TRACING OF PALYNOMORPHS IN THE EASTERN SLOVAKIAN KARST

JIŘINA DAŠKOVÁ
Institute of Geology AS CR, v. v. i, Rozvojová 269, 165 02 Prague 6, Czech Republic; daskova@gli.cas.cz
School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham B15 2TT, UK

MAGDA KONZALOVÁ
Institute of Geology AS CR, v. v. i, Rozvojová 269, 165 02 Prague 6, Czech Republic

VÁCLAV CÍLEK
Institute of Geology AS CR, v. v. i, Rozvojová 269, 165 02 Prague 6, Czech Republic

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Abstract. Normapolles pollen, fern spores, recent fungi and other palynomorphs were traced and identified from a sample of calcareous/ /clayey deposits from the Gombasek Quarry in eastern Slovakia (Rožňava district). Normapolles, pollen of the extinct angiospermous plants, dominated the spectrum, spores of ferns were also frequent. Presence of these types indicate a Mesozoic (Upper Cretaceous) to Early Paleogene age of the source rocks. The assemblage is mixed with specimens of recent fungi spores , remains of algae and rare gymnosperm and angiosperm pollen grains (Pinus, Asteraceae). Significant Tertiary (Paleogene) taxa were not discovered there. The study produced several new records of taxa which had not been found at this locality previously .

■ Palynology, Cretaceous, Tertiary, Palaeokarst, Normapolles, Gombasek, Slovak Republic

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Introduction

The Gombasek locality is situated in the Inner Western Carpathian Belt on the southern margin of the Plešivec Plateau (part of the Slovak Karst). Various sediments of the Slovak karst are mostly represented by Triassic limestones and shales. The local limestone underwent periods of intensive karstification during the Upper Cretaceous. It resulted in the formation of narrow fissure caves (sometimes with goethite flowstones) and larger sinkholes often filled with lakelets or wetlands. These sediments are described as the Gombasek Member (Santonian–Coniacian; Činčura 1973; Činčura and Köhler 1995). They characteristically consist of alternating "flyschoid" strata of dark-coloured shales and limestones that may correspond to monsoonal hydrological regimes. The occurrence of iron ores and desiccation cracks may document a relatively shallow lake environment with seasonally drying near-shore areas. It occurs in Gombasek Quarry in 200 m thick interval of beds which is probably non-tectonic interval.

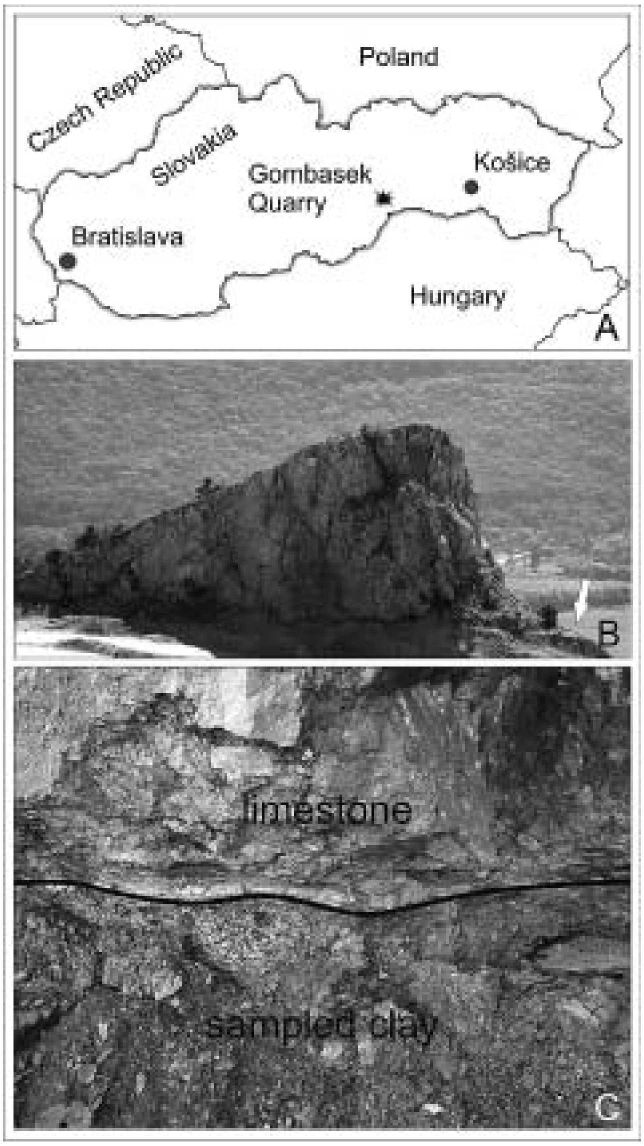
The Gombasek Quarry is an active mine where every few years new karst cavities are discovered. The importance of collected samples is based on geomorphological implications of the same type of sediment that was found at the upper part of the quarry close under the surface of the karst plateau and the samples that were found and previously described from the middle part of the valley, more than 100 m below the new find. If these samples are contemporary we can prove not only the important Upper Cretaceous phase of karstification but the existence of complex and developed karst morphology as well.

The first systematic survey of the Gombasek Member was carried out by Mello and Snopková (1973), results of recent palynological studies were published by Svobodová (in Cílek and Svobodová 1999). The tectonics and structural geology of this locality were described by Sasvári et al. (2006).

The studied material represents sediments of an open karst depression laterally connected with fissure and cave systems filled by brown-coloured sediments (weathered clays with small pyrite nodules, Text-fig. 1). While the previous studied samples were taken from an extensive Gombasek outcrop behind the so-called Gombasek Needle (Gombasecká ihľa) situated approximately in the middle part of the wide valley, the present sample comes from a site located some 60 m below the level of the Plešivec karst plateau. Clayey and silty sediments of the Gombasek Member are usually intensively weathered, forming pale brown clayey/ /silty sands which were found in several large karst depressions at the Plešivec Plateau level. Younger sinkholes are filled with red rewashed terra rossa sediments.

On the basis of morphology of the relatively numerous and widespread caves and sinkholes which contain *in situ* or almost *in situ* Gombasek Member sediments we thus assume that already during the Upper Cretaceous – Lower Paleogene a period well developed, humid and morphologically diversified karst landscape emerged as a basis for repeated cycles of younger karst processes.

The aim of this research was to record the whole assemblage of palynomorphs in the organic content, assess the presence of pollen and spore taxa which are very rare in karst infill sediments and also the presence of more evolutionary advanced angiosperms significant for the Paleogene period. This is the first study on this part of the Gombasek quarry (Text-fig. 1).



Text-fig. 1. A – outline map of the Slovak Republic, Gombasek Quarry marked; B – Gombasek needle – Gombasecká ihľa in the Gombasek Quarry, the sample was collected at the right side of the pillar; C – typical lithology, gray coloured clay.

Material and methods

The sample of grey claystone was processed in the Laboratories of the Czech Geological Survey (A. Tichá) using HCl, HF, KOH followed by acetolyse. Four prepared slides were scanned under a light microscope (Olympus BX50, magnification: ´40 and ´100, DCI). The spores and pollen were mostly well preserved, but were generally not abundant. Thus, it was not possible to perform a quantitative analysis and results of taxonomic analysis are presented only. Palynomorphs were identified by comparison with Mello and Snopková (1973), Góczán et al. (1967), and the widely known classical literature such as Couper (1953), Weyland et Krieger (1953) and Pflug (1953). A general overview of Normapolle morphology (Batten and Christopher 1981) and a specific chapter in Traverse (2008) were very helpful with regard to the higher alteration (carbonization) of thick pollen exines.

Systematic part

Fungi

Pl. 1

Several morphological types of fungal bodies including spores were observed. Among them unicellular, multicellular and rare dicellate bodies occurred, aporate or with pores. The appearance of many of the recorded remains resembles modern fungi, e.g. in their inner structure and surface patterns, composed of short spinae or granula (Pl.1, figs 14-17); rarely large dark empty dyads were present (Pl.1, fig. 4), also known from the Cretaceous and other fossil assemblages. Light-brownish or yellowish morula-like ´polyads´ (Pl.1, figs 18,19, 25,26) may belong to both multicellular fungal bodies (figs 25,26) and/or cyanobacterial/algal colonies (fig. 18,19).

This fungi remains (Pl. 1, 1-3, 13, 14-17, 25, 26) are of Quaternary age or they are recent.

?Basidiomycota s.l.

Pl.1, figs 1-3

R e m a r k s : Thick-walled spores, spherical to irregular in outline with several pores.

cf. *Alternaria* sp.

Pl.1, fig. 13

R e m a r k s : It was compared with recent specimen (gen. *Alternaria*) which shows similarities with studied fossils in shape (they are club-shaped), the conidia have transversal and longitudinal septa and long nib.

cf. *Dicellaesporites* sp.

Pl.1, fig.4

Dicellate spore, wall smooth and thin, markedly large cells.

R e m a r k s : Cretaceous, Paleocene, stratigraphically not significant.

?Cyanobacteria/Algae/(Fungi)

Pl. 1, figs 18,19

R e m a r k s : Quaternary/contemporaneous sporomorphs.

Green Algae

Genus *Ovoidites* (Potonié 1951) Krutzsch 1959

***Ovoidites* sp.**

Remarks: Recent relation – Zygnemataceae. Algal zygospores and aplanospores were rarely recorded. Zygospores were observed as oval bodies with a slight longitudinal suture, *Ovoidites* sp. (recent *Spirogyra*, *Zygnema*), or rarely as spherical bodies of morula-like forms (Pl. 1, figs 18,19). These bodies resemble other forms, smaller and tightknit, probably Fungi (Pl. 1, figs 25,26). We took into account the colour variations in both cases (rather dark brown colour in the latter) as a more characteristic feature of the fungal remains.

Spores

All trilete spores belong to bryophytes or pteridophytes.

Genus *Stereigranisporis* (Krutzsch 1963) Kedves 1982 in Kedves et Russel 1982

Syn.: ***Stereisporites*** Thomson et Pflug 1953 (Subgen. ***Stereigranisporis*** Krutzsch 1963)

aff. ***Stereigranisporis* sp.**

Pl. 2, fig. 4

Spore outline rounded triangular, trilete scar distinct, reaching the equatorial rim; surface ornamented by granula and low warts (partly coalescing), forming lines or valae along arms; isolated grana occur more densely in the middle of the proximal face. ?Cingulum or equatorial rim developed.

Relationships: This taxon is related to bryophytes, eventually to lycopods.

Remarks: Morphologically related spores, to some extend, occurred in the Cretaceous sediments redeposited into Pannonian deposits in Hungary (?*Stereisporites* sp., borehole at Szentes, Kedves 1966) and in the Cretaceous strata of equatorial Africa (?*Anthocerisporis* sp., Boltenhagen 1975).

Range of the genus. Cretaceous – Pliocene, ?recent; several species Cretaceous – Paleocene (e.g. Krutzsch 1963).

Genus *Gleicheniidites* Ross 1949

cf. ***Gleicheniidites*** sp.

Pl. 2, fig. 3

Remarks: *Gleicheniidites* spores display very wide palaeographical distribution in the Mesozoic.

Genus *Dictyophyllidites* Couper 1958 emend. Dettmann

***Dictyophyllidites harrisii* Couper 1958**

Pl. 2, figs 7,8

The exine has a conspicuously thin wall in contrast to the *Leiotriletes* triplane or semitriplane spores, and transparent elevated lips.

Relationship between fossil *Dictyophyllum* (fern leaves) and spores *Dictyophyllidites*. *Dictyophyllum* is of the *Phlebopteris* – type, a fossil fern from the family cf. Matoniaceae (Traverse 2008), Dipteridaceae family after Němejc (1963), now containing only *Dipteris* (Tryon et Lugardon 1991); spores *Dictyophyllidites* were recorded *in situ* in the Jurassic fossil fern *Dictyophyllum* and display a cheiropleuriaceous character (in comparison with recent fern spores); a general survey of the finds and their relationships is given in van Konijnenburg-van Cittert (1989) and Traverse (2008).

Range. Group of spores – Triassic, Jurassic, Cretaceous.

Genus *Cyathidites* Couper 1953

***Cyathidites australis* Couper 1953**

Pl.2, fig. 9

Remarks and Range: Cyatheaceous spores (Cyatheaceae, Dicksoniaceae; Traverse 2008) with wide palaeogeographical distribution in the Mesozoic (tab.1) known from the early Tertiary of Africa.

Genus *Leiotriletes* Krutzsch 1959

***Leiotriletes adriennis* (Potonié et Gelletich 1933) Krutzsch 1959**

Pl.2, figs 10-15

Relationships: Most probably *Lygodium*-types (Schizaeaceae). Some authors assigned the types figured in Pl. 2, figs 12,15 to *Dictyophyllidites harrisii*, but others to *Deltoidospora.* After comparison with *Lygodium* spores *in situ*, we assigned this type to the genus *Leiotriletes*. (Nevertheless, this assessement may be ambiguous, especially due to relative thinness of spore exines.)

Remarks: Discussion of the above mentioned morphological genera *Dictyophyllidites, Cyathidites,* and *Leiotriletes* and their relationships to recent families and macrofossil fern taxa, based on *in situ* spores and fern morphology, is given in van Konijnenburg-van Cittert (1989) and also reviewed in Traverse (2008).

Genus *Trilites* Cookson ex Couper 1953

Syn. *Corrugatisporites* Thomson et Pflug 1953

***Trilites* sp.**

Pl. 2, figs 5,6

Remarks: Corroded spore, remarkably tiny granula and rodlets on the surface and ghost residues of corrugae and ridges (?Schizaeaceae, ?Dicksoniaceae, *Matonia*-Matoniaceae), resembling *Corrugatisporites.* Its relatively thin exine differs from that of other spores (except for trilete spore in Pl. 2, figs 16,17).

Genus *Deltoidospora* (Delcourt et Sprumont 1955) Dettmann et Hughes 1963

cf. *Deltoidospora* sp.

Relationships: Fossil fern *Onychiopsis* Yoko-

YAMA, taxonomically indefinite type (Sukh-Dev 1980); Pteridaceae, Eocene-Oligocene sediments (Collinson 1978); Matoniaceae, Gleicheniaceae.

Genus *Vadaszisporites* DEÁK et COMBAZ 1967

cf. *Vadaszisporites* sp.

Remarks: Trilete foveolate spore only partly preserved.

cf. *Vadaszisporites sacali* DEÁK et COMBAZ 1967

Pl.2, figs 1,2

Remarks: The spore is comparable with the genus *Vadaszisporites* reported by Kedves (1984) as *V. sacali,* recorded in the rich assemblage from the Senonian deposits in southern Hungary (Upper Senonian, Csávoly-type assemblage, ibid). *Vadaszisporites sacali* is also known from the Upper Albian of Hungary (Juhász 1983). This taxon is distinguished by exine ornamentation patterns.

Relationships: Presumed to be related to the family Lycopodiaceae (Kedves 1984).

Sporae *incertae sedis*

Pl. 2, figs 16,17

Remarks: Trilete spore, with relatively thin, translucent exine, trilete scar with long arms reaching the equator. Exine with low verrucate and granulate/foveolate pattern. Corrosion and poor preservation did not permit taxonomic classification.

Gymnosperms

Pinus silvestris – type

Pl. 1, fig. 10

Remarks: Only isolated saccus, probably Quaternary or recent.

Angiosperms

Normapolles PFLUG 1953

Triporate brevaxone pollen grains with protruding complex apertures.

The recorded Normapolles (pollen of extinct plants) were documented in light microscope microphotos (Plate 3, figs 1-17). Cílek and Svobodová (1999) also reported results from SEM observations together with micrographs. They clearly documented the type of coarse exine pattern seen in several Normapolles taxa.

Genus *Oculopollis* PFLUG 1953

Oculopollis sp.

Pl. 3, figs 1,9,10

Remarks: Large-sized pollen with massive oculi.

cf. *Oculopollis* sp.

Pl. 3, figs 11,12

Remarks: Large-sized pollen with massive oculi, very similar to the genus *Oculopollis*.

***Oculopollis* cf. *zaklinskaiae* GÓCZÁN 1964**
– *Oculopollis* cf. *semimaximus* KRUTZSCH 1968

Pl. 3, figs 16,17

Remarks: Large-sized pollen with massive oculi covering part of the exine surface. Exine coarsely scabrate.

***Oculopollis concentus* PFLUG 1953 vel *Semioculopollis* sp.**

Pl. 3, figs 3,4

Genus *Pseudoculopollis* GÓCZÁN, KRUTZSCH et PACLTOVÁ 1967

aff. *Pseudoculopollis principalis*
(WEYLAND et KRIEGER 1953) KRUTZSCH 1967

Pl. 3, fig. 2

cf. *Pseudoculopollis principalis*
(WEYLAND et KRIEGER 1953) KRUTZSCH 1967

Pl. 3, fig. 13

Remarks: The above pollen grains of *Pseudoculopollis* also resemble *Oculopollis* (former synonym for the genus and species *principalis*); the connection between oculi across the pole area is not clear in our specimens. This species is known from the Middle Santonian to Early Campanian.

Genus *Trudopollis* (PFLUG 1953) emend. KRUTZSCH 1967

Trudopollis pertrudens
(PFLUG in THOMSON et PFLUG 1953**) PFLUG 1953**

Pl. 3, figs 5-8

Remarks: The genus and related species were common in the Late Cretaceous and may also occur in Palaeocene and Early Eocene spectra.

Genus *Krutzschipollis* GÓCZÁN 1967

Remarks: Stratigraphic range of the genus – Santonian to Maastrichtian.

***Krutzschipollis magnoporus* GÓCZÁN 1967**

Pl. 3, figs 14,15

Remarks: The pollen is characterized by large size, thick exine and projecting anuli. Its occurrence is characteristic for the Cretaceous, Early Maastrichtian deposits from Hungary.

Angiosperms – non Normapolles
Genus ?

Pl. 3, figs 18,19

Remarks: Unidentified pollen grain, equatorial view.

***Aster*-type**, Tubiflorae, Asteraceae

Pl.1, figs 21,22

R e m a r k s : Pollen grain displays opalescent exine, short spinae and it is of tricolpate/tricolporoide type (only one specimen recorded). Asteraceae are widespread and common in Quaternary sediments and also confirmed by numerous fossil achenes in Pliocene sediments e.g. from Poland (Kristofovic 1957, Němejc 1975).

cf. ***Graminidites*** sp., cf. Poaceae

Pl. 1, figs 11,12

R e m a r k s : Quaternary/contemporaneous sporomorphs.

? ***Graminidites*** sp., ?Poaceae

Pl. 1, figs 23,24

R e m a r k s : Recent palynomorph (according to wall character), specific assessment was not possible.

?? ***Cyperaceaepollis*** sp.

Pl. 1, figs 7,8

R e m a r k s : Angiospermous pollen grain. The compression and fixation of pollen during preparation did not allow their assessment. According to the exine character, it could be considered as both a Quaternary and pre-Quaternary plant provenance.

Incertae sedis

Pl. 1, figs 5,6,9,20

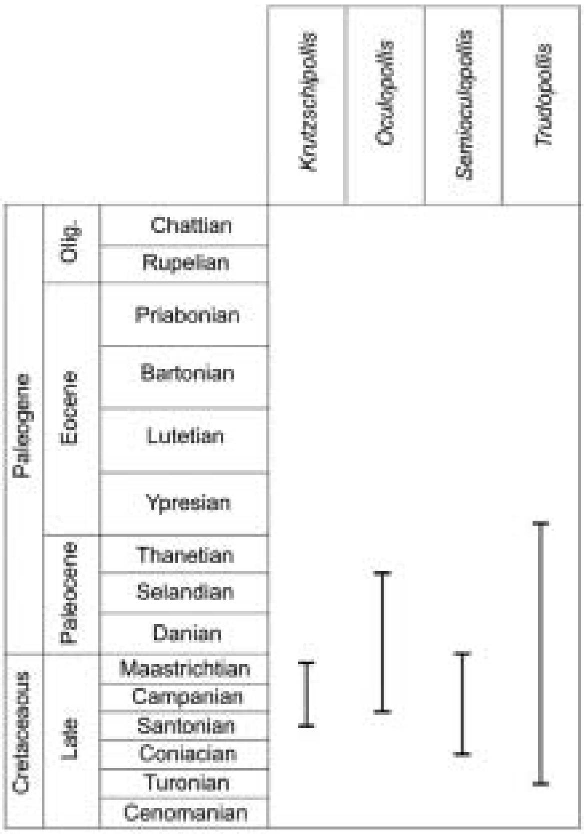
R e m a r k s : Quaternary/contemporaneous sporomorphs.

Results and discussion

Our data contribute to discussion of the palynological content and dating of karst infills in the Rožňava Region. However, it is only possible to use them for approximate estimation of age. Identified palynoflora was relatively scarce, which is in accordance with the results of a number of previous studies. The observed spectrum contains predominantly pollen of extinct taxa with a thick exine and prominent oculi. More precise dating requires further analyses of continuous sedimentary sequences and evaluation of gradual changes in richer fossil communities.

Fossil angiosperm pollen grains generally indicate a Late Cretaceous to Paleogene age for the studied sediments; however, only a few identified taxa may indicate an Early Paleogene age. With regard to the environment, fossil pollen and spores were derived from terrestrial vegetation, marine plankton was not recorded. Taking into account the plant habitus, tree and climbing ferns dominated among the pteridophytes, probably in contrast to the habit of the extinct Normapolles plants. Normapolles mother plants might have been epiphytic, parasitic plants, grassy forms or of arborescent habit (Zaklinskaya 1981).

Quaternary elements were for the first time indicated in the assemblage (fungi, algal cysts, incertae sedis palynomorphs, pollen), as scarce recent admixture (tab. 1). It is remarkable that Mesozoic cheirolepidaceous conifers or



Text-fig. 2. Normapolles range according to Krutzsch table in Góczán et al. 1967.

Abietinae were absent in this assemblage, while specimens of the angiosperm group Normapolles were relatively frequent. The studied association was dominated by genera related to *Oculopollis* (Pl. 3). Noteworthy was the co-occurrence of the significant genus *Krutzschipollis,* present at two sites from Gombasek Quarry (Mello and Snopková 1973) and also in the important sequence from Hosťovce (Cílek and Svobodová 1999); similarly co-occurence of the specimens of the *Oculopollis* cf. *zaklinskaiae* in Gombasek (Mello and Snopková 1973). Both the above mentioned taxa are known from several sites in Hungary (Góczán 1964, Góczán in Góczán et al. 1967), corresponding to a Santonian-Maastrichtian age. *Oculopollis semimaximus* is abundant in the Santonian of southern France, in the non-boreal Cretaceous province (Krutzsch 1968). Normapolles indicate a stratigraphic range from the Late Cretaceous (predominantly) to Paleogene (exceptionally). Their peak occurrence falls in the Maastrichtian. The recorded taxa predominantly show a stratigraphic range from the Santonian to the Maastrichtian, *Trudopollis* (*T. pertrudens)* specimens may appear up to the Paleocene (Pflug 1953) and then up to the early Eocene (chart for Central Europe, Krutzsch in Góczán et al. 1967 and other authors; Text-fig. 2). Identified fern spores were widespread throughout the Mesozoic; their recent analogues occur mostly in tropical and subtropical forests (Central America, south-western China). Common ferns in both the Mesozoic and particularly Tertiary Flora are represented by *Lygodium*-type lianas (Schizaeaceae). Stripped *Mohria* spores, occurring predominantly in the telmatic Cretaceous to early Tertiary palyno-and lithofacies, were not recorded. The absence of *Classopollis* pollen, a characteristic group of gymnosperms from the Jurassic and lower to mid Cretaceous deposits, is typical. The same characteristic was also reported by Snopková (Mello and Snopková 1973) from Gombasek. Čorná (1967) referred to it as a specific palynofacies in Middle Albian palynoflora (typified 1 by an abundance of conifers) from the W. Carpathians in northern Slovakia.

Summarizing the significant Normapolles group, the thick-walled normapolloid pollen with complex germinal apparatus (overview in Batten and Christopher 1981), often prominent and protruding (Pl. 3, figs 1-17), they are similar to taxa characteristic for the Late Upper Cretaceous (Góczán et al. 1967, Krutzsch 1968, 1973). In Early Paleogene deposits they occur less frequently or are represented by other taxa (Krutzsch and Vanhoorne 1977, Kedves and Russel 1982, Portnyagina 1981, a.o.), mixed with more advanced descendents, Post-Normapolles. A Paleogene age for the studied sample might be inferred from the presence of *Trudopollis* also occurringin Paleocene (e.g. Menat in France, Kedves and Russel 1982). However, the majority of identified palynomorphs indicate an Upper Cretaceous age (probably Maastrichtian). Similar conclusions were already reported in the previous palynological studies (Snopková in Mello and Snopková 1973, Svobodová in Cílek and Svobodová 1999). The significant advanced angiosperm pollen, e.g. *Stephanoporopollenites* forms, were not recorded. The post-Cretaceous period of karstification may be evidenced by the intense corrosion of some spore exines in the assemblage, caused by oxidation (Pl. 2, figs 5, 6, 16, 17) or by sulphides (Pl. 2, figs 15, 16).

In addition to the above listed taxa, modern sporomorphs were recorded in the studied association as well as the rare elements – *Pinus,* Asteraceae, cf. Poaceae, morphologically differentiated Fungi, algal spores (aplanospores, zygospores), and evidently recent palynomorphs incertae sedis (Pl. 1). Organic remains also displayed a different carbonization level: more carbonized and less or uncarbonized organic fragments were associated together.

Further search for fossiliferous samples in the Gombasek Quarry might reveal new stratigraphically significant taxa and permit more precise dating of geological and geomorphological evolution of this region.

Conclusions

Normapolles pollen, fern spores, recent Fungi and other palynomorphs were traced and newly identified from a sample of the calcareous/clayey deposits from the Gombasek Quarry in eastern Slovakia (Rožnava District). Normapolles, pollen of extinct angiospermous plants, dominate the spectrum, spores of ferns are also frequent. Both testify to a Mesozoic source of the rocks, predominantly the Upper Cretaceous, some indicate a Cretaceous/Early Paleogene age.

The significant Tertiary (Paleogene) taxa were not discovered in Gombasek. The study preduced several new records of taxa which had not been found previously at this locality.

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Explanation of the plates

PLATE 1

Fungi, Fungi – ?Algae and *Incertae sedis* palynomorphs, scale bar =10 µm (´1000).

1, 2. Fungi, ?Basidiomycota s.l.; two focus levels.
3. Fungi, ?Basidiomycota s.l., another specimen.
4. Fungi, cf. *Dicellaesporites* sp., dyade, closely associated with inorganic detritic particles; ?redeposited.
5, 6. *Incertae sedis*, palynonomorph with fine striae; two focus levels.
7, 8. ??*Cyperaceaepollis* sp., angiospermous pollen at two focus levels; not determinable in the fixed medium.
9. *Incertae sedis*, spherical palynomorph, incertae sedis; in color and light opalescent wall comparable with other specimens except Fungi and angiospermous pollen (figs 7,8).
10. *Pinus silvestris* – type, saccus of exine.
11,12. cf. *Graminidites* sp.; two focus levels.
13. Fungi, cf. *Alternaria* sp.
14,15. Fungi, *incertae sedis*; two focus levels;
16,17. Fungi, spore with long slit, *incertae sedis*; two focus levels.
18,19. ?Cyanobacteria/Algae/Fungi, light brown-yellow morula-like polyade, *incertae sedis*; two focus levels.
20. *Incertae sedis,* Fungi or Algae, two cells with plasma content.
21, 22. Asteraceae, Tubiflorae, *Aster*-type, ubisch bodies on the surface; two focus levels, Quaternary.
23, 24. ?Poaceae, deposits on the grain are secondary granulae; two focus levels, Quaternary.
25, 26. Fungi, dark brown morula-like polyade, *incertae sedis*; two focus levels.

PLATE 2

Pteridophytes, Filicinae – spores; scale bare = 10 µm (´1000).

1, 2. cf. *Vadaszisporites sacali* DEÁK et COMBAZ, Lycopodiaceae (after Deák and Combaz 1967), Pteridophytes; two focus levels.
3. cf. *Gleicheniidites* sp.
4. aff. *Stereigranisporis* sp., Pteridophyta
5, 6. Corroded trilete, likely corrugate spore (ex *Triltes*/syn. *Corrugatisporites*); two focus levels.
7, 8. *Dictyophyllidites harrisii* COUPER – "*Triplanosporites*" – morphotype, triplane aspectus; two focus levels.
9. *Cyathidites australis* COUPER, Schizeaceae, Cyatheaceae, Dicksoniaceae
10, 11. *Leiotriletes adriennis* (POTONIÉ et GELLETICH) KRUTZSCH; two focus levels.
12, 15. *Leiotriletes adriennis* (POTONIE et GELLETICH) KRUTZSCH; triplane aspectus.
13, 14. *Leiotriletes adriennis* (POTONIÉ et GELLETICH) KRUTZSCH, semi-triplane aspectus; two focus levels.
16, 17. Pteridophytes, trilete spore; two focus levels.

PLATE 3

Angiosperms – pollen; scale bare = 10 µm (´1000).

1. *Oculopollis* sp., Normapolles.
2. Aff. *Pseudoculopollis principallis* (WEYLAND et KRIEGER) KRUTZSCH, Normapolles.
3,4. *Oculopollis concentus* PFLUG, Normapolles; two focus levels.

5–8. *Trudopollis pertrudens* (Pflug in THOMSON et PFLUG) PFLUG, Normapolles, figs 5-7, one specimen, three focus levels; fig. 8, another specimen.

9,10. *Oculopollis* sp., Normapolles; two focus levels.

11,12. cf. *Oculopollis* sp., Normapolles; two focus levels.

13. cf. *Pseudoculopollis principallis* (WEYLAND et KRIEGER) KRUTZSCH, Normapolles.

14,15. *Krutzschipollis magnoporus* GÓCZÁN, Normapolles; two focus levels.

16, 17. *Oculopollis* cf. *zaklinskaiae* GÓCZÁN – *Oculopollis semimaximus* KRUTZSCH – types, Normapolles; two focus levels.

18, 19. Angiospermous pollen grain, equatorial view; two focus levels.

PLATE 1

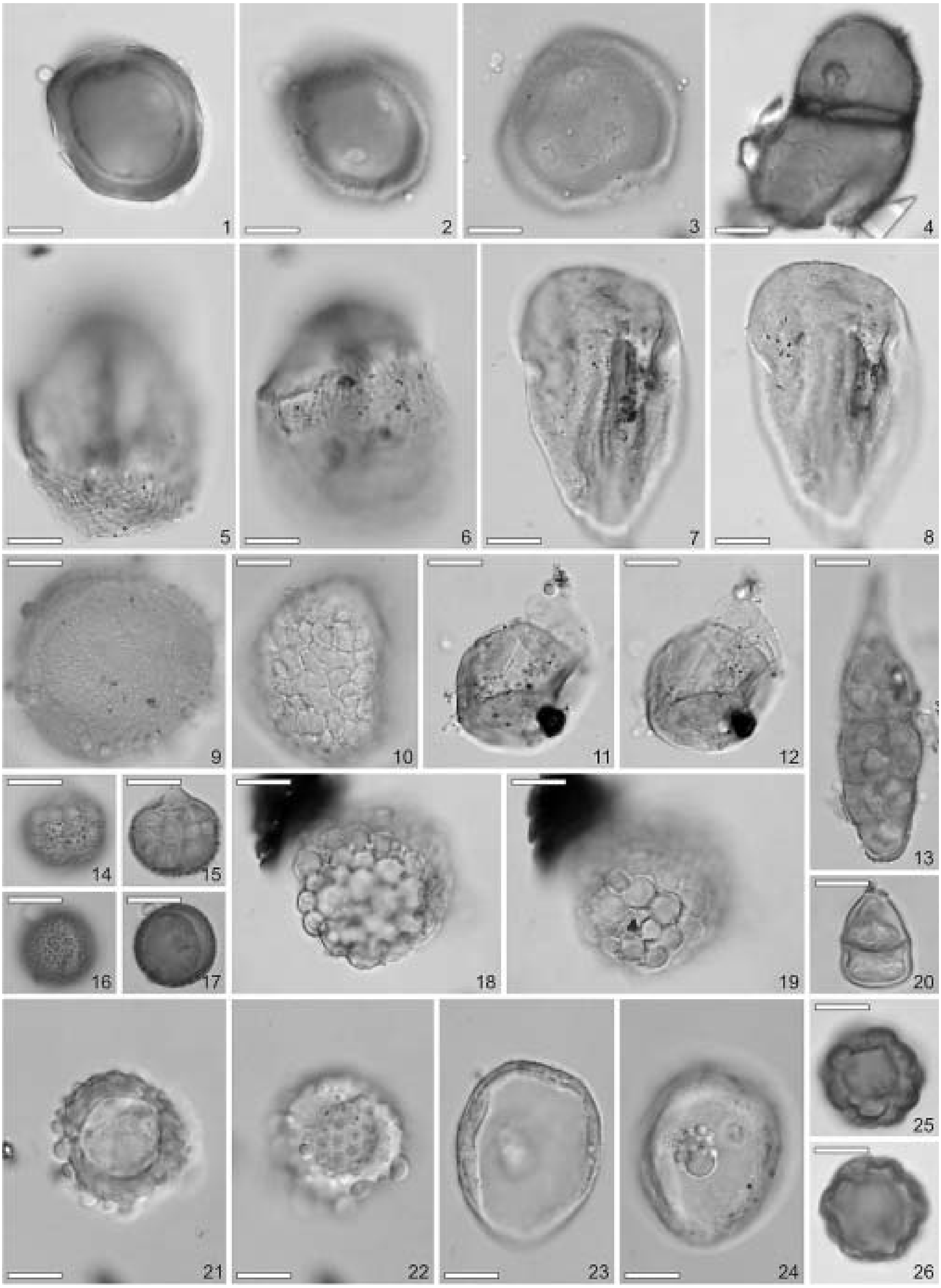

PLATE 2

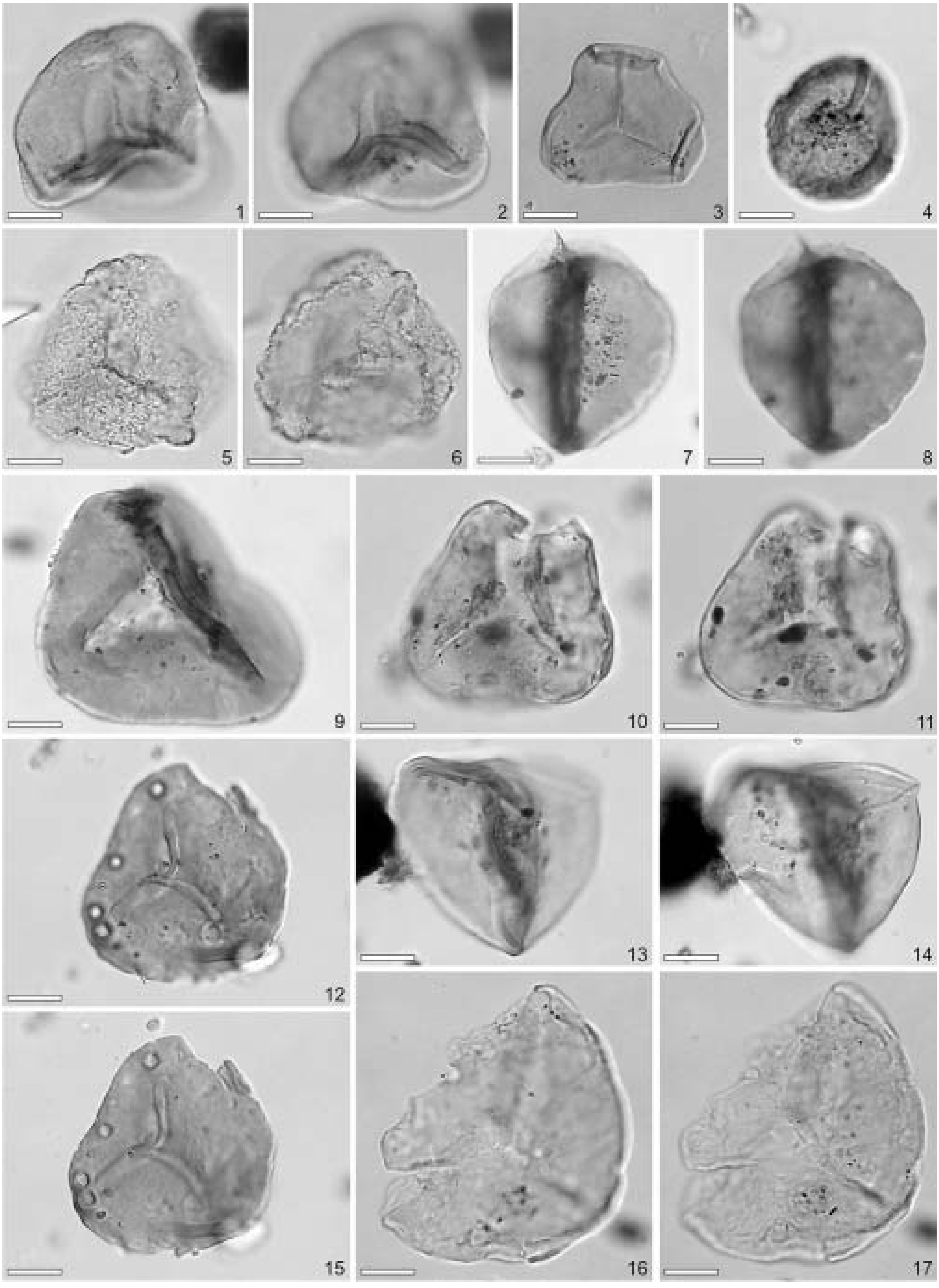

PLATE 3

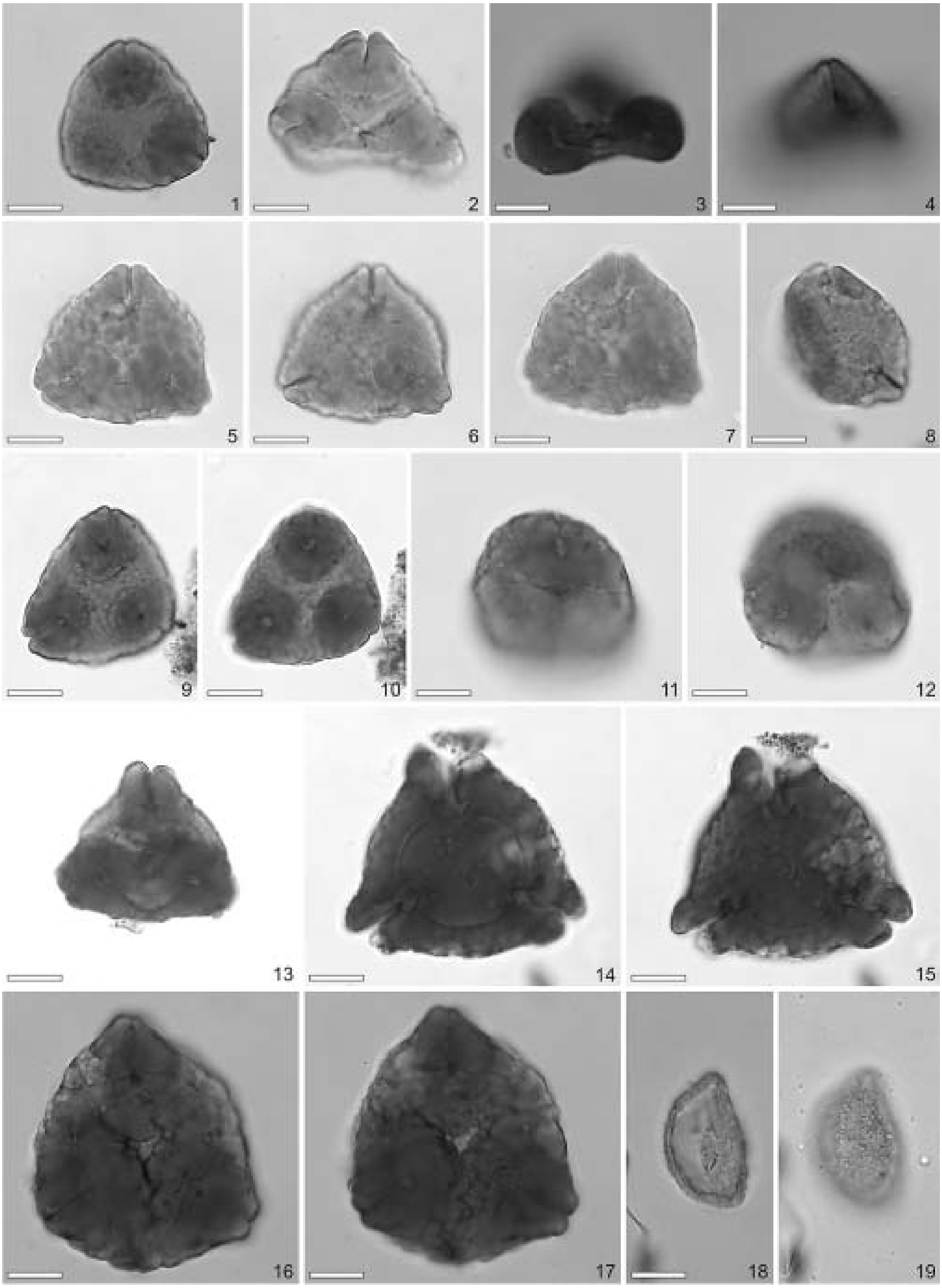

Table 1. List of fossil palynomorphs, their botanical affinity and stratigraphy.

non Quaternary sporomorphs				
group	taxon	botan. affinity	stratigraphy	plates
Fungi	*incertae sedis* , Fungi varia			
	cf. *Dicellaesporites* sp.			Pl. 1, fig. 4
Spores	*Cyathidites australis*	Cyatheaceae, Dicksoniaceae	Santonian	Pl. 2, fig. 9
	Dictyophyllidites harrisii	Matoniaceae, Dipteridaceae	since Jurassic	Pl. 2, figs. 7,8
	cf. *Deltoidospora* sp.	Pteridaceae, Matoniaceae, Gleicheniaceae	Mesozoic - Paleogene	
	cf. *Gleicheniidites* sp.	Gleicheniaceae	Mesozoic - Paleogene	Pl. 2, fig. 3
	Leiotriletes adriennis	Schizaeaceae	Upper Cretaceous – Paleogene, Neogene	Pl. 2, figs 10-15
	aff. *Stereigranisporis* sp.	Pteridophyta, Bryophytes, Lycopodiaceae	Cretaceous – Pliocene, ?Recent	Pl. 2, fig. 4
	Trilites sp.	?Schizaeaceae, ?Dicksoniaceae, *Matonia* -Matoniaceae		Pl. 2, figs 5,6
	cf. *Vadaszisporites sacali*	Lycopodiaceae	since Upper Albian	Pl. 2, figs 1,2
	cf. *Vadaszisporites* sp.			
Angiosperms: Normapolles	*Krutzschipollis magnoporus*	extinct plants	Santonian -Maastrichtian	Pl. 3, figs 14,15
	Oculopollis concentus vel *Semioculopollis* sp.	extinct plants		Pl. 3, figs 3,4
	aff. *Pseudoculopollis principallis*	extinct plants		Pl. 3, fig. 2
	Oculopollis cf. *zaklinskaiae – O.* cf.	extinct plants		Pl. 3, figs 16,17
	Oculopollis sp.	extinct plants		Pl. 3, figs 1,9,10
	cf. *Oculopollis* sp.	extinct plants		Pl. 3, figs 11,12
	cf. *Pseudoculopollis principalis*	extinct plants		Pl. 3, fig. 13
	aff. *Pseudoculopollis principalis*	extinct plants		Pl. 3, fig. 2
	Trudopollis pertrudens	extinct plants	Late Cretaceous-Early Eocene	Pl. 3, figs 5-8
Angiosperm: non	not identified (tricolpate-tricolporate)	extinct plants		Pl. 3, figs 18,19
?Kenophytic sporomorphs				
Triletes spores			?Kenophyticum,	Pl. 2, figs 16,17
Quaternary sporomorphs				
Fungi	?Basidiomycota s.l.		Quaternary, might be also in non Quaternary deposits	Pl. 1, figs1-3,
	Fungi varia, *incertae sedis*		Quaternary, might be also in non Quaternary deposits	Pl. 1, figs 14-17, 25-26
	cf. *Alternaria* sp.			Pl. 1, fig. 13
?Cyanobacteria/ Algae/Fungi				Pl. 1, figs 18,19
Gymnosperms	*Pinus silvestris* - type	Pinaceae		Pl. 1, fig. 10
Angiosperms	*Aster* - type	Asteraceae		Pl. 1, figs 21,22
	?*Graminidites* sp.	?Poaceae		Pl. 1, figs 23, 24
	cf. *Graminidites* sp.	cf. Poaceae		Pl. 1, figs 11,12
	??*Cyperaceaepollis* sp.	??Cyperaceae		Pl. 1, figs 7,8
incertae sedis	?	?		Pl. 1, figs 5,6,9,20
Mesozoic - Quaternary sporomorphs				
Algae	*Ovoidites* sp.	Zygnemataceae	Mesozoic - Recent	