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PALYNOLOGICAL INVESTIGATIONS ON SEDIMENTS OF THE LOWER DANIAN (FISH CLAY, DENMARK) I

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ABSTRACT

The first part of the spore-pollen investigations into the Fish Clay layers in Denmark, the *Angiospermatophyta* pollen grains are summarized in the present paper. We have succeeded in demonstrating altogether 57 form-species. Of these 24 are *Normapolles*, 18 *Postnormapolles*, resp. 14 *Longaxones*. There are described the following new taxons: *Semioculopollis croxtonae* n. fsp., *S. daniensis* n. fsp., *Trudopollis bangii* n. fsp., *T. hojrupensis* n. fsp., *Pompeckjoidaepollenites stockmarrii* n. fsp., *P. daniensis* n. fsp. *Jarzenipollenites trinus* [STANLEY, 1965] n. fgen. n. comb., *Vacuopollis pflugii* n. fsp., *Minorpollis hojstrupensis* n. fsp.. *Triatriopollenites grabowskae* n. fsp. The assemblage are of Upper Cretaceous character. There occurred none of the forms particularly characteristic of the Paleocene.

INTRODUCTION

The attention of geologists and palaeontologists has been engaged for a long time past by the problem of transition between the Cretaceous and Tertiary Periods. On palynological basis, too, this problem is extremely complicated. This is the cause of that a considerable part of the investigations is concentrated on the Danian, Monsian and Thanetian layers. The Danian stage is considered as the uppermost part of the Upper Cretaceous or the lower part of the Paleocene, but the designation Danian-Paleocene is frequent in palynological works. The problem is complicated by that the palaeophytogeographical regions are most express in the Upper Cretaceous and Paleocene Periods. The investigation into the Danian stage is regarded as particularly important in more than one paper. Cf. the K-TEC research programme of the Canadian work-team (BÉLAND, P., FELDMAN, P., FOSTER, J., JARZEN, D., NORRIS, G., PIROZYNSKI, K., REID, G., ROY, J.—R., RUSSEL, D., TUCKER, W.). This work-team called the attention to the palaeontological and palaeoecological importance of the supernova theory.

At datings on palynological basis, the knowledge of the spore-pollen composition of the type locality is absolutely indispensable. There are unfortunately, some cases, like that of Danian, when no sporomorphs are contained in the stratotype [KEDVES, 1967]. In this case, Fish Clay is the only comparative matter to be regarded as typical.

The stratigraphy of *Dinoflagellatae* of the sediments of the Danian, Upper Maastrichtian in Denmark was elaborated by HANSEN [1977].

MATERIAL AND METHOD

In answer to my request, an opportunity presented itself for me to investigate the following samples:
Stevns Klint — from CATHERINE A. CROXTON (The Geological Survey of Greenland),
Højrup — from JENS STOCKMARR (Geological Survey of Denmark),
Højstrup, bor. 5 DG 7, K75119, lab. no 127, 25—31 cm below top of core — from INGER BANG (Geological Survey of Denmark),
North Jütland, quarry named Dania.

At the preparation, there were applied different methods but the classical $ZnCl_2$ separation proved to be best.

RESULTS

Fgen.: OCULOPOLLIS PF. 1953b

The form-genus is complicated in respect of its electronmicroscopic structure as well. There was demonstrated endexine at *O. zaklinskaiae* GÓCZÁN 1964 by HEGEDŰS, KEDVES and PÁRDUTZ [1971]. This is an ancient characteristic within the *Normapolles* stemma. On the basis of the foregoing scanning electronmicroscopic results [KEDVES and RADVÁNSZKI 1975, ONORATINI and AZEMA 1973, MEDUS 1977], the form-genus is heterogenous, and on the basis of the ultrasculpture, two main types can be separated. The taxonomical value of these is not cleared up, as yet.

1. *O. minoris* W. KR. 1973 (Plate I, 1, 2)

As to its contour, it is no typical representative of the species described from the Maastrichtian layers of Oebisfelde.

2. Cf. *O. minoris* W. KR. 1973 (Plate I, 3, 4)

The oculi are of different sizes at the two different surfaces.

3. *O.* fsp. (Plate I, 5, 6)

Its measure is little prominent, its characteristic is given by the oculi, growing narrow in the direction of poles.

Fgen.: SEMIOCULOPOLLIS GÓCZÁN, W. KR. and PACLT. 1967

1. *Semioculopollis croxtonae* n. fsp. (Plate I, 7, 8)

Diagnosis

It has the form of an equatorial contour triangle. The surface is granulated, finely verrucate. The extragerminal exine is 1.3 μ thick, consisting light-microscopically only of ectexine its stratification can difficultly be observed, the infratectum is narrow. The exogerminalia are narrow colpi. The annulus is express, 3 μ thick. The vestibulum is narrow, it has an express endannulus which is 1.5 μ thick. The endoapertures are large, the pores have 3 μ diameters, the pollen is heteropolar, on one of the sides there are narrow oculi.
Maximum size: 24 μ (20—30 μ).
Holotype: Plate I, 7, 8, slide Stevns Klint-7, co-ordinates 6.4/110.2.
Locus typicus: Stevns Klint.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of Dr. C. A. CROXTON.
Differential diagnosis: The size of *S. praedicatus* (WEYL. and KRIEG. 1953) W. KR. 1967 is smaller and its surface is rugulate, the exine structure of *S. lapillus* (PF. 1953b) W. KR. 1967 is intrabaculate.
Occurrence: Stevns Klint, Højrup, Dania.

2. *Semioculopollis daniensis* n. fsp. (Plate I, 9, 10)

Diagnosis

Contour is triangular, with convex sides. The surface is punctate. The extragerminal exine is 1.5—2 μ thick. The tectum, infratectum and foot layer are equally thick. The exogerminalia are narrow colpi. The annulus is 4 μ thick, somewhat centripetal. The vestibulum is narrow. The endannulus is not express, the nexine does not incurve, centripetally. At one of the sides, there are express oculi. The diameter of endopores is 2.5 μ.

Maximum size: 24 μ (20—28 μ).

Holotype: Plate I, 9, 10, slide Dania-33, co-ordinates 7.6/112.2.

Locus typicus: Dania (N. Jütland).

Stratum typicum: Fish Clay.

Derivatio nominis: From the locality of the type.

Differential diagnosis: It is separated well from *S. croxtonae* n. fsp. by the ornamentation of the surface, the missing endannulus, and the narrow endopores.

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

Fgen.: TRUDOPOLLIS PF. 1953b emend. W. KR. 1967

The exine ultrastructure investigation into the *T. mechanicus* PF. 1953b was carried out by HEGEDŰS, KEDVES and PÁRDUTZ [1972]. Its endexine could not be demonstrated, that is a more developed pecularity. The infratectum consists of short elements of varied shapes. This reminds us of the recent *Amentiflorae*.

1. *Trudopollis bangii* n. fsp. (Plate I, 11, 12)

Diagnosis

Contour is triangular with convex sides. The extragerminal exine is 1.8 μ thick. The tectum is somewhat thicker than the infratectum and foot layer, respectively. The exogerminalia is narrow colpi. The annulus is centripetal and 4 μ thick. There is only a very small, narrow vestibulum. It has an express, centripetally incurved 1.3 μ thick endannulus. There is a large, triangular atrium, in the direction of the poles of the pollen.

Maximum size: 25 μ (20—28 μ).

Holotype: Plate I, 11, 12, slide Dania-20, co-ordinates 15.4/117.7.

Locus typicus: Dania (N. Jütland).

Stratum typicum: Fish Clay.

Derivatio nominis: In honour of DR. I. BANG.

Differential diagnosis: It is separated from *T. concretor* PF. 1953b by the shape of the annulus and endannulus.

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

2. *T.* fsp.$_1$ (Plate I, 13, 14)

Contour is triangular, with convex sides. The surface is smooth or finely scabrate. The extragerminal exine is 1 μ thick, the tectum, infratectum, and foot layer are equally thick. The exogerminalia are narrow colpi. There is an express 2.5 μ thick centripetal annulus. There is a narrow, comparatively long vestibulum. The endannulus is 0.9 μ thick, incurving centripetally inside. The atrium is granular.

Note. — *T. retifectus* WEYL. and KRIEG. 1953 is similar, but has a intrareticulate structure.

Occurrence: Højstrup.

3. *Trudopollis hojrupensis* n. fsp. (Plate I, 15, 16)

Diagnosis

Contour is triangular, with straight or somewhat convex sides. The surface is granulate or finely rugulate. The extragerminal exine is 1 μ thick, the infratectum is narrower than the tectum, resp. the foot layer. The exogerminalia are short, narrow colpi. The annuli are 3.5 μ thick, they incurve somewhat inside. The vestibulum is long, narrow. The endannuli are comparatively narrow (0.9 μ), they incurve only a little centripetally. The endogerminalia are broad pores (3 μ).

Maximum size: 22 μ (18—25 μ).

Holotype: Plate I, 15, 16, slide D_3-95, co-ordinates 19.5/117.4.

Locus typicus: Højrup.

Stratum typicum: Fish Clay.

Derivatio nominis: From the locality of the type.

Differential diagnosis: *T. orthomechanicus* PF. 1953b is similar but its exine is of baculate structure.

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

4. *T.* fsp.$_2$ (Plate I, 17, 18)

Contour is triangular, with convex sides. The surface is scabrate. The extragerminal exine is 2 μ thick, the tectum, infratectum, foot layer are equally thick. The annulus is 3 μ thick and centripetally incurves. There is an expressed vestibulum. The endannulus is 2 μ thick, wedge-shaped. The atrium is narrow.

Note. — It was found in two damaged specimens from the locality Højrup. There is not known any similar pollen in the literature.

Fgen.: HUNGAROPOLLIS GÓCZÁN 1964

HEGEDŰS, KEDVES and PÁRDUTZ [1971] have performed ultrastructure investigations into the genus and ascertained a particular type, not the same as the other *Normapolles*.

1. Cf. *H.* fsp. (Plate I, 19, 20)

Contour is triangular, with convex sides. The surface is scabrate. In one of the poles, there is a formation, similar to a not express papillus. The extragerminal exine is 4 μ thick, the infratectum is extremely narrow, the tectum and foot layer are equally thick. The endogerminalia are long, narrow colpi. The annulus is 3.5 μ thick, incurving centripetally. The vestibulum is narrow. The endannulus is 3 μ thick, the atrium is small.

Occurrence: Højrup.

Fgen.: POMPECKJOIDAEPOLLENITES PF. 1953b emend. W. KR. 1967

The ultrastructure investigation into the *P. subhercynicus* PF. 1953b emend. W. KR. 1967 exine was performed by KEDVES and PÁRDUTZ [1970]. The channels of the tectum and the granular infratectum refer to the origin from *Amentiflorae*. The perforated tectum and the similarly to *Amentiflorae* referring coni at the surface have been ascertained by the scanning electronmicroscopic results [STANLEY and KEDVES 1975].

1. *Pompeckjoidaepollenites stockmarrii* n. fsp. (Plate I, 21, 22)

Diagnosis

The equatorial contour is triangular, with convex sides. The surface is granulate, the sculpture elements often anastomose, a rugulate sculpture comes about. The extragerminal exine is 1.3 μ thick, the tectum, infratectum, and foot layer are equally

thick. The annuli are 3—4 μ thick, incurving centripetally. The vestibulum is small, wedge-shaped. The endannulus is wedge-shaped, 0.7 μ thick. The atrium is broad, the platea is express, broad.
Maximum size: 38 μ (35—43 μ).
Holotype: Plate I, 21, 22, slide D_3-54, co-ordinates 10.1/103.3.
Locus typicus: Højrup.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of DR. J. STOCKMARR.
Differential diagnosis: It is well-separated by the broad express platea from *P. absurdus* (WEYL. and KRIEG. 1953) W. KR. 1967.
Occurrence: For the time being, it is only known from the locality of the type.

2. *P. subhercynicus* PF. 1953b emend. W. KR. 1967 (Plate I, 23, 24)

Cf. its electronmicroscopical results at the form-genus. In our material, typical individuals of the form-species also occurred.
Occurrence: Højrup, Højstrup, Dania.

3. *Pompeckjoidaepollenites daniensis* n. fsp. (Plate I, 25, 26)

Syn. — 1969, KEDVES — *Pompeckjoidaepollenites* fsp. B, Pl. 2, 9—12.

Diagnosis

The equatorial contour is triangular, with very convex sides. The surface is scabrate, or finely punctate. The extragerminal exine is 1.2 μ thick, the infratectum is thinner than the tectum, resp. foot layer. The exogerminalia are narrow colpi. The annulus is narrow, incurving only a little, its thickness is 2.2 μ. The vestibulum is narrow, the endannulus is not express. It has a wedge-shaped, 0.8 μ thick, small atrium. The platea is only little express, narrow.
Maximum size: 16 μ (14—20 μ).
Holotype: Plate I, 25, 26, slide Dania-36, co-ordinates 18.9/107.5.
Locus typicus: Dania (N. Jütland).
Stratum typicum: Fish Clay.
Derivatio nominis: From the locality of the holotype.
Differential diagnosis: It is separated by its smaller size and narrow platea from *P. subhercynicus* PF. 1953b emend. W. KR. 1967.
Occurrence: Dania (N. Jütland), U. Sparnatian (Guitrancourt B_1 32, Faciés Argiles des Flandres: Templeuve-en-Pévèle B_1-25), Cuisian: Fosses I—III.

4. *Pompeckjoidaepollenites hojrupensis* n. fsp. (Plate II, 1, 2)

Diagnosis

Contour is triangular, with very convex sides. The surface is smooth. The extragerminal exine is 1 μ thick, the infratectum is narrower than the tectum, resp. the columellar layer. The exoapertures are only somewhat elongated pores, comparatively broad colpi. The annulus is 2.2 μ thick, prominent, somewhat incurving. The atrium is narrow, short. The endannulus is 1 μ thick, centripetally incurving. The platea is narrow, a little express.
Maximum size: 17 μ (15—18 μ).
Holotype: Plate II, 1, 2, slide D_3-75, co-ordinates 21.4/104.3.
Locus typicus: Højrup.
Stratum typicum: Fish Clay.
Derivatio nominis: From the locality of the type.
Differential diagnosis: It is separated by its surface and prominent annulus from *P. daniensis* n. fsp.

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

5. *P.* fsp. (Plate II, 3, 4)

It occurred with a single damaged specimen from the locality Stevns Klint

Fgen.: NUDOPOLLIS Pf. 1953b

Transmission electronmicroscopic data about *N. terminalis* (Th. and Pf. 1953) Pf. 1953b, by Kedves and Párdutz [1970]. The scanning elaboration of the same form-species was performed by Stanley and Kedves [1975]. The electronmicroscopic results refer to *Myricaceae* origin.

1. *N. terminalis* (Th. and Pf. 1953) Pf. 1953b (Plate II. 5, 6)

Occurrence: Højrup, Dania (N. Jütland).

Fgen.: PLICAPOLLIS Pf. 1953b

The SEM and TEM data of *P. pseudoexcelsus* (W. Kr. 1958) W. Kr. 1961 equally refer to *Myricaceae* origin [Kedves and Párdutz 1970, Stanley and Kedves 1975].

1.1. *P. pseudoexcelsus* (W. Kr. 1958) W. Kr. 1961 subfsp. *turgidus* Pf. 1953a (Plate II, 7, 8)

Occurrence: Dania (N. Jütland).

1.2. subfsp. *semiturgidus* Pf. 1953a (Plate II, 9, 10)

Occurrence: Højrup.

1.3. subfsp. *luteticus* Kds. 1969 (Plate II, 11, 12)

Occurrence: Stevns Klint, Højrup.

1.4. subfsp. *minor* Pf. 1953a (Plate II, 13, 14)

Occurrence: Højrup.

Fgen.: JARZENIPOLLENITES n. fgen.

Fgen. type: *J. trinus* (Stanley 1965) n. comb. (Plate II, 15—20)

Syn. — 1965, Stanley — *Alnus trina* n. sp., Pl. 43, 4—6

Diagnosis

The equatorial contour is triangular, with convex sides. There are three germinal apertures, these are pores, and there is a small centripetal annulus. Germinalia are connected with one another by arcuses. The surface is smooth or punctate.

Genus type: in Stanley, Pl. 43, 4—6.

Locus typicus: North Cave Hills, Harding Co., South Dakota.

Stratum typicum: Ludlow member, Fort Union Formation, Paleocene.

Derivatio nominis: In honour of Dr. D. M. Jarzen.

Differential diagnosis: The surface of *Ulmoideipites* Anderson 1960 is expressly sculptured, rugulate.

Species diagnosis: See at Stanley [1965].

Note. — The pollen grain published under the name *Simarubaceae* [Bratzeva 1969, Pl. 61, 7], may probably belong to the described form-genus. The form of Jarzen [1976], Plate I, 4; *Alnus* type is identical with the *J. trinus*.

Occurrence: North Cave Hills, Harding Co., South Dakota, Paleocene, Saskatchewan (Canada), Maastrichtian and Paleocene, Dania (N. Jütland).

2. *J.* fsp. (Plate II, 21, 22)

Occurrence: Stevns Klint.

Fgen.: INTERPOLLIS W. Kr. 1961

A modern TEM and SEM elaboration is known from Stanley and Kedves [1975]. The ultrastructure of the *I. microsupplingensis* W. Kr. 1961 differs from the

other fossil *Angiospermatophyta* pollen grains. By the SEM investigations, coni, characteristic of *Amentiflorae* were established.

1. *I. supplingensis* (PF. 1953a) W. KR. 1961 (Plate II, 23—26)
The observed specimens are smaller than the typical forms.
Occurrence: Højrup, Dania (N. Jütland).

2. *I. velum* W. KR. 1961 (Plate II, 27, 28)
Occurrence: Højrup.

3. *I. microsupplingensis* W. KR. 1961 (Plate II, 29—36)
A very great form-variation could be observed.
Occurrence: Højrup, Højstrup, Stevns Klint, Dania (N. Jütland).

Fgen.: VACUOPOLLIS PF. 1953b

TEM data are from *V. orthopyramis* PF. 1953b (Upper Cretaceous). The exine structure of this, differs from that of the other *Normapolles* [HEGEDŰS, KEDVES and PÁRDUTZ 1972]. At the surface of *V. concavus* (PF. 1953a) W. KR. 1960 from the Eocene there are coni. This is general enough within the *Normapolles* stemma and is an *Amentiflorae* characteristic.

1. *Vacuopollis pflugii* n. fsp. (Plate III, 1, 2)
Diagnosis

Contour is triangular, with concave sides. The surface is punctate-scabrate. The extragerminal exine is 1.6 μ thick, the infratectum is somewhat thicker than the tectum and foot layer.Th e infratectum is of columellar structure. The exogerminalia are 1 μ broad short colpi. The annulus is extremely narrow, hardly observable. The foot layer is only partially missing from the pore region.
Maximum size: 25 μ (23—28 μ).
Holotype: Plate III, 1, 2, slide Stevns Klint-8, co-ordinates 9.6/114.2.
Locus typicus: Stevns Klint.
Stratum typicum: Fish Clay.
Derivatio nominis: In honour of PROF. DR. H. PFLUG.
Occurrence: For the time being, it is only known from the locality of the type.

Fgen.: MINORPOLLIS W. KR. 1959

1. *Minorpollis hojstrupensis* n. fsp. (Plate III, 3, 4)
Diagnosis

Equatorial contour is triangular, with convex sides. The surface is smooth. The extragerminal exine is 0.6 μ thick, the infratectum is very narrow, its structure cannot be identified. It has an extremely small centripetal annulus. The exogerminalia are short colpi.
Maximum size: 9 μ (8—10 μ).
Holotype: Plate III, 3, 4, slide Højstrup-12, co-ordinates 16.7/117.7.
Locus typicus: Højstrup.
Stratum typicum: Fish Clay.
Derivatio nominis: From Højstrup, the locality of the type.
Differential diagnosis: It is separated from *M. gallicus* KDS. 1969 by its thinner wall and smaller size.
Occurrence: For the time being, it is only known from the locality of the type.

2. *M. gallicus* KDS. 1969 (Plate III, 5—8)
Occurrence: Højrup, Dania (N. Jütland).

Fgen.: TRIATRIOPOLLENITES PF. 1953a

1. *Triatriopollenites grabowskae* n. fsp. (Plate III, 9—16)

Diagnosis

The equatorial contour is triangular, with stratight or somewhat convex sides. The surface is punctate. The extragerminal exine is 2 μ thick, the tectum, infratectum and foot layer are equally thick. The exact structure of the infratectum cannot be identified with light microscope, it is probably of granular structure. The exogerminalia are 1 μ broad, short colpi. The infratectum becomes thick in the germinal region, the annulus is 2 μ thick. The atrium is intragranulate.

Maximum size: 16 μ (14—17 μ).

Holotype: Plate III, 9, 10, slide D_2—1—1, co-ordinates 11.6/120.2.

Locus typicus: Højrup.

Stratum typicum: Fish Clay.

Derivatio nominis: In honour of DR. I. GRABOWSKA.

Differential diagnosis: It is separated from *T. rurobituitus* PF. 1953a by its comparatively thick wall and smaller size.

Occurrence: Højrup, Dania (N. Jütland).

Note. — This species was published by GRABOWSKA [1968] from the L.—M. Eocene layers of Szczecin, without any nearer determination, Pl. III, 81.

2. *T. cycloquietus* W. KR. 1961 (Plate III, 17, 18)

Occurrence: Højrup, Dania (N. Jütland).

3. *T.* fsp. A (Plate III, 23, 24)

Equatorial contour is triangular, with convex sides. The surface is scabrate. The extragerminal exine is 1 μ thick, the tectum, infratectum and foot layer are equally thick. The exoapertures are comparatively long colpi. The annulus is 2.5 μ thick. The atrium is finely intrapunctate.

Occurrence: Højstrup.

4. *T. rurensis* PF. and TH. 1953 (Plate III, 25, 26)

Occurrence: Højrup.

5. *T.* fsp. B (Plate III, 27—30)

Occurrence: Højrup.

Fgen.: MYRTACEIDITES COOKSON and PIKE 1954 em. R. POT. 1960

1. *M.* fsp. (Plate III, 31, 32)

Occurrence: Højrup.

Fgen.: SPARGANIACEAEPOLLENITES THIERGART 1937

1. *Sp.* cf. *cuvillieri* (GRUAS-CAV. 1966) W. KR. 1970, *Sparganiaceae* (Plate III, 33, 34)

Occurrence: Højrup.

Fgen.: LABRAPOLLIS W. KR. 1968

1. Cf. *L. rotundoides* W. KR. 1968 (Plate III, 35, 36)

Occurrence: Højrup.

2. *L. labraferoides* (W. KR. 1961) W. KR. 1968 (Plate III, 19—22, 37, 38)

Occurrence: Dania (N. Jütland), Stevns Klint.

3. *L. globosus* (PF. 1953a) W. KR. 1968 (Plate III, 39, 40)

Occurrence: Dania (N. Jütland).

Fgen.: PORTNIAGINAEPOLLENITES KDS. 1974

1. *P.* fsp. (Plate IV, 1, 2)

Contour is approximately circular. The surface is scabrate. The extragerminal exine is 2 μ thick, the tectum is thicker than the foot layer. The infratectum is of express, columnar structure. The diameter of pores is 1.5 μ, the annulus is small. The atrium is also small but express.
Occurrence: Højrup.

Fgen.: TRIPOROPOLLENITES PF. and TH. 1953
1. *T. undulatus* PF. 1953a, *Ulmaceae* (Plate IV, 3—6)
Occurrence: Højrup, Højstrup.
2. *T. robustus* PF. 1953a subfsp. *robustus,* cf. *Betulaceae* (Plate IV, 7, 8)
Occurrence: Højrup.
3. *T. festatus* TAKAHASHI 1961, *Betulaceae* (Plate IV, 9, 10)
Occurrence: Stevns Klint.

Fgen.: SUBTRIPOROPOLLENITES PF. and TH. 1953
The ultrastructure investigation into *S. constans* PF. 1953a subfsp. *constans* was carried out by KEDVES and STANLEY [1976]. The anastomosing infratectum consisting of irregular, short elements refers to *Amentiflorae* origin.
1. *S. constans* PF. 1953a subfsp. *constans* (Plate IV, 11, 12)
Occurrence: Højrup, Dania (N. Jütland).
2.1. *S. anulatus* PF. and TH. 1953 subfsp. *anulatus, Juglandaceae* cf. *Carya* (Plate IV, 13, 14)
Occurrence: Højrup.
2.2. *S. anulatus* PF. and TH. 1953 subfsp. *nanus* PF. and TH. 1953, *Juglandaceae* cf. *Carya* (Plate IV, 15—18)
Occurrence: Dania (N. Jütland).
3. *S.* fsp. (Plate IV, 19, 20)
Contour is circular or ellipsoid. The surface is smooth. The exine is 1 μ thick, the tectum, infratectum and foot layer are equally thick. The exact structure of the infratectum cannot be identified with light microscope. The diameters of pores are 1.5 μ, there are narrow, annulus-like formations around them.
Occurrence: Højstrup.

Fgen.: ARECIPITES WODEH. 1933
1. *A.* fsp., *Palmae* (Plate IV, 21, 22)
Occurrence: Højstrup.

Fgen.: CUPULIFEROIPOLLENITES R. POT. 1960
1. *C. insieyanus* (TRAVERSE 1955) R. POT. 1960, *Fagaceae, Castanea* (Plate IV, 23, 24)
Occurrence: Højstrup.
2. *C. pusillus* (R. POT. 1934) R. POT. 1960, *Fagaceae,* cf. *Castanea* (Plate IV, 25—28, Plate V, 1, 2)
Occurrence: Højstrup, Stevns Klint.
3. *C. oviformis* (R. POT. 1931) R. POT. 1960, *Fagaceae, Castanea* (Plate V, 3, 4)
Occurrence: Dania (N. Jütland).

Fgen.: PSILATRICOLPORITES (VAN DER HAMMEN 1956a) VAN DER HAMMEN and WIJMSTRA 1964
1. *Ps.* fsp. (Plate V, 5, 6)
Contour is ellipsoid, the surface is smooth. The extragerminal exine is 1.6 μ thick, the tectum, infratectum and nexine are by and large of equal thickness. The

exact structure of the infratectum cannot be identified with light microscope. Colpi are narrow, reaching the poles, with an about 1 μ broad cavern. The endogerminalia are narrow, split-like fugae.
Occurrence: Stevns Klint.

2. *Ps.* cf. *microparmularius* KDS. and DIN. 1978 (Plate V, 7, 8)
Occurrence: Højrup.

Fgen.: INTRABACULITRICOLPORITES KDS. 1978

1. *I.* fsp.$_1$ (Plate V, 9, 10)

Contour is elliptical. The surface is smooth, the tectum being finely perforated. The exine is 0.8 μ thick, the infratectum is thicker than the tectum and nexine. The colpi are narrow slit-like, reaching the poles almost always. Colpi are surrounded by a 0.8 μ broad cavern. The endopores are elliptical, orientated in the direction of the longitudinal axis of the pollen, their size being 1.5×2 μ.
Occurrence: Højstrup.

2. *I.* fsp.$_2$ (Plate V, 11, 12)

Contour is elliptical, in the middle somewhat enlarging. The surface is smooth, the tectum, infratectum and nexine are equally thick. The infratectum is of expressly columellar structure. The colpi are united with the cavium, encurving a little outside at the poles. Colpi are surrounded by an about 1 μ broad cavern. The endopores are more or less circular, with 3 μ diameters.
Occurrence: Dania (N. Jütland).

3. *I.* fsp.$_3$ (Plate V, 13, 14)

Contour is elliptical. The surface is smooth or scabrate. Under the ectexine, endexine can be separated light-microscopically, its thickness being identical with one layer of ectexine. The tectum, infratectum and foot layer are equally thick. The infratectum consists of fine columellar elements. Colpi are narrow slit-like, not reaching the poles. The cavern is about 0.6 μ broad. The endopores are narrow slit-like.
Occurrence: Stevns Klint.

4. *I.* fsp.$_4$ (Plate V, 15, 16)

Contour is approximately circular. The surface is smooth. The exine is 1.3 μ thick, under the ectexine a thick endexine can be separated. The tectum, infratectum and foot layer are equally thick. The infratectum is of very fine columellar structure. Colpi are narrow slit-like, with a 0.3 μ broad cavern. Colpi are united with the cavium in the poles. The endopores are elliptical (1×2 μ).
Occurrence: Stevns Klint.

5. *I.* fsp.$_5$ (Plate V, 21, 22)

Contour elliptical. The surface is smooth or scabrate. The exine is 2.5 μ thick, consisting light-microscopically of ectexine and endexine. The infratectum is thicker than the tectum and foot layer. The infratectum is of expressly columellar structure. Colpi are slit-like, with a 1.5 μ broad cavern and reaching the poles generally. The endogerminalia are elliptical (1.5×3—4 μ).
Occurrence: Dania (N. Jütland).

Fgen.: NYSSAPOLLENITES THIERGART 1937

1. *N.* fsp., *Nyssaceae* v. *Mastixiaceae* (Plate V, 17, 18)
Occurrence: Højrup.

2. Cf. *N.* fsp., *Nyssaceae* v. *Mastixiaceae* (Plate V, 19, 20)
Occurrence: Stevns Klint.

Fgen.: RETITRICOLPORITES (VAN DER HAMMEN 1956) VAN DER HAMMEN and WIJMSTRA 1964

1. *R.* fsp. (Plate V, 23, 24)

Occurrence: Højrup.

Fgen.: ILEXPOLLENITES (THIERGART 1937) R. POT. 1960

1. I. fsp., *Aquifoliaceae, Ilex* (Plate V, 25, 26)

Occurrence: Højrup.

DISCUSSION

It is to be mentioned at evaluating the demonstrated spore-pollen assemblages that — although 57 angiospermous pollen form-species could be demonstrated — the investigated material is not rich in sporomorphs and the lack of certain types can only be evaluated under reserve. In PFLUG's material (1953a, b) from Wehmingen there are, according to our present-day knowledge, some species characteristic of the Paleocene, as well; *Stephanoporopollenites hexaradiatus, Extratriporopollenites audax,* etc. I have to mention the richness in species of the *Nudopollis* genus, as well, which is not characteristic of the material from Denmark. KRUTZSCH [1966], classifying the Danian into the Paleocene, distinguishes two main assemblage types. The type from Zahna is comparatively poor in sporomorphs. The richness of *Erdtmanipollis* fspp. is interesting. From this assemblage, the *Stephanoporopollenites* fgen. is missing, as well as the *Pompeckjoidaepollenites,* too; this latter is, however, frequent enough in the material from Denmark. The assemblages (A—C) of Roda type are very rich in the *Angiospermatophyta* pollen grains. The occurs the so-called Paleocene form of *Stephanoporopollenites, Tetrapollis, Extratriporopollenites.* From among the more developed types, *Milfordia, Pentapollenites* and *Compositoipollenites* occur.

Our demonstrated assemblage differs from those dealt with above just in the lack of the forms which are characteristic of the Paleocene. Compared with the results from the Maastrichtian till now, it can mostly be placed over the spore-pollen assemblage of KRUTZSCH and MIBUS [1973] from Walbeck. The connective link with the assemblage from Denmark is represented in this assemblage by the presence of *Interpollis* and *Pompeckjoidaepollenites.* On the other hand, the richness of the *Trudopollis, Oculopollis* fgen., the presence of *Bohemiapollis, Complexiopollis, Extremipollis, Paravacuopollis,* etc. in the assemblage of Walbeck is a good delimiting characteristic.

Summarizing, the spore-pollen assemblage of Fish Clay (Lower Danian) contains, apart from the *Normapolles* originating from the Upper Cretaceous, several *Postnormapolles,* as well, which are characteristic of the Lower Tertiary. The forms which are particularly characteristic of the early Paleocene sediments, are missing. After the Walbeck assemblage of Maastrichtian age, the Fish Clay can be located very well on palynological basis, as the representative of the lower part of the Danian, and the other assemblages (Wehmingen, Zahna, Roda) are to be classified into the Upper Danian. Thus the Danian is, from palynological point of view, of double character. Within the Danian, considerable changes took place in Europe in the development of the vegetation. The measure of the palynological difference between the Walbeck-assemblage and that from Fish Clay is by and large identical with that between the Upper Danian assemblages. In Fish Clay, the younger elements are given by the forms which are characteristic of the Eocene, as well, without the pollen grains which are characteristic of the Early Paleocene. By this is given the characteristic of this assemblage originating from the boundary of the Cretaceous and Tertiary Periods.

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PLATE I

1, 2. — *Oculopollis minoris* W. KR. 1973, D_3—2—3; 20.3/110.5.
3, 4. — Cf. *Oculopollis minoris* W. KR. 1973, D_3—75; 2.4/116.0.
5, 6. — *Oculopollis* fsp., D_2—1—8; 20.7/111.1.
7, 8. — *Semioculopollis croxtonae* n. fsp., Stevns Klint—7; 6.4/110.2.
9, 10. — *Semioculopollis daniensis* n. fsp., Dania—33; 7.6/112.2.
11, 12. — *Trudopollis bangii* n. fsp., Dania—20; 15.4/117.7.
13, 14. — *Trudopollis* fsp.$_1$, Højstrup—27; 11.8/117.4.
15, 16. — *Trudopollis hojrupensis* n. fsp., D_3—95; 19.5/117.4.
17, 18. — *Trudopollis* fsp.$_2$, D_3—88; 22.9/116.0.
19, 20. — Cf. *Hungaropollis* fsp., D_3—49; 14.5/111.2.
21, 22. — *Pompeckjoidaepollenites stockmarrii* n. fsp., D_3—54; 10.1/103.3.
23, 24. — *Pompeckjoidaepollenites subhercynicus* PF. 1953b emend. W. KR. 1967, Dania—7; 18.2/102.4.
25, 26. — *Pompeckjoidaepollenites daniensis* n. fsp., Dania—36; 18.9/107.5.
× 1000

PLATE II

1, 2. — *Pompeckjoidaepollenites hojrupensis* n. fsp., D_3—75; 21.4/104.3.
3, 4. — *Pompeckjoidaepollenites* fsp., Stevns Klint—29; 22.8/104.4.
5, 6. — *Nudopollis terminalis* (TH. and PF. 1953) PF. 1953b, D_2—1—5; 4.4/107.1.
7, 8. — *Plicapollis pseudoexcelsus* (W. KR. 1958) W. KR. 1961 subfsp. *turdigus* PF. 1953a, Dania—5; 19.5/112.5.
9, 10. — *Plicapollis pseudoexcelsus* (W. KR. 1958) W. KR. 1961 subfsp. *semiturgidus* PF. 1953a, D—3—35; 8.7/101.6.
11, 12 — *Plicapollis pseudoexcelsus* (W. KR. 1958) W. KR. 1961 subfsp. *luteticus* KDS. 1969, Stevns Klint—40; 22.2/111.5.
13, 14. — *Plicapollis pseudoexcelsus* (W. KR. 1958) W. KR. 1961 subfsp. *minor* PF. 1953a, D_2—1—1; 12.2/118.7.
15, 16. — *Jarzenipollenites trinus* (STANLEY 1965) n. fgen. n. comb., Dania—16; 12.2/112.4.
17, 18. — *Jarzenipollenites trinus* (STANLEY 1965) n. fgen. n. comb., Dania—36; 12.4/114.1.
19, 20. — *Jarzenipollenites trinus* (STANLEY 1965) n. fgen. n. comb., Dania—10; 22.0/110.2.
21, 22. — *Jarzenipollenites* fsp., Stevns Klint—6; 21.8/114.2.
23, 24. — *Interpollis supplingensis* (PF. 1953a) W. KR. 1961, D_2—1—8; 1.2/113.2.
25, 26. — *Interpollis supplingensis* (PF. 1953a) W. KR. 1961, Dania—18; 5.5/118.7.
27, 28. — *Interpollis velum* W. KR. 1961, D_2—1—2; 16.5/120.9.
29, 30. — *Interpollis microsupplingensis* W. KR. 1961, D_3—67; 11.4/112.4.
31, 32. — *Interpollis microsupplingensis* W. KR. 1961, D_3—76; 12.3/119.2.
33, 34. — *Interpollis microsupplingensis* W. KR. 1961, D_2—1—8; 8.1/126.3.
35, 36. — *Interpollis microsupplingensis* W. KR. 1961, Stevns Klint—37; 6.0/114.9.
× 1000

PLATE III

1, 2. — *Vacuopollis pflugii* n. fsp., Stevns Klint—8; 9.6/114.2.
3, 4. — *Minorpollis hojstrupensis* n. fsp., Højstrup—12; 16.7/117.7.
5, 6. — *Minorpollis gallicus* KDS. 1969, D—2—1; 17.3/106.3.
7, 8. — *Minorpollis gallicus* KDS. 1969, Dania—1; 17.3/104.4.
9, 10. — *Triatriopollenites grabowskae* n. fsp., D_2—1—1; 11.6/120.2.
11, 12. — *Triatriopollenites grabowskae* n. fsp., Højstrup—39; 10.7/116.4.
13, 14. — *Triatriopollenites grabowskae* n. fsp., Højstrup—40; 18.4/116.3.
15, 16. — *Triatriopollenites grabowskae* n. fsp., Højstrup—8; 11.6/120.6.
17, 18. — *Triatriopollenites cycloquietus* W. KR. 1961, D—1—x—9; 4.7/123.8.

19, 20. — *Labrapollis labraferoides* (W. Kr. 1961) W. Kr. 1968, Stevns Klint—20; 4.7/111.4.
21, 22. — *Labrapollis labraferoides* (W. Kr. 1961) W. Kr. 1968, D_3—1; 22.1/123.1.
23, 24. — *Triatriopollenites* fsp. A, Højstrup—33; 15.0/117.3.
25, 26. — *Triatriopollenites rurensis* Pf. and Th. 1953, D_3—5; 5.2/108.3.
27, 28. — *Triatriopollenites* fsp. B, D_3—20; 23.0/123.6.
29, 30. — *Triatriopollenites* fsp. B, D_2—1—1; 22.9/105.9.
31, 32. — *Myrtaceidites* fsp., D_2—2—6; 8.9/106.5.
33, 34. — *Sparganiaceaepollenites* cf. *cuvillieri* (Gruas—Cav. 1966) W. Kr. 1970, *Sparganiaceae*, Højstrup—41; 13.1/115.8.
35, 36. — Cf. *Labrapollis rotundoides* W. Kr. 1968, D_2—2—x—1; 16.7/119.1.
37, 38. — *Labrapollis labraferoides* (W. Kr. 1961) W. Kr. 1968, Dania—18; 5.5/112.4.
39, 40. — *Labrapollis globosus* (Pf. 1953a) W. Kr. 1968, Dania—1; 18.1/120.7.
× 1000

Plate IV

1, 2. — *Portniaginaepollenites* fsp., D_3—3; 9.4/109.7.
3, 4. — *Triporopollenites undulatus* Pf. 1953a, *Ulmaceae;* D_3—67; 14.0/110.7.
5, 6. — *Triporopollenites undulatus* Pf. 1953a, *Ulmaceae;* Højstrup—2; 7.4/105.4.
7, 8. — *Triporopollenites robustus* Pf. 1953a subfsp. *robustus*, cf. *Betulaceae*, D_2—1—5; 18.2/104.7.
9, 10. — *Triporopollenites festatus* Takahashi 1961, *Betulaceae*, Stevns Klint—1; 13.6/104.5.
11, 12. — *Subtriporopollenites constans* Pf. 1953a subfsp. *constans*, D_3—37; 18.7/119.2.
13, 14. — *Subtriporopollenites anulatus* Pf. and Th. 1953, subfsp. *anulatus*, *Juglandaceae* cf. *Carya*, D_3—95; 6.5/110.5.
15, 16. — *Subtriporopollenites anulatus* Pf. and Th. 1953 subfsp. *nanus* Pf. and Th. 1953, *Juglandaceae* cf. *Carya*, Dania—19; 4.7/114.8.
17, 18. — *Subtriporopollenites anulatus* Pf. and Th. 1953 subfsp. *nanus* Pf. and Th. 1953, *Juglandaceae* cf. *Carya*, Dania—13; 9.5/102.2.
19, 20. — *Subtriporopollenites* fsp., Højstrup—49; 18.5/110.7.
21, 22. — *Arecipites* fsp., *Palmae*, Højstrup—5; 9.2/120.7.
23, 24. — *Cupuliferoipollenites insleyanus* (Traverse 1955) R. Pot. 1960, *Fagaceae, Castanea*, Højstrup—8; 4.5/118.3.
25, 26. — *Cupuliferoipollenites pusillus* (R. Pot. 1934) R. Pot. 1960, *Fagaceae*, cf. *Castanea*, Stevns Klint—39; 13.5/120.8.
27, 28. — *Cupuliferoipollenites pusillus* (R. Pot. 1934) R. Pot. 1960, *Fagaceae*, cf. *Castanea*, D_3—3; 2.3/115.5.
× 1000

Plate V

1, 2. — *Cupuliferoipollenites pusillus* (R. Pot. 1934) R. Pot. 1960, *Fagaceae*, cf. *Castanea*, D_3—5; 19.3/124.3.
3, 4. — *Cupuliferoipollenites oviformis* (R. Pot. 1931) R. Pot. 1960, *Fagaceae, Castanea*, Dania—10; 8.3/110.1.
5, 6. — *Psilatricolporites* fsp., Stevns Klint—44; 18.6/104.0.
7, 8. — *Psilatricolporites* cf. *microparmularius* Kds. and Din. 1978, D_2—1—7; 19.1/114.5.
9, 10. — *Intrabaculitricolporites* fsp.$_1$, Højstrup—10; 16.8/114.6.
11, 12. — *Intrabaculitricolporites* fsp.$_2$, Dania—31; 8.9/116.1.
13, 14. — *Intrabaculitricolporites* fsp.$_3$, Stevns Klint—5; 9.0/120.2.
15, 16. — *Intrabaculitricolporites* fsp.$_4$, Stevns Klint—3; 12.7/118.3.
17, 18. — *Nyssapollenites* fsp., *Nyssaceae* v. *Mastixiaceae*, D_3—20; 22.1/116.6.
19, 20. — Cf. *Nyssapollenites* fsp., *Nyssaceae* v. *Mastixiaceae*, Stevns Klint—10; 12.8/116.8.
21, 22. — *Intrabaculitricolporites* fsp.$_5$, Dania—16; 3.3/104.5.
23, 24. — *Retitricolporites* fsp., D_2—1—9; 17.2/121.5.
25, 26. — *Ilexpollenites* fsp., *Aquifoliaceae, Ilex*, D_3—34; 14.7/112.7.
× 1000

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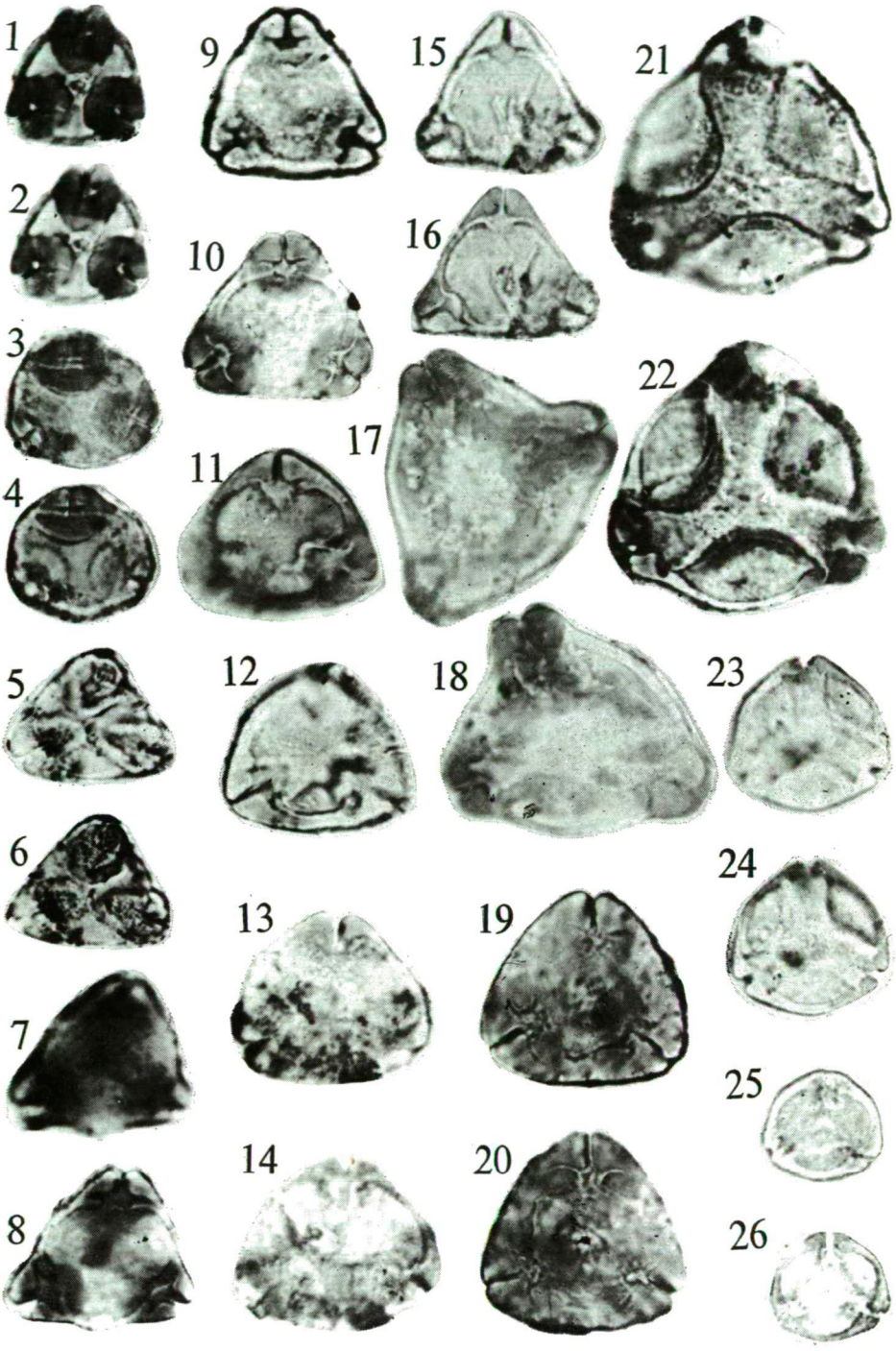
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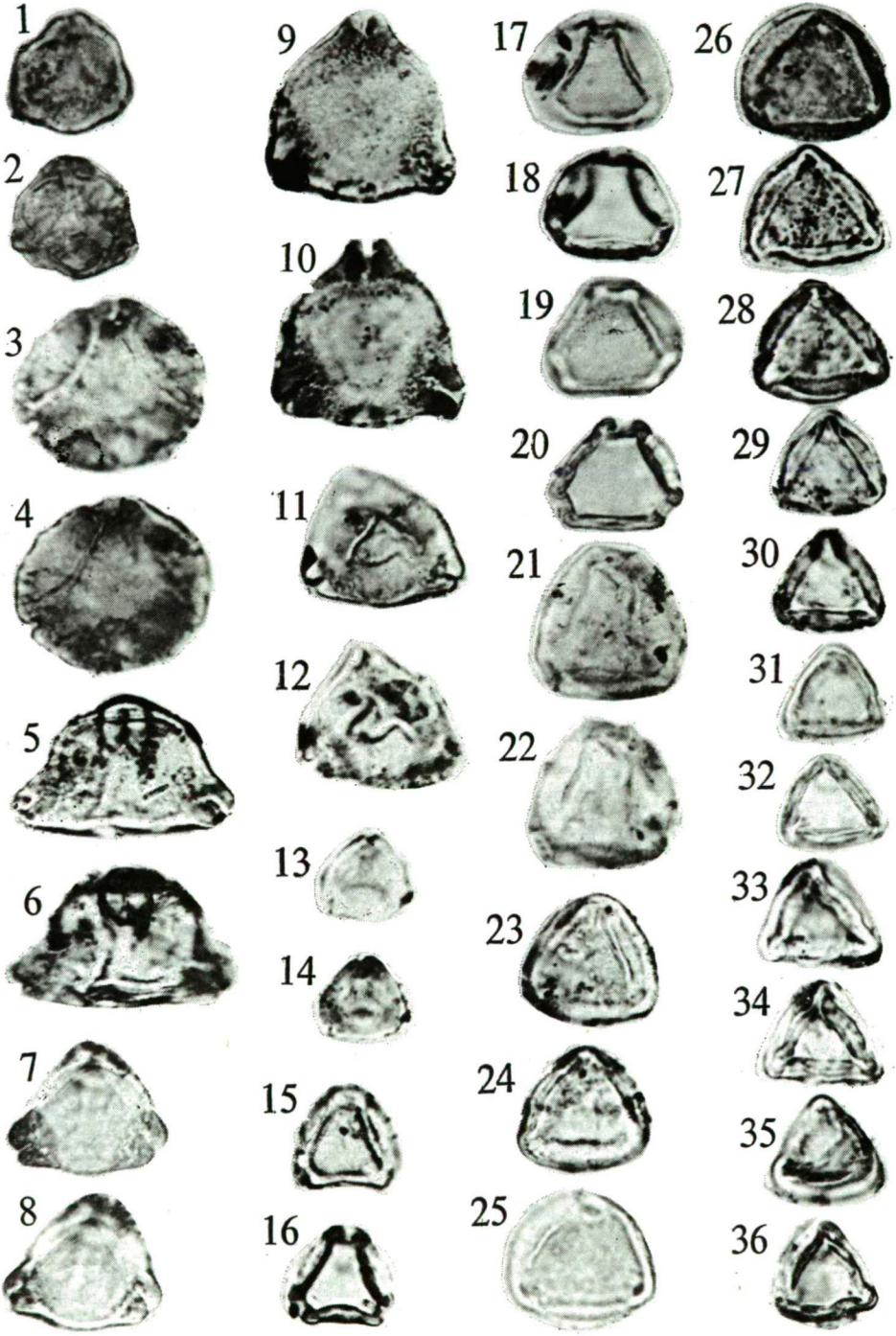
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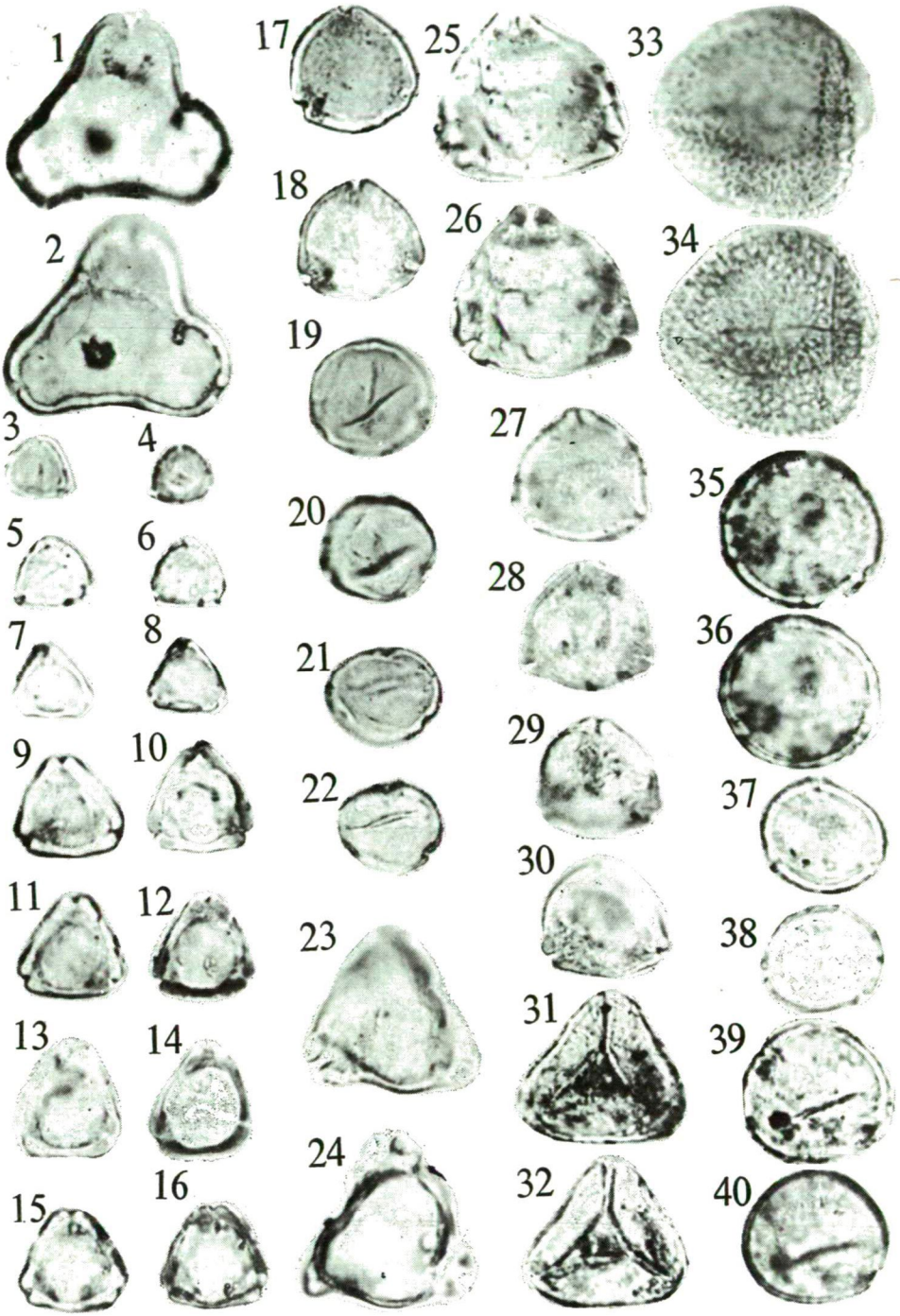
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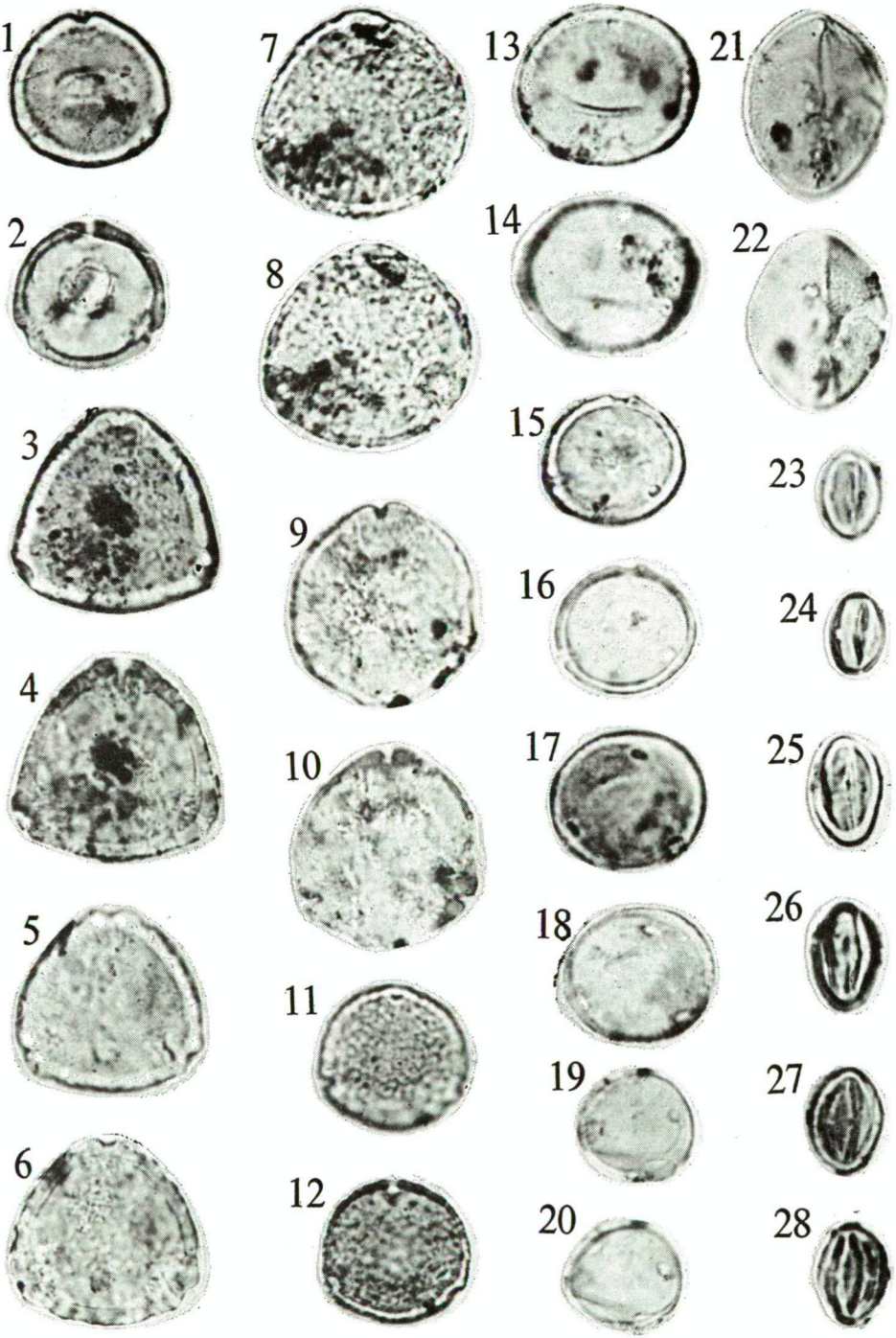
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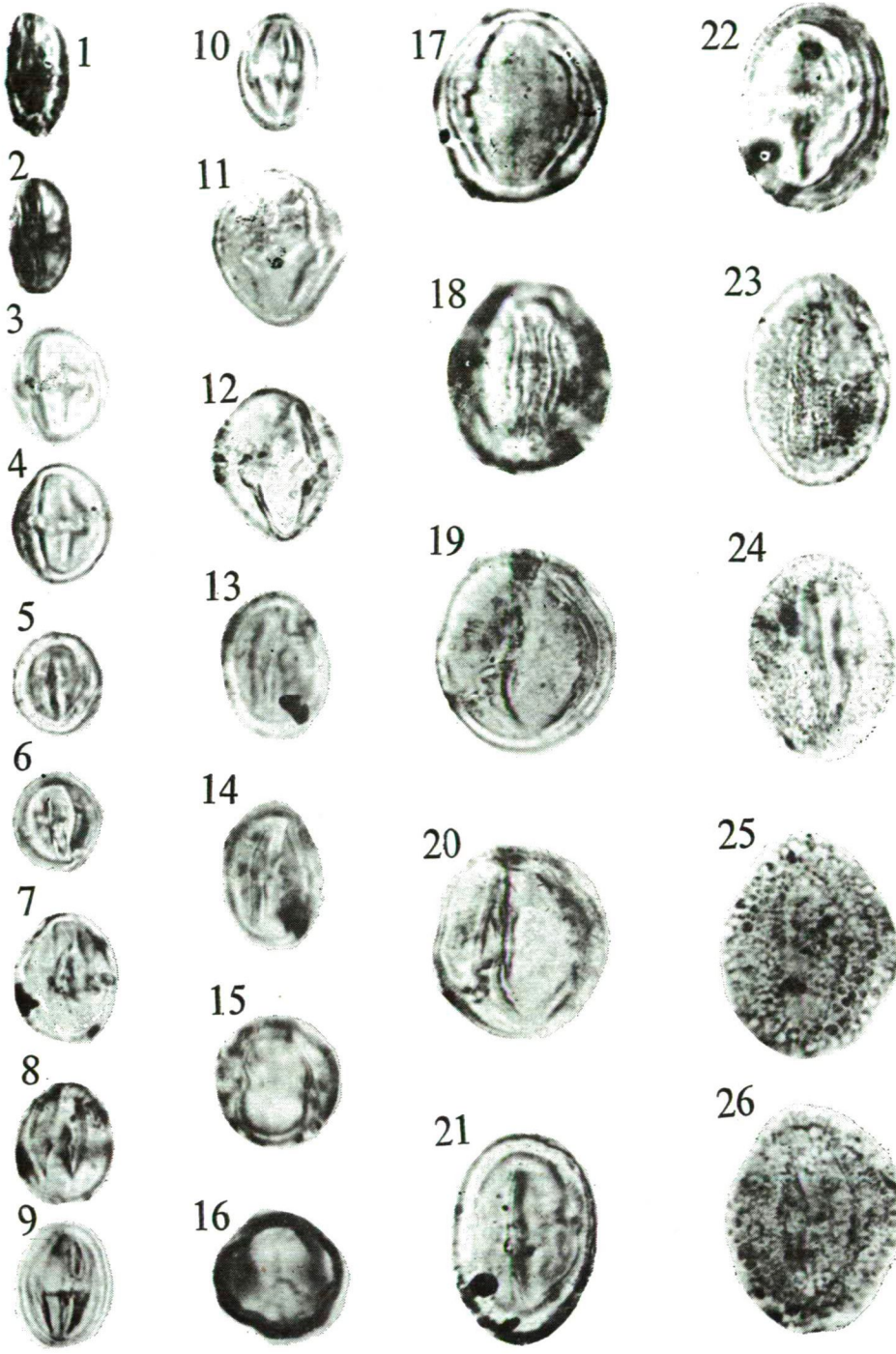
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