

Palynology of the upper Barremian and lower Aptian interval in parts of North Bulgaria

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Abstract. Upper Barremian and lower Aptian dinoflagellate cyst assemblages have been documented for the first time from five ammonite-controlled sections in Central and Northeast Bulgaria. They include important biostratigraphical markers, such as *Rhynchodiniopsis aptiana*, *Prolixosphaeridium parvispinum*, *Cerbia tabulata*, *Lithodinia stoveri* and *Ctenidodinium elegantulum*. The distribution of taxa is generally consistent with published palynostratigraphical schemes, but some differences are noted in this study. The best global markers for the lowermost Aptian interval are represented by the LOs of *R. aptiana* and *C. elegantulum*; however, in the sections studied, these taxa consistently occur only within the upper Barremian. The recorded overwhelming dominance of the *Classopollis* group, together with persistent records of pteridophyte spores, is interpreted as indicative of extremely hot and humid climate, which caused and accompanied the deposition of the OAE 1a in this part of the Tethyan Realm.

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INTRODUCTION

The late Early Cretaceous was a time of transition in the nature of ocean-climate system. The Barremian–Aptian time interval marks the beginning of these late Early Cretaceous geological changes that have been recorded on a global scale. The early Aptian was a time of global warming, leading to enhanced weathering, global ocean anoxia and increasing marine productivity (Leckie *et al.*, 2002). The widespread deposition of an anoxic horizon (OAE 1a) (Selli Level *sensu* Coccioni *et al.*, 1992) in many Tethyan and Boreal areas may be regarded as a result of these climatic and tectonic (igneous) events of the Barremian/Aptian boundary interval.

The Barremian–Aptian was also a time of rapid radiation and turnover in the marine microphytoplankton (Bujak and Williams, 1979; Leckie *et al.*, 2002) and the terrestrial plants. Extensive dinoflagellate cyst information is available from Barremian and Aptian sections in both the Tethyan and Boreal realms (*e.g.*, Costa and Davey, 1992; Leereveld, 1995; Wilpshaar, 1995; Monteil and Foucher, 1998; Torricelli, 2000; Unida and Patruno, 2016). These

studies demonstrated the high biostratigraphic potential of selected dinocyst index-species and their value for wide interregional correlations.

The purpose of the present work is to present for the first time a well-dated dinocyst and sporomorph record from the upper Barremian and lower Aptian interval in five studied sections in North Bulgaria, to estimate key bioevents with correlation value within the dinocyst successions, and to report the terrestrial palynomorphs obtained during this study.

STUDIED SECTIONS

Five outcrop sections, situated in the Central and Northeast Bulgaria, were chosen for this palynological study, namely sections Butovo, Paskalevets, Dichin, Opaka, and Kostandenets (Fig. 1). They comprise upper Barremian and lower Aptian successions belonging to the Trambesh Formation (comprising clays, marls, and rare thin sandstone beds; sections Butovo and Paskalevets), the Gorna Oryahovitsa Formation (composed of marls with thin interbeds of siltstones; sections Dichin and Opaka) and the Razgrad Forma-

tion (represented by alternation of clay-rich limestones and marls; section Kostandenets).

These sections have been studied extensively in terms of litho- and biostratigraphy (Nikolov and Stoykova, 1995) and a detailed biostratigraphical framework based on ammonites has been established (Ivanov, 1995; Ivanov and Idakieva, 2013) (Fig. 1). The OAE 1a has also been indicated in the Butovo section (Ivanov and Idakieva, 2013), based on lithological data.

MATERIAL AND METHODS

All sections were sampled at a normal pilot resolution and more than 25 samples were collected. The obtained palynological assemblages are composed of dinoflagellate cysts, trilete spores, gymnosperm and

early angiosperm pollen. The chronostratigraphical framework for the sections established by Ivanov and Idakieva (2013) was utilized in order to estimate the timing of the encountered dinocyst events.

Dinoflagellate cysts and miospores are represented nearly equally in the sediments of the Gorna Oryahovitsa and Razgrad formations, while in the Trambesh Formation miospores dominate over the rest of the palynomorphs.

RESULTS AND DISCUSSION

Dinoflagellate cyst biostratigraphy

The dinocyst record is quite representative and comprises more than 30 species. The observed dinoflagellate cyst assemblages reflect a Tethyan, rather than Bo-

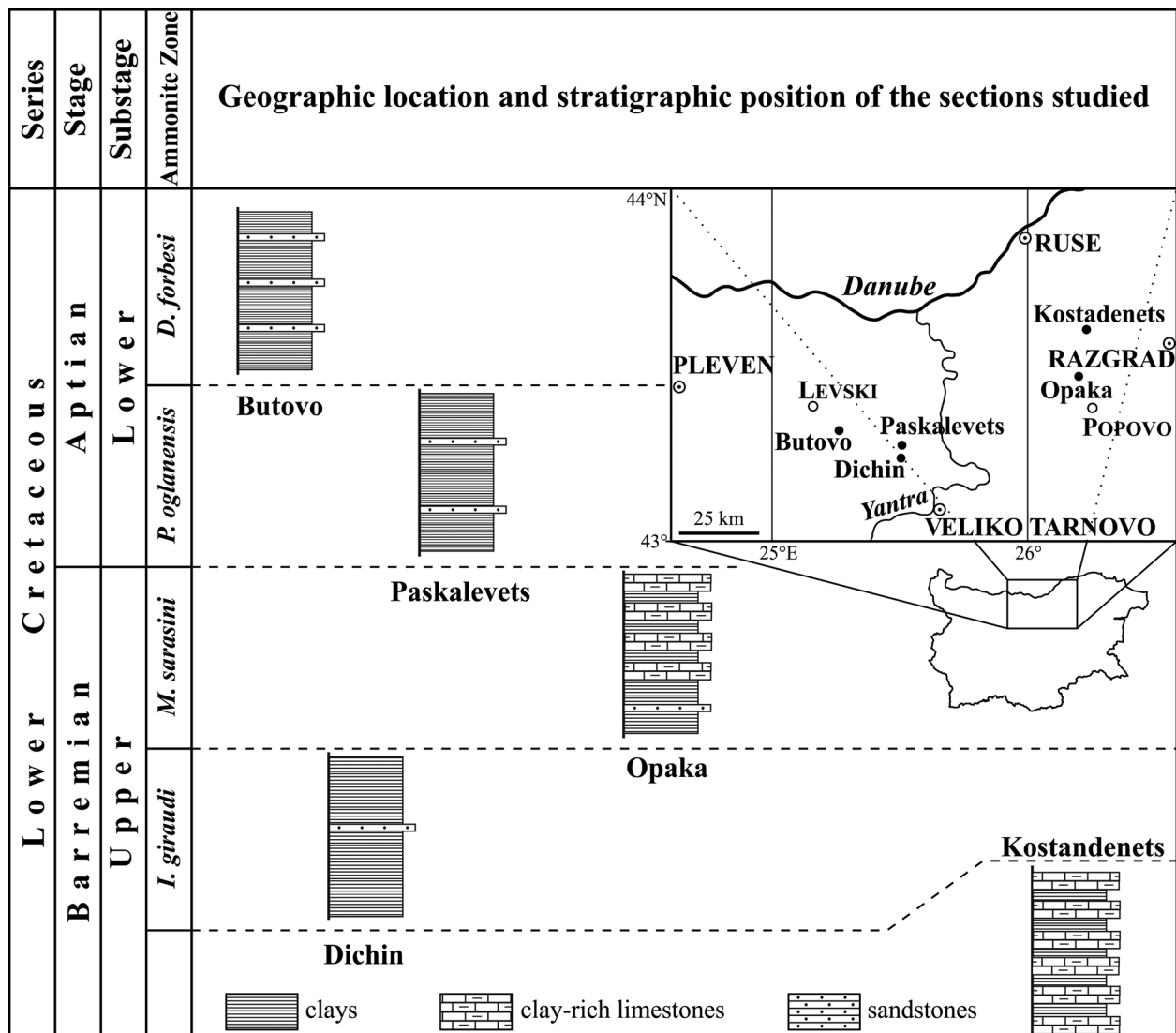


Fig. 1. Studied sections calibrated to the stratigraphical framework elaborated by Ivanov (1995) and Ivanov and Idakieva (2013) with designated geographic location.

real, character. Therefore, comparison and correlation refer mainly to associations from the Tethyan Realm and the corresponding zonation schemes of Leereveld (1995), Wilpshaar (1995), Monteil and Foucher (1998), Torricelli (2000), and the proposed Barremian/Aptian boundary GSSP at Gorgo a Cerbara, Italy (Unida and Patruno, 2016). The biostratigraphic value of selected taxa was estimated by these correlations, and the results are given below.

1) The prominent occurrence of *Prolixosphaeridium parvispinum*, *Cerbia tabulata*, *Achomosphaera neptuni*, *Lithodinia stoveri*, *Nexosispinum vetusculum*, and *Odontochitina operculata* characterize the upper Barremian–lower Aptian interval. These taxa were documented in all studied sections and have been estimated as important markers suitable for differentiating the lower Barremian from the upper

Barremian–lowermost Aptian on a wide geographic scale. Torricelli (2000) recorded the FO of *Prolixosphaeridium parvispinum* and *Odontochitina operculata* within the magnetic chron M1 in the Cismon Apticore, Italy, hence in the lower part of the upper Barremian. This correlates with the FOs reported for these species from SE Spain (Leereveld, 1995) and SE France (Wilpshaar, 1995). A similar age has also been documented for these FOs in some ammonite-dated sections of the Boreal Realm (Duxbury, 1977; Prossl, 1990), suggesting that they are important biohorizons in the lower upper Barremian of the Northern Hemisphere.

2) The occurrence of *Rhynchodiniopsis aptiana* and *Ctenidodinium elegantulum* is continuous and abundant in the upper Barremian successions, but these taxa were not documented in the lower Aptian sediments

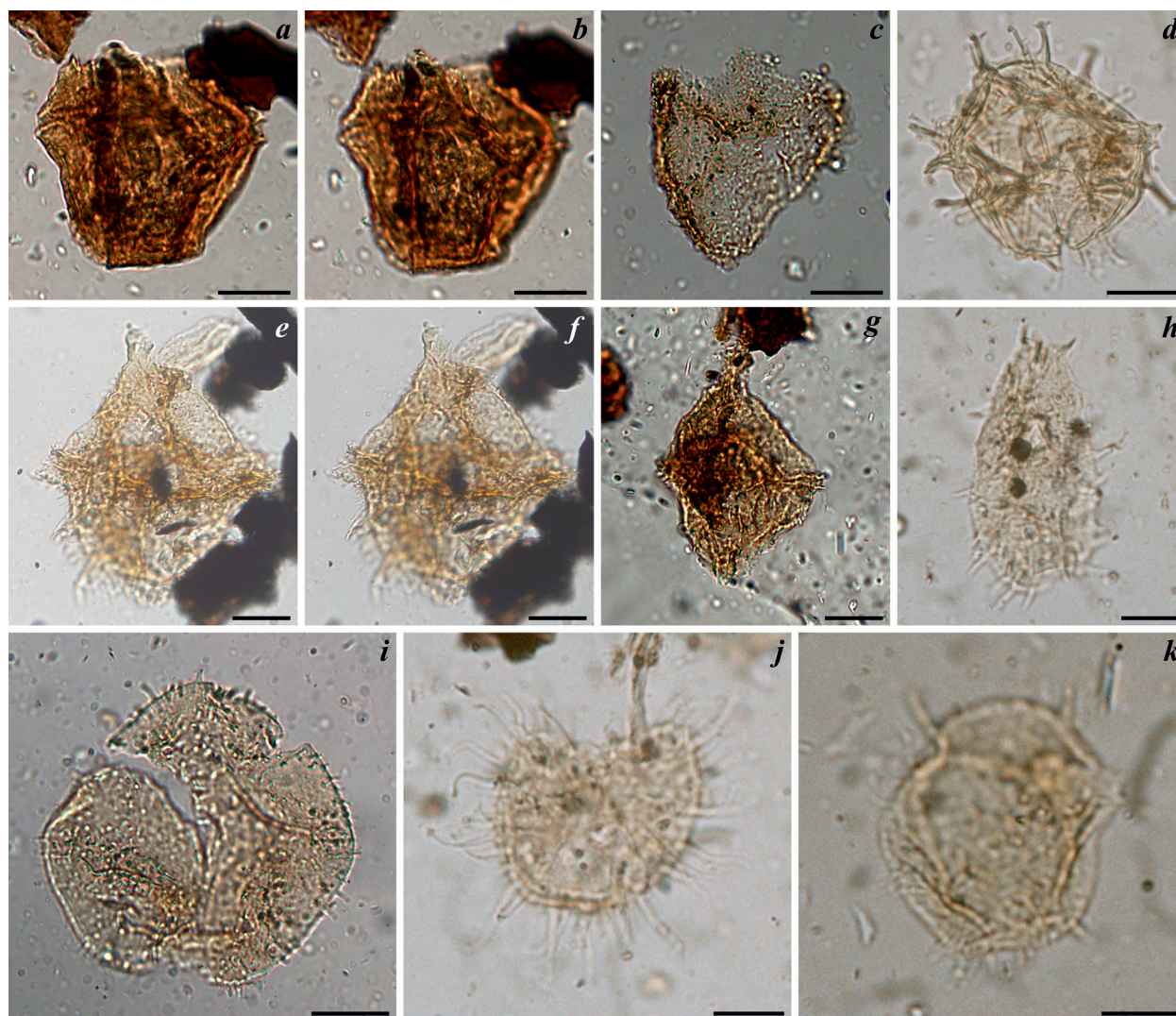


Fig. 2. Photomicrographs of important dinoflagellate cyst species recovered from the studied sections. Scale bar 10 μm . a, b) *Lithodinia stoveri*; c) *Sentusidinium* sp.; d) *Achomosphaera neptuni*; e, f) *Rhynchodiniopsis aptiana*; g) *Rhynchodiniopsis cladophora*; h) *Prolixosphaeridium parvispinum*; i) *Cerbia tabulata*; j) *Nexosispinum vetusculum*; k) *Ctenidodinium elegantulum*.

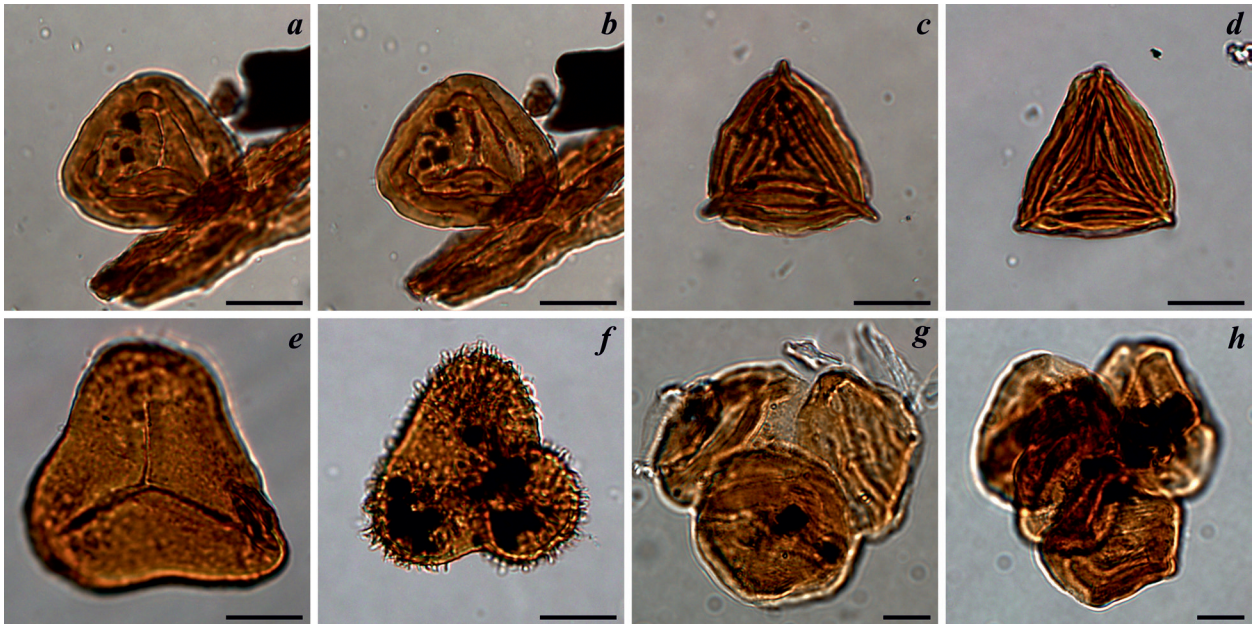


Fig. 3. Photomicrographs of important spores and pollen recovered from the studied sections. Scale bar 10 μm . *a, b*) *Bikolispорites toratus*; *c, d*) *Appendicisporites* spp.; *e, f*) *Trilobosporites* spp.; *g, h*) *Classopollis torosus* (tetrads).

studied in the sections Butovo and Paskalevets. These dinoflagellate cysts are typically Barremian species in the Tethyan Realm and display their range top in the lowermost Aptian. Torricelli (2000) noted the LO of *R. aptiana* in the Cismon Apticore at the base of the magnetic chron M0, immediately above the Barremian/Aptian boundary, placed by Erba *et al.* (1999). Leereveld and Berthrou (1990) calibrated this event as well and considered it a reliable biohorizon for basal Aptian sediments not only for the Tethyan Realm but also for the Northern Hemisphere. Unida and Patruno (2016) documented the LO of *R. aptiana* in the Barremian/Aptian boundary GSSP at Gorgo a Cerbara (Italy) within the lower Aptian Selli Level, 1.35 Myr after the magnetostratigraphically defined boundary, and concluded that its LO does not define the Barremian/Aptian boundary, but is a global marker for the lowermost Aptian. According to Stover *et al.* (1996), the LO of *C. elegantulum* also corresponds to the lower Aptian in the Tethyan and Boreal realms.

In sections Butovo and Paskalevets, *R. aptiana* and *C. elegantulum* are not present in the lowermost Aptian succession, and their top range is within the upper Barremian *M. sarasini* ammonite Zone, thus supporting their global value for the upper Barremian interval.

3) The upper Barremian–lower Aptian assemblages are also completed by the following characteristic dinocyst taxa: *Batiacasphaera macrogranulata*, *B. saidensis*, *Prolixosphaeridium conulum*, *Chlamidophorella nyei*, *Sentusidinium* spp., and *Tanyosphaeridium* spp.

Terrestrially derived palynomorphs

Pteridophyte spores are present in considerably high diversity and are typically represented by taxa assigned to the genera *Appendicisporites*, *Cicatricosisporites*, *Bikolispорites*, *Trilobosporites*, and *Concavisporites*. Gymnosperms predominate the assemblages. An overwhelming dominance of the *Classopollis* group is recorded in all sections, including the OAE 1a level throughout the Butovo section, representing up to 40–50% of the palynoflora. The *Classopollis* pollen often occurs in tetrads due to the exceptionally good preservation conditions. Such dominance, together with the persistent records of Pteridophyte spores, is a typical feature of the late Early Cretaceous low-latitude assemblages (Unida and Patruno, 2016). In the sections studied herein, their presence once more indicates the extremely hot and humid climate that caused and accompanied the deposition of the OAE 1a anoxic layer.

CONCLUSIONS

Upper Barremian and lower Aptian dinoflagellate cyst assemblages have been documented for the first time from five ammonite-controlled sections in the Central and Northeast Bulgaria. They include important biostratigraphical markers, such as *Rhynchodiniopsis aptiana*, *Prolixosphaeridium parvispinum*, *Cerbia tabulata*, *Lithodinia stoveri*, and *Ctenidodinium ele-*

gantulum. The distribution of taxa is generally consistent with published palynostratigraphical schemes, but some differences are noted in this study. The best global markers for the lowermost Aptian interval are represented by the LOs of *R. aptiana* and *C. elegantulum*. Our sections confirm their global value only for the upper Barremian.

The recorded overwhelming dominance of the *Classopollis* group, together with the persistent records of pteridophyte spores, is interpreted as indicative of the extremely hot and humid climate that caused and

accompanied the deposition of the OAE 1a in this part of the Tethyan Realm.

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