores-based) stratigraphy of the Lower Cretaceous succession of the Minqar-IX well, Shushan Basin, north Western Desert, Egypt: Biozonation and correlation approach. *Journal of African Earth Sciences*, 151: 18–35 (doi: 10.1016/j.jafrearsci.2018.11.019).
(biostratigraphy; biozonation; correlation; foraminiferal test linings; freshwater algae; lithostratigraphy [Alam El-Bueib, Alamein and Kharita formations]; palaeogeography; palaeooceanography; petroleum geology; pollen-spores; regional geology; Shushan Basin; primary data; quantitative occurrence chart; photographs; Late Jurassic–Early Cretaceous [Kimmeridgian–Tithonian to Albian]; North Africa [Minqar-IX well, north Western Desert, northern Egypt])

*MANGERUD, G., PATERSON, N.W., and RIDING, J.B. 2019. The temporal and spatial distribution of Triassic dinoflagellate cysts. *Review of Palaeobotany and Palynology*, 261: 53–66 (doi: 10.1016/j.revpalbo.2018.11.010).
(biostratigraphy; diversity; end-Triassic extinction; evolution; palaeogeography; Pangaea; provincialism; literature review; occurrence chart; Middle Triassic–earliest Jurassic [Ladinian–Hettangian]; multi-region: South America; Arctic; Australasia; East and West Europe; Middle East)

*MITTA, V.V., SAVELIEVA, Yu.N., FEODOROVA, A.A., and SHUREKOVA, O.V. 2017. Biostratigraphy of the Bajocian–Bathonian Boundary Beds in the Basin of the Bolshoi Zelenchuk River (Northern Caucasus). *Stratigraphy and Geological Correlation*, 25(6): 607–626 (doi: 10.1134/S0869593817060065). (The original Russian text was published during 2017 in *Stratigrafiya, Geologicheskaya Korrelyatsiya*, 25(6): 30–49).
(ammonites; ammonite biozones; biostratigraphy; biozonation; Djangura Formation; foraminifera; ostracods; pollen-spores; primary data; semi-quantitative occurrence chart; photographs; Middle Jurassic [Bajocian–Bathonian]; sub-Arctic Russia [Bolshoi Zelenchuk (Karachay-Cherkessia) Basin, Northern Caucasus, southwestern Russia])

*MITTA, V.V., SAVELIEVA, YU.N., FEDOROVA, A.A., and SHUREKOVA, O.V. 2018. Ammonites, microfauna, and palynomorphs from the lower part of the Upper Bajocian Parkinsoni Zone of the basin of the Bolshoi Zelenchuk River, Northern Caucasus. *Stratigraphy and Geological Correlation*, 26(5): 552–570 (doi: 10.1134/S0869593818050040). (the original Russian text was published during 2018 in *Stratigrafiya, Geologicheskaya Korrelyatsiya*, 26(5): 49–67).
(acritarchs; ammonites [*Rarecostites subarietis* ammonite subzone of the *Parkinsonia parkinsoni* ammonite zone]; biostratigraphy; biozonation; foraminifera, foraminiferal test linings; lithostratigraphy [Djangura Formation]; ostracods, pollen-spores; primary data; occurrence chart; photographs; Middle Jurassic [Bajocian]; sub-Arctic Russia [banks of the Kyafar River, Bolshoi Zelenchuk River, Karachay-Cherkessia, Northern Caucasus, southwestern Russia])

*MOSTAFA, T.F., EL SOUGHIER, M.I., and MAKLED, W.A. 2018. Middle–Upper Jurassic palynology of the South Sallum well, North Western Desert, Egypt. *Egyptian Journal of Petroleum*, doi: 10.1016/j.ejpe.2018.06.002.

(biostratigraphy; biozonation; ditch cuttings; lithostratigraphy [Khatatba and Masajid formations]; palaeoclimate; palaeoecology; pollen-spores; primary data; semi-quantitative occurrence chart; photographs; Middle–Late Jurassic [Bathonian–Oxfordian]; North Africa [South Sallum well, North Western Desert, northwestern Egypt])

*MSAKY, E.S. 2008. Middle Jurassic–earliest Late Cretaceous palynofloras, coastal Tanzania. Unpublished PhD Thesis, University of Queensland, Brisbane, Australia, 198 p. (available online at: https://espace.library.uq.edu.au/view/UQ:178439).
(biostratigraphy; biozonation; correlation; cosmopolitanism/provincialism; Elaterates [pollen] province; informal taxonomy; Kipatimi Formation; Makonde and Mkindani beds; palaeoecology; palaeogeography; palynofacies; petroleum geology; pollen-spores; quantitative bioevents; regional geology; systematics; primary data; occurrence charts; photographs; Middle Jurassic–earliest Late Cretaceous [Bajocian–Cenomanian]; East Africa [coastal Tanzania])

N

NIKITENKO, B.L., DEVYATOV, V.P., LEBEDEVA, N.K., BASOV, V.A., GORYACHEVA, A.A., PESTCHEVITSKAYA, E.B., and GLINSKIKH, L.A. 2017. Jurassic and Cretaceous stratigraphy of the New Siberian Archipelago (*Laptev and East Siberian Seas*): facies zoning and lithostratigraphy. *Russian Geology and Geophysics*, 58(12): 1478–1493 (doi: 10.1016/j.rgg.2017.11.012).
(biostratigraphy; foraminifera; lithofacies zones; lithostratigraphy; macrofossils; ostracods; pollen-spores; primary data; Early Jurassic–Cretaceous [Hettangian–Turonian]; Arctic Russia [New Siberian Islands Archipelago, East Siberian and Laptev seas])

NIKITENKO, B.L., DEVYATOV, V.P., LEBEDEVA, N.K., BASOV, V.A., FURSENKO, E.A., GORYACHEVA, A.A., PESHCHEVITSKAYA, E.B., GLINSKIKH, L.A., and KHAFAEVA, S.N. 2018. Jurassic and Cretaceous biostratigraphy and organic matter geochemistry of the New Siberian Islands (*Russian Arctic*). *Russian Geology and Geophysics*, 59: 168–185 (doi: 10.1016/j.rgg.2018.01.014).
(ammonites; biostratigraphy; biozonation; bivalves; foraminifera; lithostratigraphy; ostracods; pollen-spores; molecular biomarkers; organic geochemistry; petroleum geology;

primary data; Early Jurassic–Late Cretaceous [Hettangian–Turonian]; Arctic Russia [New Siberian Islands Archipelago, East Siberian and Laptev seas])

*NIKITENKO, B.L., PESTCHEVITSKAYA, E.B., and KHAFAEVA, S.N. 2018. High-resolution stratigraphy and palaeoenvironments of the Volgian–Valanginian in the Olenek key section (Anabar-Lena region, Arctic East Siberia, Russia). *Revue de Micropaléontologie*, 61(3–4): 271–312 (doi: 10.1016/j.revmic.2018.07.001). (acritarchs; ammonites; biostratigraphy; biozonation; Boreal Realm; correlation; foraminifera; geochemistry ($\delta^{13}C_{TOC}$); lithostratigraphy [Buolkalakh, Chekurovka and Iaedaes formations]; palaeoclimatology; palaeoecology; pollen-spores; prasinophytes; sedimentology; shallow water deposition; Volgian and Boreal Berriasian; primary data; semi-quantitative occurrence chart; photographs; Middle Jurassic–Early Cretaceous [Bathonian–Valanginian]; Arctic Russia [Outcrop O14, Olenek section, Anabar-Lena region, eastern Siberia, northeastern Russia])

O

OLIVERA, D.E., MARTÍNEZ, M.A., ZAVALA, C., OTHARÁN, G., MARCHAL, D., and KÖHLER, G. 2018. The gymnosperm pollen *Shanbeipollenites proxireticulatus* Schrank from the Vaca Muerta Formation (Upper Jurassic–Lower Cretaceous), Neuquén Basin, Argentina. *Cretaceous Research*, 90: 120–130 (doi: 10.1016/j.cretres.2018.04.003). (biomes; biostratigraphy; Cycadales/Bennettitales/Ginkgoales; lithostratigraphy [Vaca Muerta Formation]; palaeoclimate; palaeogeography; pollen-spores; prasinophytes; *Shanbeipollenites proxireticulatus* [pollen]; volcanic activity; primary data; semiquantitative occurrence chart; photographs; Early Cretaceous [?Berriasian–Valanginian]; South America [Mallin Quemado, north of Zapala, Neuquén Basin, central western Argentina])

P

PAUMARD, V., BOURGET, J., PAYENBERG, T., AINSWORTH, R.B., GEORGE, A.D., LANG, S., POSAMENTIER, H.W., and PEYROT, D. 2018. Controls on shelf-margin architecture and sediment partitioning during a syn-rift to post-rift transition: Insights from

the Barrow Group (Northern Carnarvon Basin, North West Shelf, Australia). *Earth-Science Reviews*, 177: 643–677 (doi:10.1016/j.earscirev.2017.11.026).
(biostratigraphy; biozonation; clinoforms; eustasy; lithostratigraphy [Barrow Group]; regional geology; rift tectonics; sedimentary architecture; sediment thickness maps; seismic stratigraphy; sequence stratigraphy; shelf margin depositional setting; latest Jurassic–Early Cretaceous [Tithonian–Valanginian]; Australasia [Northern Carnarvon Basin, North West Shelf, offshore Western Australia])

PENAUD, A., HARDY, W., LAMBERT, C., MARRET, F., MASURE, E., SERVAIS, T., SIANO, R., WARY, M., and MERTENS, K.N. 2018. Dinoflagellate fossils: Geological and biological applications. *Revue de Micropaléontologie*, 61(3/4): 235–254 (doi: 10.1016/j.revmic.2018.09.003).
(acritarchs; biostratigraphy; dinoflagellate cyst-motile stage relationships; DNA; geographical distributions; history of research; living dinoflagellates; palaeoecology; palaeogeography; palaeoceanography; primary productivity; transfer functions; literature review; occurrence chart; photographs; no geographical and stratigraphical focus)

PESTCHEVITSKAYA, E.B. 2017. Preliminary data on the palynostratigraphy and biofacies of the transitional Jurassic–Cretaceous interval in the Maurynya section (Northern Urals). *In*: Zakharov, V.A., Rogov, M.A., and Shchepetova E.V. (editors). *Jurassic System of Russia: Problems of stratigraphy and paleogeography*. Seventh all-Russian Conference. Moscow, September 18th–22nd, 2017. Scientific materials. Russian Academy of Sciences, Moscow, p. 156–161 (in Russian with an English abstract).
(acritarchs; biostratigraphy; biozonation; correlation; palaeoecology; prasinophytes; summary; latest Jurassic–earliest Cretaceous [Tithonian–Berriasian (=Volgian–Ryazanian]; sub-Arctic Russia [Maurynya River outcrop section, south of Tolya, Northern Ural Mountains, West Siberia])

*PESTCHEVITSKAYA, E.B. 2018. Morphology, systematics, and stratigraphic significance of the dinocyst genus *Dingodinium*. *Paleontological Journal*, 52(6): 682–696 (doi: 10.1134/S0031030118060084). (Originally Russian text published in *Paleontologicheskii Zhurnal*, 6: 94–106, 2018).
(archaeopyle; biostratigraphy; *Dingodinium*; family Cladopyxiaceae [suborder Cladopyxiineae]; morphology; partiform tabulation pattern; taxonomy; primary data and

compilation; line drawings; photographs; occurrence chart; Late Jurassic [Kimmeridgian–Tithonian]; sub-Arctic Russia [Gorodishche, Volga River, near Ulyanovsk, southwestern Russia])

PETERSEN, H.I., LINDSTRÖM, S., THERKELSEN, J., and PEDERSEN, G.K. 2013. Deposition, floral composition and sequence stratigraphy of uppermost Triassic (Rhaetian) coastal coals, southern Sweden. *International Journal of Coal Geology*, 116–117: 117–134 (doi: 10.1016/j.coal.2013.07.004).
(acritarchs; coal; eustasy; fire; lithostratigraphy [Bjuv Member]; *Lunnomidinium scaniense*; organic geochemistry; palaeoclimate; palaeoecology; palynofacies; peat-forming environments; pollen-spores; *Rhaetogonyaulax rhaetica*; sedimentology; sequence stratigraphy; vegetational analysis/dynamics; Triassic–Jurassic boundary; primary data; occurrence charts; photographs; latest Triassic [Rhaetian]; sub-Arctic West Europe [Lunnom and Norra Albert quarries, Höganäs and Danish basins, Scania, southern Sweden])

PIEŃKOWSKI, G., and WAKSMUNDZKA, M. 2009. Palynofacies in Lower Jurassic epicontinental deposits of Poland – tool to interpret sedimentary environments. *Episodes*, 32(1): 21–32.
(acritarchs; charcoal; *Dapcodinium priscum*; palaeoclimate; palaeoecology; palaeogeography; palynofacies; pollen-spores; sedimentology; sequence stratigraphy; primary data; photographs; Early Jurassic [Hettangian–Toarcian]; East Europe [Poland])

PIEŃKOWSKI, G., NIEDŹWIEDZKI, G., and WAKSMUNDZKA, M. 2012. Sedimentological, palynological, and geochemical studies of the terrestrial Triassic–Jurassic boundary in northwestern Poland. *Geological Magazine*, 149(2): 308–332 (doi: 10.1017/S0016756811000914).
(biostratigraphy; correlation; *Dapcodinium priscum*; geochemistry; Kamién Pomorski IG-1 borehole; lithostratigraphy; palaeoclimate; palaeogeography; pollen-spores; *Rhaetogonyaulax rhaetica*; sedimentology; sequence stratigraphy; compilation; latest Triassic–earliest Jurassic [Rhaetian–Hettangian]; East Europe [near Szczecin, Pomerania, northwestern Poland])

POWELL, J.H., RAWSON, P.F., RIDING, J.B., and FORD, J.R. 2018. Sedimentology and stratigraphy of the Kellaways Sand Member (Lower Callovian), Burythorpe, North

Yorkshire, UK. *Proceedings of the Yorkshire Geological Society*, 62(1): 36–49 (doi: 10.1144/pygs2017-402).
(acritarchs; ammonites; biostratigraphy; correlation; foraminiferal test linings; Kellaways Formation; Kellaways Sand Member; macrofossils; palaeogeography; sedimentology; thickness variations; trace fossils; palynofacies; pollen spores; primary data; occurrence data; photographs; Middle Jurassic [Callovian]; sub-Arctic West Europe [Burythorpe Quarry, near Malton, Howardian Hills, North Yorkshire, northern England])

R

*RISMYHR, B., BJÆRKE, T., OLAUSSEN, S., MULROONEY, M.J., and SENGER, K. 2018. Facies, palynostratigraphy and sequence stratigraphy of the Wilhelmøya Subgroup (Upper Triassic–Middle Jurassic) in western central Spitsbergen, Svalbard. *Norwegian Journal of Geology,* doi: 10.17850/njg001.
(acritarchs; algae; biostratigraphy; biozonation; carbon dioxide sequestration; condensation; correlation; facies analysis/associations; lithostratigraphy [Brentskardhaugen Bed; Wilhelmøya Subgroup;De Geerdalen, Knorringfjellet and Agardhfjellet formations; Kapp Toscana Group]; pollen-spores; provenance; regional geology; reworking; sedimentology; sequence stratigraphy; trace fossils; primary data; Late Triassic–Middle Jurassic [Carnian–Callovian]; Arctic [western central Spitsbergen, Svalbard])

*RUCKWIED, K. 2009. *Palynology of Triassic/Jurassic boundary key sections of the NW Tethyan Realm (Hungary and Slovakia).* Unpublished PhD dissertation, Technischen Universität Darmstadt, Germany, 95 p. plus 4 plates and 4 appendices. (available online at: http://tuprints.ulb.tu-darmstadt.de/1359/).
(biostratigraphy; biozonation; botanical affinities; Central Atlantic Magmatic Province (CAMP); clay mineralogy; *Dapcodinium priscum*; diversity; end Triassic mass extinction; foraminiferal test linings; lithofacies; palaeoclimate; palaeoecology; palaeogeography; palynofacies; Pangaea; pollen-spores; prasinophytes; *Rhaetogonyaulax rhaetica*; spore spike; sporomorph ecogroups; stable isotope geochemistry; statistics; Tethyan Realm; primary data; occurrence charts; photographs; latest Triassic–earliest Jurassic [Rhaetian–Hettangian]; East Europe [Csövár, northern Hungary, the Mecsek Mountains, southern Hungary and the Tatra Mountains, northern Slovakia])

S

SAPUNOV, I.G., TCHOUMATCHENCO, P.V., DODEKOVA, L.D. and ČERNJAVSKA, S.P. 1985. Contribution to the formal lithostratigraphic scheme related to the Middle Jurassic deposits from north-east Bulgaria. *Review of the Bulgarian Geological Society*, 46(2): 144–152 (in Bulgarian with an English abstract).
(ammonites; biostratigraphy; bivalves; boreholes; brachiopods; correlation; Dobrič, Kalojan, Provadija and Sultanci formations; lithostratigraphy; pollen-spores; sedimentology; primary data; Middle–Late Jurassic [Aalenian–Callovian/Tithonian]; East Europe [northeastern Bulgaria])

*SAPUNOV, I., TCHOUMATCHENCO, P., BABURKOV, I., BAKALOVA, D., DODEKOVA, L., ZHELEVA, C., NIKOLOVA, M. and ČERNJAVSKA, S. 1986. The Jurassic System in the new boreholes in the area of Provadija. *Review of the Bulgarian Geological Society*, 47(2): 103–120 (in Bulgarian with an English abstract).
(ammonites; biostratigraphy; bivalves; boreholes; brachiopods; calpionellids; correlation; Esenica, Polaten, Provadija, Sultanci and Tiča formations, eustasy; lithostratigraphy; pollen-spores; sedimentology; primary data; Early–Late Jurassic [Sinemurian–Tithonian]; East Europe [Provadija, northeastern Bulgaria])

SAPUNOV, I., TCHOUMATCHENCO, P., BÂRDAROV, S., VAVILOVA, M., DODEKOVA, L., KITOV, P. and ČERNJAVSKA, S. 1986. Stratigraphy of Jurassic rocks from the borehole sections between the villages of Resen, Veliko Târnovo area and Konak, Târgovište area. *Review of the Bulgarian Geological Society*, 47(3): 26–42 (in Bulgarian with an English abstract).
(ammonites; biostratigraphy; bivalves; boreholes; brachiopods; correlation; Drinovo, Esenica, Ginci, Javorec, Ozirovo and Tiča formations; eustasy; lithostratigraphy; pollen-spores; sedimentology; trace fossils; primary data; Early–Late Jurassic [Sinemurian–Tithonian]; East Europe [Târgovište and Veliko Târnovo areas, northeastern Bulgaria])

*SCHNEEBELI-HERMANN, E., LOOSER, N., HOCHULI, P.A., FURRER, H., REISDORF, A.G., WETZEL, A., and BERNASCONI, S.M. 2018. Palynology of Triassic–Jurassic boundary sections in northern Switzerland. *Swiss Journal of Geosciences*, 111, 99–115 (doi: 10.1007/s00015-017-0286-z).
(acritarchs; biostratigraphy; biozonation; boreholes and outcrops; correlation; end-Triassic mass extinction; eustasy; foraminiferal test linings; lithostratigraphy [Klettgau and Staffelegg formations]; palaeoecology; pollen-spores; regional geology; primary data; quantitative occurrence chart; photographs; Late Triassic–Early Jurassic [Norian–Sinemurian]; sub-Arctic West Europe [Adlerberg, Chilchzimmersattel and Weiach, northern Switzerland])

SCHNEIDER, A.C., and KÜRSCHNER, W.M. 2016. Pollen und Sporen als Indikatoren für den Klimawandel an der Jura/Kreide-Grenze. Palynologische Untersuchungen an einem Bohrprofil im Nordosten von NRW. [Pollen and spores as indicators for climate change at the Jurassic/Cretaceous boundary. Palynological investigations on a drilling profile in northeastern NRW]. *Scriptum*$^{Online.}$*, Geowissenschaftlich Arbeitsergebnisse aus Nordrhein-Westfalen*, 1, 26 p. Geologischer Dienst NRW, Krefeld, ISSN 2510-1331 (available online at: https://www.gd.nrw.de/pr_shop_scriptumonline_01_2016-09.php) (in German with an English abstract).
(biostratigraphy; freshwater algae; Jurassic-Cretaceous boundary; lithostratigraphy [Münder Formation and Bückeberg Group]; Lower Saxony Basin; organic geochemistry; ostracods; palaeoclimatology; palaeoecology; palynofacies; petroleum prospectivity; pollen-spores; regional geology; Wealden type facies; primary data; photographs; latest Jurassic–earliest Cretaceous [Tithonian–Berriasian]; sub-Arctic West Europe [the Husen 1/08 borehole, southwest of Hannover, northern Germany])

SCHNEIDER, A.C., HEIMHOFER, U., HEUNISCH, C., and MUTTERLOSE, J. 2018. From arid to humid – The Jurassic–Cretaceous boundary interval in northern Germany. *Review of Palaeobotany and Palynology* 255: 57–69 (doi: 10.1016/j.revpalbo.2018.04.008).
(biostratigraphy; correlation; freshwater algae; Jurassic–Cretaceous boundary; lithostratigraphy [Münder Formation and Bückeberg Group]; palaeoclimatology; palaeoecology; pollen-spores; vegetational dynamics; Wealden type facies; primary data; photographs; quantitative occurrence charts; latest Jurassic–earliest Cretaceous [Tithonian–Berriasian]; sub-Arctic West Europe [boreholes C-1 and Eulenflucht-1 (E-1), west of Hannover, Lower Saxony Basin, northern Germany])

SCHNEIDER, A.C., HEIMHOFER, U., HEUNISCH, C., and MUTTERLOSE, J. 2018. The Jurassic–Cretaceous boundary interval in non-marine strata of northwest Europe – New light on an old problem. *Cretaceous Research*, 87: 42–54 (doi: 10.1016/j.cretres.2017.06.002). (acritarchs; biostratigraphy; calcareous nannofossils; correlation; eustacy; freshwater algae; Jurassic–Cretaceous boundary; lithostratigraphy [Münder Formation and Bückeberg Group]; ostracods; palaeoclimatology; palaeoecology; pollen-spores; provincialism; Purbeck and Wealden type facies; regional geology; primary data; photographs; latest Jurassic–earliest Cretaceous [Tithonian–Berriasian]; sub-Arctic West Europe [boreholes 1/08 Husen (H-1), "core-1" (C-1), Eulenflucht-1 (E-1) and Isterberg 1001 (I-1), west of Hannover, Lower Saxony Basin, northern Germany])

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SHUREKOVA, O.V. 2018. The Berriasian dinocysts of the section Uruh (North Caucasus). *In*: Baraboshkin, E.Yu., Lipnitskaya, T.A., and Guzhikov, A.Yu. (editors). *Cretaceous system of Russia and near abroad: problems of stratigraphy and paleogeography*. Proceedings of the Ninth All-Russian Conference, Belgorod State National Research University, Belgorod, September 17th–21st, 2018. Polyterra Publishing House, Belgorod, ISBN 978-5-98242-250-7, 282–286 (in Russian with an English abstract). (acritarchs; biostratigraphy; biozonation; correlation; summary of primary data; semi-quantitative range chart; photographs; earliest Cretaceous [Berriasian]; sub-Arctic Russia [Uruh, Crimean Mountains, North Caucasus, southwestern Russia])

SMELROR, M., FOSSUM, K., DYPVIK, H., HUDSON, W., and MWENEINDA, A. 2018. Late Jurassic–Early Cretaceous palynostratigraphy of the onshore Mandawa Basin,

southeastern Tanzania. *Review of Palaeobotany and Palynology*, 258: 248–255 (doi: 10.1016/j.revpalbo.2018.09.001).
(acritarchs; biostratigraphy; biozonation; correlation; *Dingodinium jurassicum-Kilwacysta* assemblage; eustasy; freshwater algae; fungal palynomorphs; lithostratigraphy [the Kipatimu, Mitole, Nalwehe and Kihuluhulu formations]; palaeoecology; pollen-spores; prasinophytes; regional geology; primary data; photographs; Late Jurassic–Early Cretaceous [Oxfordian–Tithonian to Aptian–Albian]; East Africa [Mandawa Basin, southeastern coastal Tanzania])

*SMITH, G.A. 1999. *Palynology of the Jurassic/Cretaceous boundary interval in the Volga Basin, Russia*. Unpublished PhD Thesis, University of Bristol, UK, 527 p. (available online at: https://research-information.bristol.ac.uk/en/theses/palynology-of-the-jurassiccretaceous-boundary-interval-in-the-volga-basin-russia(a981fc30-fa69-4cf5-aae5-7290d2a489df).html).
(acritarchs; biostratigraphy; diversity; Jurassic–Cretaceous boundary; informal taxonomy; palynofacies; pollen-spores; prasinophytes; regional stratigraphical synthesis; sedimentology; total organic carbon [TOC]; Volgian lectostratotype; primary data; occurrence charts; photographs; latest Jurassic–Early Cretaceous [Tithonian–Valanginian]; sub-Arctic Russia [Gorodische and Kashpir, Ulyanovsk region, Volga River Basin, western Russia])

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(*Beaumontella langii*; coral bleaching; ecology; evolution; fossil and modern coral reefs; modern corals; photosymbiosis; *Suessia swabiana*; *Symbiodinium*; review; photographs; occurrence chart; Late Triassic–Early Jurassic [Carnian–Toarcian]; multi-region: North Africa [Libya]; Australasia [northwestern Australia]; sub-Arctic West Europe [Austria, southwestern Germany, southern Sweden])

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(acritarchs; ammonites; biogeochemical cycles; calcareous nannofossils; correlation; euxinia; foraminiferal test linings; inorganic and organic geochemistry; palaeoceanography; palaeogeography; palynofacies; Pieniny Klippen Belt; pollen-spores; prasinophytes; pyrite framboid size; regional geology; scolecodonts; Tethyan Realm; Toarcian Oceanic Anoxic Event [T-OAE]; primary data; Early Jurassic [Toarcian]; East Europe [Zázrivá, northwestern Slovakia])

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(acritarchs; biostratigraphy; biozonations; *Botryococcus*; chitinozoa; chlorophytes; foraminiferal test linings; graptolites; history of research; *incertae sedis*; organic-walled microplankton; prasinophytes; scolecodonts; testate amoebae [formerly thecamoebians]; zooplankton; compilation of genera and species; Silurian [undifferentiated]–Holocene; East Europe [Hungary])

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*TURNER, H.E., BATENBURG, S.J., GALE, A.S., and GRADSTEIN, F.M. 2018. The Kimmeridge Clay Formation (Upper Jurassic–Lower Cretaceous) of the Norwegian Continental Shelf and Dorset, UK: a chemostratigraphic correlation. *Newsletters on Stratigraphy*, doi: 10.1127/nos/2018/0436.
(biostratigraphy; carbon cycle perturbations; carbon isotope excursions; chemostratigraphy; chronostratigraphy; correlation; cyclostratigraphy; gamma ray logs; geochemistry; lithostratigraphy [Kimmeridge Clay Formation]; pollen-spores; wavelet analyses; primary data; occurrence chart; Late Jurassic–Early Cretaceous [Oxfordian–Valanginian]; multi-region: Arctic [Barents Sea; Arctic Russia; Svalbard]; East Europe [Brodno, Slovakia]; sub-Arctic West Europe [Dorset, southern England; North Sea, offshore Norway])

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*VAN DE SCHOOTBRUGGE, B., RICHOZ, S., PROSS, J., LUPPOLD, F.W., HUNZE, S., WONIK, T., BLAU, J., MEISTER, C., VAN DER WEIJST, C.M.H., SUAN, G., FRAGUAS, A., FIEBIG, J., HERRLE, J.O., GUEX, J., LITTLE, C.T.S., WIGNALL, P.B., PÜTTMANN, W., and OSCHMANN, W. 2018. The Schandelah Scientific Drilling Project: A 25-million year record of Early Jurassic palaeo-environmental change from northern Germany. *Newsletters on Stratigraphy*, doi: 10.1127/nos/2018/0259, 48 p.
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(biostratigraphy; evolution; evolutionary radiation; flowering plants; Glossata; insect-plant interactions; Lepidoptera (butterflies and moths); lepidopteran wing scales; *Lunnomidinium scaniense*; mass extinction; pollen-spores; primary data; quantitative selective occurrence chart; latest Triassic–Early Jurassic [Rhaetian–Sinemurian]; sub-Arctic West Europe [Schandelah-1 well, near Braunschweig, Lower Saxony, northern Germany])

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*VERREUSSEL, R.M.C.H., BOUROULLEC, R., MUNSTERMAN, D.K., DYBKJÆR, K., GEEL, C.R., HOUBEN, A.J.P., JOHANNESSEN, P.N., and KERSTHOLT-BOEGEHOLD, S.J. 2018. Stepwise basin evolution of the Middle Jurassic–Early Cretaceous rift phase in the Central Graben area of Denmark, Germany and The Netherlands. In: Kilhams, B., Kukla, P.A., Mazur, S., McKie, T., Mijnlieff, H.F., and van Ojik, K. (editors). Mesozoic Resource Potential in the Southern Permian Basin. *Geological Society, London, Special Publications*, No. 469, doi: 10.1144/SP469.23, 36 p.
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(acritarchs; ammonites; biostratigraphy; informal taxonomy; pollen-spores; *Rhaetogonyaulax rhaetica*; *Suessia swabiana*; Tethyan Realm; compilation; occurrence charts; photographs; Triassic–earliest Jurassic [Induan–Hettangian]; multi-region: East Europe and sub-Arctic

West Europe [The Alpine region, i.e. Austria; Germany, Hungary, Italy and the former Yugoslavia])

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(acritarchs; allocyclicity; biostratigraphy; boreholes; chronostratigraphy; coalbed methane; ; colonial alga; correlation; estuarine, freshwater-brackish dinoflagellate cysts; marine and terrestrial [fluviolacustrine] facies analysis; eustasy; isopach maps; lithostratigraphy; palaeoclimatology; palaeodrainage patterns; palaeogeography; regional geology; sedimentology; sequence stratigraphy; Walloon Coal Measures [Injune Creek Group]; uranium–lead [U–Pb] dating; wireline log analysis; primary data; photographs; Late Jurassic [Oxfordian–Tithonian]; Australasia [Surat Basin, Queensland, eastern Australia])

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(acritarchs; biostratigraphy; biozonation; boreholes; correlation; economic geology; fungi; geochronology; *Moorodinium*; pollen-spores; regional geology; *Skuadinium*; tuff horizons; uranium–lead chemical abrasion thermal ionization mass spectroscopy [U–Pb CA-TIMS] dating; Walloon Coal Measures [Injune Creek Group]; primary data; photographs; Middle–Late Jurassic [Bathonian–Tithonian]; Australasia [Surat Basin, Queensland, eastern Australia])

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chart; photographs; Late Jurassic [Tithonian]; Australasia [Indy 3 well, western Surat Basin, Queensland, southeastern Australia])

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WILLEMS, C.J.L., VONDRAK, A., MUNSTERMAN, D.K., DONSELAAR, M.E., and MIJNLIEFF, H.F. 2017. Regional geothermal aquifer architecture of the fluvial Lower Cretaceous Nieuwerkerk Formation – a palynological analysis. *Netherlands Journal of Geosciences – Geologie en Mijnbouw*, 96(4): 319–330 (doi: 10.1017/njg.2017.23) (includes online supplementary material). (aquifers; biostratigraphy; boreholes; correlation; downhole logging; fluvial sandstones; geothermal groundwaters and heat; lateral thickness variability; Nieuwerkerk Formation; pollen-spores; sedimentary architecture; seismic interpretation; sequence stratigraphy; sporomorph eco-grouping; tectonic activity; primary data; Early Cretaceous [Berriasian/Ryazanian–Barremian]; sub-Arctic West Europe [West Netherlands Basin, The Netherlands])

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(acritarchs; biostratigraphy; chitinozoa; evolution; *Gonyaulacysta jurassica*; history of study; miscellaneous palynomorphs; morphology; palaeoclimatology; palaeoecology; palaeogeography; palynofacies; palynology; pollen-spores; preparation techniques; photographs; review article; no specific geographical or stratigraphical focus)

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(assemblage zones; biostratigraphy; correlations with China; lithostratigraphy; Murihiku Terrane; pollen-spores; systematics; Triassic–Jurassic boundary; primary data; occurrence charts; photographs; Late Triassic–Early Jurassic [Norian–Sinemurian]; Australasia [Awakino Gorge, southwestern Auckland, Hokonui Hills, Southland, and southwestern Kawhia, New Zealand])

Appendix 2. List of palynomorph species and subspecies

This Appendix alphabetically lists all valid, formally-defined palynomorph taxa below generic level which are mentioned in this contribution with full author citations. This listing largely comprises dinoflagellate cysts, together with colonial alga and miospores; these are given separately below. References to the majority of the author citations for the dinoflagellate cysts can be found in Williams et al. (2017). Note that the proposals of Correia et al. (2017, p. 93, appendix 2) regarding the taxonomy of *Nannoceratopsis gracilis* and *Nannoceratopsis senex* are followed herein.

Dinoflagellate cysts:

Acanthaulax crispa (Wetzel 1967) Woollam & Riding 1983

Aldorfia aldorfensis (Gocht 1970) Stover & Evitt 1978
Ambonosphaera calloviana Fensome 1979
Amphorulacysta? *dodekovae* (Zotto et al. 1987) Williams & Fensome 2016
Amphorulacysta? *expirata* (Davey 1982) Williams & Fensome 2016
Batioladinium pomum Davey 1982
Batioladinium reticulatum Stover & Helby 1987
Batioladinium varigranosum (Duxbury 1977) Davey 1982
Beaumontella langii (Wall 1965) Below 1987
Canningia reticulata Cookson & Eisenack 1960
Cantulodinium speciosum Alberti 1961
Chytroeisphaeridia chytroeides (Sarjeant 1962) Downie & Sarjeant 1965
Circulodinium distinctum (Deflandre & Cookson 1955) Jansonius 1986
Cometodinium whitei (Deflandre & Courteville 1939) Stover & Evitt 1978
Compositosphaeridium? *polonicum* (Górka 1965) Lentin & Williams 1981
Cribroperidinium? *longicorne* (Downie 1957) Lentin & Williams 1985
Ctenidodinium combazii Dupin 1968
Ctenidodinium continuum Gocht 1970
Ctenidodinium cornigerum (Valensi 1947) Jan du Chêne et al. 1985
Ctenidodinium elegantulum Millioud 1969
Ctenidodinium ornatum (Eisenack 1935) Deflandre 1938
Ctenidodinium sellwoodii (Sarjeant 1975) Stover & Evitt 1978
Cyclonephelium cuculliforme (Davies 1983) Århus 1992
Dapcodinium priscum Evitt 1961
Dichadogonyaulax? *pannea* (Norris 1965) Sarjeant 1969
Dingodinium albertii Sarjeant 1966
Dingodinium jurassicum Cookson & Eisenack 1958
Dingodinium tuberosum (Gitmez 1970) Fisher & Riley 1980
Dingodinium nequeas Pestchevitskaya 2018
Durotrigia daveyi Bailey 1987
Endoscrinium galeritum (Deflandre 1938) Vozzhennikova 1967
Egmontodinium polyplacophorum Gitmez & Sarjeant 1972
Emmetrocysta sarjeantii (Gitmez 1970) Stover & Evitt 1978
Epiplosphaera gochtii (Fensome 1979) Brenner 1988
Epiplosphaera reticulospinosa Klement 1960

2252 *Gochteodinia villosa* (Vozzhennikova 1967) Norris 1978

2253 *Gonyaulacysta centriconnata* Riding 1983

2254 *Gonyaulacysta eisenackii* (Deflandre 1938) Górka 1965

2255 *Gonyaulacysta jurassica* (Deflandre 1938) Norris & Sarjeant 1965

2256 *Hebecysta balmei* (Stover & Helby 1987) Below 1987

2257 *Heibergella asymmetrica* Bujak & Fisher 1976

2258 *Hystrichosphaerina*? *orbifera* (Klement 1960) Stover & Evitt 1978

2259 *Impletosphaeridium varispinosum* (Sarjeant 1959) Islam 1993

2260 *Kaiwaradinium scruttinum* Backhouse 1987

2261 *Kalyptea stegasta* (Sarjeant 1961) Wiggins 1975

2262 *Korystocysta gochtii* (Sarjeant 1976) Woollam 1983

2263 *Korystocysta pachyderma* (Deflandre 1938) Woollam 1983

2264 *Luehndea spinosa* Morgenroth 1970

2265 *Liasidium variabile* Drugg 1978

2266 *Lithodinia jurassica* Eisenack 1935

2267 *Mancodinium semitabulatum* Morgenroth 1970

2268 *Meiourogonyaulax bulloidea* (Cookson & Eisenack 1960) Sarjeant 1969

2269 *Meiourogonyaulax caytonensis* (Sarjeant 1959) Sarjeant 1969

2270 *Meiourogonyaulax reticulata* Dodekova 1975

2271 *Meiourogonyaulax valensii* Sarjeant 1966

2272 *Mendicodinium groenlandicum* (Pocock & Sarjeant 1972) Davey 1979

2273 *Mendicodinium microscabratum* Bucefalo Palliani et al. 1997

2274 *Moorodinium crispa* Wainman et al. 2018

2275 *Muderongia simplex* Alberti 1961

2276 *Muderongia simplex* Alberti 1961 subsp. *microperforata* Davey 1982

2277 *Nannoceratopsis dictyambonis* Riding 1984

2278 *Nannoceratopsis gracilis* Alberti 1961

2279 *Nannoceratopsis plegas* Drugg 1978

2280 *Nannoceratopsis pellucida* Deflandre 1938

2281 *Nannoceratopsis raunsgaardii* Poulsen 1996

2282 *Nannoceratopsis senex* van Helden 1977

2283 *Nannoceratopsis spiculata* Stover 1966

2284 *Neuffenia willei* Brenner & Dürr 1986

2285 *Noricysta fimbriata* Bujak & Fisher 1976

Occisucysta tentorium Duxbury 1977

Palaecysta palmula (Davey 1982) Williams & Fensome 2016

Pareodinia brevicornuta Kunz 1990

Pareodinia ceratophora Deflandre 1947

Pareodinia prolongata Sarjeant 1959

Pareodinia halosa (Filatoff 1975) Prauss 1989

Perisseiasphaeridium pannosum Davey & Williams 1966

Phallocysta elongata (Beju 1971) Riding 1994

Phallocysta eumekes Dörhöfer & Davies 1980

Phoberocysta neocomica (Gocht 1957) Millioud 1969

Pseudoceratium iehiense Helby & May in Helby 1987

Pseudoceratium pelliferum Gocht 1957

Rhaetogonyaulax arctica (Wiggins 1973) Stover & Evitt 1978

Rhaetogonyaulax rhaetica (Sarjeant 1963) Loeblich Jr. & Loeblich III 1968

Rhynchodiniopsis cladophora (Deflandre 1938) Below 1981

Rynchodiniopsis? *regalis* (Gocht 1970) Jan du Chêne et al. 1985

Sahulidinium ottii Stover & Helby 1987

Scriniocassis weberi Gocht 1964

Scriniodinium crystallinum (Deflandre 1938) Klement 1960

Senoniasphaera jurassica (Gitmez & Sarjeant 1972) Lentin & Williams 1976

Sentusidinium villersense (Sarjeant 1968) Sarjeant & Stover 1978

Skuadinium fusum Wainman et al. 2018

Suessia swabiana Morbey 1975

Susadinium faustum (Bjaerke 1980) Lentin & Williams 1985

Sverdrupiella baccata Bujak & Fisher 1976

Sverdrupiella manicata Bujak & Fisher 1976

Sverdrupiella ornaticingulata Bujak & Fisher 1976

Sverdrupiella septentrionalis Bujak & Fisher 1976

Sverdrupiella usitata Bujak & Fisher 1976

Systematophora areolata Klement 1960

Systematophora penicillata (Ehrenberg 1843 ex Ehrenberg 1865) Sarjeant 1980

Tabulodinium senarium Dodekova 1990

Trichodinium scarburghense (Sarjeant 1964) Williams et al. 1993

Valensiella ovulum (Deflandre 1947) Eisenack 1963

Wanaea acollaris Dodekova 1975
Wanaea digitata Cookson & Eisenack 1958
Wanaea thysanota Woollam 1982

Colonial alga:
Palambages pariunta Wainman et al. 2018

Miospores:
Ricciisporites umbonatus Felix & Burbridge 1977
Shanbeipollenites proxireticulatus Schrank 2004

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