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NORMAPOLLES TAXA FROM PALAEOCENE SEDIMENTS

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Introduction

The genera of Normapolles stemma were elaborate in PFLUG's paper (1953), the description of several species were, however, included in a previous publication by THOMSON and PFLUG (1953). The papers of WEYLAND and GREIFELD (1953) as well as of WEYLAND and KRIEGER (1953) are also of prime importance. Later on, the spore-pollen assemblage of sediments from the Upper Cretaceous period was treated in several works, and numerous data came to light recently. Particularly the monographs of ZAKLINSKAIA (1963), and GÓCZÁN, GROOT, KRUTZSCH and PACLTOVÁ (1967) are noteworthy.

These grains of pollen are the remains of a group of ancient *Angiospermae*, their exine and germinal structure being extremely complicated. In respect of determining the geological age, their occurrence besides the Upper Cretaceous period also in the Lower Palaeogene sediments is particularly important. The palaeophytographic region, established on the basis of their limited geographical distribution, is referring among others to the European centre of the development of *Angiospermae*. In the spore-pollen assemblage of the sediments from the Lower Tertiary period we need — particularly for determining the geological age — a more comprehensive knowledge of them from morphological, taxonomical and stratigraphic point of view.

Our work is dealing with the species belonging to genera *Basopollis* PF. 1953, *Nudopollis* PF. 1953, *Trudopollis* PF. 1953, *Pompeckjoidaepollenites* (PF. 1953) W. KR. 1967, *Oculopollis* PF. 1953. *Tetrapollis* PF. 1953, and *Stephanoporopollenites* PF. et TH. 1953, from three localities of Palaeocene age (Oiching, Kleinoiching — Austria — and Menat — France). Furthermore, the description of a new genus is also necessary. The pollen grains belonging to genus *Stephanoporopollenites* PF. et TH. 1953 are of outstanding significance from the point of view of sediments of the Palaeocene period. Their literary data are, therefore, summed up separately, as follows.

The first data was published by THIERGART (1940) from the sediments in Hannover of the Palaeocene age, under the name: *Poll. hexaradiatus* n. sp. (Plate XII, Figs. 32, 33). Its stratigraphic importance, i. e. its role as an „index fossil" in determining the geological age, was first referred by POTONIÉ (1935). Its exact description was published in the monograph of THOMSON and PFLUG (1953) (Fgen.: *Stephanoporopollenites* PFLUG et THOMSON 1953; Fgen. type: *Stephanoporopollenites hexaradiatus* (THIERGART) TH. et PF. 1953), by issuing

further localities: Wehmingen — Danian? (Palaeocene; Antweiler — Palaeocene) Lower Eocene. TSCHIGOURIAEVA (1956) published by the name of *Heliotropium anomalum?* (*Pollenites hexaradiatus* THIERG.) a recent valuable data from the Palaeocene sediments from Ukraine. KRUTZSCH (1958) in his work, summing up the most important sporomorphic types of the Upper Cretaceous — Tertiary periods, published several further localities concerning the „Hexaradiatus Gruppe", and later on KRUTZSCH — in KRUTZSCH, PCHALEK and SPIEGLER 1960 — mentioned the occurrence of the genus in the Lower Palaeocene of W. Brandenburg. The Siberian data of KOPITOVA and GRIAZEVA (1960) is important [*Stephanoporo-poll. hexaradiatus* (THIERG.) PFLUG]. It occurred only in one of the four bore-holes mentioned by them — No. 32 — in 1,7 per cent. The modern taxonomical elaboration of the genus was carried out by KRUTZSCH (1961). Further data: in the works of LENK (1961, 1964 — in KUNERT and LENK), KEDVES (1967a, b, 1968a, b) and GRABOWSKA (1968). GÓCZÁN, GROOT, KRUTZSCH and PACLTOVÁ (1967) published new data about the morphology and taxonomy of the pollen grains of *Stephanoporopollenites* PF. et TH. 1953 genus, while revising the *Normapolles* PFLUG 1953 stemma genus. Their stratigraphic importance has been supported by newer, exact data whose essence is as follows:

1) The Palaeocene age is indicated with certainty by the presence of pollen grains in the *Normapolles* province.

2) The Palaeocene age can be clearly divided into zones by the occurrence of some members (form-species, resp. form-subspecies) of their development series.

We have to refer to, as well, that GÓCZÁN, GROOT, KRUTZSCH and PACLTOVÁ (1967) emphasized the necessity of the modern morpho-statistical elaboration of the domain of forms, in hope further results.

Results

Fgen.: *Basopollis* PFLUG 1953

From Lower Tertiary sediments several species are known, the revision of a considerable part of which seems to be reasonable. In order to solve taxonomical problems presenting themselves during our investigations, we need to know the germinal structure of *Basopollis atumescens* (PF. 1953) PF. 1953 and *Basopollis basalis* (TH. et PF. 1953) PF. 1953. On the basis of diagnoses and the published microphotographs, we endeavour to represent them as precisely as possible (Fig. 1).

The genus is represented in our material only in the Thanetian of Menat with two new species to be described below.

N o t e. — As one of the results of our exine ultrastructure investigations of the *Normapolles* species from the Upper Cretaceous and Lower Eocene ages — KEDVES, HEGEDŰS and PÁRDUTZ — we disuse the expressions ectexine and endexine, used so far, in descriptions with the light microscope method. On the basis of the ultrastructural data, the ectexine is of triple proportions (tectum, columellae, foot layer). Endexine — that differs from ectexine in its electron affinity — could not be observed so far in Normapolles from the Lower Eocene

age. The part found by the light microscope to be endexine may be identified with foot layer, lamella „a" of the ectexine with the tectum, and „b" with the columella layer. We endeavour with the help of ultrastructure investigations to elucidate these problems.

1. *Basopollis vancampoae* n. fsp. (Plate I, 1—6; Fig. 1).

Diagnosis

The outer contour has a concave form, the inner contour is approximately triangular. The outer layer of exine is undetachable from the inner one. The extragerminal exine is about 2—2,3 μ thick, the outer layer is much thicker than the inner (V = 3,5—4/1). The outer layer divides into further two parts, the exolamella „b" is of about the same thickness and structure like the inner one, the exolamella „a" considerably thickens in the pore-region. Its thickness is 2,3—3 μ. The pore-canal is 5—8 μ long, its inner two-third part widening out. The pore-canal index, P/d = 0,28—0,41. Owing to the characteristic and several hollows of exolamella „b", there develop several (5—7) small praevestibules being asymmetric in the holotype. There is no vestibule. The inner layer sometimes rises somewhat in V-form in the germinal region.

Maximum size: 20—25 μ.
Holotype: Plate I, 1—3, prep. Menat—34; 22,1/115,9.
Locus typicus: Menat, Palaeocene, Thanetian, zone II.
Stratum typicum: Palaeocene marl.
Derivatio nominis: In honor of Dr. M. VAN CAMPO.
Differential diagnosis: It is well separable from *Basopollis atumescens* (PF. 1953) PF. 1953 by its several tiny praevestibules.

2. *Basopollis guinetii* n. fsp. (Plate I, 7—9; Fig. 1).

Diagnosis

The contour is more or less triangular, with concave sides. The extragerminal exine is 1,9—2,5 μ thick, the outer layer being thicker than the inner one (V = 2—3/1). Exolamella „b" is structured, its thickness being about equal with the inner layer. Exolamella „a" thickens very much in the pore region, the anulus becomes thinner towards the exopore. The pore-canal is 6—9 μ long with numerous (10 or more) tiny praevestibules. Pore-canal index, P/d = 0,32 in average. In optical section, the anulus has a radial structure in interstices more or less corresponding to the praevestibules. The vestibule is developed narrow, crescentformed. The inner layer often rises in the germinal region, with small endopore.

Maximum size: 25—30 μ.
Holotype: Plate I, 7—9, prep. Menat—38; 20,1/113,6.
Locus typicus: Menat, Palaeocene, Thanetian, zone II.
Stratum typicum: Palaeocene marl.
Derivatio nominis: In honor to Dr. PH. GUINET.
Differential diagnosis: It is well separable from *Basopollis basalis* (TH. et PF. 1953) PF. 1953 by the numerous tiny praevestibules and the structure of the anulus.

Fgen.: *Menatipollenites* n. fgen.
Fgen. type: *Menatipollenites triangulus* n. fsp. (Plate I, 10—14; Fig. 2)

Diagnosis

It is a heteropolar, three-germinal pollen with a roughly triangular equatorial contour, on the proximal side with plicae. The germinal openings are split-like, being shorter on the distal side than on the proximal one. The pore-canal index, P/d, is above 0,3.

Locus typicus: Menat, Palaeocene, Thanetian, zone II.

Stratum typicum: Palaeocene marl.

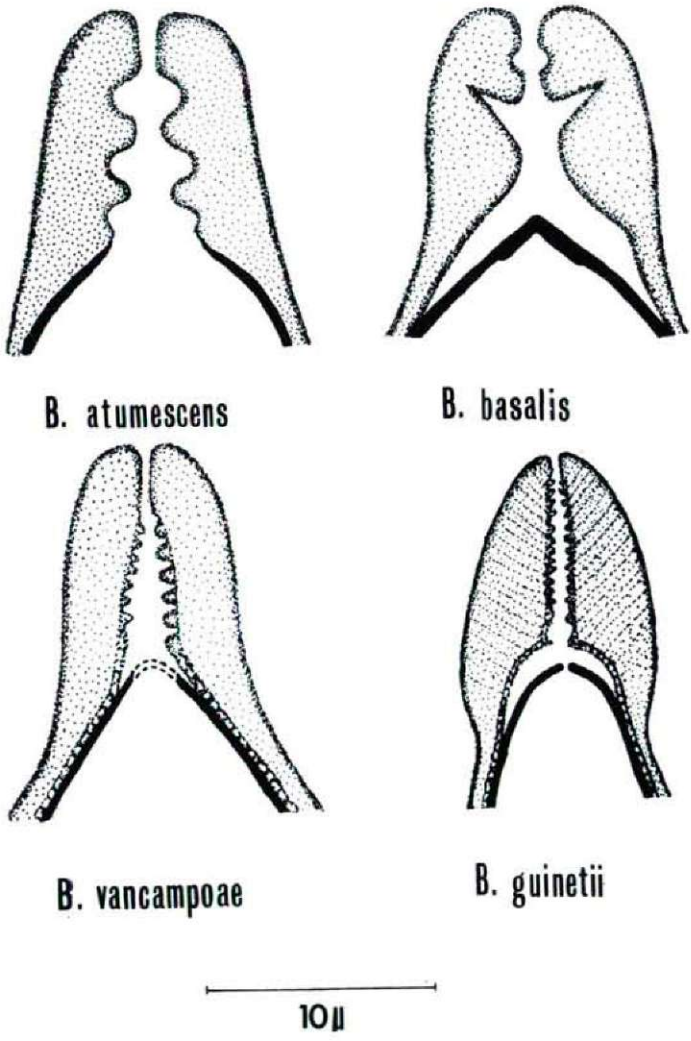

Fig. 1. Pore wall region of some *Basopollis* species in optical section .

Derivatio nominis: From Menat, the locality of type.

Differential diagnosis: It is similar to *Lusatipollis* W. KR. et PACLT. 1967 but with a different exogerminal, „äquatorialen Exogerminalien, die oculusartig verstärkt".

Menatipollenites triangulus n. fsp.

Diagnosis

The equatorial contour is triangular, sometimes with somewhat convex lateral lines. The extragerminal exine is thin, 0,8—1,2 μ, the outer and inner walls are roughly equal in thickness (V = 1/1). The anulus is nearly triangular, on the bottom 3—5 μ wide. In about the width of the base of anulus, in the inner layer, there are four-five characteristic, centripetal thickenings and at the endoporus a small endanulus. The pore canal is 7—9 μ long, the pore-canal index, P/d is about 0,34. On the proximal side, the length of the split-like exogerminal corresponds to that of pore-canal, on the distal side it is, however, shorter (about 5 μ). The proximal surface is smooth or punctuated, the distal side is rarely granulated. The plicae of the proximal surface connect the bases of anuli and are bent towards the pole.

Maximum size: 20—25 μ.

Holotype, locus typicus, stratum typicum: cf. above.

Derivatio nominis: From its characteristic contour.

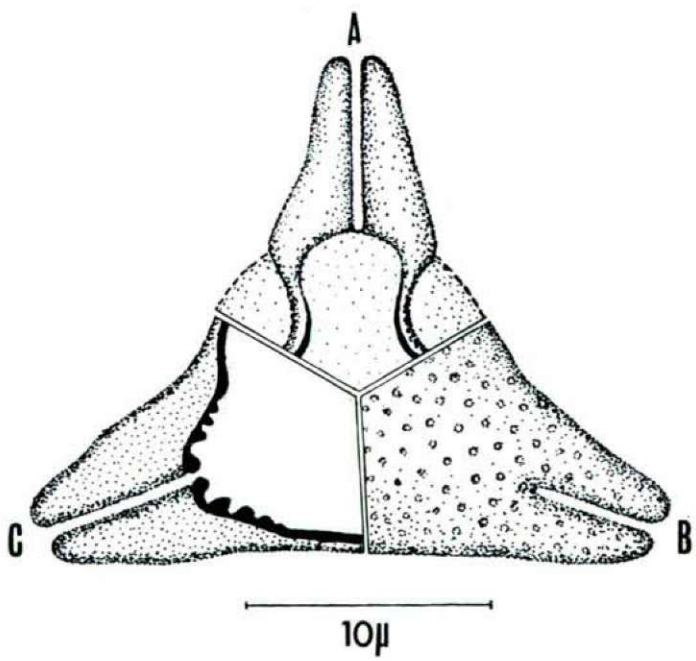

Fig. 2. *Menatipollenites triangulus* n. fgen. et fsp.; A: Proximal surface, B: Distal surface, C: Optical section.

Fgen.: *Nudopollis* PFLUG 1953

It is a frequent genus not only in the sediments of Palaeocene but also in those of Lower Eocene. Among the species described so far we could observe several transitions, as well.

1. *N. endangulatus* (PF. 1953) PF. 1953 (Plate I, 15—17). It is frequent in all the three localities investigated. Particularly in the material from Menat there occurred in large number exemplars with plicae, too. Also the occurrence of transitional specimens between this species and N. terminalis (TH. et PF. 1953) PF. 1953 is general; they are frequent first of all in the Thanetian at Menat (Plate I, 18—20).

2. *N. thiergarti* (TH. et PF. 1953) PF. 1953. Its typical specimens occurred in the sediments Monsian at Oiching, and in the deeper sediments of Thanetian stage at Kleinoiching (Plate II, 1—3). The so-called „younger" forms of thin wall (Plate II, 4, 5) are frequent in the layers of Menat. This latter is also showing a transition in some degree towards *N. terminalis* (TH. et PF. 1953) PF. 1953.

3. *N. terminalis* (TH. et PF. 1953) PF. 1953 (Plate II, 6—8). It is frequent in the Thanetian at Menat, and even in older sediments. The specimens observed belong to the hastaformis subfsp., a typical representative of the form-species.

The temporary name cf. *Nudopollis* fsp. is denoting a pollen form, so far found in a few exemplars only at Menat (Plate II, 9, 10). It is quite likely that they belong to a new taxon. However, we need further data to elucidate that problem.

Fgen.: *Trudopollis* PFLUG 1953

1. *T. nonperfectus* (PF. 1953) PF. 1953 (Plate II, 11, 12). It occurred but sporadically in our samples.

2. *T. subperfectus* (PF. 1953) PF. 1953 (Plate III, 1, 2, cf. 8—10). We have found them in the sediments Monsian at Oiching and in the deeper sediments of Thanetian stage at Kleinoiching. In the latter locality it occurs frequently.

3. *T. orthomechanicus* PF. 1953 (Plate III, 3—5). Its locality of occurrence is identical with the former one but rarer.

4. *T. varioreticulatus* (STELMAK 1960) ZAKLINSKAIA 1963 (Plate II, 13—15). It is sporadic in all the three localities. It occurred with specimens in very good preservation in the material of Menat.

5. *T. hemiperfectus* (PF. 1953) PF. 1953 (Plate III, 6, 7). It occurred first of all in the deeper part of the Thanetian (Kleinoiching) but sporadically it was also found in the Monsian (Oiching).

Fgen.: *Pompeckjoidaepollenites* (PFLUG 1953) emend. W. KR. 1967

It is a genus only little elaborated in its details. From the genus *P. subhercynicus* (W. KR. 1954) W. KR. 1967 we can observe several transitional forms towards many further types. Comparing our data with previous results (KEDVES, 1967a) it seems that the size of these pollen-grains in the Lower

and Middle Eocene decreased in opposite to those from the Palaeocene age. In the course of the present investigations we could observe the typical *P. subhercynicus* (Plate III, 14—16) in the sediments of Thanetian stage, and in the deeper parts of the Monsian and Thanetian its forms of large size that form a transition a little towards *P. absurdus* (WEY. et KRIEG. 1953) W. KR. 1967. In the Kleinoiching layers we have found also the specimens of *P. subhercynicus* with a strongly granulated surface (Plate III, 17—19), which can later be described as a subspecific form. From Menat *P. peneperfectus* (PF. 1953) W. KR. 1967 (Plate III, 11—12) was found, connected with *P. subhercynicus* also by essentially transitional forms.

Fgen.: *Oculopollis* PFLUG 1953

During our investigations, this genus was found only in localities at Oiching (Monsian). We publish here one of its specimens in good condition. — *O.* cf. *fastidicus* WEYL. et KRIEG. 1953 (Plate III, 20—22).

Fgen.: *Tetrapollis* PFLUG 1953

The two species — *T. validus* (PF. 1953) PF. 1953 (Plate IV, 1—3), *T. polyangulus* (PF. 1953) W. KR. 1967 (Plate IV, 4, 5) — occurred in localities at Oiching and Kleinoiching.

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

1/a. *St. hexaradiatus* (THG. 1940) TH. et PF. 1953 subfsp. *hexaradiatus* (Plate IV, 6—8).

1/b. *St. hexaradiatus* (THG. 1940) TH. et PF. 1953 subfsp. *semitribinae* W. KR. 1961 (Plate IV, 12—14).

1/c. *St. hexaradiatus* (THG. 1940) TH. et PF. 1953 subfsp. *tribinae* W. KR. 1961 (Plate IV, 18—20).

2. *St. pentaradiatus* W. KR. 1961 (Plate IV, 21—23).

We have observed several transitional forms among the subspecies of *St. hexaradiatus* (THG. 1940) TH. et PF. 1953:

hexaradiatus/semitribinae (Plate IV, 9—11)
semitribinae/tribinae (Plate IV, 15—17).

The stratigraphic occurrence (that is according to localities) of the forms observed is as follows (Fig. 3):

The typical forms of *St. hexaradiatus hexaradiatus* occurred only in the Lower Palaeocene — Monsian — sediments of Oiching. In addition, we have found several transitional forms resembling semitribinae, a part of which differ only to a slight degree from the practically symmetrical forms. In the Lower Thanetian sediments of Kleinoiching we have found only the transitional forms mentioned above, with the difference that the triple symmetry of the forms that are transitional towards the semitribinae is more expressed than in the former layers. In the Thanetian of Menat (zone II) only semitribinae and tribinae subfsp. occurred, with a great many transitional types.

St. pentaradiatus W. KR. 1961 cannot be included in this series. As referred to by KRUTZSCH (1961), it might be that it is not an independent form-species but an abnormal form of *St. hexaradiatus*.

Discussion

The *Normapolles* taxa treated in our work may be classified from phylogenetic and stratigraphic points of view. In the Lower Eocene sediments of the Paris basin pollen-types representing four degrees of development could be separated (KEDVES, 1968a). Taking that into consideration:

1. The *Normapolles* originating from the Upper Cretaceous period are the following in our material:

Oculopollis cf. *fastidicus*
Pompeckjoidaepollenites absurdus
Trudopollis orthomechanicus
Trudopollis hemiperfectus
Trudopollis nonperfectus
Trudopollis subperfectus.

2. We consider *Tetrapollis* validus and *Tetrapollis polyangulus,* as well as *Stephanoporopollenites hexaradiatus* and *Stephanoporopollenites pentaradiatus* as Palaeocene of stratigraphic distribution. On the above basis, *Trudopollis varioreticulatus* is a species marking the Palaeocene or Lower Eocene period, although in this respect we are still in need of further verifying data.

Characteristic forms of the Palaeocene and Lower Eocene sediments are: *Basopollis basalis,*

Basopollis atumescens. Our newly described species may belong to this group *(Basopollis vancampoae, Basopollis guinetii)* and also *Menatipollenites triangulus,* owing to their basic morphology.

The stratigraphic value of the discussed *Nudopollis* species is roughly similar, as well, although from them *Nudopollis terminalis* can occur in the layers of the Middle Eocene age, too. *Nudopollis endangulatus* and *Nudopollis thiergarti* contain an extremely high number of transitional types, first of all in the direction of *Nudopollis terminalis.* Thus *Nudopollis terminalis* may be considered „younger" than the two species mentioned above. From a taxonomic point of view, nevertheless the species of *Nudopollis* owing to the high number of their transitional forms, may be a subjectmatter of further investigations. In connection with them, we have again to refer to the question of the limits of form-species and the variation within the form-species. This problem seems to be particularly significant in taxa in formation during the initial phase of their development and it also gains importance in the case of other types too.

Summary

The paper discusses species belonging to the genera *Basopollis* PF. 1953, *Nudopollis* PF. 1953, *Trudopollis* PF. 1953, *Pompeckjoidaepollenites* (PF. 1953) W. KR. 1967, *Oculopollis* PF. 1953, *Tetrapollis* PF. 1953 and *Stephanoporopollenites* PF. et TH. 1953 from three Palaeocene localities (Oiching, Kleinoiching and Menat). The description of two new species *(Basopollis vancampoae, Basopollis guinetii)* and a new genus are given *(Menatipollenites).* The taxe represent several degrees of the evolutionary history of pollens.

M O N S I A N T H A M E T I A N

Z.I. Z.II.

T R I B I N A E

Plate I

1—3. — *Basopollis vancampoae* n. fsp., prep. Menat—34; 22,1/115,9.
4—6. — *Basopollis vancampoae* n. fsp., prep. Menat—34; 21,5/108,6
7—9. — *Basopollis guinetii* n. fsp., prep. Menat—38; 20,1/113,6.
10—14. — *Menatipollenites triangulus* n. fgen. et fsp., prep. Menat—39; 15,8/119,3.
15—17. — *Nudopollis endangulatus* (Pf. 1953) Pf. 1953, prep. Menat—25; 20,7/113,6.
18—20. — *Nudopollis endangulatus* terminalis, prep. Menat—31; 20,2/102,8.

Plate II

1—3. — *Nudopollis thiergarti* (Th. et Pf. 1953) Pf. 1953, prep. DI/2—28; 20,5/117,9.
4,5. — *Nudopollis thiergarti* (Th. et Pf. 1953) Pf. 1953, prep. Menat—34; 13,2/106,9.
6—8. — *Nudopollis terminalis* (Th. et Pf. 1953) Pf. 1953, prep. Menat—21; 11,2/110,2.
9,10. — *Cf. Nudopollis* fsp., prep. Menat—39; 12,2/102,8.
11,12. — *Trudopollis nonperfectus* (Pf. 1953) Pf. 1953, prep. Menat—38; 6,4/107,9.
13—15. — *Trudopollis varioreticulatus* (Stelmak 1960) Zaklinskaia 1963, prep. Menat—31; 5/115,9.

Plate III

1,2. — *Trudopollis subperfectus* (Pf. 1953) Pf. 1953, prep. DI/2—26; 4,2/107,9.
3—5. — *Trudopollis orthomechanicus* Pf. 1953, prep. DI/2—25; 12,4/119,2.
6,7. — *Trudopollis hemiperfectus* (Pf. 1953) Pf. 1953, prep. DI/2—16; 12,7/109,8.
8—10. — *Cf. Trudopollis subperfectus* (Pf. 1953) Pf. 1953, prep. DI/2—36; 4,2/114,3.
11—13. — *Pompecjoidaepollenites peneperfectus* (Pf. 1953) W. Kr. 1967, prep. Menat—44; 20,6/105,8.
14—16. — *Pompeckjoidaepollenites subhercynicus* (W. Kr. 1954) W. Kr. 1967, prep. DI/2—21; 20,6/105,8.
17—19. — *Pompeckjoidaepollenites subherynicus* (W. Kr. 1954) W. Kr. 1967, prep. DI/2—28; 22/115,6.
20—22. — *Oculopollis* cf. *fastidicus* Weyl. et Krieg. 1953, prep. DI/1b—22; 4,6/116,4.

Plate IV

12—14. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. 1953 subfsp. *semitribinae* W. Kr. 1961, prep. Menat—36; 9,3/109,2.
15—17. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. 1953 subfsp. *semitribinae/tribinae* W. Kr. 1961, prep. Menat—39; 17,6/117,3.
18—20. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. 1953 subfsp. *tribinae* W. Kr. 1961, prep. Menat—37; 15,4/115,7.
21—23. — *Stephanoporopollenites pentaradiatus* W. Kr. 1961, prep. DI/1b—25; 19,9/105,4.
1—3. — *Tetrapollis validus* (Pf. 1953) Pf. 1953, prep. DI/2—29; 5,1/111,8.
4,5. — *Tetrapollis polyangulus* (Pf. 1953) W. Kr. 1967, prep. DI/2—28; 6,1/114,2.
6—8. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. 1953 subfsp. *hexaradiatus*, prep. DI/1b—34; 8,4/113,7.
9—11. — *Stephanoporopollenites hexaradiatus* (Thg. 1940) Th. et Pf. subfsp. *hexaradiatus/semitribinae* W. Kr. 1961, prep. DI/1b—33; 17,6/106,8.

Plate I

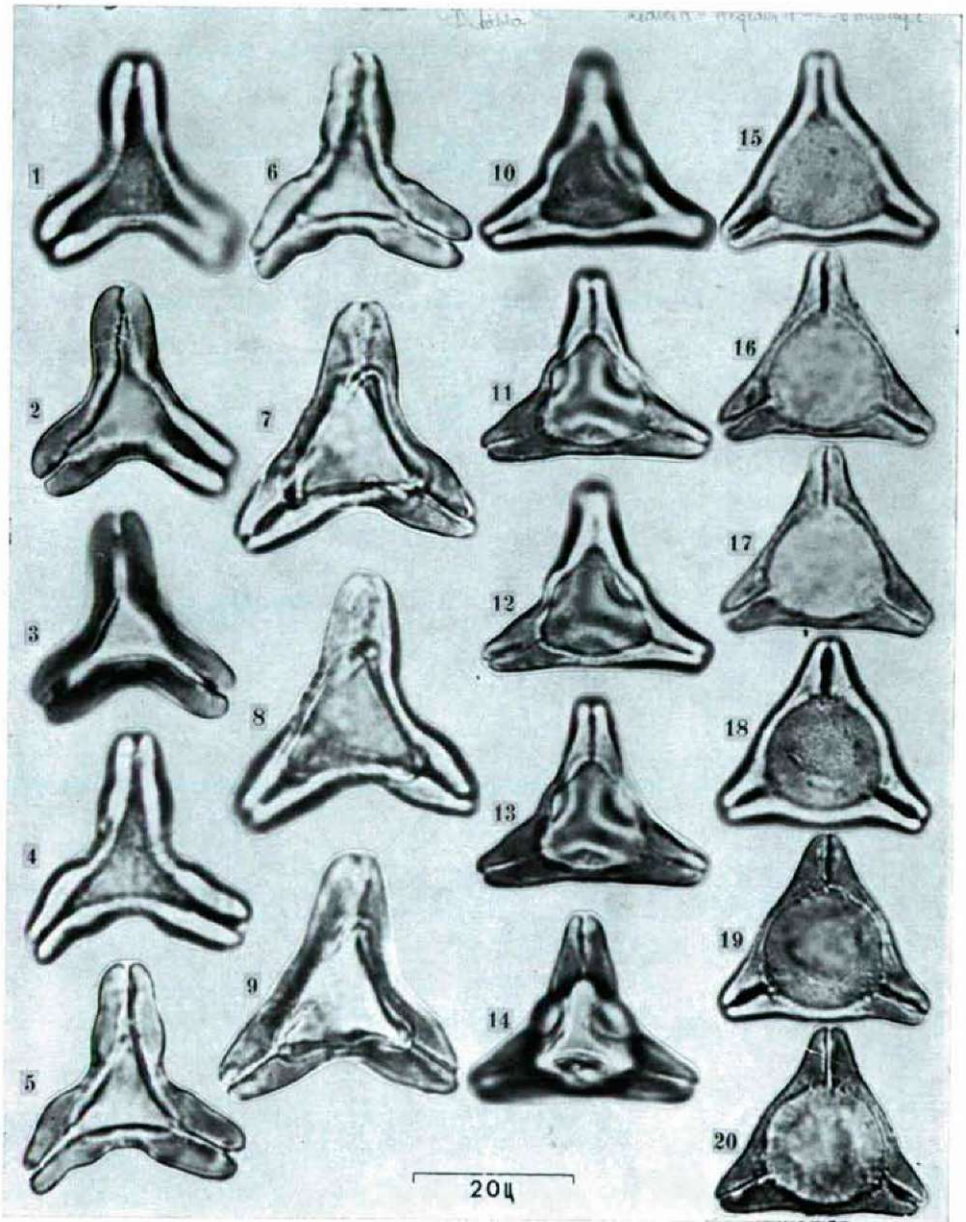

Plate II

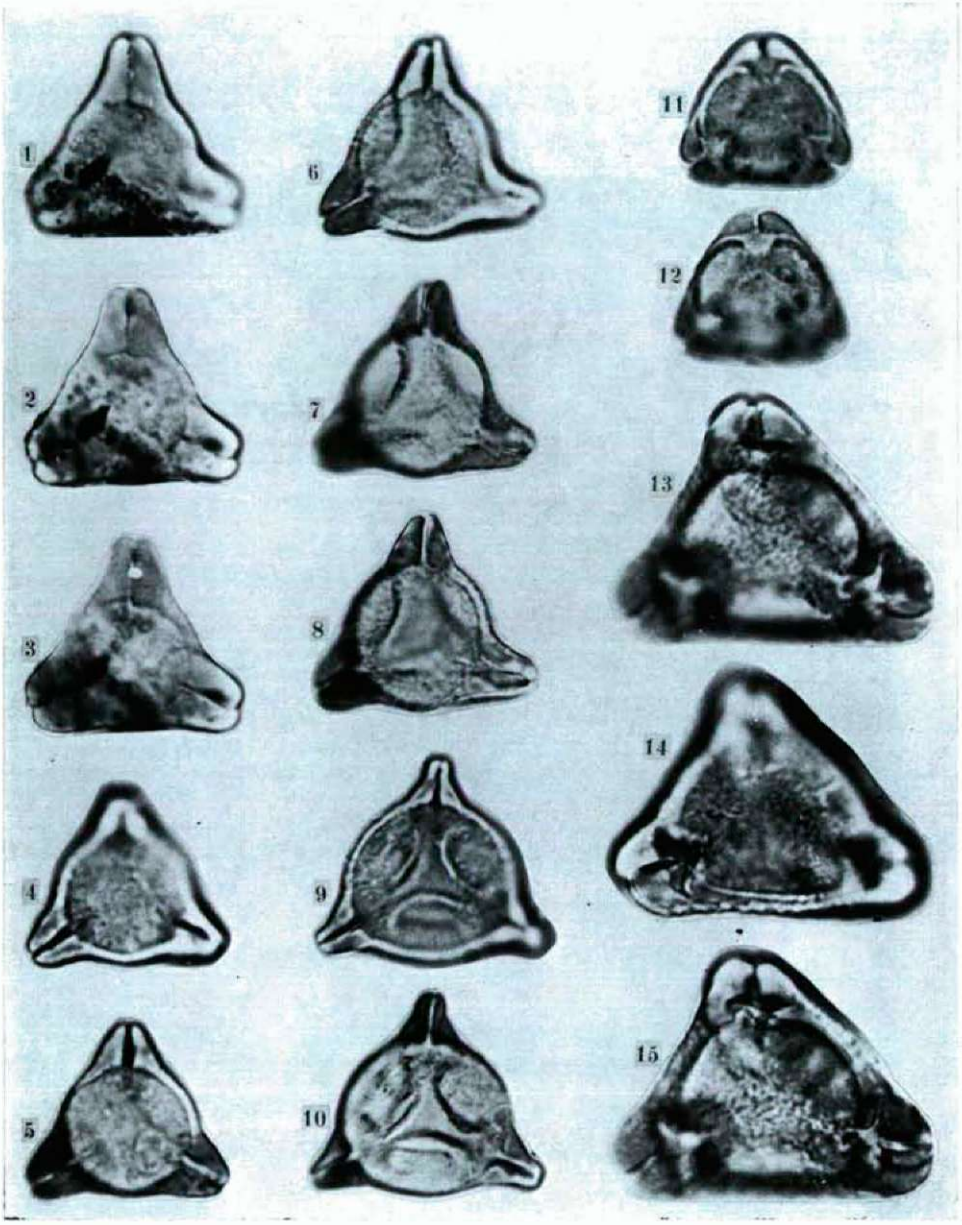

Plate III

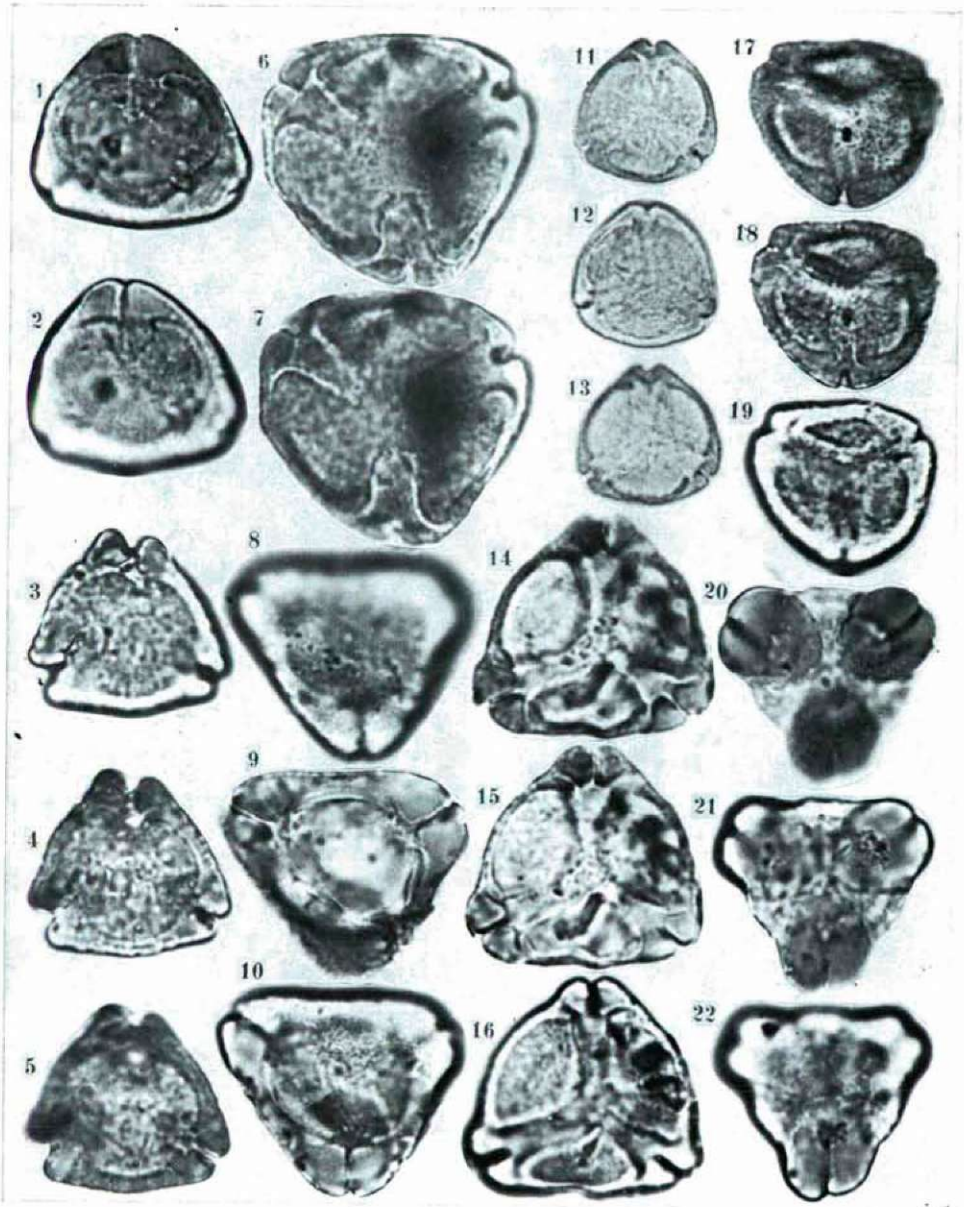

Plate IV