

Early Tertiary Normapolles and Related Palynomorphs of China (III)

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ABSTRACT: This paper mainly describes the Normapolles and other palynomorphs from the Caomuhao Gypsum Mine strata of the Otog Banner, Inner Mongolia, the Funing Group of northern Jiangsu and the Menli Formation of the Sanmenxia Area in Henan including a total of 24 genera and 66 species. There are 9 new genera, namely *Paleopachydermites*, *Parapecakipollis*, *Paraprenudopollis*, *Paratriangulipollis*, *Paravacuopollis*, *Pseudoproteacidites*, *Spinotriporites*, *Subtriaperturites* and *Trimagnaporites*, 10 new combination, 2 uncertain and 42 new species. It is hoped that this paper would bring the Chinese palynologist's attention to the Normapolles and more palynomorphs of this group could be discovered.

KEY WORDS: Early Tertiary, Normapolles, China.

This is the third part of my work on Early Tertiary Normapolles and related palynomorphs of China (Song, 1996 a, b). The main treatment is to describe the taxa so far we identify. For this paper only for identification, the following papers were consulted: Goczan *et al.*, 1967; Pflug, 1953; Hao & Chen 1983; Song 1996; Song *et al.*, 1981, 1986; Sun *et al.*, 1979; and Tschudy, 1975.

All specimens have been collected from the Lower Tertiary, the Naomugen Formation of Inner Mongolia unless otherwise stated. All specimens illustrated here are preserved at the Palynological Division of Nanjing Institute of Geology and Palaeontology, Academia Sinica. All figures are at a magnification of x 800 unless otherwise stated.

PALEOPACHYDERMITES *gen. nov.*

Type species *Paleopachydermites granulatus gen. et sp. nov.*

Diagnosis: Pollen nearly spherical, outline rounded; exine very thick, over 4 μm in thickness, nexine thin, sexine several times thicker than nexine; homogeneous and without baculate structure; inaperturate, only with one slit dividing palynomorph into two parts; ornamentation variable.

Remarks: *Harskutipollis* Jukasz et Goczan 1985 resembles this new genus in the thick exine and slit, but differs in the nexine thicker than sexine with baculate structure.

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Haplocystia Segroves 1967, *Palynomorphitus* Moore 1963 and *Inderites* Abramova et Marchenko 1964 are also have thick exine, but without circular slit.

This new genus might include *Paleopachydermites* (al. *Monocolpites*) *bisulcus* (Martynova) comb. nov., which occurs from late Upper Cretaceous to Palaeocene of the Vural Area, Russia.

Occurrence: Asia, Late Cretaceous to Early Tertiary.

***Paleopachydermites granulatus* gen. et sp. nov.**

P1. 11, figs. 1, 2

Outline circular, holotype ca. 35 μm in diameter; exine 4-5 μm thick, nexine thin, under 1 μm thick, sexine homogeneous, without tectum and baculate structure; inaperturate, a slit dividing palynomorph into two parts; granulate.

P. bisulcus (Martynova) comb. nov. differs from the new species in the reticulate ornamentation and the slit bifurcated at terminal end.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 11, fig. 1; slide no.: 681(B-2)

PARAPECAKIPOLLIS gen. nov.

Type species *Parapecakipollis elegans* gen. et sp. nov.

Diagnosis: Pollen oblate, amb triangular with straight or slightly concave / convex sides and rounded or obtuse angles; triporate, equato-angulaperturate, pore with vestibula commonly ladder-shaped, pore canal index 0.3-0.4; exopore oval and large, endopore slightly wider than exopore, bearing a clear boundary with body, inner contour circular; exine moderately thick, two layers equally thick or with sexine thicker than nexine, nexine extending to base of vestibula and curved to form endopore, sexine without thickening along pore margin, with inner side uneven; granulate to tuberculate, or microechinate.

Remarks: This new genus differs from *Pecakipollis* Krutzsch 1967 in the large exopore instead of slit exogerminal and the absence of incidence; from *Paravacuopollis* also in the large exopore and clear vestibula (the latter has small exopore and atria, but no vestibula). The inner contour is circular in this genus, but triangular in *Pecakipollis* and *Paravacuopollis*.

Occurrence: China, Late Cretaceous to Early Tertiary.

***Parapecakipollis elegans* gen. et sp. nov.**

P1. 11, figs. 3-5

Amb triangular with straight or slightly concave sides and obtuse angles, 25-32 μm (holotype 30 μm) in diameter; triporate, pore with cylindrical vestibula, pore canal index 0.4; exopore oval, ca. 5 μm wide, endopore ca. 10 μm wide; exine 1-1.5 μm thick, sexine slightly thicker than nexine, with inner side uneven, inner contour formed by nexine circular, about 20 μm in diameter; granulate, coarser in pore area.

This new species resembles *Pecakipollis bohemiensis* Krutz. et Pacltova (Goczan et al., 1967, S.487, Taf. 12, Figs. 14-18) in the shape and size, but differs from the latter in the larger exopore and the absence of incidence. *Trudopollis* sp. (Weyland et Krieger, 1953, S. 17, Taf. 5, Figs. 50, 51) is also similar to this new species in the shape but differs from the new species in the thickened exine in pore area and coarser ornamentation.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 11, fig. 3; slide no.: 687(B-1)

Paraprecakipollis densus *gen. et sp. nov.*

P1. 11, figs. 6-8

Amb triangular with slightly concave sides, angles elongated with rounded or obtuse terminal ends; 35-40 μm (holotype 38 μm) in diameter; triporate, pore with cylindrical vestibula, pore canal index 0.4-0.5; exopore *ca.* 5 μm and endopore over 10 μm wide; endobody contour circular, about 25 μm in diameter; exine *ca.* 1.5 μm thick, sexine thicker than nexine and slightly thickened along base of vestibula and pore margin, with inner side uneven; tuberculate to verrucate.

This new species differs from *P. tuberculatus* in the larger pore canal index (over 0.4) and coarser ornamentation.

Occurrence: Same as the preceding species.

Type: Pl. 11, fig. 6; slide no.: 683(6-3)

Paraprecakipollis tuberculatus *gen. et sp. nov.*

P1. 11, figs. 9, 10

Amb triangular with slightly concave / convex sides and rounded angles, holotype 38 μm in diameter; triporate, pore with cylindrical-trapezoidal vestibula, pore canal index 0.4; exopore over 5 μm and endopore *ca.* 12 μm wide; endobody circular 25-27 μm in diameter; exine *ca.* 1.5 μm thick; sexine thicker than nexine and slightly thickened along base of vestibula and pore margin, devoid of baculate structure, with inner side uneven; tuberculate-granulate, coarser in vestibula area.

This new species differs from *P. elegans* in the larger size and coarser ornamentation.

Occurrence: Same as the preceding species.

Type: Pl. 11, fig. 9; slide no.: 687(1-1)

PARAPRENUDOPOLLIS *gen. nov.*

Type species *Paraprenudopollis sexangulus* *gen. et sp. nov.*

Diagnosis: Pollen oblate, amb triangular with straight or slightly concave sides and rounded angles; triporate, angulaperturate, pore probably with atria, exopore oval; exine thin, two layers subequally thick, nexine extending to base of stria and curved, sexine expanded into atria showing punctate or spongy structure; granulate or microechinate.

Remarks: This new genus resembles *Prenudopollis* Kedves *et* Diniz 1983 in the pore structure, but differs from the latter in the oval exopore and unclear endopore (the latter has colpate exogerminal and porate endogerminal formed by nexine).

Occurrence: China, Early Tertiary.

Paraprenudopollis sexangulus *gen. et sp. nov.*

P1. 11, figs. 11, 12

Amb triangular with slightly concave sides and rounded angles, holotype 30 μm in diameter; triporate, pore with vestibula or atria; exine *ca.* 1 μm thick in middle part of each side, two layers nearly equal in thickness; pore canal index nearly 0.3, exopore oval, *ca.* 3 μm

wide, endopore larger; atria triangular, in dark colour, and body hexangular; granulate or microbaculate; pore structure as stated in diagnosis of genus.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 11, fig. 12; slide no.: 687(7-3)

PARATRIANGULIPOLLIS *gen. nov.*

Type species *Paratriangulipollis triangulus* (Sung et Lee) *gen. et comb. nov.*

Diagnosis: Pollen oblate, amb triangular with straight sides and rounded angles; triporate, equatoangulaperturate, pore probably with unclear atria; exine moderately thick, two layers equally thick or with sexine thicker than nexine; exopore small and with annulus; psilate to granulate.

Remarks: The new genus resembles *Triangulipollis* Krutz. 1967 in the outline, but the latter differs in the mesopore, multiatria and elongated exopore. The new genus differs from *Tripoporopollenites* Pflug 1953 in the triangular shape (the latter has a round outline).

Occurrence: China, Early Tertiary.

Paratriangulipollis triangulus (Sung et Lee) *gen. et comb. nov.* P1. 11, figs. 13-15

1976 *Tripoporopollenites triangulus* Sung et Lee, p. 36, pl. 8, fig. 1.

Amb triangular with straight sides and obtuse or rounded angles, 23-30 μm in diameter; triporate, pore small, ca. 2 μm wide; exine ca. 1 μm thick, sexine thickened to 1-1.5 μm in pore area to form thin annulus, inner side of annulus with small and oval atria; scabrate or finely granulate.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Paratriangulipollis gracilis *gen. et sp. nov.* P1. 11, figs. 16-18

Amb triangular with straight or slightly concave sides and obtuse angles, 18-20 μm (holotype 18 μm) in diameter; triporate, pore oval, 2-4 μm wide and with unclear atria; exine under 1 μm in thickness; granulate.

This new species is characterized by the unclear atria and thin exine, without thickening in pore area.

Occurrence: Same as the preceding species.

Type: Pl. 11, fig. 16; slide no.: 523(4-1)

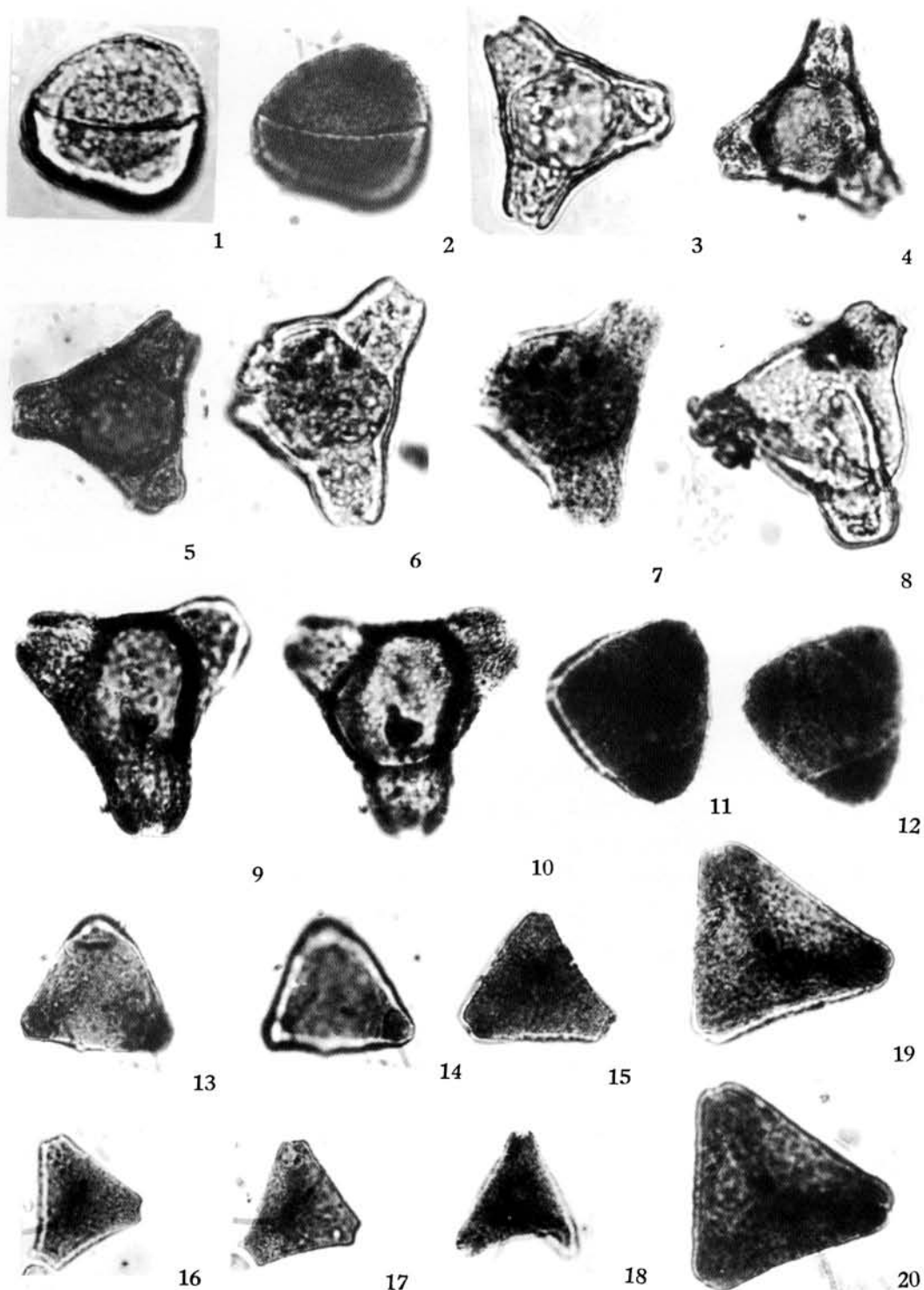
Paratriangulipollis triletoides *gen. et sp. nov.* P1. 11, figs. 19, 20

Amb triangular with straight sides and rounded angles, holotype 38 μm in diameter; triporate, pore simple and oval, 2-3 μm wide; exine 1-2 μm thick and thickened along pore area in dark colour; granulate or microrugulate, outline smooth; triletoid thickening bands extending from angles to pole.

This new species is characterized by the larger size and triletoid bands.

Occurrence: Same as the preceding species.

Type: Pl. 11, fig. 19; slide no.: 479(13-2)



Pl. 11. Figs 1, 2. *Paleopachydermites granulatus* gen. et sp. nov. Slide no.: 681(B-2). Figs. 3-5. *Parapecakipollis elegans* gen. et sp. nov. Slide no.: 687(B-1), 687(12-2). Figs. 6-8. *Parapecakipollis densus* gen. et sp. nov. Slide no.: 683(6-3), 523(D-1). Figs. 9, 10. *Parapecakipollis tuberculatus* gen. et sp. nov. Slide no.: 687(1-1). Figs. 11, 12. *Paraprenudopollis sexangulus* gen. et sp. nov. Slide no.: 687(7-3). Figs. 13-15. *Paratriangulipollis triangulus* (Sung et Lee) gen. et sp. comb. nov. Slide no.: 479(A-6), 479(C-13). Figs. 16-18. *Paratriangulipollis gracilis* gen. et sp. nov. Slide no.: 523(4-1), 687(1-3). Figs. 19, 20. *Paratriangulipollis triletoides* gen. et sp. nov. Slide no.: 479(13-2).

PARAVACUOPOLLIS *gen. nov.*

Type species *Paravacuopollis tuberculatus* *gen. et sp. nov.*

Diagnosis: Pollen oblate, amb triangular with straight or slightly convex / concave sides and rounded or obtuse angles, inner contour not circular; triporate, equato-angulaperturate, pore without vestibula but with large atria formed by sexine only, pore canal index nearly 0.3; exogerminal oval to round and not slit, endogerminal larger, without clear boundary between body; exine thin to moderately thick, sexine with baculate structure, thicker than nexine and slightly thickened in pore area, with inner side in pore area uneven, nexine extending to base of pore; scabrate, granulate and tuberculate.

Remarks: This new genus is very similar to *Vacuopollis* Pflug 1953 in the shape, but differs from the latter in the porate exogerminal, nexine not divided into many layers to form multi-atria. The new genus differs from *Pseudovacupollis* Krutzsch et Pacltova 1967 which has concave sides, multi-layered nexine and small multi-atria; from *Pecakipollis* Krutzsch et Pacltova 1967 which has clear vestibula and incidens; and from *Osculapollis* Tschudy 1975 which has interlocum.

Occurrence: China, Late Cretaceous to Early Tertiary.

Paravacuopollis tuberculatus *gen. et sp. nov.*

P1. 12, figs. 1-3

Amb triangular with slightly concave sides and rounded angles, diameter of holotype 35 μm ; triporate, pore with large atria, pore canal index under 0.3; exopore round, 2-3 μm wide, endopore larger than exopore; exine *ca.* 1.5 μm thick, sexine with baculate structure, twice thicker than nexine and thickening along pore margin, with its inner side uneven, nexine extending to base of atria; tuberculate.

This new species is characterized by the tuberculate ornamentation.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 12, fig. 1; slide no.: 687(2-2)

Paravacuopollis elegans *gen. et sp. nov.*

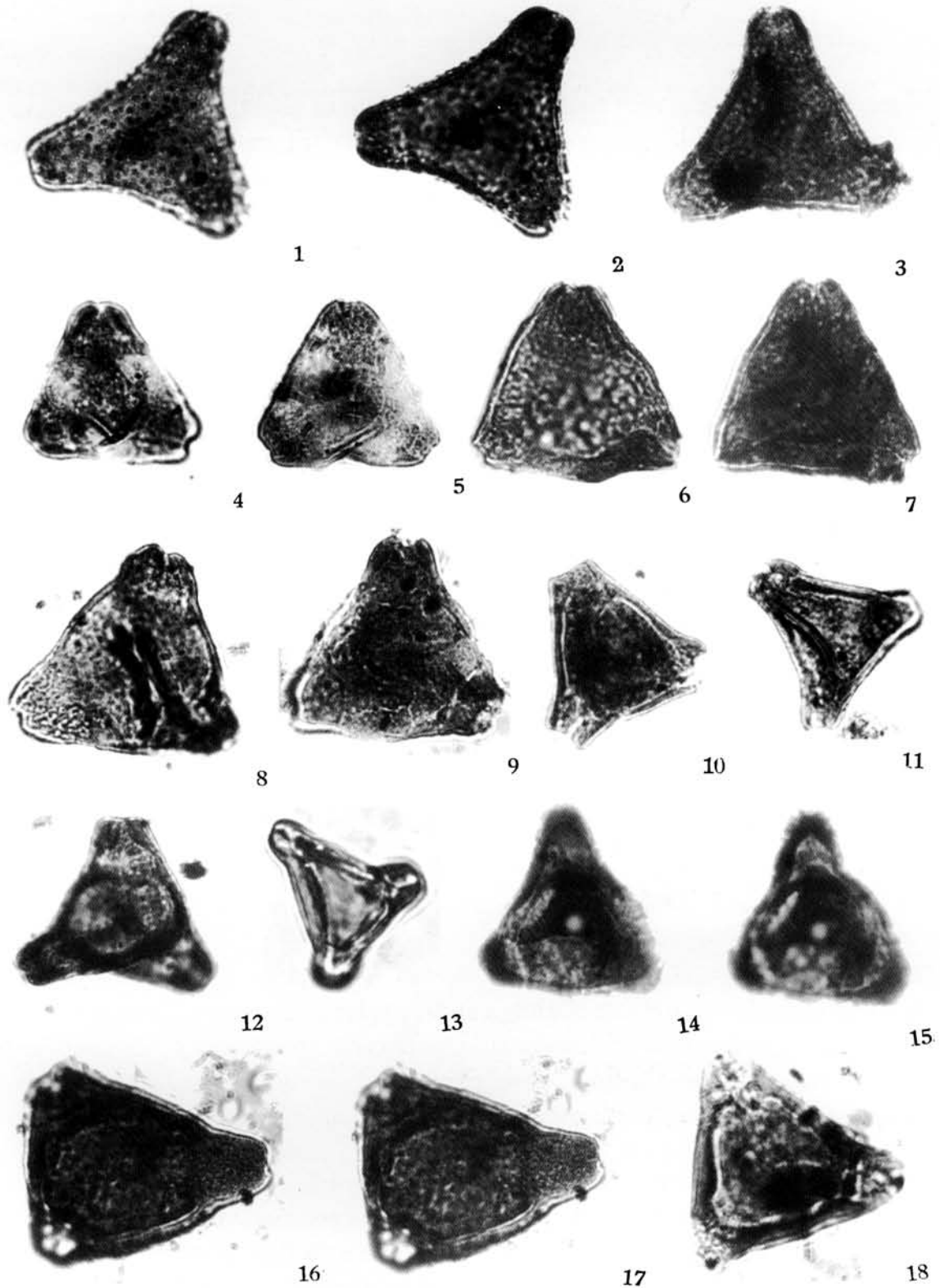
P1. 12, figs. 4, 5

Amb triangular with straight or slightly concave sides and rounded angles, diameter of holotype 25 μm ; triporate, pore with large atria, pore canal index nearly 0.3; exopore round, 2-3 μm wide, endopore larger than exopore; exine *ca.* 1 μm thick, two layers equally thick, sexine thickened in conclave form along pore margin *ca.* 1.5 μm thick, with inner side uneven; granulate, coarser in pore area.

This new species is very similar to *Vacuopollis exilis* Pflug (1953, S. 104, Taf. 20, Figs. 15, 16) in the shape, but differs from the latter in the exogerminal, larger atria and thickened sexine along pore margin (the latter has slit exogerminal, without sexine thickening along pore margin). It is also similar to *V. cf. proconcavus* Weyland et Krieger (Pflug, 1953, Taf. 20, fig. 10) in shape, but the holotype of the latter (Weyland et Krieger, 1953, Taf. 2, Fig. 44) has concave sides. The mentioned two species proposed above occur in Upper Cretaceous of Europe.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; Sanmenxia Area, Henan, Menli Formation.

Type: Pl. 12, fig. 4; slide no.: 523(8-2)



Pl. 12. Figs. 1-3. *Paravacuopollis tuberculatus* gen. et sp. nov. Slide no.: 687(2-2), 683(2-10). Figs. 4, 5. *Paravacuopollis elegans* gen. et sp. nov. Slide no.: 523(8-2), 523(17-1). Figs. 6-9. *Paravacuopollis communis* gen. et sp. nov. Slide no.: 479(14-2), 479(A-1), 683(13-2). Figs. 10-12. *Paravacuopollis granulatus* gen. et sp. nov. Slide no.: 523(2-3), 523(6-2), 683(6-1). Fig. 13. *Plicapollis conserta* Pflug 1953. Slide no.: 479(B-4) Figs. 14, 15. *Pseudoplicapollis otogiensis* sp. nov. Slide no.: 683(7-2) Figs. 16-18. *Prenudopollis major* sp. nov. Slide no.: 683(C-13), 683(C-15).

Paravacuopollis communis *gen. et sp. nov.*

Pl. 12, figs. 6-9

Amb triangular with straight or slightly convex sides and rounded angles, 35-45 μm (holotype 35 μm) in diameter; triporate, pore with atria, exopore 3-5 μm wide, endopore wider than exopore; exine *ca.* 1.5 μm thick, sexine thicker than nexine; scabrate to granulate, sometimes tuberculate.

This new species differs from other species of this genus in the triangular shape and larger size; and from *Pseudoproteacidites microverrucatus* in the thin exine and straight sides.

Occurrence: Same as the preceding species.

Type: Pl. 12, fig. 6; slide no.: 479(14-2)

Paravacuopollis granulatus *gen. et sp. nov.*

Pl. 12, figs. 10-12

Amb triangular with straight or slightly concave sides and rounded angles, diameter of holotype 25 μm ; triporate, pore with atria, pore canal index nearly 0.25; exopore round, 2-4 μm and endopore over 5 μm wide; exine 2-2.5 μm thick, sexine twice thicker than nexine with its inner side uneven; microgranulate.

This new species resembles *Conclavipollis purgatus* Pflug (1953, S. 105, Taf. 20, Figs. 40, 41) in shape, but the latter has interlocum, with sexine thickened in pore area, and occurs in Upper Cretaceous of Europe.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 12, fig. 11; slide no.: 523(6-2)

PLICAPOLLIS Pflug 1953

Type species: *Plicapollis conserta* Pflug 1953

Plicapollis conserta Pflug 1953 Pl. 12, fig. 13

Plicapollis conserta Pflug, S. 98, Taf. 19, Fig. 23-27, 32-34 1953.

Amb triangular, diameter 20-25 μm .

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

PRENUDOPOLLIS Kedves *et* Diniz, 1981

Type species *Prenudopollis endocirculus* Kedves *et* Diniz 1981

Prenudopollis major *sp. nov.* Pl. 12, figs. 16-18

Amb triangular with straight or slightly convex sides and rounded or obtuse angles, 40-50 μm (holotype 47 μm) in diameter; triporate, angulaperturate, pore oval; exine 2-3 μm thick, sexine twice thicker than nexine and expanded in pore area to form punctate or spongy structure in atria, nexine extending to base of atria; scabrate to granulate.

This new species differs in the larger size from another species of this genus, which is 22-38 μm in diameter, occurring in the Upper Cretaceous of Portugal (Kedves *et* Diniz, 1981, p. 26).

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 12, fig. 17; slide no.: 683(C-13).

PSEUDOPLICAPOLLIS Krutzsch, 1967Type species *Pseudoplicapollis palaeocaenicus* Krutzsch, 1967**Pseudoplicapollis otogiensis** *sp. nov.*

Pl. 12, figs. 14, 15

Amb triangular with straight or slightly concave / convex sides and rounded angles, holotype 30 μm in diameter; triporate, equato-angulaperturate, pore with unclear atria; exine 1.5 μm thick in middle part of sides, nexine thin and extending to pore margin, sexine twice thicker than nexine and gradually thickening to 3 μm in pore area to form annulus, exopore 1-3 μm wide, pore canal slit; a thickened triangular area present, each angle extending only on border but not into atria; granulate.

This new species differs from *P. palaeocaenicus* Krutzsch (Goczan *et al.*, 1967, S. 497, Taf. 14, Figs. 26-31) only in each angle of the thickened triangular area not extending into atria as in the latter.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 12, fig. 14; slide no.: 683(7-2)

PSEUDOPROTEACIDITES *gen. nov.*Type species *Pseudoproteacidites microverrucatus* (Sun *et* Zhang) *gen. et sp. comb. nov.*

Diagnosis: Pollen oblate or lenticulate, amb triangular with straight or slightly convex / concave sides and rounded or obtuse angles; triporate, equato-angulaperturate, pore without vestibula but with atria, inner side uneven, denticulate; pore canal index nearly 0.3; exopore and endopore large; exine thin to moderately thick, two layers equal thick or with sexine thicker than nexine, extending to base of pore, sexine slightly thickened in pore area and with unclear baculate structure on inner part; granulate, verrucate and echinate.

Remarks: *Proteacidites* Cookson *et* Couper 1953 emend. Martin *et* Harris 1975 is characterized by the nexine which is thicker than sexine, with clear baculate structure and thinned in pore area (in the new genus, on the contrary, the sexine is thicker than nexine, clear baculate structure and slightly thickened in pore area). *Propylipollis* Martin *et* Harris 1975 has complicated structure in pore area, *Otogipollis* has elongated angles and pore canal index over 0.4, while *Megatriopollis* Goczan *et* Krutzsch 1967 has interlocum and small exopore. In these characteristics they all differs from this new genus.

Occurrence: Asia, Late Cretaceous to Early Tertiary.

Pseudoproteacidites microverrucatus (Sun *et* Zhang) *gen. et sp. comb. nov.* Pl. 13, figs. 1-3

1979 *Proteacidites microverrucatus* Sun *et* Zhang, p. 289, pl. 2, figs. 7, 8, 10, 11, 13.

1980 *Proteacidites adenanthoides* Cookson, Sun *et al.*, p. 109, pl. 26, fig. 7.

1981 *Proteacidites adenanthoides*, Song *et al.*, p. 121, pl. 35, figs. 16-20.

1986 *Proteacidites adenanthoides*, Song *et al.*, p. 85, pl. 20, figs. 18-22.

Amb triangular or sometimes tetragonal, sides straight or slightly concave and angles rounded or obtuse, 30-50 μm in diameter; triporate, pore with atria, pore canal index 0.3-0.4; exopore 5-11 μm and endopore 9-15 μm wide; exine 1.5-2.5 μm thick, sexine thicker than nexine, slightly thickening in pore area, and showing a baculate structure, nexine extending to base of atria; scabrate to tuberculate.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; Sanmenxia Area, Henan, Menli Formation; Ya'an County, Sichuan, Yuguangpo Formation; Northern Jiangsu, Funing Group.

Pseudoproteacidites elongatus *gen. et sp. nov.* Pl. 13, figs. 4-6

Amb triangular with straight or slightly convex sides, angles slightly elongated and terminal ends obtuse; 30-40 μm (holotype 35 μm) in diameter; triporate; exine 1.5 μm thick, sexine thicker than nexine, slightly thickened and then thinned to form atria in pore area; pore canal index over 0.3; exopore oval, 4-5 μm wide, endopore larger; microgranulate, outline nearly smooth.

The new species is characterized by the slightly elongated angles, fine ornamentation and smooth outline.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; Sanmenxia Area, Henan, Menli Formation.

Type: Pl. 13, fig. 5; slide no.: 683(A-5)

Pseudoproteacidites funingensis (Zheng, Qian *et* Song) *gen. et sp. comb. nov.* Pl. 13, figs. 7, 8
1993 *Proteacidites funingensis*, Qian *et al.*, p. 57, pl. 3, Figs. 20, 21.

Amb triangular, diameter 35-40 μm .

Occurrence: North Jiangsu; the 2nd formation of Funing Group.

Pseudoproteacidites kucheensis (Zhao, Sun *et* Wang) *gen. et sp. comb. nov.* Pl. 13, figs. 9, 10
1982 *Proteacidites kucheensis* Zhao, Sun *et* Wang, p. 108, pl. 2, figs. 18, 23, 24.

Amb triangular, diameter 33-45 μm .

Occurrence: North Jiangsu, Funing Group; Otog Banner, Inner Mongolia, Lower Tertiary.

Pseudoproteacidites miniporus *gen. et sp. nov.* Pl. 13, figs. 11-13, 16

Amb triangular with nearly straight sides and acute angles, holotype 36 μm in diameter; triporate; exine 1-1.5 μm thick, two layers subequally thick or with sexine thicker than nexine, sexine thickened (about 2 μm) at base of pore, becoming thinner and then thickened again along pore margin to form clear atria, nexine extending to base of pore, pore canal index over 0.3; exopore small, *ca.* 2 μm wide, endopore larger, *ca.* 10 μm wide; microgranulate.

This new species is characterized by the small exopore.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 13, fig. 11; slide no.: 522(B-2)

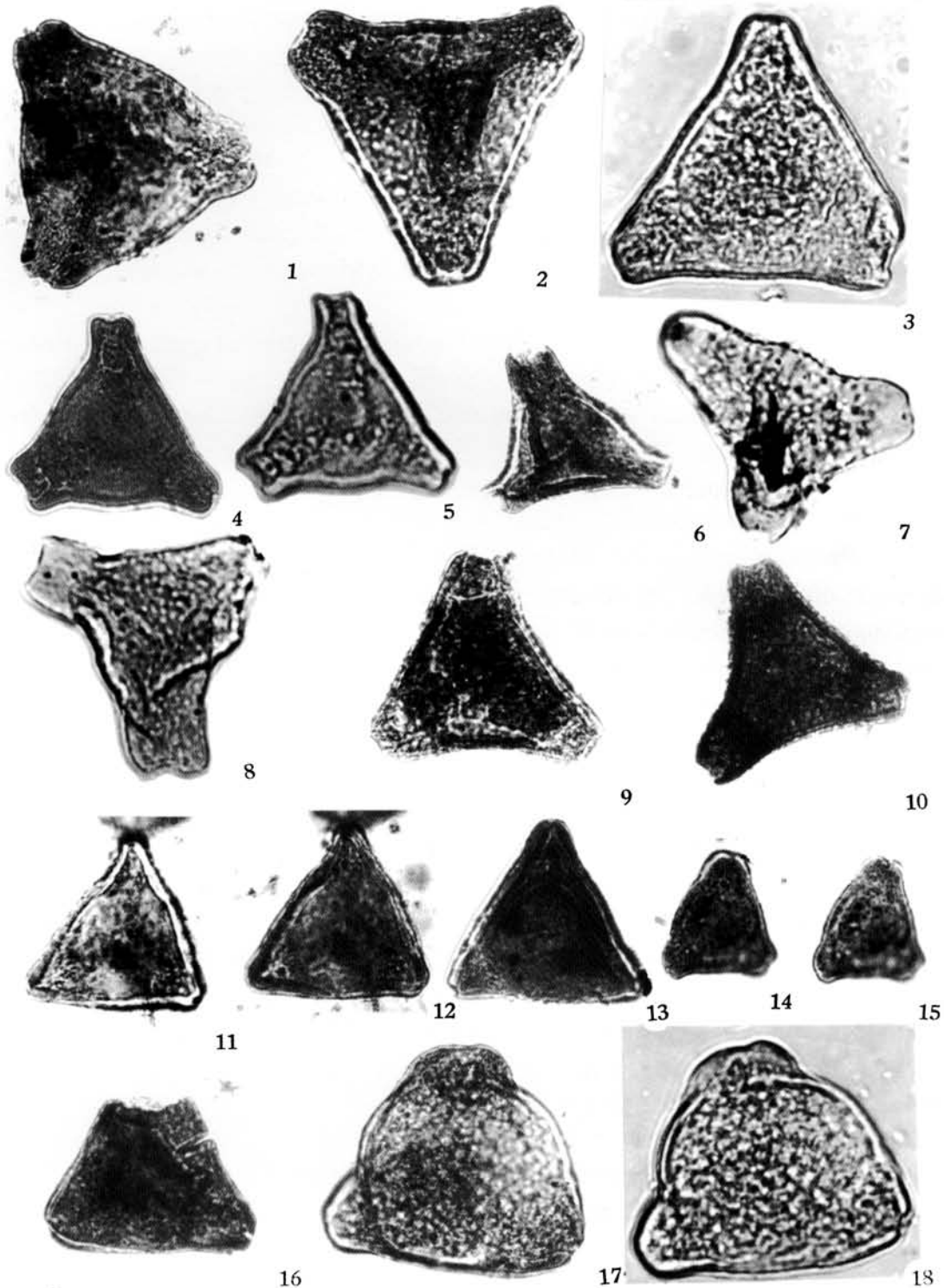
Pseudoproteacidites minutus *gen. et sp. nov.* Pl. 13, figs. 14, 15

Amb triangular with nearly straight or slightly convex sides and rounded angles, 18-25 μm (holotype 22 μm) in diameter; triporate; exine *ca.* 1.5 μm thick, nexine thin and extending to base of pore, sexine thicker than nexine, becoming thinner at base, and then slightly thickened in atria, with inner side uneven; pore canal index nearly 0.3; exopore oval, *ca.* 2 μm wide, endopore over 5 μm wide; microgranulate.

This new species is characterized by the small size and relatively thick exine.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 13, fig. 14; slide no.: 683(D-8)



Pl. 13. Figs. 1-3. *Pseudoproteacidites microverrucatus* (Sun et Zhang) gen. et sp. comb. nov. Slide no.: 683(13-1), 683(C-15), 683(D-7). Figs. 4-6. *Pseudoproteacidites elongatus* gen. et sp. nov. Slide no.: 683(A-5), Men 2(2-1). 6. Sanmenxia Area, Henan; Menli Formation. Figs. 7, 8. *Pseudoproteacidites funingensis* (Zheng, Qian et Song) gen. et sp. comb. nov. Slide no.: 870, 637. North Jiangsu; Funing Group. Figs. 9, 10. *Pseudoproteacidites kucheensis* (Zhao, Sun et Wang) gen. et sp. comb. nov. Slide no.: 523(D-11), 683(12-1). Figs. 11-13, 16. *Pseudoproteacidites miniporus* gen. et sp. nov. Slides no.: 522(B-2), 522(C-1), 520(C-2). Figs. 14, 15. *Pseudoproteacidites minutus* gen. et sp. nov. Slide no.: 683(D-8). Figs. 17, 18. *Pseudoproteacidites subrotundus* gen. et sp. nov. Slide no.: 683(A-4).

Pseudoproteacidites subrotundus *gen. et sp. nov.* Pl. 13, figs. 17, 18

Amb roundedly triangular, holotype 50 μm in diameter; triporate, exine 1-1.5 μm thick, two layers subequally thick or with sexine thicker than nexine, sexine slight thickening in pore area and showing punctate structure, nexine extending to base of atria, with inner side uneven, pore canal index nearly 0.3; exopore 4-5 μm and endopore over 10 μm wide; microgranulate or rugulate when eroded, outline nearly smooth.

This new species is characterized by the roundedly triangular amb, which is triangular in other species of this genus.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 13, fig. 17; slide no.: 683(A-4)

Pseudoproteacidites tantouensis (Zhang) *gen. et sp. comb. nov.* Pl. 14, figs. 1-3

1978 *Proteacidites tantouensis* Zhang, p. 553, pl. 153, figs. 5-7.

Amb triangular, diameter 30-40 μm .

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; Sanmenxia Area, Henan, Menli Formation.

Pseudoproteacidites tenuis *gen. et sp. nov.* Pl. 14, figs. 4, 5

Amb triangular with nearly straight sides and rounded angles, 35-45 μm (holotype 42 μm) in diameter; triporate; exine 1 μm thick, two layers subequally thick, nexine extending to base of pore, sexine slightly thickened to 2 μm in pore area and showing unclear baculate structure; pore canal index nearly 0.3; exopore 4-8 μm wide and endopore wider; granulate, with a roundedly triangular area on polar area where the exine is thinner.

This new species is characterized by the thin exine and a roundedly triangular area on polar area.

Occurrence: Otog Banner, Inner Mongolia, and Yulin County, Guangxi, Lower Tertiary.

Type: Pl. 14, fig. 5; slide no.: 683(8-2)

Pseudoproteacidites tenuispinosus (Sun, Zhao et He) *gen. et sp. comb. nov.* Pl. 14, figs. 6, 7

1980 *Proteacidites tenuispinosus* Sun, Zhao et He, p. 50, pl. 2, figs. 11, 12.

Amb triangular, diameter 40-50 μm .

Occurrence: same as the preceding species.

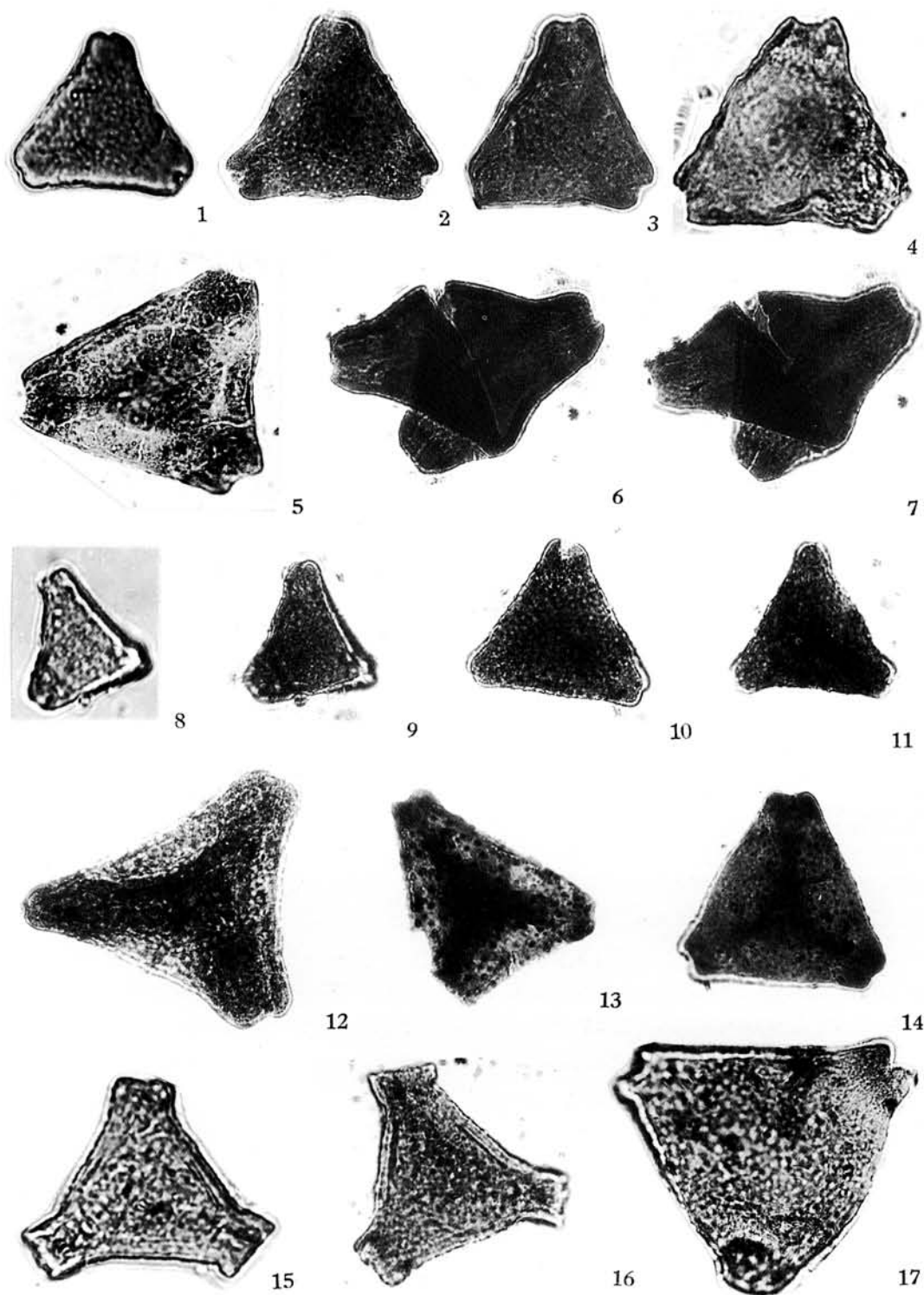
Pseudoproteacidites triangulus *gen. et sp. nov.* Pl. 14, figs. 8-11

Amb triangular with nearly straight sides and acutely rounded angles, 20-30 μm (holotype 25 μm) in diameter; triporate, pore with atria in triangular shape, pore canal index nearly 0.4; exopore 1-2 μm and endopore over 5 μm wide; exine 1.5 μm thick, sexine thicker than nexine, extending to base of atria, slightly thinned at base of atria and then thickened along pore margin with inner side uneven; scabrate to granulate.

This new species which is also in small size, differs from *P. minutus* in the straight sides and slightly elongated angles. It resembles *Proteacidites tenellus* Wang (1982, p. 86, pl. 1, figs. 15, 16) in the shape, but the latter has microreticulate ornamentation and larger exopore, 4-7 μm wide.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 14, fig. 8; slide no.: 687(7-2)



Pl. 14. Figs. 1-3. *Pseudoproteacidites tantouensis* (Zhang) *gen. et sp. comb. nov.* Slide no.: 884, Men 3(5-1), San 2(2-1). 1. North Jiangsu; Funing Group. 2, 3 Sanmenxia Area, Henan; Menli Formation. Figs. 4, 5. *Pseudoproteacidites tenuis* *gen. et sp. nov.* Slide no: 683(8-2). 4. Yulin County, Guangxi; Lower Tertiary. Figs. 6, 7. *Pseudoproteacidites tenuispinosus* (Sun, Zhao et He) *gen. et sp. comb. nov.* Slide no: 683(16-1). Figs. 8-11. *Pseudoproteacidites triangulus* *gen. et sp. nov.* Slide no: 687(7-2), 687(10-1), 479(20-1), 523(C-14). Figs. 12-14. *Psseudoproteacidites triletoides* *gen. et sp. nov.* Slide no: 523(16-1), 365, 687(9-1). 13. North Jiangsu; Funing Group. Figs. 15, 16. *Pseudoproteacidites truncatus* *gen. et sp. nov.* Slide no: 683(B-4). Fig. 17. *Pseudoproteacidites xiningensis* (Sun, Zhao et He) *gen. et sp. comb. nov.* Slide no: 683(C-6).

Pseudoproteacidites triletoides *gen. et sp. nov.*

Pl. 14, figs. 12-14

Amb triangular, 35-50 μm (holotype 38 μm) in diameter; triporate; exine 1.5-2 μm thick, granulate to tuberculate, a thickening band like triletes extending from angles to pole.

This new species resembles *P. microverrucatus* in shape and structure, but differs from the latter only in a thickening band like triletes.

Occurrence: Same as *P. microverrucatus*.

Type: Pl. 14, fig. 14; slide no.: 687(9-1)

Pseudoproteacidites truncatus *gen. et sp. nov.*

Pl. 14, figs. 15, 16

Amb triangular with straight sides and a cuted angles, slightly projected along terminal margin, 35-40 μm (holotype 38 μm) in diameter; triporate, pore canal index nearly 0.3; exopore as large as or slightly larger than endopore, *ca.* 5-6 μm wide; exine 2 μm thick, sexine twice thicker than nexine and slightly thickening along pore margin, baculate structure visible; granulate.

This new species, characterized by the truncate angles and subequally large exopore and endopore, is different from other species of this genus.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 14, fig. 15; slide no.: 683(B-4)

Pseudoproteacidites xiningensis (Sun, Zhao *et* He) *gen. et sp. comb. nov.* Pl. 14, fig. 17

1980 *Proteacidites xiningensis* Sun, Zhao *et* He, p. 50, pl. 2, figs. 13-15.

Amb triangular, diameter 35-50 μm .

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; Sanmenxia Area, Henan, Menli Formation.

PSEUDOTRUDOPOLLIS Krutzsch, 1967

Type species *Pseudotrudopollis pseudoalnus* Krutzsch

Pseudotrudopollis basoides *sp. nov.*

Pl. 16, figs. 1, 2

1979 *Proteacidites microverrucatus* Sun *et* Zhang, p. 2, figs. 10, 11

1987 *Proteacidites* sp. 1., Hao, p. 38, fig. 4.

Amb tetragonal or pentagonal, with concave sides and cylindrical angles, 35-45 μm (holotype 35 μm) in diameter; tetra- to pentaporate, equato-angulaperturate, pore with cylindrical vestibula formed by highly protruded sexine; exine *ca.* 1.5 μm thick, sexine thicker than nexine and slightly thickening along pore margin, nexine extending over base of vestibula; granulate to tuberculate.

This new species differs from the type species (*P. pseudoalnus*) of this genus in the concave sides, thin exine and the absence of incidens (the type species has straight sides, thick exine and incidens)

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 16, fig. 2; slide no.: 687(19-1)

ROMEINIPOLLENITES Kedves *et* Herngreen, 1980

Type species: *Romeinipollenites granulatus* Kedves *et* Herngreen, 1980

Romeinipollenites granulatus Kedves *et* Herngreen, 1980 P1. 15, figs. 8, 9, 15-18
1980 *Romeinipollenites granulatus* Kedves *et* Herngreen, p. 517, pl. 8, figs. 18-20.

Amb triangular, diameter 30-35 μm .

Occurrence: North Jiangsu, Funing Group.

Romeinipollenites magnus *sp. nov.* P1. 15, figs. 19-22

Amb roundedly triangular to circular, 40-50 μm (holotype about 40 μm) in diameter; triaperturate, angulaperturate, exogerminal colpate, half colpus about 1/4-1/3 radius length, endogerminal porate, probably unclear, with narrow and small vestibula on type specimen; exine 4-5 μm thick, tectum as thin as nexine, sexine thicker and thickened at aperturate area; scabrate to microgranulate, outline smooth.

The new species is similar to *R. laevigatus* (Kedves *et* Herngreen, 1980, p. 517, pl. 9, figs. 1, 2) in shape, but differs from the latter in the porate endogerminal and thin nexine; the latter has thicker nexine (2 μm) and is smaller in size 28-35 μm in diameter. It differs from *R. tenuicolpatus* in the larger size (over 40 μm); the latter is 25-38 μm in diameter.

Occurrence: Northern Jiangsu, 2nd and 3rd Formations of Funing Group.

Type: Pl. 15, fig. 19; slide no.: 390

Romeinipollenites microechinatus Zheng, Qian *et* Song 1993 P1. 15, figs. 5, 10
1993 *Romeinipollenites microechinatus* Qian *et al.*, p. 58, pl. 4, figs. 22-34.

Amb nearly rounded, diameter 35 μm .

Occurrence: Same as the preceding species.

Romeinipollenites tenuicolpatus (Sun *et* He) Zheng, Qian *et* Song 1993
P1. 15, figs. 1-4, 6, 7, 12

1980 *Psilabratricolpites tenuicolpatus* Sun *et* He, p. 116, pl. 23, figs 13-16.

1993 *Romeinipollenites tenuicolpatus*, Qian *et al.*, p. 58, pl. 4, figs. 20, 21, 26, 27.

Amb roundedly triangular to circular, diameter 35-40 μm .

Occurrence: Same as the preceding species.

Romeinipollenites triangulus *sp. nov.* P1. 15, figs. 11, 13, 14

Amb roundedly triangular to circular, 35-40 μm (holotype 35 μm) in diameter; triaperturate, exogerminal colpate and endogerminal porate, probably with small vestibula; exine solid, scabrate to microgranulate; a small triangular area present on polar area, where the exine is thinner but the ornamentation is coarser than in other parts.

The new species is characterized by the small triangular area on polar area, and differs from other species of this genus.

Occurrence: Same as the preceding species.

Type: Pl. 15, fig. 11; slide no.: 847

- Romeinipollenites cf. laevigatus** Kedves *et* Herngreen, 1980 Pl. 16, figs. 3, 4
 cf. 1980 *Romeinipollenites laevigatus* Kedves *et* Herngreen, p. 517, pl. 9, figs 1, 2.
 Amb nearly circular, diameter 30 μm .
 Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

SPINOTRIPORITES *gen. nov.*

Type species *Spinotriporites unicannulatus gen. et sp. nov.*

Diagnosis: Pollen oblate to spherical, amb triangular to roundedly triangular; triporate, equato-angulaperturate, pore round, probably with small vestibula and atria; exine moderately thick and slightly thickening toward pore, sexine thicker than nexine and probably divided at pore; microechinate or microbaculate, spinae less than 2 μm in length; pollen small to medium in size.

Remarks: This new genus differs from *Echitriporites*, *Diervillapollenites* and *Echibasopollis* in its small size and microspinate ornamentation. It differs from *Weigelapollis* Takahashi 1982 which has subequatorial pore and thin exine; from *Triatriopollenites* which has laevigate to scabrate but no echinate ornamentation, from *Compositoipollenites* Potonie 1951 which has rounded amb and pore not situated on angles, and from *Thomsonpollis* Krutzsch 1960 which has thick exine and complicated pore structure.

Occurrence: China and Central Asia, Late Cretaceous to Early Tertiary.

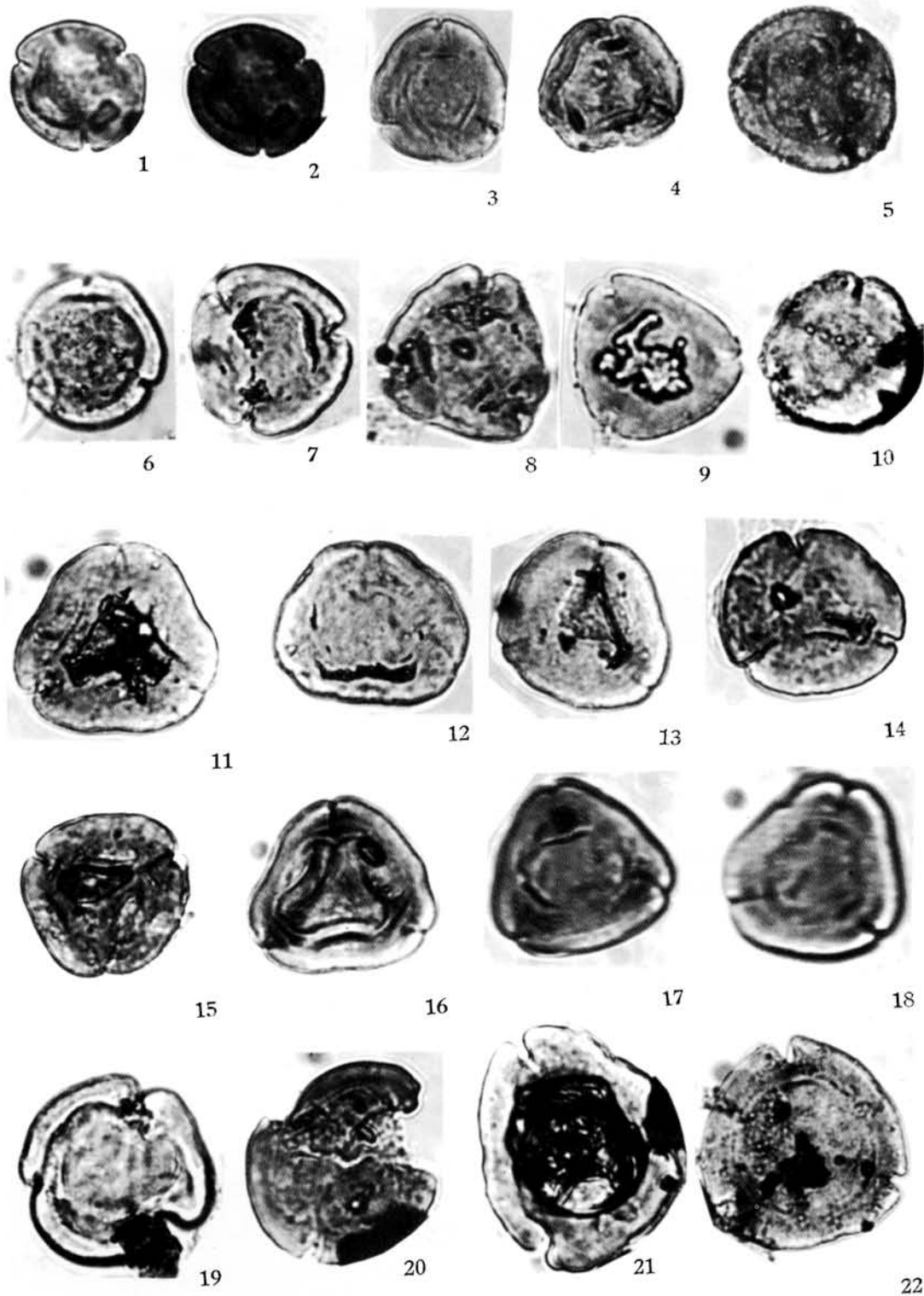
- Spinotriporites echinatus** (Sun *et* Zheng) *gen. et sp. comb. nov.* Pl. 17, figs. 1-4
 1979 *Triatriopollenites echinatus*, Sun *et al.*, p. 290, pl. 2, figs. 14-16, 20.
 Amb triangular, diameter 30-45 μm .
 Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; Sanmenxia Area, Henan, Menli Formation.

- Spinotriporites minor** (Wang, Sun *et* Zheng) *gen. et sp. comb. nov.* Pl. 17, figs. 8-13
 1990 *Echitriporites minor*, Wang *et al.*, p.122, pl. 17, figs. 28, 29, 34.
 Amb triangular, diameter 18-35 μm .
 Occurrence: Same as the preceding species.

- Spinotriporites unicannulatus** *gen. et sp. nov.* Pl. 16, figs. 5-11
 Amb triangular to roundedly triangular, diameter 25-35 μm (holotype 30 μm); triporate, exopore oval, 4-8 μm wide and endopore slightly larger than exopore, pore canal index *ca.* 0.25; exine 1.5-2.5 μm thick, sexine thicker than nexine and thickened about 4 μm at pore area to form annulus; baculo-spinate, spinae commonly *ca.* 1 μm long, with grana in between, outline microdenticulate.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; Sanmenxia Area, Henan, Menli Formation.

Type: Pl. 16, fig. 5; slide no.: 523(4-2)



Pl. 15. Figs. 1-4, 6, 7, 12 *Romeinipollenites tenuicolpatus* (Sun et He) Zheng, Qian et Song 1993. Slide no.: 1020, 50, 613, 830, 445, 738. Figs. 5, 10 *Romeinipollenites microechinatus* Zheng, Qian et Song 1993. Slide no.: 604, 381. Figs. 8, 9, 15-18. *Romeinipollenites granulatus* Kedves et Herngreen 1980. Slide no.: 446, 882, 927, 462, 741, 738. Figs. 11, 13, 14. *Romeinipollenites triangulus* sp. nov. Slide no.: 847, 372, 861. Figs. 19-22. *Romeinipollenites magnus* sp. nov. Slide no.: 390, 848, 335, 605. All specimens of this plate have been collected from Funing Group, North Jiangu.

Spinotriporites biannulatus *gen. et sp. nov.*

Pl. 16, figs. 12-15

Amb triangular to roundedly triangular, diameter 30-40 μm (holotype 36 μm); triporate, exopore smaller than endopore, oval, 4-5 μm wide, with long pore canal and small vestibula formed by thickened sexine, which is divided in pore area, pore canal index about 0.3; exine 1.5-2 μm thick, sexine thicker than nexine and thickened to 4-6 μm in pore area; baculo-spinate, spinae commonly 1 μm long, less than 2 μm , sparsely distributed and with puncta in between, outline microdenticulate.

The new species is characterized by strongly thickened sexine in pore area, small vestibula and pore canal index 0.3, which distinguishes it from the type species of this genus.

Occurrence: Same as the preceding species.

Type: Pl. 16, fig. 12; slide no.: 523(7-1)

Spinotriporites atriaporus *gen. et sp. nov.*

Pl. 16, figs. 16-19

Amb triangular with slightly convex sides and rounded angles, 30-40 μm (holotype 35 μm) in diameter; triporate, exopore oval, 4-5 μm wide; exine *ca.* 2 μm thick, sexine thicker than nexine and thickened to about 5 μm in pore area, nexine extending to somewhere at 1/2 between pore margin and middle part of each side and divided to form postatrium, about 15 μm wide on holotype; baculo-spinate, spinae less than 2 μm long and with puncta in between them, outline microdenticulate.

This new species is characterized by its postatrium.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 16, fig. 17; slide no.: 683(A-5)

Spinotriporites annulatus *gen. et sp. nov.*

Pl. 16, figs. 20, 21

Amb triangular with slightly convex sides and rounded angles, 30-40 μm (holotype 32 μm) in diameter; triporate, pore simple, oval, 6-8 μm wide; exine *ca.* 1.5 μm thick, sexine thicker than nexine and thickened to *ca.* 2 μm in pore area, nexine not extending into pore area; with an annulus band as thick as exine on subequatorial belt; microspinate, spinae 1-1.5 μm long, outline microdenticulate.

This new species is characterized by its subequatorial annulus band as thick as exine.

Occurrence: Same as the preceding species.

Type: Pl. 16, fig. 20; slide no.: 681(2-1)

Spinotriporites intrannulatus *gen. et sp. nov.*

Pl. 17, figs. 5, 6

Amb roundedly triangular, holotype 30 μm in diameter; triporate, pore oval, *ca.* 8 μm wide, atria large; exine solid, thickened along inner side in pore area to 5-6 μm in dark colour; microspinate, spinae *ca.* 1 μm long, outline denticulate.

The new species is characterized by the exine thickened along inner side in pore area.

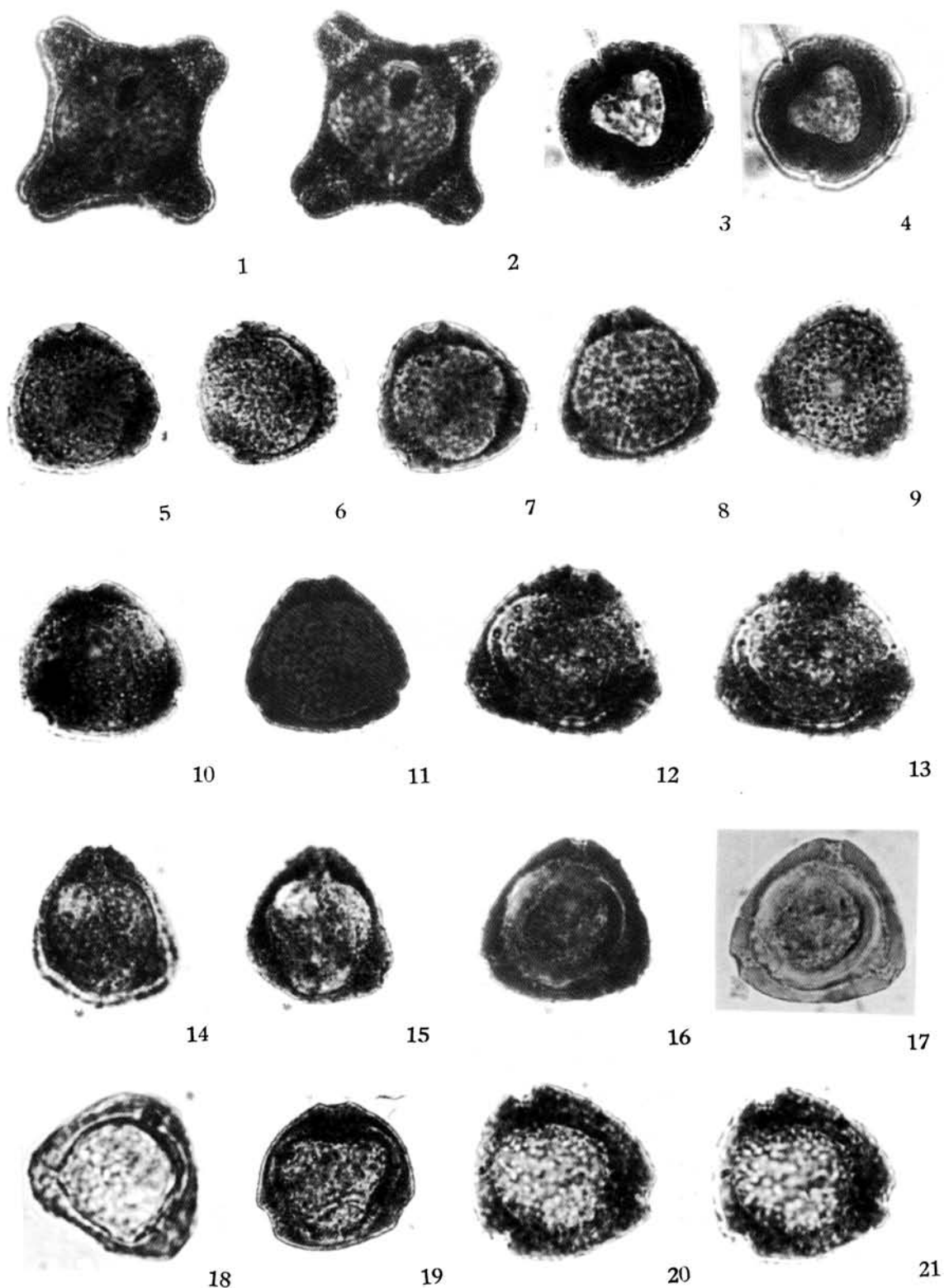
Occurrence: Same as the preceding species.

Type: Pl. 17, fig. 5; slide no.: *San 1* (12-1-3)

Spinotriporites pachydermus *gen. et sp. nov.*

Pl. 17, figs. 14-18

Amb triangular to roundedly triangular, 22-30 μm (holotype 24 μm) in diameter; triporate, pore round, pore canal index 0.3; exine 2-2.5 μm thick, sexine 2-3 times thicker



Pl. 16. Figs. 1, 2. *Pseudotrudopollis basoides* sp. nov. Slide no.: 687(19-1). Figs. 3, 4. *Romeinipollenites* cf. *laevigatus* Kedves et Herngreen 1980 Slide no.: 542(A-1). Figs. 5-11. *Spinotriporites unicannulatus* gen. et sp. nov. Slide no.: 523(4-2), 523(9-12), 523(9-2), 683(10-3). Figs. 12-15. *Spinotriporites biannulatus* gen. et sp. nov. Slides no.: 523(7-1), 523(7-2). Figs. 16-19. *Spinotriporites atriaporus* gen. et sp. nov. Slide no.: 683(A-5), 687(9-1), 523(3-1). Figs. 20, 21. *Spinotriporites annulatus* gen. et sp. nov. Slide no.: 681(2-1).

than nexine and gradually thickened to 4-5 μm in pore area, without vestibula; microspinate, spinae about 1 μm long, outline denticulate.

The new species differs from *S. unicannulatus* and *S. biannulatus* in its smaller size and very thick exine.

Occurrence: Same as the preceding species.

Type: Pl. 17, fig. 14; slide no.: 687(4-1)

Spinotriporites microspinus *gen. et sp. nov.*

Pl. 17, fig. 7

Amb roundedly triangular, diameter of holotype *ca.* 50 μm ; triporate, pore with large exopore, *ca.* 7 μm wide and atria in dark colour; exine *ca.* 1 μm thick, sexine and nexine equally thick and without variations along pore margin; microspinate, spinae *ca.* 1 μm long, well-distributed.

This new species is characterized by larger size, wide pore and thin exine, which distinguishes it from other species of this genus.

Occurrence: Same as the preceding species.

Type: Pl. 17 fig. 7; slide no.: 489(D-2)

Spinotriporites tenuis *gen. et sp. nov.*

Pl. 17, figs. 19-22

Amb roundedly triangular to circular, 35-40 μm (holotype 35 μm) in diameter; triporate, pore round, *ca.* 6 μm wide on type specimen; exine thin, under 1 μm thick; microspinate, spinae commonly 1 μm long, outline denticulate.

The new species is characterized by the thin exine.

Occurrence: Ya' an County, Sichuan, Yuguangpo Formation; Sanmenxia Area, Henan, Menli Formation.

Type: Pl. 17, fig. 19; slide no.: *San 1(12-3-1)*

SPOROPOLLIS Pflug 1953

Type species: *Sporopollis documentum* Pflug 1953

Sporopollis laqueaeformis Weyland *et* Greifeld 1953

Pl. 18, figs 1-4

1953 *Sporopollis laqueaeformis* Weyland *et* Greifeld, S. 45, Taf. 13, Fig. 111, 112.

Amb triangular, diameter about 20 μm .

Occurrence: Otog Banner, Inner Mongolia; Lower Tertiary.

Sporopollis pseudosporites (Pflug) Pflug 1953

Pl. 18, fig. 5

1953 *Sporopollis pseudosporites* Pflug, S 97, Taf. 25, Fig. 1-3.

Amb triangular, diameter about 25 μm .

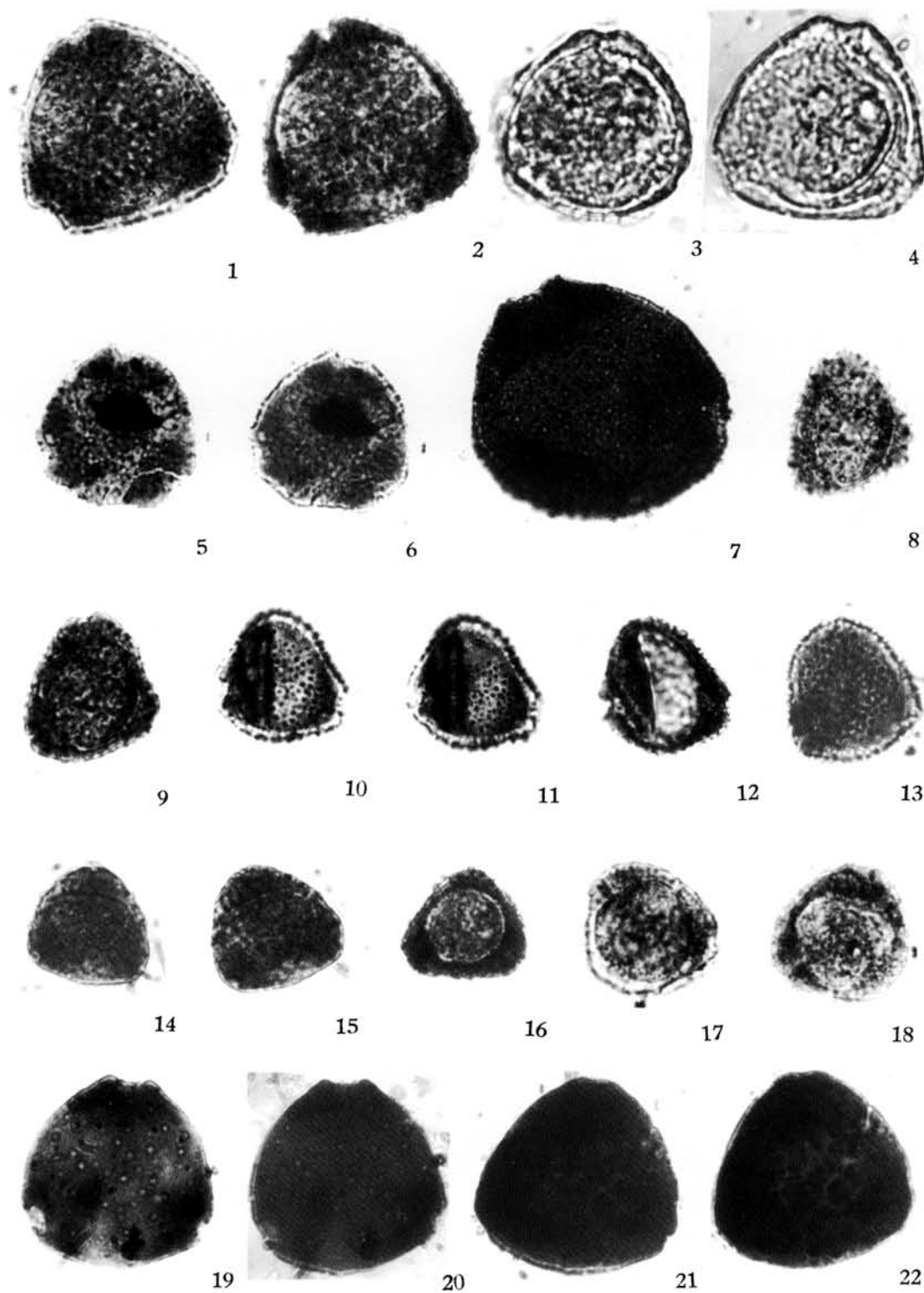
Occurrence: same as the preceding species.

Sporopollis sp.

Pl. 18, fig. 6-8

Amb triangular, diameter about 35 μm .

Occurrence: same as the preceding species.



Pl. 17. Figs. 1-4. *Spinotriporites echinatus* (Sun et Zhang) gen. et sp. comb. nov. Slide no.: 523(2-2), 460(3-2), 683(C-15). Figs. 5, 6. *Spinotriporites intrannulatus* gen. et sp. nov. Slide no.: San 1(12-1-3). Sanmemxia Area, Henan; Menli Formation. Fig. 7. *Spinotriporites microspinus* gen. et sp. nov. Slide no.: 489(D-2). Figs. 8-13. *Spinotriporites minor* (Wang, Sun et Zhao) gen. et sp. comb. nov. Slide no.: 683(C-1), 683(I-3), 681-11, 523(9-1) Figs. 14-18. *Spinotriporites pachydermus* gen. et sp. nov. Slide no.: 687(4-1), 523(19-1), 523(B-6). Figs. 19-22. *Spinotriporites tenuis* gen. et sp. nov. Slide no.: San 1(12-3-1), San 1(11-2). Sanmemxia Area, Henan; Menli Formation.

SUBTRIAPERTURITES *gen. nov*

Type species *Subtriaperturites tuberculatus gen. et sp. nov.*

Diagnosis: Pollen oblate to spherical, amb roundedly triangular to circular; triaperturate, subequatorial and angulaperturate, aperture composed of large atria and slit exogerminal; exine thin to moderately thick and thinning toward aperture; granulate, brevibaculate, rugulate and tuberculate.

Remarks: The new genus differs from *Subtrudopollis*, *Interpollis* Krutzsch 1961 and *Interporopollenites* Weyland et Krieger 1953 in its structure of aperture and ornamentation; the latter two genera have only with pore but no slit exogerminal, although the aperture is also situated subequatorially.

Occurrence: China, Early Tertiary.

Subtriaperturites tuberculatus *gen. et sp. nov.*

Pl. 18, figs. 9-12

1978 *Beaupreaidites verrucosus* Zhou, Geoscience Institute of Hubei Province *et al.*, p. 554, pl. 153, fig. 17.

1990 *Beaupreaidites aggrregatus* Sun, Zhao et He, Wang *et al.*, pl. 17, fig. 7.

Amb triangular to roundedly triangular, 20-25 μm (holotype 22 μm) in diameter; triaperturate, subequato-angulaperturate, aperture composed of large atria and slit exogerminal pore, atria round, *ca.* 5 μm wide; exine *ca.* 1 μm thick and thinned in aperture area; tuberculate, tuberculae large than 1 μm in diameter and well distributed; outline microundulate, punctate in atria area.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 18, fig. 11; slide no.: 479(A-6)

SUBTRIPOROPOLLENITES Pflug et Thomson 1953

Type species: *Subtriporopollenites annulatus notus* Pflug et Thomson 1953

Subtriporopollenites firmus Pflug 1953

Pl. 18, figs. 13, 14

1953 *Subtriporopollenites firmus* Pflug, S. 86, Taf. 9, Figs. 62, 63.

Amb nearly circular, diameter about 20 μm .

Occurrence: Otog Banner, Inner Mongolia; Lower Tertiary.

Subtriporopollenites tuberus Sung et Lee, 1976

Pl. 18, figs. 15, 16

1976 *Subtriporopollenites tuberus* Sung et Lee, p. 36, pl. 7, figs. 30-38.

Amb triangular, diameter about 20 μm .

Occurrence: Same as the preceding species.

SUBTRUDOPOLLIS Krutzsch 1967

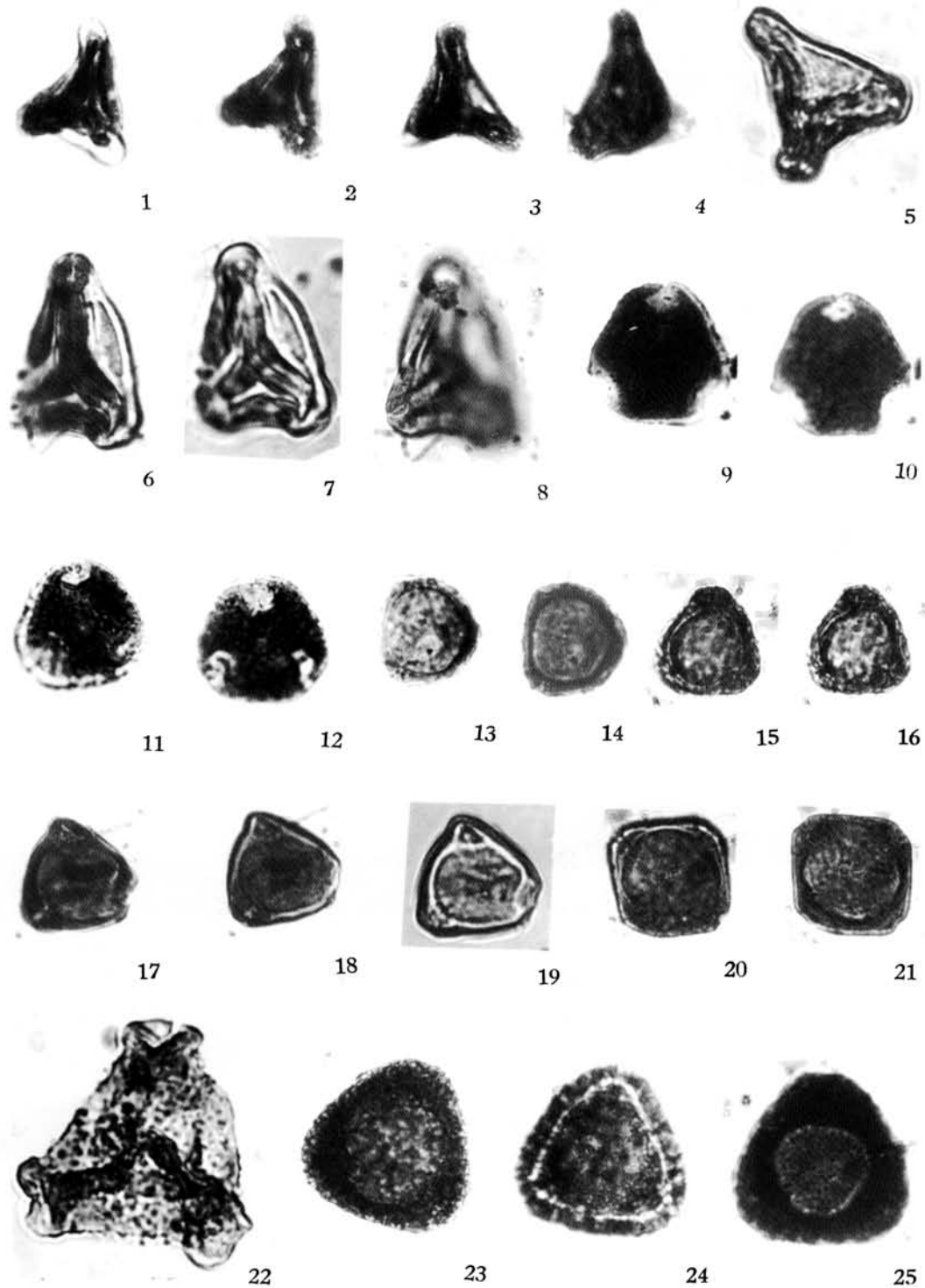
Type species: *Subtrudopollis subtrudens* (Pflug) Krutzsch 1967

Subtrudopollis subtrudens (Pflug) Krutzsch 1967

Pl. 18, figs. 17-19

1953 *Extratiporopollenites subtrudens* Pflug, S. 73, Taf. 6, Fig. 73.

1967 *Subtrudopollis subtrudens* (Pflug) Krutzsch, S. 506, Taf. 16, Fig. 41-47.



Pl. 18. Figs. 1-4. *Sporopollis laqueaeformis* Weyland et Greifeld 1953 Slide no.: 683(5-2), 683(A-9), 479(18-5). Fig. 5. *Sporopollis pseudosporites* (Pflug) Pflug 1953. Slide no.: 479(B-2). Figs. 6-8. *Sporopollis* sp. Slide no.: 683(C-2). Figs. 9-12. *Subtriaperturites tuberculatus* gen. et sp. nov. Slide no.: 687(5-2), 479(A-6). Figs. 13, 14. *Subtriporopollenites firmus* Pflug 1953. Slide no.: 687(10-6). Figs. 15, 16. *Subtriporopollenites tuberus* Sung et Lee 1976. Slide no.: 523(C-11). Figs. 17-19. *Subtrudopollis subtrudens* (Pflug) Krutzsch 1967. Slide no.: 479(B-1). Figs. 20, 21. *Tetrapollis validus* (Pflug) Pflug 1953. Slide no.: 522(A-2). Fig. 22. *Tantoupollis prominens* Wang, Sun et Zhao 1985. Slide no.: 308. North Jiangsu, Funing Group. Figs. 23-25. *Thomsonipollis magnificus* (Thomson et Pflug) Krutzsch 1960. Slide no.: 523(B-1).

Amb triangular, diameter about 20 μm .

Occurrence: Otog Banner, Inner Mongolia; Lower Tertiary.

TANTOUPOLLIS Wang, Sun *et* Zhao 1985

Type species: *Tantoupollis echinatus* Wang, Sun *et* Zhao 1985

Tantoupollis prominens Wang, Sun *et* Zhao 1985

Pl. 18, fig. 22

1985 *Tantoupollis prominens* Wang, Sun *et* Zhao, p. 119, pl. 1, figs. 6-8.

1993 *Corsinipollenites echinatus*, Qian *et al.*, p. 57, pl. 3, figs. 22, 25.

Amb triangular, diameter about 40 μm .

Occurrence: North Jiangsu, Funging Group.

TETREPOLLIS Pflug 1953

Type species: *Tetrepollis validus* (Pflug) Pflug 1953

Tetrepollis validus (Pflug) Pflug 1953

Pl. 18, figs. 20, 21

1953 *Tetrepollis validus* (Pflug) Pflug, S. 113, Taf. 24, figs. 72, 74, 76-79.

Amb tetragonal, diameter 22-25 μm .

Occurrence: Otog Banner, Inner Mongolia; Lower Tertiary.

THOMSONIPOLLIS Krutzsch 1960

Type species: *Thomsonipollis magnificus* (Thomson *et* Pflug) Krutzsch 1960

Thomsonipollis magnificus (Thomson *et* Pflug) Krutzsch 1960

Pl. 18, figs. 23-25

1953 *Intratropopollenites magnificus* Thomson *et* Pflug, S. 88, Taf. 9, fig. 112.

1960 *Thomsonipollis magnificus*, Krutzsch, S. 58.

Amb triangular, diameter 30-35 μm .

Occurrence: Otog Banner, Inner Mongolia; Lower Tertiary.

TREVISANAEPOLLENITES Kedves *et* Diniz, 1981

Type species *Trevisanaepollenites triangulus* Kedves *et* Diniz, 1981

Trevisanaepollenites intrabaculatus *sp. nov.*

Pl. 19, figs. 1, 2

Amb triangular with straight or slightly convex sides and rounded angles, diameter of holotype 35 μm ; triporate, pore with large atria in triangular shape formed by sexine only, pore canal index nearly 0.3, exogerminal slit, symmetrical to equator; exine ca. 1.5 μm thick, sexine thicker than nexine and slightly thickening to 1.5-2 μm in proe area, with baculate

structure and clearer in pore area, inner side of sexine uneven; granulate, coarser in pore area, an unclear thickening shown on polar area.

The new species resembles the type species of this genus, *T. triangulus* Kedves et Diniz (1981, p. 25, pl. 2, figs. 79, 80) in the shape and structure, but the latter has a larger (40-50 μm) diameter and psilate ornamentation.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 19, fig. 2; slide no.: 687(3-3)

TRIATRIOPOLLENITES Pflug, 1953

Type species *Triatriopollenites rurensis* Pflug, 1953

Triatriopollenites furvatrium Sun 1989

P1. 19, figs. 3, 4

1989 *Triatriopollenites furvatrium* Sun, p. 101, pl. 17, figs. 44-47.

Amb triangular or tetragonal, diameter 30-40 μm .

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; North Jiangsu, Funing Group.

Triatriopollenites granulatus *sp. nov.*

P1. 19, figs. 5-7

Amb triangular to roundedly triangular, 30-40 μm (holotype 34 μm) in diameter; triporate, pore with clear atria; exine 1.5-2 μm thick, sexine thicker than nexine extending to base of atria, and thickened inside in pore area to form club-shaped; granulate.

The new species which is characterized by strongly granulate ornamentation, resembles *Spinotriporites echinatus* in the shape and structure, but the latter differs in the echinate ornamentation only.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; Sanmenxia Area, Henan, Menli Formation.

Type: Pl. 19, fig. 5; slide no.: 681(B-1)

Triatriopollenites raribaculus *sp. nov.*

P1. 19, figs. 8-10

Amb triangularly rounded, holotype 46 μm in diameter; triporate, pore with atria; exine ca. 2 μm thick, nexine thin and extending only to base of atria, sexine twice thicker than nexine and slightly thickened in pore area, with inner side uneven, denticulate or even dissolved to punctate structure; pore canal index under 0.3; exopore oval, ca. 8 μm wide, endopore over 10 μm wide; baculate, bacula commonly 1 μm long and slightly expanded at terminal ends, sparsely distributed, with about 15-20 on outline, punctate in atria area.

The new species is characterized by its sparsely baculate ornamentation.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 19, fig. 8; slide no.: 476(A-1)

Triatriopollenites roboratus Pflug 1953

P1. 19, fig 11

1953 *Triatriopollenites roboratus* Pflug, S. 78, Taf. 7, fig. 71-74.

Amb triangular, diameter about 35 μm .

Occurrence: Otog Banner, Inner Mongolia: Lower Tertiary.

TRIMAGNAPORITES *gen. nov.*

Type species *Trimagnaporites magnaporus gen. et sp. nov.*

Diagnosis: Pollen oblate, amb triangular or with concave sides; triporate, equato-angulaperturate, pore with large atria formed by sexine only, exopore commonly large, endopore relatively smaller than exopore, bearing no clear boundary with body; exine moderately thick, without clear thickening but with baculate structure in pore area; laevigate, granulate, microspinate and tuberculate.

Remarks: This new genus differs from *Concavitriporites* in the large atria, the exopore and endopore in the same size and the absence of thickening in pore area. It is similar to *Santonipollis* Groot, Krutzsch et Pacltova 1967 in the amb, large atria and ornamentation, but the latter differs in the slit exogerminal and clear thickening in pore area. It differs from *Oculosa* Blyakhova 1975, which has subequatorial aperture and strongly thickened exine in endopore.

Occurrence: China, Early Tertiary.

Trimagnaporites magnaporus *gen. et sp. nov*

P1. 19, figs. 12, 13

Amb triangular with concave sides and obtuse angles, 30-40 μm (holotype 34 μm) in diameter; triporate, pore with large atria formed by sexine only, exopore ragged, 7-10 μm wide, endopore smaller than exopore; exine 1.5-2 μm thick, sexine thicker than nexine and slightly thickened in pore area, with inner side uneven, nexine extending to base of atria; granulate, grana sparsely distributed.

The new species is characterized by its ragged exopore.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Type: Pl. 19, fig. 12; slide no.: 687(10-2)

Trimagnaporites tenuis *gen. et sp. nov*

P1. 19, fig. 17

Amb triangular with concave sides and rounded angles, holotype *ca.* 40 μm in diameter; triporate, pore with atria formed by sexine only, exopore oval, 5-7 μm wide; exine under 1 μm in thickness and slightly thickened to 1 μm in pore area, with inner side uneven in pore area; granulate.

The new species is characterized by the thin exine.

Occurrence: Same as the preceding species.

Type: Pl. 19, fig. 17; slide no.: 479(6-2)

Trimagnaporites triangulus *gen. et sp. nov.*

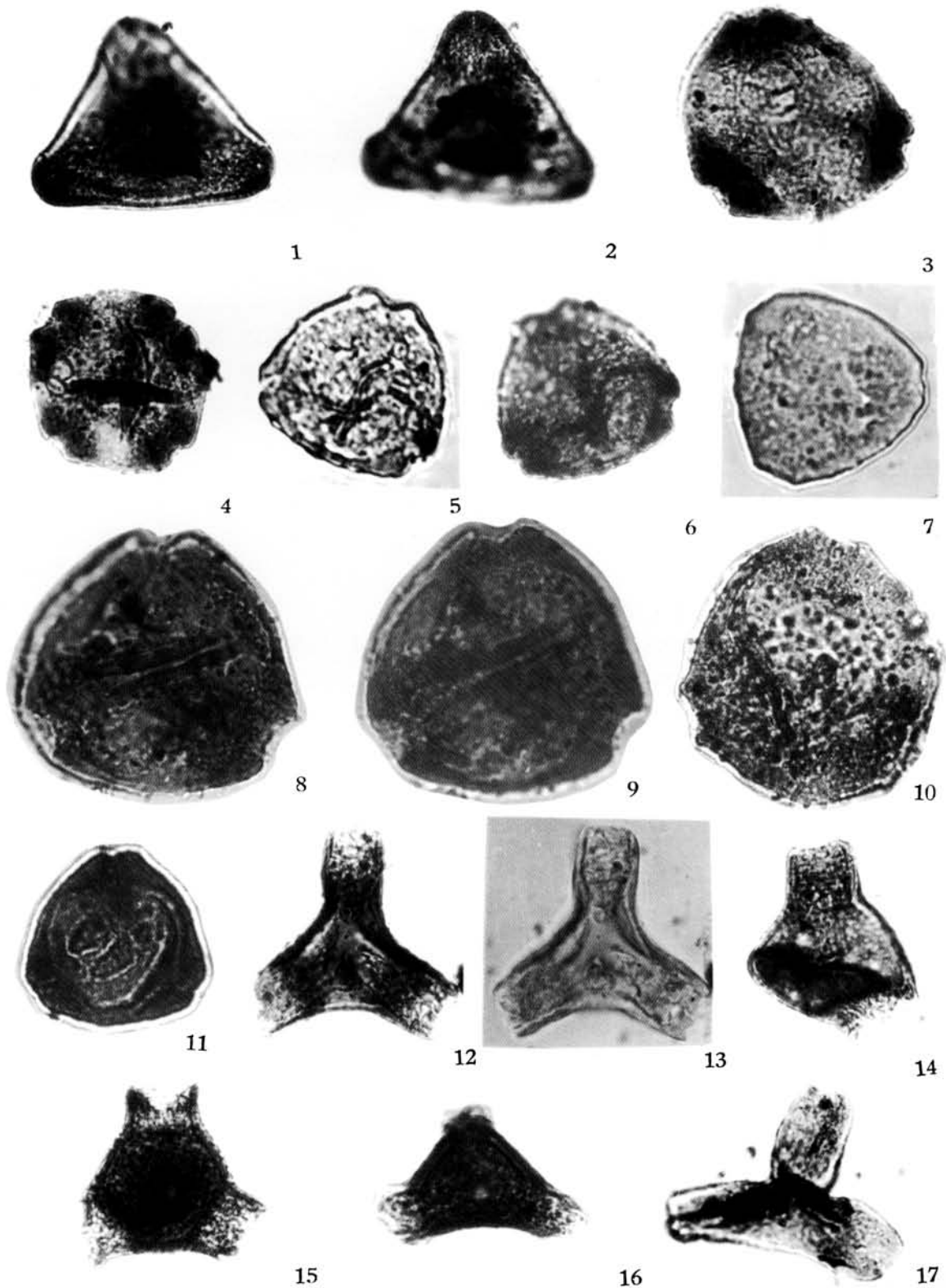
P1. 19, figs. 14-16

Amb triangular with straight or slightly concave / convex sides, diameter of holotype 30 μm ; triporate, pore with large atria formed by protruded sexine in dome-shape, exopore smaller than endopore; exine 2-2.5 μm thick, sexine twice thicker than nexine and with unclear baculate structure, inner side of sexine in pore area uneven, nexine extending to base of atria; scabrate to microgranulate.

The new species is characterized by the triangular amb and dome-shaped pore.

Occurrence: Same as the preceding species.

Type: Pl. 19, fig. 15; slide no.: 687(16-1)



Pl. 19. Figs. 1, 2. *Trevisanaepollenites intrabaculatus* sp. nov. Slide no.: 687(3-3). Figs. 3, 4. *Triatriopollenites furviatrium* Sun 1989. Slide no.: 523(2-1), 683(11-5). Figs. 5-7. *Triatriopollenites granulatus* sp. nov. Slide no.: 681(B-1), 683(17-5). Figs. 8-10. *Triatriopollenites raribaculus* sp. nov. Slide no.: 476(A-1), 683(A-8). Fig. 11. *Triatriopollenites roboratus* Pflug 1953. Slide no.: 683(13-2). Figs. 12, 13. *Trimagnaporites magnaporus* gen. et sp. nov. Slide no.: 687(10-2). Figs. 14-16. *Trimagnaporites triangulus* gen. et sp. nov. Slide no.: 687(12-5), 687(16-1), 523(8-1). Fig. 17. *Trimagnaporites tenuis* gen. et sp. nov. Slide no.: 479(6-2)

Trimagnaporites mixis *gen. et sp. nov.*

Pl. 20, figs. 1-4

Amb triangular with concave sides, angles elongated and terminal ends rounded, 40-55 μm (holotype 45 μm) in diameter; triporate, pore with cylindrical atria formed by sexine only, exopore equal or smaller than endopore; exine 2-3 μm thick, sexine with baculate structure several times thicker than nexine; scabrate to granulate.

The new species is characterized by the different widths of exopores in one specimen.

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary; Sanmenxia Area, Henan, Menli Formation.

Type: Pl. 20, fig. 1; slide no.: 683(A-2)

Trimagnaporites *sp.*

Pl. 20, figs. 5, 6

Amb triangular with concave sides, about 35 μm in diameter.

Occurrence: Otog Banner, Inner Mongolia; Lower Tertiary.

TRIPOROPOLLENITES Pflug *et* Thomson, 1953

Type species *Triporopollenites coryloides* Pflug 1953

Triporopollenites tuberculatus *sp. nov.*

Pl. 20, figs. 7-9

1981 *Proteacidites* *sp.* 3, Song *et al.*, p. 124, pl. 35, fig. 23.

Amb triangular with slightly convex sides and rounded angles, diameter of holotype *ca.* 40 μm ; triporate, equato-angulaperturate, exopore oval, 4-7 μm wide; exine *ca.* 1.5 μm thick and gradually thickening to 2-3 μm in proe area, tuberculate; with grana distributed among round tuberculae.

The new species is characterized by the tuberculate ornamentation and the rounded tuberculae.

Occurrence: Northern Jiangsu, Funing Group; Sanmenxia Area, Henan, Menli Formation.

Type: Pl. 20, fig. 7; slide no.: 313

TRUDOPOLLIS Pflug 1953

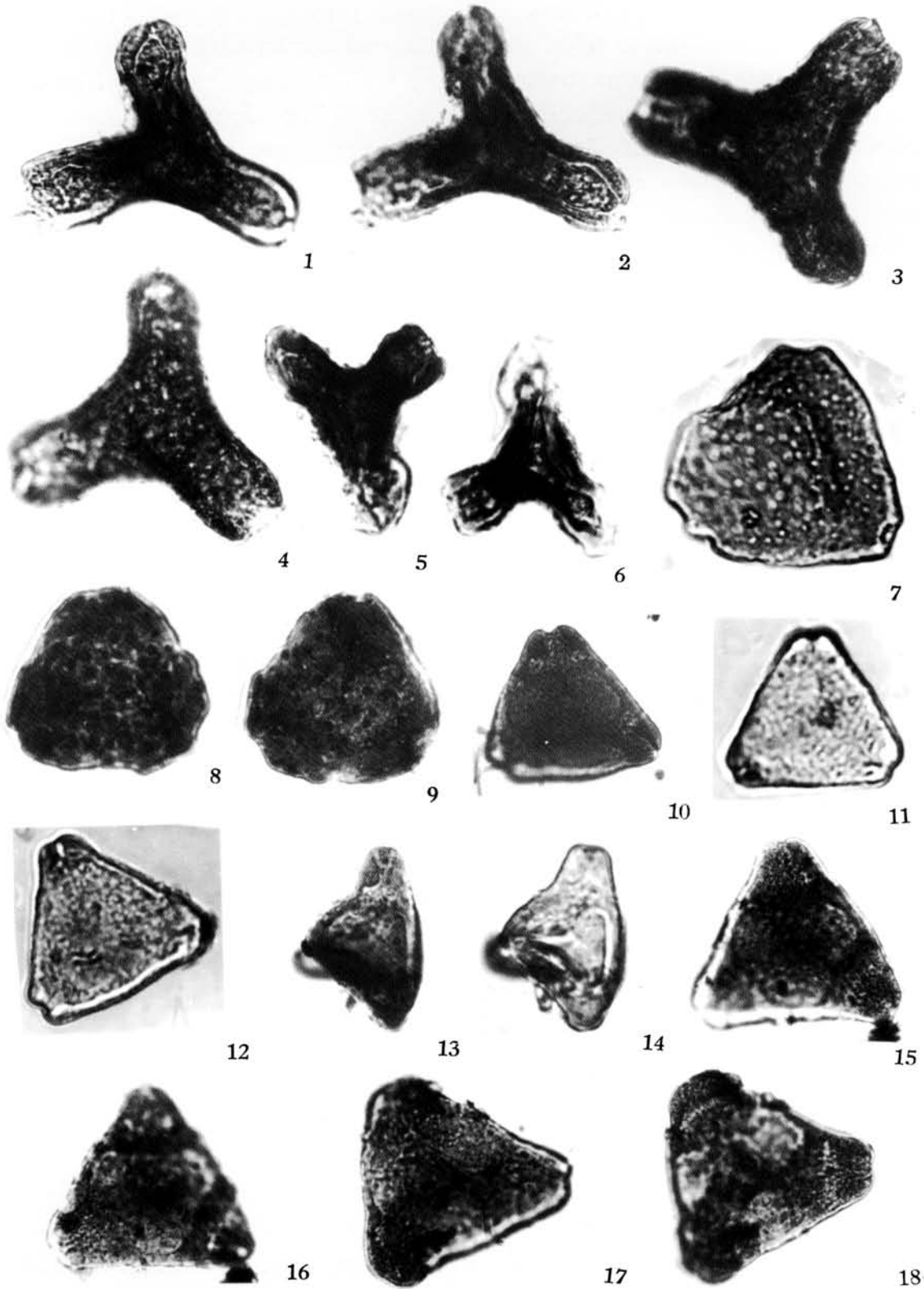
Type species: *Trudopollis pertrudens* (Pflug) Pflug 1953

Trudopollis otogiensis *sp. nov.*

Pl. 20, figs. 15-18

Amb triangular with straight or slightly concave sides and rounded angles, 30-40 μm (holotype 35 μm) in diameter; triporate, pore with vestibula and unclear atria, vestibula oval, with inner side uneven, pore canal index over 0.3, exopore smaller than endopore, pore canal slit; exine 2-3 μm thick, sexine twice thicker than nexine extending to base of atria, thickened at base of atria, and then becoming thinned and thickened again to 5 μm along pore margin to form annulus; granulate, with punctate structure especially developed in pore area.

The new species is characterized by the sexine with punctate structure especially in pore area.



Pl. 20. Figs. 1-4. *Trimagnaporites mixis* gen. et sp. nov. Slide no: 683(A-2). Figs. 5, 6. *Trimagnaporites* sp. Slide no.: 683(C-4). Figs. 7-9. *Triporopollenites tuberculatus* sp. nov. Slide no.: 313, San 1(10-2). 7. North Jiangsu, Funging Group. 8, 9 Sanmemxia Area, Henan; Menli Formation. Figs. 10-12. *Trudopollis argutus* (Martynova) comb. nov. Slide no.: 683(4-4), 479(C-1), 479(B-6). Figs. 13, 14. *Trudopollis ordinatus* Zaklinskaya 1963. Slide no.: 478(A-5), 687(C-2). Figs. 15-18. *Trudopollis otogiensis* sp. nov. Slide no.: 479(7-1), 479(3-2).

Occurrence: Otog Bannerr, Inner Mongolia; Lower Tertiary.

Type: pl. 20, fig. 16; slide no: 479(3-2)

Trudopollis argutus (Martynova) *comb. nov.*

Pl. 20, figs. 10-12

1960 *Extratropopollenites argutus* Martynova, p. 377, pl. 5, fig. 5.

Amb triangular, diameter 30-40 μm .

Occurrence: Otog Banner, Inner Mongolia, Lower Tertiary.

Trudopollis ordinatus Zaklinskaya 1963

Pl. 20, figs. 13, 14

1963 *Trudopollis ordinatus* Zaklinskaya, p. 210, pl. 27, figs. 4, 5, 8.

Amb triangular, diameter 30-40 μm .

Occurrence: Otog Banner, Inner Mongolia: Lower Tertiary.

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中國早第三紀正型粉類及相關孢型(III)

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摘 要

本文研究了中國一些地區古新統及下始新統的正型粉類及其相關的一些孢型。全文分三部份在 *Taiwania* 上發表。這是此文的第三部份，主要是孢型的分類學研究，共描述 24 屬和 66 種，其中包括 9 新屬，即：*Paleopachydermites*, *Parapecakipollis*, *Paraprenudopollis*, *Paratriangulipollis*, *Paravacuopollis*, *Pseudoproteacidites*, *Spinotriporites*, *Subtriaperturites* 和 *Trimagnaporites*, 10 新組合和 42 新種。除註明產地者外，其它均產于內蒙古鄂托克旗草木浩石膏礦地層，時代為晚古新世至早始新世。

關鍵詞：早第三紀，正型粉類，中國。