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PALYNOLOGICAL AND SEDIMENTOLOGICAL DATA ABOUT LATE SARMATIAN PALAEOCLIMATIC CHANGES IN THE FORECARPATHIAN AND EUXINIAN BASINS (NORTHERN BULGARIA)

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ABSTRACT. The Bessarabian and Chersonian sediments from the Forecarpathian and Euxinian Basins were studied palynologically and sedimentologically. Both sedimentological and palynological data show that the climate at that time became dry in the proximity of the basins. The deposition of aragonite sediments took place under a dry climate. The presence of xerophytic palaeocommunities also provides evidence that the climate was warm, with long dry periods and minimal rainfall.

KEY WORDS: Bulgaria, Sarmatian, palynology, sedimentology, climate

INTRODUCTION

During the early Sarmatian (about 14–15 m.y. ago) the Paratethys Basins were isolated from the ocean. The inflow of fresh water exceeded the amount lost through evaporation and led to a rise of sea level in the Forecarpathian and Euxinian Basins, and a decrease in salinity. After the elevation of the Carpathians during the Bessarabian (about 12.5 m. y. ago) these basins were isolated from the Pannonian Basin which turned into an almost freshwater lake, while in the other parts of the Paratethys the basins decreased in area, the Pannonian remained almost the same size until nearly the end of the Chersonian. The equilibrium between the inflow and evaporation in the Euxinian Basin was maintained mainly at the expense of the rivers flowing from the north (Volga, Don and Dnepr). The Danube was not yet in existence. Part of the waters which comprise the contemporary Danube flowed into a strongly desalinized Pannonian Basin and the other part drained into the Forecarpathian Basin. In the present study an attempt to establish the palaeoclimatic changes which occured during the late Bessarabian and Chersonian is made on the basis of both palynological and sedimentological data.

The studied material originated from two boreholes (C-12, near the village of Deleina, and C-136A, near the town of Balchik) in northern Bulgaria (Fig. 1). It consists of aragonite sediments (aragonitites) and clays of Bessarabian and Chersonian age. The total thickness of the aragonite sediments from borehole C-136A (the Topola Formation) is about 67 m. Massive aragonite sediments of Bessarabian age occur in the lower part of the section. They alternate with micritic limestones, dolomites and clays. The middle and upper parts of the section are represented by materials of Chersonian age, composed of aragonite and clay laminae. In borehole C-12 the Chersonian clays are about 83 m thick (the Florentin Formation). They are interbedded with laminated aragonite-clay materials and rare limestone beds.

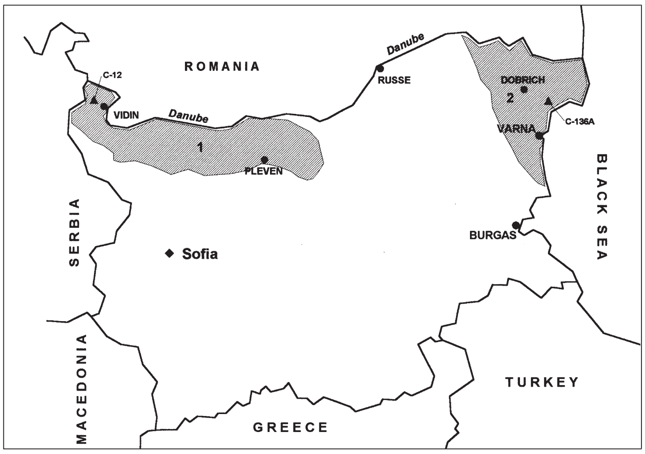

Fig. 1. Location of the studied sections – boreholes C-12 and C-136A (1. Forecarpathian Basin; 2. Euxinian Basin)

PALYNOLOGICAL DATA

During the Bessarabian changes in the composition of the plant palaeocommunities are apparent in the territory of northern Bulgaria (Figs 2, 3). They are characterized mainly by a decrease (in comparison with the Volhynian) in the role of thermophilous plants like *Engelhardia,* Araliaceae, Arecaceae, Theaceae, *Pandanus* and Sapotaceae, which, in the upper part of the Bessarabian sediments and in the Chersonian ones, are presented by single pollen grains or not at all. Meanwhile an increase in the proportions of arctotertiary elements (*Abies*, *Cedrus*, *Castanea*, *Quercus*, *Ulmus*, *Zelkova*, *Pterocarya, Carya, Fagus*, *Betula* and *Carpinus*) can be seen. Dominant in the composition of mixed mesophilous forest were species of the genera *Quercus* and *Ulmus,* accompanied by *Castanea, Eucommia, Fagus, Betula, Carya, Juglans* and *Acer* (Pl. 1, figs 3–18). Wet habitats were occupied by swamp and riparian forest composed of species of the Taxodiaceae, *Myrica, Nyssa, Alnus, Planera, Liquidambar* and *Salix.*

A significant change in the fossil vegetation is the increasing role of subxerophytic and xerophytic shrub palaeocommunities. They were composed of species of *Celtis, Pistacia, Rhus,* Oleaceae, *Ephedra, Spiraea,* and also *Quercus* (ex. sect. *Ilex*), *Robinia, Arbutus, Berberis, Paliurus, Celastrus* and *Caesalpinites,* remains of which occur as macrofossils (Palamarev 1989, 1991, Palamarev & Ivanov 1998). At that time herbaceous palaeocommunities appeared (Chenopodiaceae, *Artemisia*, Caryophyllaceae, Asteraceae, Apiaceae etc.). Palynological data relating to the Chersonian palaeoflora (Figs 2, 3) show increasing shares of Chenopodiaceae (16–23%), *Celtis,* Asteraceae*, Artemisia,* Caryophyllaceae etc. (Ivanov 1995). This is evidence of the appearance of open landscapes and the development of xerophytic herbaceous palaeocommunities. Simultaneously the distribution of swamp and riparian forest contracted

These changes in the fossil vegetation reflect the increasingly arid climate during the late Bessarabian – Chersonian period. The appearance and development of this semi-arid phase were associated with the retreat of the Miocene sea from the territory of northern Bulgaria. The climate at that time could be described as warm-temperate with long dry periods and minimal rainfall.

Comparison of the pollen spectra from the Forecarpathian and Euxinian Basins shows that in the latter area the increasingly dry conditions appeared earlier and were more pronaunced, and overall the climate was drier. Obviously the large territories surrounding the basin were covered by steppe and xerophytic plant communities and mixed mesophytic forest was preserved in the far distant mountains. The higher humidity along the seacoast in north-western Bulgaria was probably due to its situation between a large water basin and the West Balkan mountains. The humid air accumulating above the sea, and the upward airstreams on the mountains, resulted in the condensation of moisture and greater rainfall in that area.

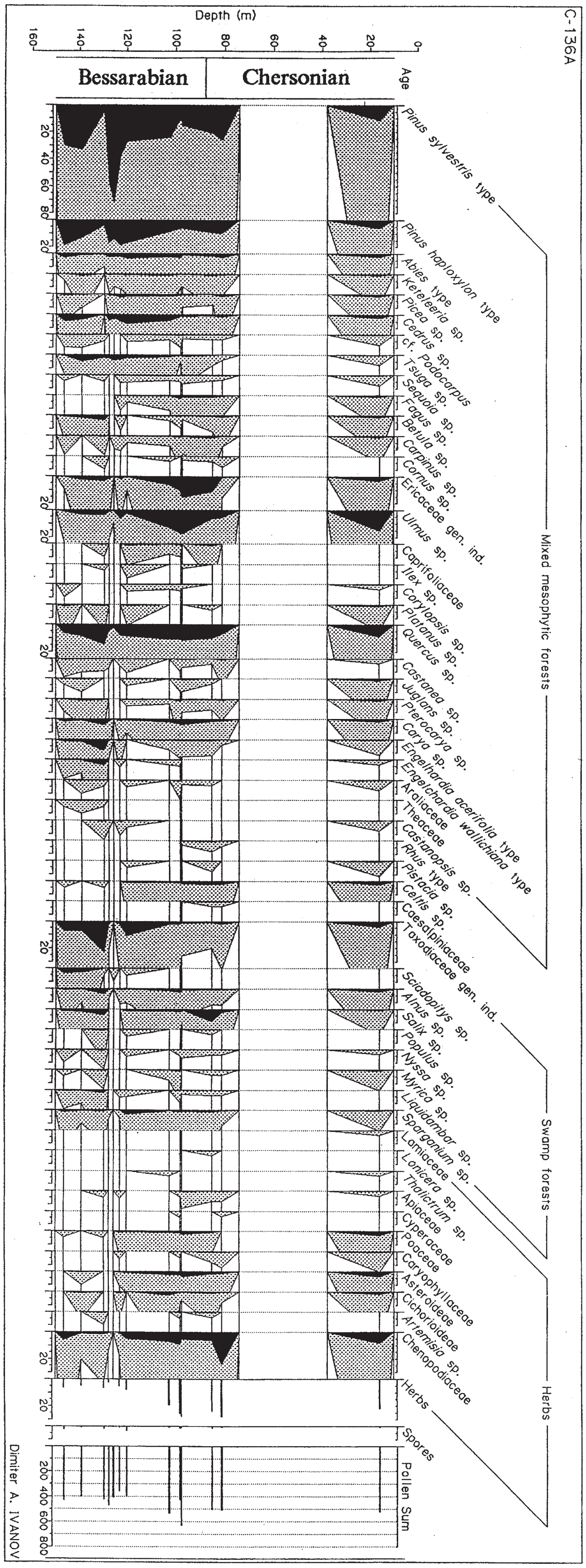

Fig. 2. Simplified pollen diagram of borehole C-136A (shaded = 20 × multiplied)

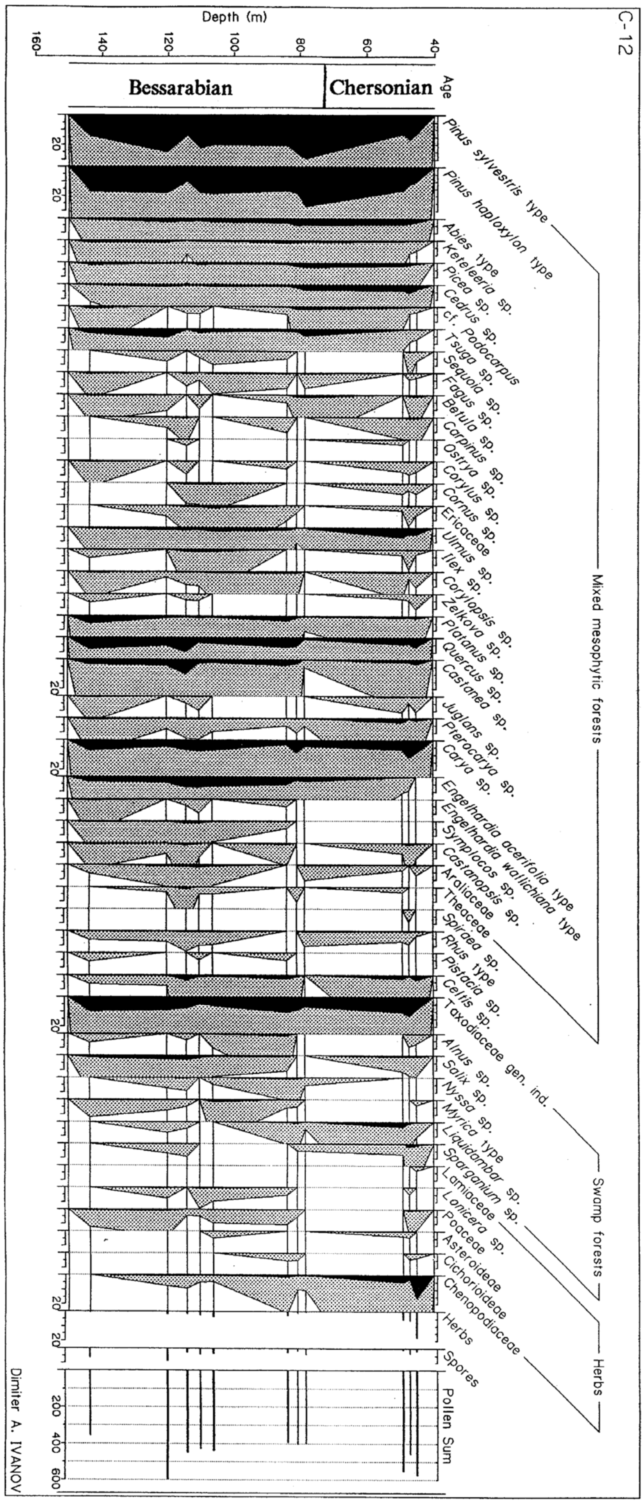

Fig. 3. Simplified pollen diagram of borehole C-12 (shaded = 20 × multiplied)

SEDIMENTOLOGICAL DATA

The aragonite sediments (aragonitites) vary in colour from white to yellowish. The Bessarabian aragonitites are massive, but the Chersonian sediments are distinctly laminated (Pl. 1, fig. 1). The thickness of the massive aragonite sediments veries greatly – from 7 to 30–40 cm, but the laminae are less than 1 mm thick and the sediments have a varved structure, aragonite laminae alternating with the others enriched with clay minerals. The massive aragonite sediments of Bessarabian age occur only in the sections from north-eastern Bulgaria (the Euxinian Basin) whereas the Chersonian laminated sediments are found in the sections from both the Forecarpathian and Euxinian Basins.

The aragonite sediments are composed of crystals which are mainly of prismatic shape (Pl. 1, fig. 2). The crystals are about 8–10 mm long, are chaotically arranged and exhibit a high microporosity – 50–55% (Pl. 1, fig. 2) (Koleva-Rekalova *et al.* 1996).

The aragonite is probably inorganic in origin (Koleva-Rekalova 1994). Its chemical precipitation requires a high temperature, normal marine salinity, shallow water and a limited inflow of terrigenous components etc. Nowadays suitable conditions for the precipitation of aragonite mud exist in tropical and subtropical arid zones in shallow and protected places with limited inflow of terrigenous components, e. g. the Great Bahama Bank, the Persian Gulf, the Red Sea etc.

The massive aragonitites from the studied region were formed under arid to semi-arid conditions. The laminated materials show the presence of a seasonal climate with a dry period. The precipitation of the aragonite laminae took place during the warm and dry period of the year, while the clay laminae were deposited during the wet season. The Chersonian part of the sediment sequence is characterized by rapid transformation and petrification of the aragonite deposits under the conditions of periodic fresh water inflow from the land, creating a brackish environment. The fact that massive aragonitites are confined to the Euxinian Basin agrees with the palynological data which show drier climatic conditions in that area.

CONCLUSION

The data obtained show that the appearance and development of a semi-arid phase on Bulgarian territory began during the Bessarabian period and continued into the Chersonian. This phase coincided with the period of dry climate at the end of the Sarmatian s. str. and early Pannonian, established in other areas of the Paratethys (Pantič & Mihajlovič 1980). The palynological data of Syabryay & Shchekina (1983) testify to the increasingly xerophytic nature of the vegetation and appearance of open landscapes at the end of the middle and during the late Sarmatian (s.l.) in the south of the Ukraine. The growing aridity of the climate during the the Bessarabian and Chersonian periods in the southern Ukraine was also proved by Belokris (1988) on the basis of the presence of dolomites, which arise under very dry conditions. Clearly this dry climate belt arose north or north-east of the Carpathians and later gradually spread to southwards occupying firstly the western parts of the Euxinian Basin and later the south of the Forecarpathian and Pannonian Basins.

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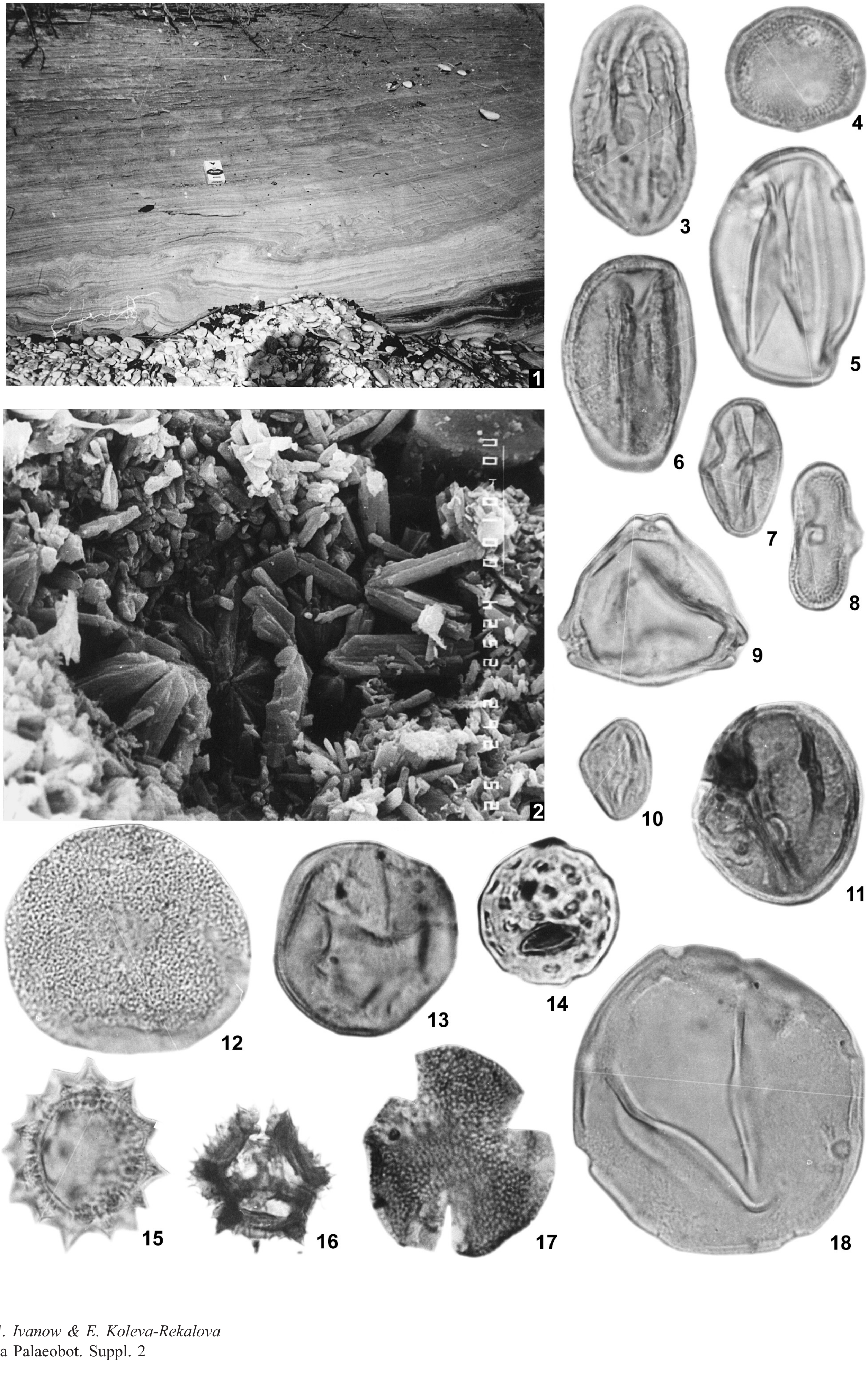
PLATE

Plate 1

1. Chersonian laminated aragonite-clay materials of the Topola Formation, north-eastern Bulgaria
2. Prismatic aragonite crystals in massive aragonite, and high microporosity of the aragonite sediments (C-136A, Topola Formation, north-eastern Bulgaria) SEM microphotograph

2–18. Selected pollen grains from the Euxinian and Forecarpathian Basins (×1000)

3. *Ephedra* sp.: C-136A, Euxinian Basin
4. *Thalictrum* sp.: C-136A, Euxinian Basin
5. *Eucommia* sp.: C-136A, Euxinian Basin
6. *Quercus* sp.: C-136A, Euxinian Basin
7. *Tricolporopollenites caesalpiniaceaeformis* Nagy 1969: C-136A, Euxinian Basin
8. Apiaceae gen. ind.: C-136A, Euxinian Basin
9. *Betula* sp.: C-136A, Euxinian Basin
10. *Tricolporopollenites minor* Takahashi 1961: C-136A, Euxinian Basin
11. *Fagus* sp.: C-12, Forecarpathian Basin
12. *Fraxinus* sp.: C-136A, Euxinian Basin
13. *Pistacia* sp.: C-12, Forecarpathian Basin
14. Chenopodiaceae gen. ind.: C-12, Forecarpathian Basin
15. Asteroideae gen. ind.: C-136A, Euxinian Basin
16. Cichorioideae gen. ind.: C-12, Forecarpathian Basin
17. *Retitricolpites vulgaris* Pierce 1961: C-12, Forecarpathian Basin
18. *Pterocarya* sp.: C-136A, Euxinian Basin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