

## PALYNOLOGICAL INVESTIGATIONS ON AUSTRIAN UPPER CRETACEOUS AND LOWER TERTIARY SEDIMENTS

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### Abstract

The strata of Haselhof (Maastrichtian), Haidhof (Danian), Oiching, Kleinoiching (L. Thanetian), St. Pankraz (U. Thanetian, L. Cuisian), Michelsberg (Cuisian) have been investigated palynologically. Of these the Thanetian sediments of Kleinoiching and St. Pankraz are rich in sporomorphs. Kleinoiching is rich in Gymnospermatophyte pollen grains with bladders and the *Normapolles* pollen grains, characteristic of the older strata, are also frequent. Of the Upper Thanetian and the Lower Cuisian the dominance of the Fagaceae pollen grains (*Cupuliferoipollenites pusillus*) is characteristic. All in all, the demonstration of 86 sporomorph species took place; of these, one is n. fgen. and together eight are n. fsp. The richness of the *Interporopollenites* is to be emphasized in the Lower Thanetian in Kleinoiching. This, and the occurrence of *Extratripopollenites conjunctus*, as well as that of the *Tetrapollis* genus refer to the Danian, resp. the Paleocene (Monsian stage). The number of sporomorphs indicating an expressed tropical climate is low.

### Introduction

Of the spore-pollen composition of the Lower Paleocene (Monsian) sediments in Austria an account was rendered in an earlier publication (KEDVES, 1970). By the results obtained the continuation of investigations was necessitated because the palynological problems of the transitional period of the Paleocene and the Upper Cretaceous are not solved within the *Normapolles* region, either. In this way, the palynological investigation into the Maastrichtian, Danian, Thanetian and Cuisian samples has taken place. The Maastrichtian and Danian samples are particularly important from the point of view of the development of the Upper Cretaceous — Lower Tertiary floras. The importance of the Upper Paleocene is given by that the number of the elements of the flora of the Lower Eocene is already considerable, as well. By the problem of the Cuisian, the spore-pollen assemblages of the Lower and Middle Eocene are affected.

Some *Normapolles* taxa of the Lower Thanetian sediments of Kleinoiching took also place in our publication dealing with the taxonomy of the Paleocene *Normapolles* (KEDVES, HEGEDŰS—BOHONY, 1971).

### Materials and Methods

The investigated material was given to my disposal by Dr. T. KECSKEMÉTI. For his kind help I wish to express my thanks in this way, too. The investigated samples are the following:

Maastrichtian: Haselhof, its mark is: A/4.

Danian: Haidhof, clayey fine sand, its mark is: B/7.

Lowest part of Thanetian: Oiching, dark-grey, clayey marl with fine sand, its mark is: DI/1c, Kleinoiching, dark-grey, sandy marl, its mark is: DI/2.

Upper part of Thanetian: St. Pankraz, dark-grey sandy marl, its mark is: DI/3a.

Lower part of Cuisian: St. Pankraz, its mark is: DI/3c. Cuisian: Michelsberg, its mark is: B/9.

In addition to these, Dr. I. Draxler (Geologische Bundesanstalt, Wien) sent several Danian and Paleocene samples; these, however, do not contain any sporomorphs.

### Results

- 1) In the course of the investigations, the following taxa were described

Fgen.: *Interporopollenites* WEYL. et KRIEG. 1953

1. *Interporopollenites klausii* n. sp. (Plate I, 11—14)

#### Diagnosis

Equatorial contour is triangular, generally with straight sides and rounded apices. The germinal area is a little prominent. The surface is smooth or finely scabrate. At the poles, there are triangular exine extenuations, these are generally different at the two poles; at one of them, they have the shape of an equilateral triangle with pointed apex; at the other pole, the apices are strongly rounded. This exine part is sometimes circular. The exopores are circular, generally 1.5  $\mu$  in diameter. The germinal areas are connected with about 2  $\mu$  wide arcuses at both sides. The extragerminal exine is generally 2  $\mu$  wide, its structure can only be observed with difficulty by means of a light microscope. But it can be established that the infratectum is thicker than the tectum, resp. the foot layer. The foot layer is strongly thickened in the germinal area; it is generally 2.5 — 3  $\mu$  and the endopore 4  $\mu$  wide generally.

Diameter: 26  $\mu$ , at other specimens: 19—28  $\mu$ .

Holotype: Plate I, 11, 12, slide DI/2—18; 7.1/116.2.

Locus typicus: Kleinoiching, lowest part of Thanetian.

Stratum typicum: Dark-grey, fine-sandy clayey marl.

Derivatio nominis: From Prof. DR. W. KLAUS, a prominent representative of the Austrian palynology.

Differential diagnosis: It is separated from *I. zaklinskaiae* KDS. et HEG. 1975 by its wider endogerminalia and its less prominent germinal area and from the *I. stanleyi* KDS. et HEG. 1975 by the lack in vestibulum.

Occurrence: It is for the time being only known from the locality type.

2. *Interporopollenites draxlerae* n. sp. (Plate I, 15—17, Plate II, 1)

#### Diagnosis

Equatorial contour is triangular, with straight or mildly concave sides. The apices are rounded, the germinal area is prominent. The size of exopores is about

2  $\mu$ , their shape is varied: slit-like, triangular or elliptical. The surface is finely punctate, the tectum is perforated. At the poles there are exine extenuations of irregular shape. The germinal areas are connected with 2.5  $\mu$  wide arcuses. The extragerminal exine is 2—2.5  $\mu$  thick, the tectum and foot layer are equally thin, about 0.5  $\mu$ . The infratectum is the thickest. Its structure cannot be recognized with light microscope but it is probably granular. The foot layer is very strongly thickened in the germinal area. There is a characteristic wedge-shaped endannulus. The endopore is 4—5  $\mu$  wide.

Diameter: 35  $\mu$ , at further specimens 30—38  $\mu$ .

Holotype: Plate I, 15, 16, slide DI/2—18; 5.7/107.2.

Locus typicus: Kleinoiching, the lowest part of Thanetian.

Stratum typicum: Dark-grey, fine-sandy clayey marl.

Derivatio nominis: From Dr. I. DRAXLER (Wien).

Differential diagnosis: It is separated from *I. thomsoni* KDS. et HEG. 1975 by its larger size and with the arcuses.

Occurrence: It is for the time being only known from the locality type.

### 3. *Interporopollenites kleinoichingi* n. fsp. (Plate II, 2—5)

#### Diagnosis

Equatorial contour is triangular, with straight sides and but a little rounded apices. The surface is smooth or finely scabrate. At the poles there are only very small exine extenuations of irregular shape. The exopores are circular or slit-like, with a maximum size of 1.5—2  $\mu$ . The extragerminal exine is 2—2.5  $\mu$  thick. Of the three layers of ectexine the infratectum is the thickest one. The tectum is thin, the foot layer is somewhat thicker than this. The infratectum is granulated. At the apices the tectum and the infratectal layer become thicker, the foot layer is separated from both outer layers. There is an expressed vestibulum. The endannulus is very thick (3—3.5  $\mu$ ), the endopore is narrow, canal-like, its diameter being about 1  $\mu$ .

Diameter: 25  $\mu$ , at further specimens 21—27  $\mu$ .

Holotype: Plate II, 2, 3, slide DI/2—24; 7.1/117.4.

Locus typicus: Kleinoiching, the lowest part of Thanetian.

Stratum typicum: Dark-grey, fine-sandy clayey marl.

Derivatio nominis: From the locality type.

Differential diagnosis: It differs from *I. klausii* n. fsp. and similar pollen grains in the extenuation of the polar exine of small, irregular shape.

Occurrence: For the time being, it is only known from the locality type.

### 4. *Interporopollenites gregussii* n. fsp. (Plate II, 6—9)

#### Diagnosis

Equatorial contour is triangular, with rounded apices, straight, mildly convex or concave sides. The germinal area is prominent. The surface is punctate or finely granulated. The exopores are elliptical, their maximum size is 2  $\mu$ . The extragerminal exine is 2—2.5  $\mu$  thick. Of the three layers of the ectexine the infratectum, which is of granular structure, is the thickest one. Both two outer layers of the ectexine at the apices become strongly thick. The foot layer becomes strongly thick, as well, in the area of the pore. There is a 4  $\mu$  thick annulus. The endopore is generally 4  $\mu$  wide.

Diameter: 29  $\mu$ , at other specimens 27—30  $\mu$ .

Holotype: Plate II, 6, 7, slide DI/2—37; 12.8/115.9.

Locus typicus: Kleinoiching the lowest part of Thanetian.

Stratum typicum: Dark-grey, fine-sandy clayey marl.

Derivatio nominis: In honour of Prof. Dr. P. GREGUSS, the prominent palaeontologist.

Differential diagnosis: It differs from *I. subgranulosus* KDS. et HEG. 1975 in its essentially smaller endopores, as well as in its somewhat smaller size.

Occurrence: For the time being, it is only known from the locality type.

#### 5. *Interporopollenites elsikii* n. sp. (Plate II, 10, 11)

##### Diagnosis

Equatorial contour is triangular, with mildly concave sides, the apices are strongly rounded. The surface is smooth or finely scabrate. Both poles are concave triangular exine extenuation. The exopores are generally elliptical, their maximum size is about 2  $\mu$ . The extragerminal exine is 2—3  $\mu$  thick. Of the three layers of the ectexine the infratectum is the thickest, being of granular structure. The germinal areas are connected with arcuses. Both outer layers of the ectexine became thick in the germinal area. The foot layer becomes but a little thick round the endopores. The endannulus is not expressed. The endopores are generally 4  $\mu$  wide.

Diameter: 24  $\mu$ , at further specimens 23—28  $\mu$ .

Holotype: Plate II, 10, 11, slide DI/2—13; 15.3/115.5.

Locus typicus: Kleinoiching, the lowest part of Thanetian.

Stratum typicum: Dark-grey, fine-sandy clayey marl.

Derivatio nominis: From Dr. W. C. ELSIK a prominent researcher of the Paleogene sporomorphs.

Differential diagnosis: It differs from *I. klausii* n. sp. in the lack of vestibulum, as well as in the extenuations of polar exine.

Occurrence: For the time being it is only known from the locality type.

#### 6. *Interporopollenites* fsp. (Plate II, 12, 13)

Fgen.: *Kleinoichingipollenites* n. fgen.

Fgen. type: *Kleinoichingipollenites triangulus* n. fsp. (Plate II, 14, 15)

##### Diagnosis

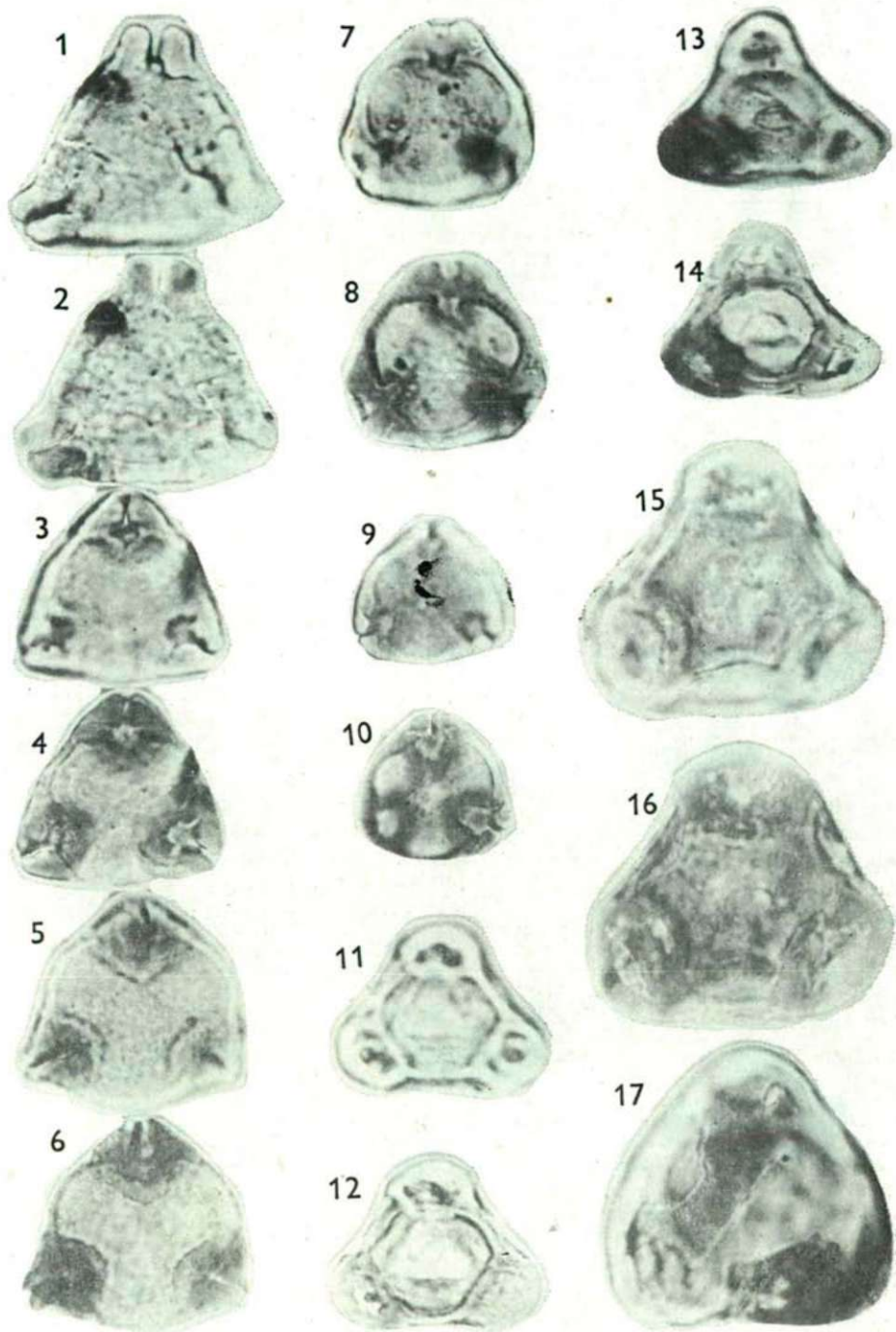
Triangular pollen grains of three pores. The surface is smooth or finely scabrate.

#### Plate I

- 1, 2. — *Extratropopollenites conjunctus* Pf. 1953a, DI/2—27; 18.2/116.9
- 3, 4. — *Oculopollis exemplum* (Pf. 1953a) n. comb., DI/2-26; 8.1/103.1.
- 5, 6. — *Oculopollis* fsp., DI/2—40; 16.9/102.6.
- 7, 8. — *Semioculopollis* fsp.<sub>1</sub>, DI/2—35; 8.1/109.5.
- 9, 10. — *Semioculopollis* fsp.<sub>2</sub>, DI/2—13; 13.5/115.0.
- 11, 12. — *Interporopollenites klausii* n. sp., DI/2—18; 7.1/116.2.
- 13, 14. — *Interporopollenites klausii* n. sp., DI/2—24; 13.2/104.6.
- 15, 16. — *Interporopollenites draxlerae* n. sp., DI/2—18; 5.7/107.2.
17. — *Interporopollenites draxlerae* n. sp., DI/2—26; 6.3/115.1.

x1000

## Plate I



The germinal apertures are of equatorial, rarely of subequatorial position. At the rim of pores there is a wavy laminiform appendage.

Locus typicus: Kleinoiching, the lowest part of Thanetian.

Stratum typicum: Dark-grey, fine-sandy clayey marl.

Derivatio nominis: From Kleinoiching, the locality type.

Differential diagnosis: The pollen grains belonging to the new genus described are well-separated from the pollen grains belonging to *Corsinipollenites* NAKOMAN 1965, as well as to *Triporopollenites* PF. et TH. 1953 by the appendages around the pores.

1. *Kleinoichingipollenites triangulus* n. fsp. (Plate II, 14, 15)

Diagnosis

Equatorial contour is triangular, with convex sides. The surface is finely scabrate. The extragerminal exine is 1—1.3  $\mu$  thick. Light-microscopically it only consists of ectexine. The tectum, infratectum and foot layer are equally thick. The diameter of pores is generally 2  $\mu$ , the appendage surrounding the exopores is 2.5—4  $\mu$  long and generally 0.5  $\mu$  wide. At the site of the beginning of the appendages of pores the exine becomes thin, generally 0.5  $\mu$  wide.

Diameter: 30  $\mu$ , at further specimens 27—32  $\mu$ .

Holotype: Plate II, 14, 15, slide DI/2—22; 8.7/110.7.

Locus typicus et stratum typicum: cf. at the diagnosis of fgen.

Derivatio nominis: From its triangular contour.

Fgen.: *Triporopollenites* PF. et TH. 1953

1. *Triporopollenites kleinoichingi* n. fsp. (Plate II, 16, 17)

Diagnosis

Equatorial contour is triangular, with strongly convex sides. The extragerminal exine is very thin 0.5—0.6  $\mu$ , always below 1  $\mu$ ; its stratification can be recognized with light microscope only with difficulty. The surface is granulated, the size of ornamental elements extends as long as 0.5  $\mu$ . The granules anastomose but rarely, when a fine rugulate ornamentation is produced. The diameter of pores is 1—2  $\mu$ , these are surrounded with a 0.6—1  $\mu$  wide annulus.

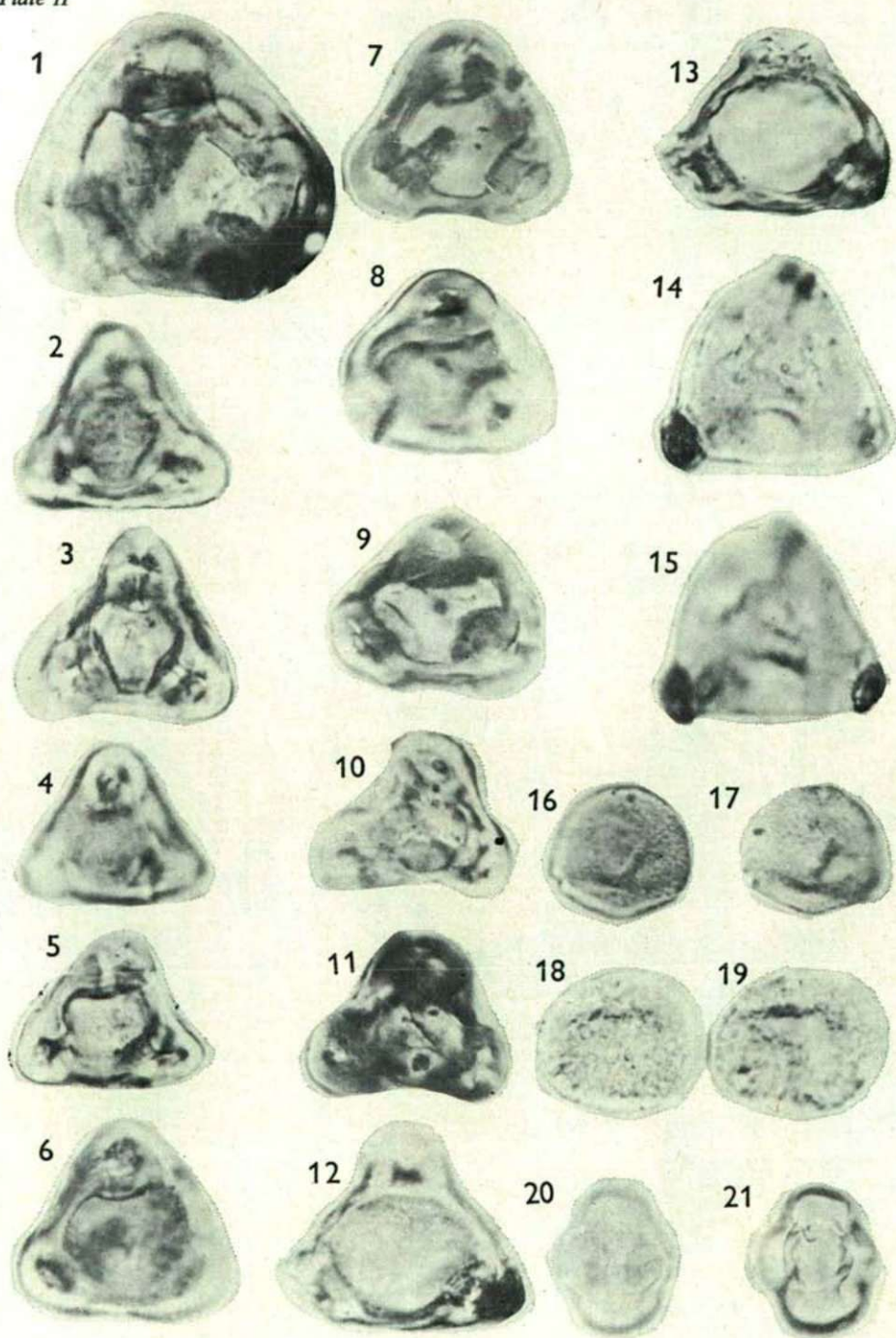
Diameter: 19  $\mu$ , at further specimens 16—22  $\mu$ .

Plate II

1. — *Interporopollenites draxlerae* n. fsp., DI/2—26; 6.3/115.1.
- 2, 3. — *Interporopollenites kleinoichingi* n. fsp., DI/2—24; 7.1/117.4.
- 4, 5. — *Interporopollenites kleinoichingi* n. fsp., DI/2—22; 16.6/117.3.
- 6, 7. — *Interporopollenites gregussii* n. fsp., DI/2—37; 12.8/115.9.
- 8, 9. — *Interporopollenites gregussii* n. fsp., DI/2—13; 20.2/111.5.
- 10, 11. — *Interporopollenites elsikii* n. fsp., DI/2—13; 15.3/115.5.
- 12, 13. — *Interporopollenites* fsp., DI/2—22; 10.0/111.7.
- 14, 15. — *Kleinoichingipollenites triangulus* n. fgen. et fsp., DI/2—22; 8.7/110.7.
- 16, 17. — *Triporopollenites kleinoichingi* n. fsp., DI/2—11; 18.9/104.1.
- 18, 19. — *Subtriporopollenites palaeocenicus* n. fsp., DI/2—14; 13.3/117.2.
- 20, 21. — *Tricolporate incertae* pollen DI/2—3; 6.8/106.8.

x1000

Plate II



Holotype: Plate II, 16, 17, prep. DI/2—11; 18.9/104.1.

Locus typicus: Kleinoiching, the lowest part of Thanetian.

Stratum typicum: Dark-grey, fine-sandy clayey marl.

Derivatio nominis: From Kleinoiching, the locality type.

Differential diagnosis: It is well-separated from the pollen grains classified into the form-genus by means of its ornamentation.

Occurrence: For the time being it is only known from its locality type.

Fgen.: *Subtriporopollenites* PF. et TH. 1953

1. *Subtriporopollenites palaeocenicus* n. fsp. (Plate II, 18, 19)

Diagnosis

Equatorial contour is circular or elliptical. The pores have a 2—2.5  $\mu$  diameter, they are narrow, with a 0.5—0.8  $\mu$  annulus. The extragerminal exine is 1—1.5  $\mu$  thick, it consists light-microscopically only of ectexine; the tectum, infratectum and the foot layer are equally thick. The sculpture is fine rugulate, the width of the ornamenting elements is 0.5  $\mu$ . There are rarely also some verrucae among the rugulate ornamental elements.

Diameter: 22  $\mu$ , at further specimens 18—26  $\mu$ .

Holotype: Plate II, 18, 19, prep. DI/2—14; 13.3./117.2.

Locus typicus: Kleinoiching, the lowest part of Thanetian.

Stratum typicum: Dark-grey, fine-sandy clayey marl.

Derivatio nominis: From the geological age of the stratum typicum.

Differential diagnosis: It can be separated from *S. constans* PF. 1953a subfsp. constans by means of its finer ornamental elements and the sporadically occurring verrucae.

Occurrence: Kleinoiching, the lowest part of Thanetian, Haidhof, Danian.

Longaxones

*Tricolporate incertae* pollen (Plate II, 20, 21)

2. Sporomorphs demonstrated in the course of investigations

Fgen.: *Leiotriletes* (NAUMOVA 1937) R. ROT. et KRP. 1954

*L. adriennis* (R. POT. et GELL 1933) W. KR. 1959, Schizaeaceae cf. *Lygodium* (DI)1c, DI(3), *L. cf. microadriennis* W. KR. 1959, Schizaeaceae cf. *Lygodium* (DI)/1c), *L. dorogensis* (KDS. 1960) KDS. 1961, Schizaeaceae, cf. *Lygodium* (DI/2), *L. fsp.*<sub>1</sub> (DI/1c), *L. fsp.*<sub>2</sub> (DI/2).

Fgen.: *Stereisporites* TH. et PF. 1953

Form-subgenus: *Stereisporites (Distgranisporis)* W. KR. 1963

*St. (Distgranisporis) fsp.*, Sphagnaceae (DI/2).

Fgen.: *Toroisporis* W. KR. 1959

*T. (Toroisporis) ecoenicus* KDS. 1966, cf. Gleicheniaceae (DI/2), *T. (Toroisporis) guinetii* KDS. 1973, cf. Gleicheniaceae (DI/3c), *T. (Toroisporis) fsp.*, cf. Gleicheniaceae (DI/2).

Fgen.: *Gleicheniidites* (ROSS. 1949) W. KR. 1959 *Gl. (Gleicheniidites) fsp.*, Gleicheniaceae (DI/2).

Fgen.: *Undulatisporites* PF. 1953

U. fsp., Gleicheniaceae (DI/1c).

Fgen.: *Echinatisporis* W. KR. 1959

*E. longechinus* W. KR. 1959, Selaginellaceae, *Selaginella* (DI/2).

Fgen. *Ischyosporites* BALME 1957

*I. asolidus* (W. KR. 1959) W. KR. 1967, Schizaeaceae (DI/1c, DI/2).

Fgen.: *Cicatricosisporites* R. POT. et GELL. 1933 *C. dorogensis* R. POT. et GELL. 1933 subfsp. *dorogensis*, Schizaeaceae, *Anemia* (DI/1c, DI/2), *C. fsp.*, Schizaeaceae, *Anemia* (DI/2.)

Fgen.: *Polypodiaceoisporites* R. POT. 1956

*P. fsp.*, Pteridaceae, *Pteris* (DI/2).

Fgen.: *Verrucingulatisporites* KDS. 1961

*V. fsp.* (DI/2).

Fgen.: *Camarozonosporites* PANT 1954 ex R. POT. 1956

Form-subgenus: *Camarozonosporites* (*Hamulatisporis*) W. KR. 1959

*C. (Hamulatisporis) bellus* (MARTYNOVA 1960) KDS. 1973, Lycopodiaceae, *Lycopodium* (DI/2).

Fgen.: *Laevigatosporites* IBR. 1933

*L. haardti* (R. POT. et VEN. 1933) TH. et PF. 1953 subfsp. *haardti*, Polypodiaceae (DI/2).

Fgen.: *Pityosporites* SEWARD 1914

*P. microalatus* (R. POT. 1931) TH. et PF. 1953, Abietaceae, *Pinus* (DI/1c, DI/2), *P. labdacus* (R. POT. 1931) TH. et PF. 1953 subfsp. *labdacus*, Abietaceae, *Pinus* (DI/1c, DI/2, B/7).

Fgen.: *Cupressacites* BOLCHOVITINA 1956

*C. hiatipites* (WODEH. 1933) W. KR. 1971, Taxodiaceae v. Cupressaceae (DI/2).

Fgen.: *Inaperturopollenites* TH. et PF. 1953

*I. concedipites* (WODEH. 1933) W. KR. 1971, Taxodiaceae (DI/1c, A/2).

Fgen.: *Ephedripites* BOLCH. 1953 ex R. POT. 1958 *E. (Ephedripites) fsp.*, Ephedraceae, *Ephedra* (DI/1c).

Fgen.: *Extratripoporollenites* (PF. 1953a) PF. 1953b *E. conjunctus* PF. 1953a (Plate I, 1, 2; DI/2).

Fgen.: *Trudopollis* PF. 1953b em. W. KR. 1967 *T. nonperfectus* (PF. 1953a) PF. 1953b (Plate II, 11, 12, in KEDVES et al. 1971; DI/2), *T. subperfectus* (PF. 1953a) PF. 1953b (Plate III, 1, 2, in KEDVES et al. 1971; DI/2), *T. hemiperfectus* (PF. 1953a) PF. 1953b (Plate III, 6, 7, in KEDVES et al. 1971; DI/2), *T. orthomechanicus* (PF. 1953a) PF. 1953b (Plate III, 3—5, in KEDVES et al. 1971; DI/2), *T. varioreticulatus* (STELMAK 1960) ZAKL. 1963 (Plate II, 13—15, in KEDVES et al. 1971; DI/2).

Fgen.: *Oculopollis* PF. 1953b

*O. exemplum* (PF. 1953a) n. comb. (Plate I, 3, 4; DI/2).

Syn.: 1953a PFLUG — *Extratripoporollenites exemplum* n. sp., p. 75, 6, 102—105

1953b PFLUG — *Trudopollis exemplum* (PFLUG) n. comb. p. 100, Pl. 25, 50.

*O. fsp.* (Plate I, 5, 6; DI/2).

Fgen.: *Semioculopollis* GÓCZÁN, W. KR. et PAULT. 1967

*S. fsp.*<sub>1</sub> (Plate I, 7, 8; DI/2), *S. fsp.*<sub>2</sub> (Plate I, 9, 10; DI/2).

- Fgen.: *Pompeckjoidaepollenites* PF. 1953b em. W. KR. 1967  
*P. subhercynicus* (W. KR. 1954) W. KR. 1967 (Plate III, 14—19, in KEDVES et al. 1971; DI/2).
- Fgen.: *Nudopollis* PF. 1953b  
*N. endangulatus* (PF. 1953a) PF. 1953b (DI/2), *N. terminalis* (PF. 1953a) PF. 1953b (Plate II, 6—8, in KEDVES et al. 1971; DI/2), *N. thiergartii* (TH. et PF. 1953) PF. 1953b (Plate II, 1—5, in KEDVES et al. 1971; DI/2), subfsp. *conspicuus* PF. 1953a (DI/2), subfsp. *minutus* PF. 1953a (DI/2).
- Fgen.: *Interporopollenites* WEYL. et KRIEG. 1953 *I. klausii* n. fsp. (Plate I, 11—14; DI/2), *I. draxlerae* n. fsp. (Plate I, 15—17, Plate II, 1, DI/2), *I. kleinoichingi* n. fsp. (Plate II, 2—5; DI/2), *I. gregussii* n. fsp. (Plate II, 6—9 DI/2), *I. elsikii* n. fsp. (Plate II, 10, 11; DI/2), *I. fsp.* (Plate II, 12, 13; DI/2).
- Fgen.: *Interpollis* W. KR. 1961  
*I. supplingensis* (PF. 1953) W. KR. 1961 (DI/2, DI/3a), *I. microsupplingensis* W. KR. (1961 (DI/2), *I. velum* W. KR. 1961 (DI/2, DI/3c).
- Fgen.: *Plicapollis* PF. 1953b  
*P. pseudoexcelsus* (W. KR. 1958) W. KR. 1961 subfsp. *turgidus* PF. 1953a, Myricaceae (DI/2, DI/3a), subfsp. *semiturgidus* PF. 1953a, Myricaceae (DI/2), subfsp. *minor* PF. 1953a, Myricaceae (DI/2, DI/3a, DI/3c).
- Fgen.: *Vacuopollis* PF. 1953b  
*V. concavus* (PF. 1953a) W. KR. 1960 (DI/2).
- Fgen.: *Minorpollis* W. KR. 1959  
*M. gallicus* KDS. 1969 (DI/2)
- Fgen.: *Stephanoporopollenites* TH. et PF. 1953  
*St. hexaradiatus* (Thg. 1940)  
 Th. et PF. 1953 subfsp. *hexaraditus* (DI/2, A/2), subfsp. *tribinae* W. KR. 1961 (DI/2).
- Fgen.: *Tetrapollis* PF. 1953b  
*T. validus* (PF. 1953a) PF. 1953b (Plate IV, 1—3, in KEDVES et al. 1971; DI/2).
- Fgen.: *Kleinoichingipollenites* n. fgen.  
*K. triangulus* n. fsp. (Plate II, 14, 15; DI/2).
- Fgen.: *Plicatopollis* W. KR. 1962  
*Pl. plicatus* (R. POT. 1934) W. KR. 1962, Juglandaceae (DI/2).
- Fgen.: *Platycaryapollenites* E. NAGY 1969  
*P. fsp.*, Juglandaceae, *Platycarya* (DI/3c).
- Fgen.: *Triatriopollenites* PF. 1953a  
*T. sauerae* (GLADKOVA 1965) KDS. 1974, Myricaceae (DI/1c), *T. intermedius* (GLADKOVA 1965) KDS. 1974, Myricaceae (DI/3a), *T. minimus* (GLADKOVA 1965) KDS. 1974, Juglandaceae, *Engelhardtia* (DI/3a), *T. sibiricus* (GLADKOVA 1965) KDS. 1974, Myricaceae (DI/2), *T. conspicuus* (GLADKOVA 1965) KDS. 1974, Myricaceae (DI/2), *T. microcoryphaeus* (R. POT. 1931) SONTAG 1972, Myricaceae (DI/2, DI/3), *T. bituitus* (R. POT. 1931) TH. et PF. 1953, Myricaceae (DI/2), *T. roboratus* PF. 1953a, Myricaceae (DI/2, A/2, B/7), *T. pseudogranulatus* (GLADKOVA 1965) KDS. 1974, Myricaceae (DI/2).
- Fgen.: *Momipites* WODEH. 1933  
*M. quietus* (R. POT. 1934) W. KR. 1972 (DI/2).
- Fgen.: *Tripoporopollenites* PF. et TH. 1953 *T. nointelensis* KDS. 1960, Corylaceae

(DI/2), *T. robustus* PF. 1953a subfsp. *robustus*, Betulaceae (DI/2), *T. coryloides* PF. 1953a, Corylaceae (DI/3c), *T. kleinoichingi* n. fsp. (Plate II, 16, 17; DI/2).

Fgen.: *Subtriporopollenites* PF. et TH. 1953

*S. constans* PF. 1953a subfsp. *constans*, Juglandaceae (DI/2, DI/3a), subfsp. *magnus* W. KR. 1961, Juglandaceae (DI/2, DI/3a), *S. subporatus* W. KR. 1961 subfsp. *subporatus*, Juglandaceae (DI/2, B/7), *S. anulatus* PF. et TH. 1953 subfsp. *anulatus*, Juglandaceae cf. *Carya* (DI/2), *S. palaeogenicus* n. fsp. (Plate II, 18, 19, DI/2, B/7).

Fgen.: *Intratriporopollenites* PF. et TH. 1953

*I. microreticulatus* MAI 1961, Tiliaceae (DI/2).

Fgen.: *Duplopollis* W. KR. 1959

*D.* fsp., Myrtaceae (DI/1c).

Fgen.: *Pentapollenites* W. KR. 1958

*P. triangulus* W. KR. 1962 (DI/2).

Fgen.: *Monocolpopollenites* TH. et PF. 1953

*M. tranquilus* (R. POT. 1934) TH. et PF. 1953 subfsp. *tranquillus*, Palmae (DI/2, DI/3a, DI/3c).

Fgen.: *Sparganiaceapollenites* THIERGART 1937 *S. cuvillieri* (GRUAS-CAV. 1966) W. KR. 1970, Sparganiaceae (DI/1c).

Fgen.: *Cupuliferoideaepollenites* R. POT. 1960 *C. liblarensis* (THOMS. in POT., THOMS. et THIERG. 1950) R. POT. 1960, Fagaceae v. Leguminosae (DI/1c, DI/3a, DI/2), *C. quisqualis* (R. POT. 1934) R. POT. 1960, Fagaceae v. Leguminosae (DI/2, B/7, DI/3c).

Fgen.: *Cupuliferoipollenites* R. POT. 1960

*C. pusillus* (R. POT. 1934) R. POT. 1960, Fagaceae cf. *Castanea* (DI/1c, DI/3a, DI/2, B/7, DI/3c), *C. oviformis* (R. POT. 1931) R. POT. 1960, Fagaceae, *Castanea* (DI/3a, DI/2, A/2, DI/3c).

Fgen.: *Psilatricolporites* (Van der HAMMEN 1956) Van der HAMMEN et WIJSTRA 1964

*Ps. parmularius* (R. POT. 1934) KDS. 1978, Eucommiaceae (DI/2), *Ps.* fsp. (DI/1c).

Fgen.: *Striatricolporites* (Van der HAMMEN 1956) LEIDELMEYER 1966

*S.* fsp. (DI/2).

### *Longaxones incertae sedis*

*Tricolporate incertae pollen* (Plate II, 20, 21; DI/2).

Fgen.: *Tetracolporopollenites* PF. et TH. 1953

*T. oblongus* PF. et TH. 1953, Sapotaceae (DI/1c), *T. halimbaense* KDS. 1961, Sapotaceae (DI/2).

Apart from sporomorphs, we could also observe other microfossils: *Botryococcus*, *Pediastrum*, *Concentricystes* (=Pseudoschizaea), *Pleurozonaria concinna* (COOKSON et MANUM 1960 MADLER 1968, Hystrichosphaeridae, chitin-framed Foraminiferae).

## 3. Quantitative data

### 3.1. Maastrichtian

Haselhof

The investigated sample is poor in sporomorphs. Normapollens are few, resp. there did not occur in any forms characteristic of this period. The presence of *Stephanopropollenites hexaradiatus* is rather referring to the Paleocene, Monsian or

## Thanetian age.

## 3.2 Danian

## Haidhof

In this locality as well, we could only observe a few sporomorphs. *Triatriopollites roboratus* is the only „old Tertiary” pollen grain.

## 3.3 Monsian

## Oiching

The results relating to this can be found in KEDVES's publication (1970). The composition of the sporomorphs of suitable quantity refers to the typical lower Paleocene period.

## 3.4 Thanetian

## Lowest part of Thanetian

## Oiching

There are only few sporomorphs but their composition is interesting. The content of 38.7 per cent spores and 3.2 per cent plankton refers to an open assemblage. This is supported by Sparganiaceae and Myricaceae, as well, indicating the vegetation of a river-side bog. The 25.8 per cent pine-pollen grains with bladders give the character of an extrapalustral forest. The quantity of the pollen grains of the marsh Gymnospermae — Taxodiaceae v. Cupressaceae — is very small.

## Kleinoiching

It is extremely rich in sporomorphs. The quantity of spores is small (9.5 per cent). Plankton organisms (*Botryococcus*, *Pediastrum*, *Concentricystes*, *Pleurozonaria concinna*, Hystrichosphaeridae) are similarly few 4.7 per cent. Angiospermae represent 38.3 per cent in the spore-pollen spectrum. The ratio of Gymnospermae (47 per cent) is the highest and within this, the amount of those with bladders is abundant (40.2 per cent). Within Angiospermae, the ratio of *Normapolles* is 30.4 per cent. The riverside vegetation is characterized by the 33.6, resp. 23.6 per cent ratio of Myricaceae and ancient Juglandaceae (*Carya* type). In the extrapalustral vegetation, in addition to the *Pinus* genus, Fagaceae are also considerable.

## St. Pankraz (a level more closely not specified, of the Thanetian stage)

In contrast to the above-mentioned Thanetian localities, the number of pine pollen grains is but a minimum, not more than 4 per cent. It is interesting that there occurred no pine pollen with bladders at all in this locality. The ratio of spores, Hystrichosphaeridae and Foraminiferae is similarly low, 1 per cent each. The dominating role of Angiospermae in the spore-pollen spectrum is outstanding: 93 per cent. Within Angiospermae, Fagaceae dominate (85.7 per cent), indicating a semiterrestrial marshy environment. Myricaceae are 7.6 per cent, Juglandaceae 3.2 per cent, Normapolles 3.2 per cent. In this way, the quantity of the palustral-forest elements is but a minimum.

## 3.5 Cuisian

## Lower Cuisian

## St. Pankraz

The sporomorphous quantity is middle-sized. The pollen grain of Fagaceae, *Castanea*-type is dominant. From the point of view of geological age, *Interpollis velum* and *Plicapollis pseudoexcelsus* minor are considerable. The beginning of the

Middle Eocene tropical flora is indicated by the higher number of *Palmae* pollen grains.

Michelsberg (a level of Cuisian, not specified more closely)

This exclusively contains *Hystriochosphaeridae* remnants.

### Discussion

The demonstrated microscopic remnants refer to the following taxa:

Chrysophyta, Xanthophyceae, Heterochloridales (*Botryococcus*).

Chlorophyta, Chlorophyceae, Chlorococcales (*Pediastrum*), Bryophyta, Musci, Sphagnales (*Sphagnum*).

Pteridophyta, Lycopsidea, Lycopodiales (*Lycopodium*), Selaginellales (*Selaginella*).

Pteropsida, Leptosporangiatae, Filicales, Schizaeaceae (cf. *Lygodium*, *Anemia*), Gleicheniaceae, Polypodiaceae, Pteridaceae (*Pteris*).

Gymnospermatophyta, Coniferopsida, Pinales, Abietaceae (*Pinus*), Taxodiaceae v. Cupressaceae.

Ephedropsida, Ephedrales, (*Ephedra*).

Angiospermatophyta, Dicotyledonopsida, Hamamelidales, Eucommiaceae, Leguminosae, Myrtiflorae, Myrtaceae, Malvales, Tiliaceae, Ebenales, Sapotaceae, Fagales, Betulaceae, Corylaceae, Fagaceae (*Castanea*), Juglandaceae (*Platycarya*, *Engelhardtia*, cf. *Carya*), Myricaceae, Monocotyledonopsida, Palmales, *Palmae*, Pandanales, Sparganiaceae.

In respect to the climatic conditions of the Paleocene it is to be established by reason of the present results, as well, that in its vegetation the number of the expressed tropical elements is comparatively low. This is shown partly by ferns, partly by *Palmae*. The plants pollinated by wind are widely distributed, while the species and individual number of plants pollinated by insects is very low. The outstanding dominance of the *Pinus* genus in the sediments of Oiching and Kleinoiching considered as Thanetian is particularly interesting. This is namely known beginning from the Upper Eocene. But it is characteristic of the upper part of the Oligocene when a further pine type with bladders, the *Picea* genus also appears. The richness of the modern pine pollen grains in form and individual is characteristic of the Neogene.

In connection with the stratigraphic value of spore-pollen assemblages of the investigated sediments the following comments are to be made:

The Maastrichtian age of Haselhof is not probable, owing to the occurrence of the typical forms of *Stephanoporopollenites hexaradiatus hexaradiatus*. This pollen type characterizes in Europe the Paleocene very well and can be divided by its subsp. well. The problem needs some further investigations. By reason of the data so far, Monsian or the lower part of Thanetian is the most probable age.

In the lower Thanetian of Kleinoiching the co-called „old forms” are very frequent. These are characteristic partly of the Upper Danian (*Extratropopollenites conjunctus*, *Tetrapollis validus*, *T. polyangulus*), partly they are characteristic taxa rather of the Upper Cretaceous (*Trudopollis nonperfectus*, *T. subperfectus*, *T. hemiperfectus*, *T. orthomechanicus*, *Oculopollis exemplum*, *Interporopollenites* spp.). It can, therefore, be possible that a number of the pollen grains of *Normapollis* are redeposited. This possibility is, however, not supported by the state of preservation of sporomorphs. It is much more possible that the strata of Kleinoic-

hing that are considered as Thanetian, are of older age. As a probable geological age, the Upper Danian or Lower Monsian can be given.

It is to refer here to our results achieved at the Monsian strata of Oiching. It is interesting that Kleinoiching is very rich in pollen grains originating from the Upper Cretaceous which can be found only restrainedly in the Monsian strata of Oiching; on the other hand, the "old Postnormapolles" (*Triatriopollenites pseudovestibulum*, *T. aroboratus*) occur just here. The lack of fgen. *Interporopollenites* in the Monsian is worth mentioning. This is supporting the conclusion that the taxa of plants producing this pollen type — on the basis of electron-microscopic data, the ancient Juglandales — are facies-sensitive.

We could not observe any pollen grains of typical Paleocene Angiospermatophytes from the Thanetian strata of Oiching. The spore-pollen assemblage first of all refers to the conditions of the sedimentary process, cf. with the high percentage of Pteridophytes.

The *Stephanoporopollenites* genus, which is very characteristic of the age, was not found from the Thanetian strata of St. Pankraz. At any rate, the Plicapolis, *Interpollis*, *Subtriporopollenites constans* refer to the old Tertiary.

The problem of Cuisian is still to be clarified by means of further investigations. The vegetation history of the transition from the flora of the Lower Eocene to that of the Middle Eocene and on the basis of this its pollen stratigraphy demand further investigations.

Finally, the palynology of the sediments of the Austrian Upper Cretaceous — Lower Paleogene cannot be considered as closed. Several problems have been raised by the present investigations as well. Particularly the solution of the problem of the Danian and Cuisian needs further investigations. These results are very important from the point of view of the Paleogene of the Carpathian basin, as well, because in the Lutetian a tropical vegetation existed. This had developed from the Lower Eocene flora, the question of which cannot be regarded as closed down even today.

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