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743. MIOSPORES FROM THE EOCENE NANGGULAN FORMATION IN THE YOGYAKARTA REGION, CENTRAL JAVA*

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Abstract. The author has discriminated and descrided 48 palynomorph types which consist of 4 spores and 44 pollen grains from the Eocene Nanggulan Formation in the Yogyakarta region, central Java. 17 species of 48 palynomorph types are new: *Laevigatosporites javanicus* n. sp., *Smilacipites spinulifer* n. sp., *Magnoliaepollenites ellipticus* n. sp., *Quercoidites ellipsodeus* n. sp., *Tricolpopollenites elongatus* n. sp., *Brevitricolpites circularis* n. sp., *Tricolporopollenites javanensis* n. sp., *T. marginatus* n. sp., *T. rasus* n. sp., *Retitricolporites protensus* n. sp., *Striatricolporites striolatus* n. sp., *Polygalacidites speciosus* n. sp., *Graminidites punctulosus* n. sp., *Proteacidites matsuokae* n. sp., *Subtriporopollenites minutulus* n. sp., *Subtriporopollis specialis* n. sp. and *Tiliaepollenites tropicus* n. sp.

The Nanggulan palyno-assemblage is characterized by main pollen grains of *Dicolpopollis malesianus, Polygalacidites speciosus, Striatricolporites* spp., *Proteacidites* spp., *Graminidites punctulosus* etc. and a comparative study with some Eocene palyno-assemblages in other areas is made.

Introduction

This paper is a report on spores and pollen grains from a lignite seam of the Eocene Nanggulan Formation in the Yogyakarta region, central Java.

The lignite material was provided by K. Matsuoka, member of the Overseas Field Research (grant no. 504308; project leader T. Saito), who has collected it near Kalisongo, west of Nanggulan in the Yogyakarta region, central Java.

The author has distinguished 17 new species and described 48 palynomorph types which consist of 4 spores and 44 pollen grains. This palyno-assemblage is characterized by main pollen grains of *Dicolpopollis malesianus, Polygalacidites speciosus, Striatricolporites* spp., *Proteacidites* spp., *Graminidites punctulosus* etc., which occur relatively abundantly or show morphologically characteristic features, is conspicuously different from the Eocene palynofloras of Japan and some other areas.

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Material and method

The examined lignite material was collected by K. Matsuoka from the lowest part of the Nanggulan Formation in the Kali Puru section near Kalisongo, west of Nanggulan, central Java.

The material was processed by mechanical and chemical methods (maceration by $KClO_3$ and conc. HNO_3, treatment by 15% KOH and then by acetolysis method, centrifuging and washing in pure water after each step). The residues were mounted in glycerine jelly. All slides were sealed with a manicure.

All specimens illustrated in this paper and the material from which they were obtained are in the palynological collection of the Department of Geology, Faculty of Liberal Arts, Nagasaki University.

Paleontological notes and palynological assemblage

According to Kadar's report (1981), the Nanggulan Formation, which is subdivided into two members, namely the lower Kalisongo and the upper Kaliseputih Members, consists of four biostratigraphic units of foraminifera and *Axinea*. The lignite seam belongs to the lowest *Axinea* zone of the Kalisongo Member, which consists mostly of shallow-marine sedimentary rocks. Based on a recent study of planktonic foraminifera, the Nanggulan Formation ranges from Middle Eocene to Oligocene.

Okada (1981) found well-preserved nannofossils in the middle and upper parts of the Nanggulan Formation and confirmed correlation with the Middle Eocene *Nannotetrina quadrata* Zone (CP 13) and *Reticulofenestra umbilica* Zone (CP 14).

Matsuoka (1981) made a list of dinoflagellate cysts and *Pediastrum* from the Nanggulan Formation and stated that this cyst assemblage is characterized by a lack of Wetzeliaceae and Deflandreaceae.

The miospores recovered from the examined lignite material indicate 48 palynomorph types which appear to be important for characterizing the Nanggulan palynoassemblage.

The fossil genera and species found are as follows.

Trilete spores:
- *Leiotriletes maxoides* Krutzsch *minoris* Krutzsch
- *Alsophilidites kerguelensis* Cookson

Monolete spores:
- *Laevigatosporites javanicus* n. sp.
- *?Laevigatosporites* sp.

Pollen grains:

Inaperturate:
- *Smilacipites spinulifer* n. sp.
- *Smilacipites echinatus* Wodehouse
- *Classites capucinii* González Guzmán

Monocolpate:
- *Clavapalmaedites* sp.
- *Magnoliaepollenites ellipticus* n. sp.

Dicolpate:
- *Dicolpopollis malesianus* Muller

Tricolpate:
- *Quercoidites umiensis* (Takahashi) Takahashi
- *Quercoidites ellipsodeus* n. sp.
- *Tricolpopollenites elongatus* n. sp.
- *Cupuliferoidaepollenites fallax* (Potonié) Potonié
- *Tricolpites minutireticulosus* Takahashi

Tricolpate—Tetracolpate:
- *Brevitricolpites circularis* n. sp.

Tricolporate:
- *Cupuliferoipollenites* sp.
- *Tricolporopollenites javanensis* n. sp.
- *Tricolporopollenites marginatus* n. sp.
- *Tricolporopollenites rasus* n. sp.
- *Tricolporopollenites consularis* Takahashi *consularis*
- *Tricolporopollenites ovatorotundus* Takahashi

Tricolporopollenites sp. a
Tricolporopollenites sp. b
Tricolporopollenites sp. c
Tricolporopollenites sp. d
Cyrillaceaepollenites minor (Takahashi) Takahashi
Retitricolporites protensus n. sp.
Ilexpollenites tertiarius (Takahashi) Takahashi
Striatricolporites striolatus n. sp.
Striatricolporites agustinus González Guzmán
Striatricolporites sp.
Euphorbiacites sp.

Tetracolporate:
Tetracolporopollenites obscurus Pflug & Thomson

Stephanocolporate:
Polygalacidites speciosus n. sp.

Monoporate:
Graminidites punctulosus n. sp.

Triporate:
Proteacidites mollis Samoilovitch
Proteacidites cf. *annularis* Cookson
Proteacidites similis Harris
Proteacidites matsuokae n. sp.
Subtriporopollenites minutulus n. sp.
Subtriporopollenites sp.
Subtriporopollis specialis n. sp.
Triporopollenites sp. a
Triporopollenites sp. b
Tiliaepollenites tropicus n. sp.
Tiliaepollenites cf. *punctulosus* Takahashi
?*Tiliaepollenites* sp.

There are only a few papers on Tertiary palynology of Southeast Asia. Of 48 palyhomorph types, 6 species are assigned to the miospores previously described from Paleocene-Eocene sediments of Southeast Asia and the Southern Hemisphere.

Alsophilidites kerguelensis Cookson was, hitherto, described and illustrated from the Tertiary brown coal of the Kerguelen Island and from the bright coal seam of the Eocene Yaw Series of Kalewa in Burma.

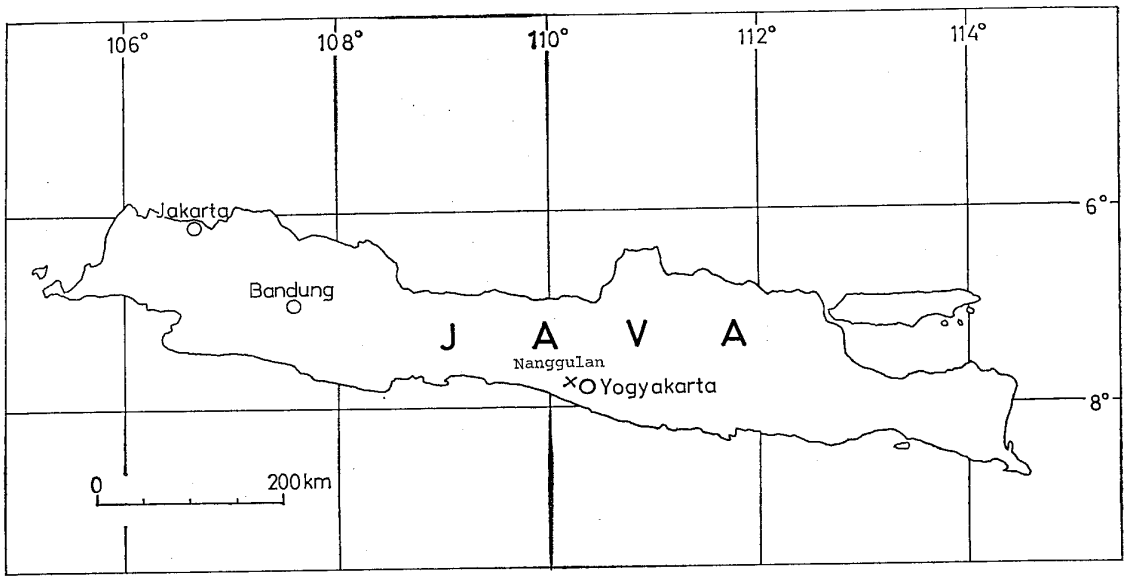
Classites capucinii González Guzmán and *Striatricolporites agustinus* González Guzmán are known from the Eocene Mirador Formation of the Tibu area in Colombia, South America. Botanical affinity of the former is unknown, but it may be a coniferous pollen type, judging from its morphological characteristics. The latter somewhat resembles the Anacardiaceae type, according to González Guzmán's opinion. The author is, however, of opinion that the latter rather resembles the Cucurbitaceae (*Gymnostemma* or *Actinostemma*) type.

Muller (1968) described and illustrated *Dicolpopollis malesianus* Muller and *Dicolpopollis elegans* Muller from the *Proxapertites* Zone (Paleocene?) to *Retitriporites variabilis* Zone (Eocene) of the Plateau Sandstone Formation of Sarawak, Malaysia.

The *Dicolpopollis* specimens of the Nanggulan Formation of Java can be assigned to the species *D. malesianus* of Sarawak. This species is one of representatives of the Nanggulan palyno-assemblage.

Proteacidites annularis Cookson is known from the Paleocene-Miocene formations of Australia and from the Paleocene-Oligocene formations of New Zealand. *Proteacidites similis* Harris was first described from the Middle Paleocene Pebble Point Formation, Dilwyn Bay, Victoria, Australia. Both species occur very rarely in the lignite seam of the Nanggulan Formation.

Some tricolpate, tricolporate and triporate pollen grains occur in common with the Paleogene and Miocene of Japan and the Miocene of Korea: *Quercoidites umiensis* (Takahashi) Takahashi, *Cupuliferoidaepollenites fallax* (Potonié) Potonié, *Tricolpites minutireticulosus* Takahashi, *Tricolporopollenites consularis* Takahashi *consularis*, *Tricolporopollenites ovatorotundus* Takahashi, *Cyrillaceaepollenites minor* (Takahashi) Takahashi, *Ilexpollenites tertiarius* (Takahashi) Takahashi



Text-fig. 1. Map showing the locality of the lignite seam of the Nanggulan Formation (×).

and *Tiliaepollenites* cf. *punctulosus* Takahashi.

Smilacipites echinatus Wodehouse which belongs doubtfully to the genus *Smilax*, is an American species from the Eocene Green River Formation, Colorado, U. S. A.

Leiotriletes maxoides Krutzsch *minoris* Krutzsch, *Cupuliferoidaepollenites fallax* (Potonié) Potonié, and *Tetracolporopollenites obscurus* Pflug & Thomson are Tertiary European species.

Proteacidites mollis Samoilovitch is one of the Maestrichtian-Danian Siberian species.

The genus *Polygalacidites* was established by Sah and Dutta (1966) as a monotypic genus with type species *Polygalacidites clarus* Sah & Dutta from the Umsawmat bed of the Cherra Formation (Eocene or? Paleocene) in Assam, India. The new species *Polygalacidites speciosus* is one of the most remarkable species of the Nanggulan assemblage. This species shows strong resemblance to pollen grains of *Polygala* (Family Polygalaceae) which is herbs.

The Nanggulan palyno-assemblage is relatively similar to the Kalewa palyno-assemblage from the Eocene coal in Burma, in spite of the different species constituting the assemblage. The Kalewa assemblage with *Dicolpopollis kalewensis* as a main constituent and consisting of tricolpate, tricolporate, triporate and *Tetracolporopollenites* possesses some common characteristics with the Nanggulan assemblage.

Germeraad, Hopping and Muller (1968) reported on the palynological zonation of Tertiary sediments from tropical areas, namely Colombia, Venezuela, Trinidad, Nigeria and Borneo. However, there is no common species between the Nanggulan assemblage and the Tertiary assemblages of the tropical areas above mentioned, excepting *Dicolpopollis malesianus* Muller (1968) from the *Proxapertites* Zone (Paleocene?) to the *Retitriporites variabilis* Zone (Eocene) of the Plateau Sandstone Formation in Sarawak, Malaysia.

Descriptive palynology

Anteturma Sporites Potonié 1893

Turma Triletes Reinsch 1881 emend. Potonié & Kremp 1954

Subturma Azonotriletes Luber 1935

Infraturma Laevigati Bennie & Kidston 1886 emend. Potonié 1956

Genus *Leiotriletes* Naumova 1939 emend. Potonié & Kremp 1954

Type species: *Leiotriletes sphaerotriangulus* (Loose 1932) Potonié & Kremp 1954.

Leiotriletes maxoides Krutzsch *minoris* Krutzsch

Pl. 49, Fig. 1.

1962. *Leiotriletes maxoides* Krutzsch *minoris* Krutzsch, Atlas, Lief. I, 16, Taf. 1, Fig. 2-8.

Dimensions: Grain size 50 μm in diameter; amb broadly rounded triangular with convex sides; exine 1.5 μm thick, laevigate; trilete mark not extending to the equator.

Occurrence: Rare.

Comparison: The present grain seems to belong to *Leiotriletes maxoides* Krutzsch *minoris* Krutzsch from the Miocene and Oligocene of Germany.

Botanical affinity: Unknown.

Genus *Alsophilidites* Cookson 1947 ex Potonié 1956

Type species: *Alsophilidites kerguensis* Cookson 1947.

Alsophilidites kerguelensis Cookson

Pl. 49, Figs. 2-3.

1947. *Trilites* (*Alsophilidites*) *kerguelensis* Cookson, B.A.N.Z. Ant. Res. Exped. 1929-1931, Rpts-ser. A, 2, pt. 8, 136, pl. 16, fig. 69.

1956. *Alsophilidites kerguelensis* Cookson, Potonié, *Beih. Geol. Jb.*, 23, 14, Taf. 1, Fig. 3.

1960a. *Alsophilidites kerguelensis* Cookson, Potonié, *Senck. leth.*, 41, 1/6, 459-460, Taf. 1, Fig. 20.

Dimensions: Grain size 45-61 μm in equatorial diameter; exine 1-1.5 μm thick, laevigate; trilete mark straight or slightly undulate, reaching almost to the equator.

Occurrence: Few.

Comparison: These grains belong to *Alsophilidites kerguelensis* Cookson from the Tertiary brown coal of the Kerguelen Island and from the bright coal belonging to the Eocene Yaw Series of Kalewa in Burma.

Botanical affinity: Unknown.

Turma Monoletes Ibrahim 1933

Subturma Azonomonoletes Luber 1935

Infraturma Laevigatomonoleti Dybova & Jachowicz 1957

Genus *Laevigatosporites* Ibrahim 1933

Type species: *Laevigatosporites vulgaris* (Ibrahim 1932) Ibrahim 1933.

Laevigatosporites javanicus n. sp.

Pl. 49, Figs. 5-6.

Description: Monolete spore; reniform or elliptical in lateral view. Exine smooth, 0.6-1 μm thick. Dehiscence moderately long, straight or slightly arc. Grain size 49-51 μm × 32.5-42 μm.

Holotype: Pl. 49, Fig. 5; grain size 49 × 34 μm; exine 1 μm thick, laevigate; slide GN 4654.

Occurrence: Rare.

Comparison: The present species is

morphologically similar to the European species *Laevigatosporites nutidus* (Mamczar) Krutzsch *nutidus* (Krutzsch, 1967, 149–150, Taf. 53, Fig. 4–12), but the former can be distinguished from the latter by the much thinner exine.

Botanical affinity: Polypodiaceae.

?*Leavigatosporites* sp.

Pl. 49, Fig. 4.

Description: Monolete spore; reniform or bean-shape in lateral view. Dehiscence long, arc. Exine 1 μm thick, 1.5 μm thick in dehiscence side, laevigate except finely punctate sculpture in dehiscence area. Grain size 55.3×29.5 μm.

Occurrence: Very rare.

Remark: This specimen with the finely punctate sculpture only in the dehiscence area was very rarely found. This species belongs doubtfully to the genus *Laevigatosporites*.

Botanical affinity: Polypodiaceae.

Anteturma Pollenites Potonié 1931

Turma Aletes Ibrahim 1933

Subturma Azonaletes Luber 1935 emend. Potonié & Kremp 1954

Infraturma Subpilonapiti Erdtman 1947 emend. Vimal 1952

Genus *Smilacipites* Wodehouse 1933

Type species: *Smilacipites echinatus* Wodehouse 1933.

Smilacipites spinulifer n. sp.

Pl. 49, Figs. 7, 8a–b.

Description: Inaperturate pollen grains; ellipsoidal or originally spherical in form. Exine thin, 0.5 μm± thick, provided with finely granulate or punctate sculptures and sharp conical spines somewhat densely or sparsely arranged, 0.5–1.5 μm in length, apparently folded and deformed by pressure. Grain size 30–33 μm×25–26 μm in diameter.

Holotype: Pl. 49, Fig. 7; grain size 33×25.5 μm in diameter; exine thin, finely punctate and sparsely echinate, 0.5–1 μm in length; slide GN 4654.

Occurrence: Rare.

Comparison: Wodehouse (1933) established the genera *Smilacipites* and *Peltandripites* with large or small spines and/or granules. The genus *Smilacipites* is much smaller in size than the *Peltandripites*. The present specimens belong apparently to the genus *Smilacipites* and are similar to *Smilacipites molloides* Wodehouse (1933, p. 500, fig. 25) from the Eocene Parachute Creek Member of the Green River Formation, Colorado, U. S. A., however this new species is much smaller than *S. molloides*.

Botanical affinity: *Smilax*.

Smilacipites echinatus Wodehouse

Pl. 49, Figs. 10–12.

1933. *Smilacipites echinatus* Wodehouse, *Bull. Torr. Bot. Club*, 60, 500, fig. 27.

Dimensions: Grain size 22.5–27 μm×16.6–21.5 μm in diameter; exine thin, smooth, provided with sharp spines irregularly arranged, varying from 1.7 μm to 3.5 μm in length, from 1 μm to 2.5 μm in width at base.

Occurrence: Few.

Remarks: The present specimens seem to belong to *Smilacipites echinatus* Wodehouse from the Eocene Parachute Creek Member, Green River Formation, Colorado, U. S. A. The grain of the Figure 10 possesses more numerous spines than other grains. Wodehouse found two specimens of *Smilacipites echinatus* and described

that one of these shows the granular character rather distinctly while in the other it is absent. The present specimens show no granular character.

Botanical affinity: Belonging to the genus *Smilax* is doubtful.

Infraturma Circumpollini (Pflug 1953) Klaus 1960

Genus *Classites* González Guzmán 1967

Type species: *Classites capucinii* González Guzmán 1967.

Classites capucinii González Guzmán

Pl. 50, Figs. 1-3.

1967. *Classites capucinii* González Guzmán, E. J. Brill, 62, pl. 30, figs. 2-2a.

Dimensions: Grain size 24.4-30 μm$\times$ 24-27 μm in diameter; size of ring 20(?)-28 μm$\times$20(?)-23 μm in diameter; exine 0.5-0.8 μm thick; psilate; exine of ring 1 μm thick (ektexine: endexine=1: 1); a reduced scar not visible on the proximal side.

Occurrence: Few.

Remarks: The grains seem to belong to *Classites capucinii* González Guzmán from the Eocene Mirador Formation (pollen zone IIIa) of the Tibu area, Colombia, South America. A ring on one hemisphere of the grain exist distinctly, but a reduced scar on one hemisphere is not visible. The Figure 3 belongs very doubtfully to *Classites capucinii*.

Botanical affinity: Unknown.

Turma Plicates Naumova 1937 emend. Potonié 1960

Subturma Monocolpates Iversen & Troels-Smith 1950

Genus *Clavapalmaedites* Rao & Ramanujam 1978

Type species: *Clavapalmaedites hammenii* Rao & Ramanujam 1978.

Clavapalmaedites sp.

Pl. 49, Fig. 9.

Description: Monosulcate pollen grain; oval in distal polar view. Sulcus long, narrow, extending all along long axis of grain. Exine 1 μm thick; baculate and clavate, 1.3 μm in length. Grain size 25.5 $\times$22 μm in diameter.

Occurrence: Very rare.

Comparison: This grain is comparable with that of *Clavapalmaedites hammenii* Rao & Ramanujam (1978, p. 414) from the Miocene strata of India. However, the former differs from the latter in having baculate and clavate sculptures.

Botanical affinity: ?Palmae.

Genus *Magnoliaepollenites* Nagy 1969

Type species: *Magnoliaepollenites simplex* Nagy 1969.

Magnoliaepollenites ellipticus n. sp.

Pl. 49, Figs. 13-15.

Description: Heteropolar, monocolpate pollen grains; ellipsoidal to elongate oval in distal polar view. Colpus long, strong, straight or somewhat arc. Exine 2-2.5 μm thick; ektexine : endexine=1 : 1; ektexine finely intrabaculate or intrarugulate, endexine chagrenate. On the surface of exine very small pores relatively sparsely visible. Grain size 46.5-55 μm in length; 25-32.5 μm in width.

Holotype: Pl. 49, Figs. 15a-b; grain size 50$\times$32.5 μm; exine 2.5 μm thick (ektexine: endexine=1 : 1); ektexine intrabaculate,

endexine chagrenate; very small pores visible on the surface of ektexine; slide GN 4656.

Occurrence: Few.

Comparison: Nagy (1969) first established the new genus *Magnoliaepollenites* and in the next year Krutzsch (1970) proposed the genus *Magnolipollis*. However, the author recognizes that the latter is a junior synonym of the former.

This new species differs from *Magnoliaepollenites simplex* Nagy (1969, p. 399, pl. 41, figs. 1, 4) in form and structure of exine. *Magnoliaepollenites* (*al. Magnolipollis*) *magnolioides* Krutzsch n. comb., *Magnoliaepollenites* (*al. Magnolipollis*) *micropunctatus* Krutzsch n. comb., and *Magnoliaepollenites* (*al. Magnolipollis*) *neogenicus* Krutzsch n. comb. *neogenicus* differ in much thinner exine and structure of exine.

Botanical affinity: ?Magnoliaceae.

Subturma Dicolpates Erdtman 1947

Genus *Dicolpopollis* Pflanzl 1956 emend. Potonié 1966

Type species: *Dicolpopollis kockelii* Pflanzl 1956.

Dicolpopollis malesianus Muller

Pl. 50, Figs. 4–10.

1968. *Dicolpopollis malesianus* Muller, *Micropaleontology*, 14, 1, p. 13, pl. 5, fig. 5.

Dimensions: Grain size 29–36 μm in width, 20.5–27.5 μm in height; exine up to 1.5 μm thick; columellae small, arranged in a reticulate pattern, forming baculate to clavate muri; lumina variable in size and shape, generally larger in central zone, up to 1.5 μm.

Occurrence: Abundant.

Comments: Potonié (1960a) described *Disulcites kalewensis* Potonié (464–466, Taf. 2, Fig. 27–43; Abb. 3–4) from the Eocene coal of Kalewa in Burma and he (1966) considered the genus *Disulcites* as a junior synonym of the genus *Dicolpopollis* and gave the emended diagnosis. *Dicolpopollis malesianus* Muller is closely similar to *Dicolpopollis kalewensis* (Potonié) Potonié, but differs apparently in more remarkable sculpture.

Muller (1968) found that *Dicolpopollis malesianus* and *Dicolpopollis elegans* occur from the *Proxapertites* Zone (Paleocene?) to the *Retitriporites variabilis* Zone (Eocene) of the Plateau Sandstone Formation in Sarawak, Malaysia.

Botanical affinity: Palmae—*Calamus*.

Subturma Triptyches Naumova 1939

Genus *Quercoidites* Potonié, Thomson & Thiergart 1950 ex Potonié 1960

Type species: *Quercoidites henrici* (Potonié 1931) Potonié 1960.

Quercoidites umiensis (Takahashi) Takahashi

Pl. 50, Figs. 11–13, 30.

1957. *Tricolpopollenites umiensis* Takahashi, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., 5, 4, 217, Taf. 38, Fig. 37–39; Taf. 39, Fig. 31–32.

1979. *Quercoidites umiensis* (Takahashi) Takahashi, Takahashi & Kim, *Palaeontographica*, B, 170, 38, pl. 9, figs. 3–5, 24.

Dimensions: Grain size 27–34.2 μm × 19–19.5 μm; exine 1–1.5 μm thick, intrabaculate; breadth/length ratio 0.56–0.72.

Occurrence: Rare.

Remarks: Morphologically the present specimens appear to be closely comparable to those of *Quercoidites umiensis* (Takahashi) Takahashi from the Paleogene and

Miocene formations of Japan and from the Miocene formations of Korea.

Potonié (1960a) bescribed *Quercoidites* sp. (grain size 20–30 μm), which is comparable with the present species, from the Eocene coal of Kalewa in Burma.

Botanical affinity: Cupuliferae.

Quercoidites ellipsodeus n. sp.

Pl. 50, Figs. 16–17.

Description: Tricolpate pollen grains; elliptical to oval in equatorial view. Outline weakly crenate or finely wavy. Extremities of grain rounded or somewhat broadly rounded. Three colpi slender, more or less parallel, almost reaching poles. Exine 1–2 μm thick, somewhat thicker in the pole area, intrabaculate; ektexine : endexine=2 : 1. Grain size 30–36 μm×22–24 μm. Breadth/length ratio 0.67–0.74.

Holotype: Pl. 50, Fig. 16; grain size 35.5×24 μm; exine 2 μm thick, intrabaculate; ektexine : endexine=2 : 1; surface of exine uneven; breadth/length ratio 0.68; slide GN 4656.

Occurrence: Few.

Comparison: This new species can be distinguished from *Quercoidites henrici* (Potonié) Potonié, Thomson & Thiergart (Potonié, 1931, p. 329, pl. 2, fig. 19; Potonié, Thomson & Thiergart, 1950, p. 54, pl. B, figs. 22–23) in having slender colpus and rough ornamentation of exine surface and from *Quercoidites microhenrici* (Potonié) Potonié, Thomson & Thiergart (Potonié, 1931, p. 26, pl. 1, fig. V 19c; Potonié, Thomson & Thiergart, 1950, p. 55, pl. B, figs. 24–25) in general form, size and ornamentation.

Quercoidites fusus Sah (1967, p. 51–52, pl. 5, figs. 2–3) from the Upper Neogene strata in Rusizi valley, Burundi, Africa, differs from the present species in general form, size, and ornamentation of exine.

Botanical affinity: Cupuliferae.

Genus *Cupuliferoidaepollenites* Potonié, Thomson & Thiergart 1950 ex Potonié 1960

Type species: *Cupuliferoidaepollenites liblarensis* (Thomson in Potonié, Thomson & Thiergart 1950) Potonié 1960.

Cupuliferoidaepollenites fallax (Potonié) Potonié

Pl. 50, Figs. 19–24.

1934. *Pollenites fallax* Potonié, *Arb. Inst. Palaeobot. Petrogr. Brennst.*, 4, p. 70, fig. 10.

1953. *Tricolpopollenites liblarensis* (Thomson) Thomson & Pflug *fallax* (Potonié) Thomson & Pflug, *Palaeontographica*, B, 94, S. 97, Taf. 11, Fig. 133–151.

1960a. *Cupuliferoidaepollenites fallax* (Potonié) Potonié, *Senck. leth.*, 41, 1/6, S. 468, Taf. 2, Fig. 64–65; Abb. 6.

Dimensions: Grain size 15–17.5 μm×8.5–10.5 μm; exine thin, 0.4–0.8 μm thick, laevigate or faintly chagrenate; Fig. 22—exine 0.8 μm thick.

Occurrence: Common.

Remarks: These specimens belong clearly to *Cupuliferoidaepollenites fallax* (Potonié) Potonié.

Botanical affinity: Cupuliferae.

Genus *Tricolpopollenites* Pflug & Thomson 1953

Type species: *Tricolpopollenites parmularis* (Potonié 1934) Thomson & Pflug 1953.

Tricolpopollenites elongatus n. sp.

Pl. 50, Figs. 14-15.

Description: Tricolpate pollen grains; prolate or perprolate shape in equatorial view. Meridional furrows (colpi) extending from pole to pole. Extremities of grain sharply rounded. Exine 1-1.5 μm thick, chagrenate or/and punctate. Grain size 38-43 μm×16-21 μm. Breadth/length ratio 0.38-0.55.

Holotype: Pl. 50, Fig. 14; grain size 38.5×21 μm; exine 1 μm thick, chagrenate to punctate; breadth/length ratio 0.54; slide GN 4657.

Occurrence: Few.

Comparison: The present species is apparently similar to *Quercoidites ellipsodeus* Takahashi n. sp., but differs from the latter in having larger size, more elongate shape, and different structure of exine.

Botanical affinity: Unknown.

Genus *Tricolpites* Cookson 1947 ex Couper 1953 emend. Belsky, Boltenhagen & Potonié 1965

Type species: *Tricolpites reticulatus* Cookson 1947 ex Couper 1953.

Tricolpites minutireticulosus Takahashi

Pl. 50, Figs. 18, 25-27.

1979. *Tricolpites minutireticulosus* Takahashi, Takahashi & Kim, *Palaeontographica*, B, 170, p. 40, pl. 10, figs. 5-8.

Dimensions: Grain size 15-21 μm×12.5-17.5 μm (Fig. 18—22.5 μm in diameter); exine 0.5-0.9 μm thick (fig. 18-1 μm thick), intrabaculate; surface of exine very finely reticulate (lumen less than 1 μm in diameter); breadth/length ratio 0.73-0.83.

Occurrence: Few.

Comparison: Morphologically the present specimens appear to be closely comparable to those of *Tricolpites minutireticulosus* Takahashi from the Miocene Changgi and Yonil Groups in the Yeoungill Bay district, Korea.

Botanical affinity: Salicaceae or Cruciferae.

Genus *Brevitricolpites* González Guzmán 1967

Type species: *Brevitricolpites variabilis* González Guzmán 1967.

Brevitricolpites circularis n. sp.

Pl. 50, Figs. 28-29.

Description: Tricolpate or tetracolpate pollen grains; spherical or spheroidal in polar view. Three or four colpi very short but distinct, 2-3 μm deep in polar view, extending one third (or less) the radius. Exine thin, 1 μm or less thick, somewhat coarsely punctate. Grain size 15-17 μm×14-16 μm in diameter.

Holotype: Pl. 50, Fig. 28; grain size 16.8×14.5 μm in diameter; colpi three, very short; exine 1 μm thick, somewhat coarsely punctate; slide GN 4653.

Occurrence: Few.

Comparison: This new species can be distinguished from *Brevitricolpites variabilis* González Guzmán with tricolpate to tricolporate feature (1967, p. 35, pl. 12, figs. 6-6b) from the pollen zones I-IV of the Eocene Upper Los Cuervos and Mirador Formations, Colombia, in ornamentation of exine.

Tricolpites pachyexinus Couper with three or four colpi (1953, p. 62, pl. 8, figs. 120-121) from the Upper Cretaceous Lower Ohai Group, New Zealand, differs from the present species in having longer colpi and smooth exine.

Tricolpites sp. A (Drugg, 1967, p. 49, pl. 7, fig. 37) from the Maestrichtian Marca shale and the Danian Lower Dos Palos

shale at Escarpado Canyon in California is similar to this new species, but the former differs from the latter in having larger size and smooth exine.

Botanical affinity: Unknown.

Subturma Ptychotriporines Naumova 1939

Genus *Tricolporopollenites* Pflug & Thomson 1953

Type species: *Tricolporopollenites dolium* (Potonié 1931) Thomson & Pflug 1953.

Tricolporopollenites javanensis n. sp.

Pl. 51, Figs. 1–5.

Description: Tricolporate pollen grains; prolate to subprolate in equatorial view. Three colpi extending from pole to pole. Caverna relatively deep. Equatorial pores round, large, on a certain occasion with short rugae. Exine smooth or weakly chagrenate, 0.5–2 μm thick. Grain size 30–42 μm×21–29 μm. Breadth/length ratio 0.55–0.78.

Holotype: Pl. 51, Fig. 1; grain size 40.5 ×22.5 μm; exine 1 μm thick, weakly chagrenate; pores round, large; breadth/length ratio 0.56; slide GN 4656.

Occurrence: Common.

Comparison: The present species is similar to *Tricolporopollenites* (*al. Cupuliferoipollenites*) *prolongatus* (Takahashi) n. comb. from the Miocene Cheonbug Conglomerate of the Yonil Group, Korea, but differs from the latter in size and pore shape.

Botanical affinity: Unknown.

Tricolporopollenites consularis Takahashi subsp. *consularis*

Pl. 51, Figs. 7–9.

1961. *Tricolporopollenites consularis* Takahashi, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., 11, 3, p. 323, pl. 24, figs. 55–56 (pro parte).
1979. *Tricolpolporopollenites consularis* Takahashi subsp. *consularis*, Takahashi & Kim, *Palaeontographica*, B, 170, p. 41, pl. 10, figs. 9–27; pl. 11, fig. 2.

Dimensions: Grain size 30–37 μm×20–23 μm; exine intrabaculate or intrarugulate, 1–1.2 μm thick; breadth/length ratio 0.56–0.66.

Occurrence: Few.

Comparison: These grains seem to belong to those of *Tricolporopollenites consularis* Takahashi *consularis* from the Paleogene and Miocene formations of West Japan and from the Miocene Changgi and Yonil Groups of Korea.

Botanical affinity: ?Cupuliferae.

Tricolporopollenites marginatus n. sp.

Pl. 51, figs. 10–14.

Description: Tricolporate pollen grains; oval to subcircular in equatorial view; circular to oval in polar view. Polar axis longer than equatorial axis. Three colpi parallel or converging to the poles, almost reaching the poles; each with a somewhat large and round pore. Exine punctate or intrabaculate, 1–1.5 μm thick. Grain size 23–27 μm×19–26 μm. Breadth/length ratio 0.83–0.96.

Holotype: Pl. 51, Fig. 11; grain size 24 ×21.5 μm; exine 1 μm thick, intrabaculate; pore large, round; breadth/length ratio 0.895; slide GN 4655.

Occurrence: Common.

Comparison: *Tricolporopollenites marginatus* is similar to *Tricolporopollenites emarginalis* Takahashi (Takahashi & Kim, 1979, p. 41, pl. 11, figs. 11–22) from the

Miocene Changgi and Yonil Groups of Korea, but can be distinguished from the latter in its comparatively larger pores and more spherical form.

Botanical affinity: Unknown.

Tricolporopollenites rasus n. sp.

Pl. 51, Figs. 18-20.

Description: Tricolporate pollen grains; prolate to subprolate in equatorial view. Three colpi narrow, converging to the poles, extending from pole to pole, with meridionally elongated pores. Exine laevigate to faintly chagrenate, 0.5 μm thick. Grain size 15-19 μm$\times$11-14 μm. Breadth/length ratio 0.71-0.77.

Holotype: Pl. 51, Fig. 19; grain size 19 $\times$13.5 μm; exine 0.5 μm thick, laevigate; pores meridionally elongated; breadth/length ratio 0.71; slide GN 4656.

Occurrence: Few.

Comparison: This new species is closely related to *Tricolporopollenites* (*al. Cupuliferoipollenites*) *pseudopusillus* (Takahashi) Takahashi n. comb. (1979, p. 45, pl. 13, figs. 6-7) from the Middle Miocene Pohang Formation of the Yonil Group, Korea, but the exine in the latter is thicker and its shape is much slender.

Botanical affinity: Unknown.

Tricolporopollenites ovatorotundus Takahashi

Pl. 51, Fig. 24.

1979. *Tricolporopollenites ovatorotundus* Takahashi, Takahashi & Kim, *Palaeontographica*, B, 170, p. 42, pl. 12, fig. 28-32.

Dimensions: Grain size 22 μm in diameter; exine 1.5 μm thick, intrabaculate; equatorial pores small, round.

Occurrence: Very rare.

Comparison: Only one specimen was found. This specimen is comparable with the grain of *Tricolporopollenites ovatorotundus* Takahashi from the lower coal bearing formation of the Changgi Group, Korea.

Botanical affinity: Unknown.

Tricolporopollenites sp. a

Pl. 51, Figs. 15a-b.

Description: Tricolporate pollen grains; subprolate in equatorial view. Three colpi comparatively narrow, extending from pole to pole, with short rugae. Caverna not so deep. Exine intrabaculate, 1.5 μm thick in the pole area, 0.8 μm thick in equatorial area; ektexine : endexine= 2 : 1. Grain size 22.5$\times$17.5 μm Breadth/length ratio 0.78.

Occurrence: Very rare.

Remarks: Only one specimen was found.

Botanical affinity: Unknown.

Tricolporopollenites sp. b

Pl. 51, Fig. 17.

Description: Tricolporate pollen grain; prolate in equatorial view. Three colpi parallel, almost reaching the poles. Exine chagrenate, 2 μm thick, with somewhat meridionally elongated pores; Grain size 24$\times$16 μm. Breadth/length ratio 0.67.

Occurrence: Very rare.

Comparison: The present specimen is similar to *Tricolporopollenites* (*al. Cupuliferoipollenites*) *ovuliformis* (Takahashi) n. comb. (Takahashi & Kim, 1979, p. 44, pl. 12, figs. 8-24) from the Miocene Changgi and Yonil Groups of Korea, but the former differs from the latter in having thicker exine and small rugae. However, the author can not determine its species name.

Botanical affinity: Unknown.

Tricolporopollenites sp. c

Pl. 51, Fig. 28.

Description: Tricolporate pollen grain; spheroidal in equatorial view. Three colpi parallel, not so long; caverna comparatively deep. Equatorial pores meridionally elongated. Exine 1 μm thick, intrabaculate. Grain size 24×21.5 μm. Breadth/length ratio 0.895.

Occurrence: Very rare.

Remarks: Only one specimen was found.

Botaeical affinity: Unknown.

Tricolporopollenites sp. d

Pl. 51, Fig. 16.

Description: Tricolporate pollen grain; prolate in equatorial view. Three colpi parallel, comparatively short, with large and equatorially somewhat elongated pores (equatorial diameter 4 μm, meridional diameter 3 μm). Exine 1 μm thick, finely intrabaculate. Grain size 28×20 μm. Breadth/length ratio 0.71.

Occurrence: Very rare.

Remarks: Only one specimen was found.

Botanical affinity: ?Leguminosae.

Genus *Cupuliferoipollenites* Potonié 1951 ex Potonié 1960

Type species: *Cupuliferoipollenites pusillus* (Potonié 1934) Potonié 1960.

Cupuliferoipollenites sp.

Pl. 51, Fig. 6.

Description: Tricolporate pollen grain; subprolate in equatorial view. Three colpi relatively narrow, almost reaching the poles. Caverna not deep. Equatorial pores large, equatorially elongated (rugae). Exine 1.3 μm thick, smooth. Grain size 35.5×29 μm. Breadth/length ratio 0.82.

Occurrence: Very rare.

Remarks: This specimen possesses three large rugae and smooth exine. Accordingly, this belongs undoubtedly to the genus *Cupuliferoipollenites*.

Botanical affinity: Unknown.

Genus *Cyrillaceaepollenites* Mürriger & Pflug 1951 ex Potonié 1960

Type species: *Cyrillaceaepollenites megaexactus* (Potonié 1931) Potonié 1960.

Cyrillaceaepollenites minor (Takahashi) Takahashi

Pl. 51, Fig. 29.

1961. *Tricolporopollenites minor* Takahashi, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., 11, 3, p. 320–321, pl. 24, figs. 18–31.

1979. *Cyrillaceaepollenites minor* (Takahashi) Takahashi, Takahashi & Kim, *Palaeontographica*, B, 170, p. 46, pl. 13, figs. 32–36.

Dimensions: Grain size 13.5×12.5 μm; exine 0.5 μm thick, laevigate; rugae small; breadth/length ratio 0.93.

Occurrence: Very rare.

Comparison: Only one specimen was found. The present specimen is apparently identified with *Cyrillaceaepollenites minor* (Takahashi) Takahashi from the Paleogene and Miocene formations of West Japan and from the Miocene Yonil Group of Korea.

Botanical affinity: Cyrillaceae.

Genus *Euphorbiacites* Sung & Lee 1976

Type species: *Euphorbiacites wallensenensis* (Pflug 1953) Sung & Lee 1976.

Euphorbiacites sp.

Pl. 50, Fig. 31.

Description: Tricolporate pollen grain; prolate in equatorial view. Three colpi more or less parallel, converging to the poles, almost extending from pole to pole. Caverna very deep. Pores large, elongating somewhat equatorially. Exine is relatively firm with sculpture which consists of closely spaced bacula of 2 μm high in the polar area and 1.5 μm high in the equatorial area. Grain size 41× 30 μm. Breadth/length ratio 0.73.

Occurrence: Very rare.

Comparison: Only one specimen was found. The present specimen is similar to *Euphorbiacites* sp. (Li, Sung & Li, 1978, p. 34, pl. 10, fig. 32) from the Eocene and Oligocene formations of the Yangtze-Han River plain, China, but the former differs from the latter in having smaller size, thinner exine, and somewhat equatorially elongated pores (rugae).

Botanical affinity: Euphorbiaceae.

Genus *Retitricolporites* v. d. Hammen 1956 ex v. d. Hammen & Wijmstra 1964

Type species: *Retitricolporites guianensis* v. d. Hammen & Wijmstra 1964.

Retitricolporites protensus n. sp.

Pl. 51, Figs. 21-23.

Description: Tricolporate pollen grains; prolate in equatorial view. Three colpi narrow, slender, converging to the poles, extending from pole to pole with meridionally somewhat elongated pores. Exine very finely reticulate. Lumen of reticulum less than 1 μm in diameter. Muri baculate to clavate, 0.5-0.7 μm high. Grain size 16-17 μm×9-12 μm. Breadth/length ratio 0.56-0.71.

Holotype: Pl. 51, Fig. 22; grain size 16 ×10.5 μm; muri baculate to clavate, 0.5-0.7 μm high. Breadth/length ratio 0.66; slide GN 4653.

Occurrence: Few.

Comparisom: *Retitricolporites protensus* is similar to the elongate form of *Retitricolporites* (*al. Tricolporopollenites*) *microreticulatus* (Pflug & Thomson) n. comb., but differs from the latter in having baculate and clavate muri.

Amongst the pollen of recent plants a close similarity is seen with the pollen of *Hydrangea* and it is quite likely that the present pollen grains are related to the family Saxifragaceae.

Botanical affinity: Saxifragaceae.

Genus *Ilexpollenites* Thiergart 1937 ex Potonié 1960

Type species: *Ilexpollenites iliacus* (Potonié 1931) Potonié 1960.

Ilexpollenites tertiarius (Takahashi) Takahashi

Pl. 51, Figs. 25-27.

1961. *Tricolporopollenites tertiarius* Takahashi, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., 11, 3, p. 332, pl. 26, figs. 29-33.

1963. *Ilexpollenites tertiarius* (Takahashi) Takahashi, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., 14, 2, p. 150, pl. 21, fig. 18.

Dimension: Grain size 18.5-27 μm× 15.5-19.5 μm; clavae 1.5-2 μm high, 1 μm ± in diameter; breadth/length ratio 0.57-0.92.

Occurrence: Few.

Comparison: The present specimens

belong to *Ilexpollenites tertiarius* (Takahashi) Takahashi from the Paleogene and Miocene formations of West Japan and from the Miocene Changgi and Yonil Groups of Korea. The Figures 26 and 27 with densely spaced clavae are closely comparable with the grain of *Ilexpollenites tertiarius* from the Hioki Group of Waku, Yamaguchi Prefecture (Takahashi, 1963, pl. 21, fig. 18).

Botanical affinity: *Ilex*.

Genus *Striatricolporites* v. d. Hammen 1956 ex Leidelmeyer 1966

Type species: *Striatricolporites pimulis* Leidelmeyer 1966.

Striatricolporites striolatus n. sp.

Pl. 51, Figs. 30–32.

Description: Tricolporate pollen grains; prolate in equatorial view. Three colpi narrow, converging to the poles, extending from pole to pole, with meridionally more or less elongated pores. Exine finely striate; muri 0.9–1.5 μm high. Striae running parallel or more or less obliquely to the colpus. Grain size 21–24 μm × 13–16 μm. Breadth/length ratio 0.57–0.72.

Holotype: Pl. 51, Fig. 32; grain size 23 × 13.2 μm; exine finely striate; muri 0.9 μm high; breadth/length ratio 0.57; slide GN 4653.

Occurrence: Common.

Comparison: This new species is closely similar to *Striatricolporites augustinus* González Guzmán (1967, p. 39, pl. 12, figs. 1–1f) from the Middle Eocene Mirador Formation (pollen zones III–IV) of the Tibu area, Colombia, but the former differs from the latter in possessing equatorially elongated pores (rugae), judging from the Guzman's photographs.

The morphological characters of *Striatricolporites striolatus* seem to be much similar to that of the *Gymnostemma*-type, and it is quite likely that they might represent that genus.

Botanical affinity: Cucurbitaceae—*Gymnostemma*.

Striatricolporites agustinus González Guzmán

Pl. 51, Figs. 33–34.

1967. *Striatricolporites agustinus* González Guzmán, E. J. Brill, p. 39, pl. 12, figs. 1-1f.

Dimensions Grain size 21 μm × 16–17.5 μm; exine finely striate; muri 1 μm± high; breadth/length ratio 0.67–0.83.

Occurrence: Few.

Remarks: *Striatricolporites agustinus* is somewhat broader than *Striatricolporites striolatus* and possesses the equatorially elongated pores.

Botanical affinity: Cucurbitaceae—*Gymnostemma* or *Actinostemma*.

Striatricolporites sp.

Pl. 51, Fig. 35.

Description: Tricolporate pollen grain; prolate in equatorial view. Three colpi long, relatively narrow, longitudinal, converging to the poles, reaching to the poles, with equatorial rugae. Exine finely striate; muri 1 μm high. Grain size 32.5 × 17 μm. Breadth/length ratio 0.52.

Occurrence: Very rare.

Botanical affinity: Unknown.

Subturma Ptychopolyporines Naumova 1937 emend. Potonié 1960

Genus *Tetracolporopollenites* Pflug & Thomson 1953

Type species: *Tetracolporopollenites sapotoides* Pflug & Thomson 1953.

Tetracolporopollenites obscurus Pflug & Thomson

Pl. 52, Figs. 1-3.

1953. *Tetracolporopollenites obscurus* Pflug & Thomson, *Palaeontographica*, B, 94, S. 108, Taf. 14, Fig. 86-99, 102-108.

Dimensions: Grain size 33-34 μm×25-27 μm; exine 1-1.5 μm thick, finely intrabaculate or faintly intrarugulate; pores large, round or equatorially elongate.

Occurrence: Few.

Comparison: The grains seem to belong to those of *Tetracolporopollenites obscurus* Pflug & Thomson from the Lower and Middle Tertiary of West Germany.

Botanical affinity: Sapotaceae.

Genus *Polygalacidites* Sah & Dutta 1966

Type species: *Polygalacidites clarus* Sah & Dutta 1966.

Polygalacidites speciosus n. sp.

Pl. 52, figs. 4-14.

Description: Stephanocolporate pollen grains; suboblate to spheroidal with swelling in the equatorial area in equatorial view; amb circular to subcircular in polar view. Colpi numerous, generally six to eight in number, comparatively not so long, running more or less parallel meridionally, not reaching to the poles. Ora (pores) transversally parallel, connected transversally as ring or belt (synorate). Exine 0.5-1.5 μm thick, chagrenate. Grain size 17-26 μm×20-27 μm. Breadth/length ratio 0.94-1.14.

Holotype: Pl. 52, Figs. 5a-b; grain size 25×24 μm; six colpi; synorate; exine 1 μm thick, chagrenate; breadth/length ratio 0.96; slide GN 4655.

Occurrence: Abundant.

Comparison: Hitherto, *Polygalacidites clarus* Sah & Dutta (1966) has been described by Sah & Dutta (1966, 1968) from the Eocene (?Paleocene) Jaintia Series of Assam. *Polygalacidites speciosus* differs from the Indian species *Polygalacidites clarus* Sah & Dutta in number of colpus and development of synora.

Botanical affinity: Polygalaceae—*Polygala*.

Turuma Poroses Naumova 1937 emend. Potonié 1960

Explanation of Plate 49

(All figures ×1000)

Fig. 1. *Leiotriletes maxoides* Krutzsch subsp. *minoris* Krutzsch Slide GN 4655.

Figs. 2-3. *Alsophilidites kerguelensis* Cookson
Fig. 2: slide GN 4654; Fig. 3: slide GN 4655.

Fig. 4. *?Laevigatosporites* sp. Slide GN 4653.

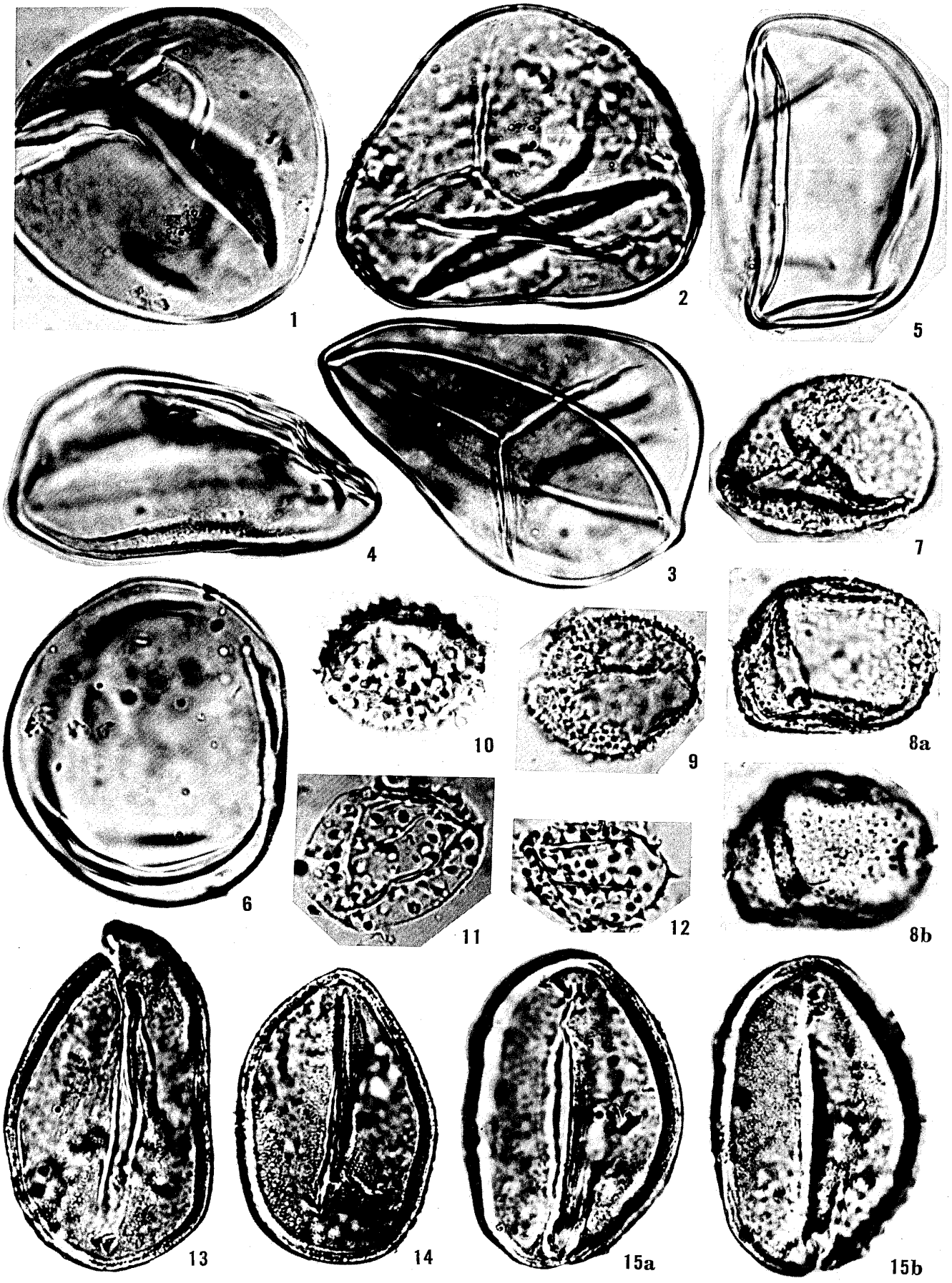
Figs. 5-6. *Laevigatosporites javanicus* n. sp.
Fig. 5: holotype, slide GN 4654; Fig. 6: slide GN 4657.

Figs. 7-8. *Smilacipites spinulifer* n. sp. Slide GN 4654; Fig. 7: holotype.

Fig. 9. *Clavapalmaedites* sp. Slide GN 4654.

Figs. 10-12. *Smilacipites echinatus* Wodehouse
Fig. 10: slide GN 4655; Fig. 11: slide GN 4657; Fig. 12: slide GN 4653.

Figs. 13-15. *Magnoliaepollenites ellipticus* n. sp.
Figs. 13-14: slide GN 4657; Figs. 15a-b: holotype, slide GN 4656.



Subturma Monoporines Naumova 1937
emend. Potonié 1960

Genus *Graminidites* Cookson 1947

Type species: *Graminidites media* Cookson 1947.

Graminidites punctulosus n. sp.

Pl. 52, Figs. 15–19.

Description: Monoporate pollen grains. Figura circular to subcircular in outline. Pore single, 3–4.7 μm in diameter, surrounded by large annulus of 3–4.5 μm in width. Exine finely punctate, 0.5–1 μm thick, with secondary folds. Grain size 28–41 μm in diameter.

Holotype: Pl. 52, Fig. 19; grain size 38 μm in diameter; pore single, 4.7 μm in diameter, surrounded by the annulus of 4 μm in width; exine 1 μm thick, very finely punctate or intrapunctate; slide GN 4656.

Occurrence: Common.

Comparison: This new species is closely comparable with *Graminidites pseudogramineus* Krutzsch (1970, S. 52, Taf. 1, Fig. 6–11) from the Pliocene or Plio-Pleistocene sediments of Germany, but the former differs from the latter in possessing much broader or stronger annulus surrounding the pore.

Graminidites sp. from the Pohang Formation of the Yonil Group (Takahashi & Kim, 1979, p. 61, pl. 24, fig. 7) has only a very weak annulus surrounding the pore.

Botanical affinity: Gramineae.

Subturma Triporines Naumova 1939
emend. Potonié 1960

Genus *Proteacidites* Cookson 1950
ex Couper 1953

Type species: *Proteacidites adenanthoides* Cookson 1950.

Proteacidites mollis Samoilovitch

Pl. 52, Figs. 20a-b; pl. 53, Figs. 1–2.

1961. *Proteacidites mollis* Samoilovitch, Samoilovitch et al., *Trudy VNIGRI*, no. 117, p. 185, pl. 54, fig. 14; pl. 59, figs. 1a-d; pl. 61, fig. 9.

Dimensions: Grain size 29–33 μm in diameter; triangular with convex sides in polar view; exine punctate, 1.5–2 μm thick.

Occurrence: Few.

Comparison: In general morphological characters the present specimens are considered to belong to *Proteacidites mollis* Samoilovitch from the Maestrichtian-Danian Upper Symsk Subseries, western Siberian Lowland, USSR.

Botanical affinity: Proteaceae.

Proteacidites matsuokae n. sp.

Pl. 53, Fig. 3–7.

Description: Triporate pollen grains; isopolar; amb triangular with somewhat concave sides in polar view. Exine finely punctate, 1.3–2.5 μm thick; ektexine : endexine=1 : 2. Apertures 3–9 μm in diameter. Grain size 29–35 μm in equatorial diameter.

Holotype: Pl. 53, Figs. 5a–b; grain size 29 μm in equatorial diameter; exine finely punctate, 1.5 μm thick; ektexine : endexine =1 : 2; slide GN 4653.

Occurrence: Few.

Comparison: *Proteacidites matsuokae* can be distinguished from *Proteacidites scaboratus* Couper (1960, p. 52, pl. 5, figs. 22–23) from the Upper Senonian or Maestrichtian to Danian strata of New Zealand in ornamentation and structure of exine.

The present species resembles *Proteaci-*

dites incurvatus Cookson forma *minor* Samoliovitch (Samoilovitch et al., 1961, p. 188, pl. 60, figs. 3a-b; pl. 61, fig. 8) from the Maestrichtian-Danian Upper Symsk Subseries, western Siberian Lowland, USSR, but the former differs from the latter in having smaller grain size and aperture.

Botanical affinity: Proteaceae.

Proteacidites cf. *annularis* Cookson

Pl. 53, Fig. 8.

1950. *Proteacidites annularis* Cookson, *Australian Jour. Sci., Res.*, Ser. B, Biol. Sci., 3. 2, p. 170, pl. 1, fig. 15.

Dimensions: Grain size 27 μm in equatorial diameter; exine 2 μm thick (Ektexine: endexine=1 : 2), punctate; apertures 4-5 μm.

Occurrence: Very rare.

Comparison: Except for the comparatively thinner exine, the present specimen appears to be almost identical with the grain of *Proteacidites annularis* Cookson from the Oligocene-Miocene(?) brown coal, South Australia.

Range: Paleocene (Wangerip Group in the Princetown area, South Australia); Oligocene-Miocene (?) (brown coal, Moorlands, South Australia); Paleocene-Eocene (*Lygistepollenites balmei—Nothofagidites asperus* Zone, Latrobe Group, Gippsland, Australia); Paleocene (Waipawan)-Upper Eocene (Runangan) (Dannevirke Series-Arnold Series, New Zealand); Middle Oligocene (Waitakian, Landon Series, New Zealand).

Botanical affinity: Proteaceae.

Proteacidites similis Harris

Pl. 53, Figs. 9a-b.

1965. *Proteacidites similis* Harris, *Palaeontographica*, B, 115, p. 94, pl. 29, figs. 11-12.

Dimensions: Grain size 31.5 μm in equatorial diameter; ora circular 2 μm in diameter; exine 2.3 μm thick, scabrate appearing minutely reticulate.

Occurrence: Very rare.

Comparison: The present specimen is very closely similar to *Proteacidites similis* Harris from the Middle Paleocene Pebble

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Explanation of Plate 50

(All figures ×1000)

Figs. 1-3. *Classites capucinii* González Guzmán
Fig. 1: slide GN 4656; Fig. : slide GN 4653; Fig. 3: slide GN 4655.

Figs. 4-10. *Dicolpopollis malesianus* Muller
Figs. 4, 6, 10: slide GN 4654; Figs. 5a-b, 8, 9: slide GN 4653; Fig. 7: slide GN 4656.

Figs. 11-13, 30. *Quercoidites umiensis* (Takahashi) Takahashi
Fig. 11: slide GN 4654; Fig. 12: slide GN 4655; Figs. 13, 37: slide GN 4653.

Figs. 14-15. *Tricolpopollenites elongatus* n. sp. Slide GN 4657; Fig. 14: holotype.

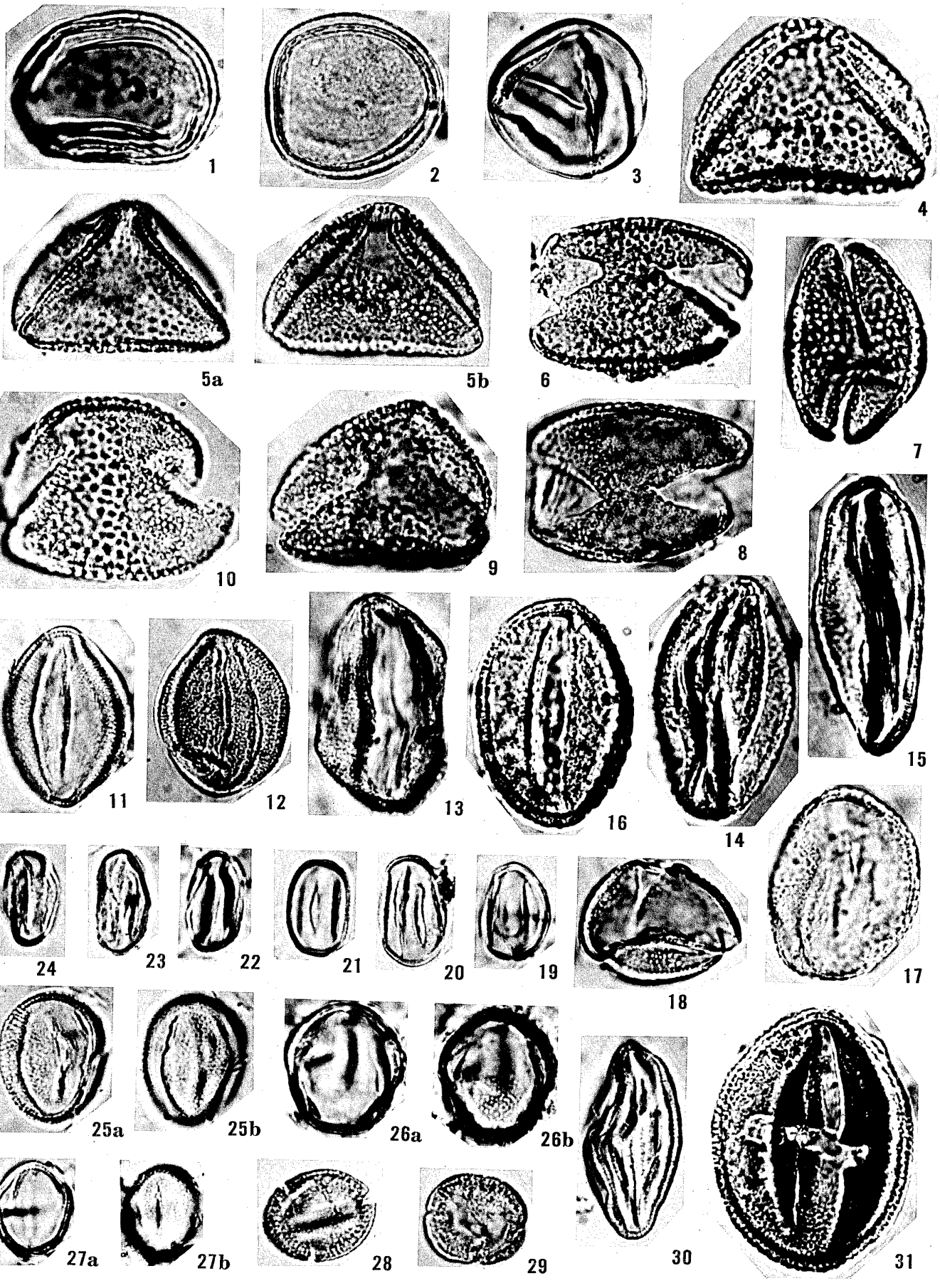
Figs. 16-17. *Quercoidites ellipsodeus* n. sp.
Fig. 16: holotype, slide GN 4656; Fig. 17: slide GN 4654.

Figs. 18, 25-27. *Tricolpites minutireticulosus* Takahashi
Figs. 18, 27a-b: slide GN 4655; Figs. 25a-b: slide GN 4657; Figs. 26a-b: slide GN 4653.

Figs. 19-24. *Cupuliferoidaepollenites fallax* (Potonié) Potonié
Figs. 19, 20: slide GN 4655; Fig. 21: slide GN 4654; Figs. 22-23: slide GN 4653.

Figs. 28-29. *Brevitricolpites circularis* n. sp. Slide GN 4653; Fig. 28: holotype.

Fig. 31. *Euphorbiacites* sp. Slide GN 4656.



Point Formation, Dilwyn Bay, Victoria, Australia.

Botanical affinity: Proteaceae.

Genus *Subtriporopollenites* Pflug & Thomson 1953

Type species: *Subtriporopollenites anulatus* Pflug & Thomson 1953 subsp. *anulatus*

Subtriporopollenites minutulus n. sp.

Pl. 53, Figs. 10-12, 13 (?), 18-19.

Description: Triporate pollen grains. Equatorial outline circular to subcircular or oval. Pores relatively large, circular, 2-2.5 μm in diameter; two or three pores subequatorial. Exine 0.6-1.5 μm thick, finely punctate, with a weak annulus of 1 μm± in width around the pore. Grain size 18-22 μm×16-22 μm in equatorial diameter.

Holotype: Pl. 53, Fig. 10; grain size 20 ×19.5 μm in equatorial diameter; exine 1 μm thick, punctate; pores relatively large, 2.5 μm in diameter; slide GN 4654.

Occurrence: Common.

Comparison: The present specimens are comparable to *Subtriporopollenites anulatus* Pflug & Thomson subsp. *nanus* Pflug & Thomson (1953, S. 86, Taf. 9, Fig. 54-55) and *Subtriporopollenites firmus* Pflug (1953, S. 86, Taf. 9, Fig. 62-63) from the Tertiary deposits of Germany, but *S. anulatus nanus* has intrabaculate to laevigate exine and *S. firmus* has fossulate sculpture of exine.

Botanical affinity: ?Juglandaceae.

Subtriporopollenites sp.

Pl. 53, Fig. 15.

Description: Triporate pollen grain. Subcircular or oval in equatorial outline. Pores very small; two pores subequatorial and one pore equatorial. Exine 1 μm thick, chagrenate, without atrium, labrum and annulus around the pore. Grain size 23.5 μm in equatorial diameter.

Occurrence: Very rare.

Botanical affinity: Unknown.

Genus *Triporopollenites* Pflug & Thomson 1953 emend. Potonié 1960

Type species: *Triporopollenites coryloides* Pflug 1953.

Triporopollenites sp. a

Pl. 53, Fig. 16.

Description: Triporate pollen grain. Triangular in equatorial outline. Three pores very small, planaperturate; two pores equatorial. Exine 1 μm thick, finely punctate, with annulus around the pore. Grain size 15 μm in equatorial diameter.

Occurrence: Very rare.

Remarks: This grain has three apertures (pores) and each is situated at the midpoints of the sides of the triangular amb.

Botanical affinity: Unknown.

Triporopollenites sp. b

Pl. 53, Fig. 17.

Description: Triporate pollen grain. Triangular with convex sides in equatorial outline. Three pores round, equatorial. Exine 2.5 μm thick, intrarugulate or finely punctate, without labrum and annulus; ektexine: endexine=1 : 3. Grain size 32 μm in equatorial diameter.

Occurrence: Very rare.

Botanical affinity: Unknown.

Genus *Subtriporopollis* Sah 1967

Type species: *Subtriporopollis tenuis* Sah 1967.

Subtriporopollis specialis n. sp.

Pl. 53, Figs. 20-21.

Description: Triporate pollen grains. Amb rounded triangular or circular in polar view. Pores circular, slightly protruded; two pores subequatorial. Exine finely reticulate; lumina very small; muri baculate, 0.5-0.7 μm high; annulus drop-shaped. Grain size 19-22 μm $\times$ 17.5-18 μm in equatorial diameter.

Holotype: Pl. 53, Fig. 20; grain size 19 $\times$ 17.5 μm in equatorial diameter; exine reticulate; muri baculate, 0.7 μm high; slide GN 4656.

Occurrence: Few.

Comparison: Sah (1967) established the genus *Subtriporopollis* by the triporate pollen grains with reticulum yielded from the Neogene strata, Rusizi valley, Burundi. The present species differs from *Subtriporopollis tenuis* Sah (1967, p. 119-120, pl. 10, fig. 16) and *Subtriporopollis rotundis* Sah (1967, p. 120-121, pl. 10, figs. 17-19) in grain zize and pore size.

Botanical affinity: Rubiaceae.

Genus *Tiliaepollenites* Potonié 1931

Type species: *Tiliaepollenites indubitabilis* Potonié 1931.

Tiliaepollenites tropicus n. sp.

Pl. 53, Figs. 23-24.

Description: Triporate pollen grains. Amb circular in polar view. Three germinals circular, relatively large, more or less protruded, with postvestibulum. Exine

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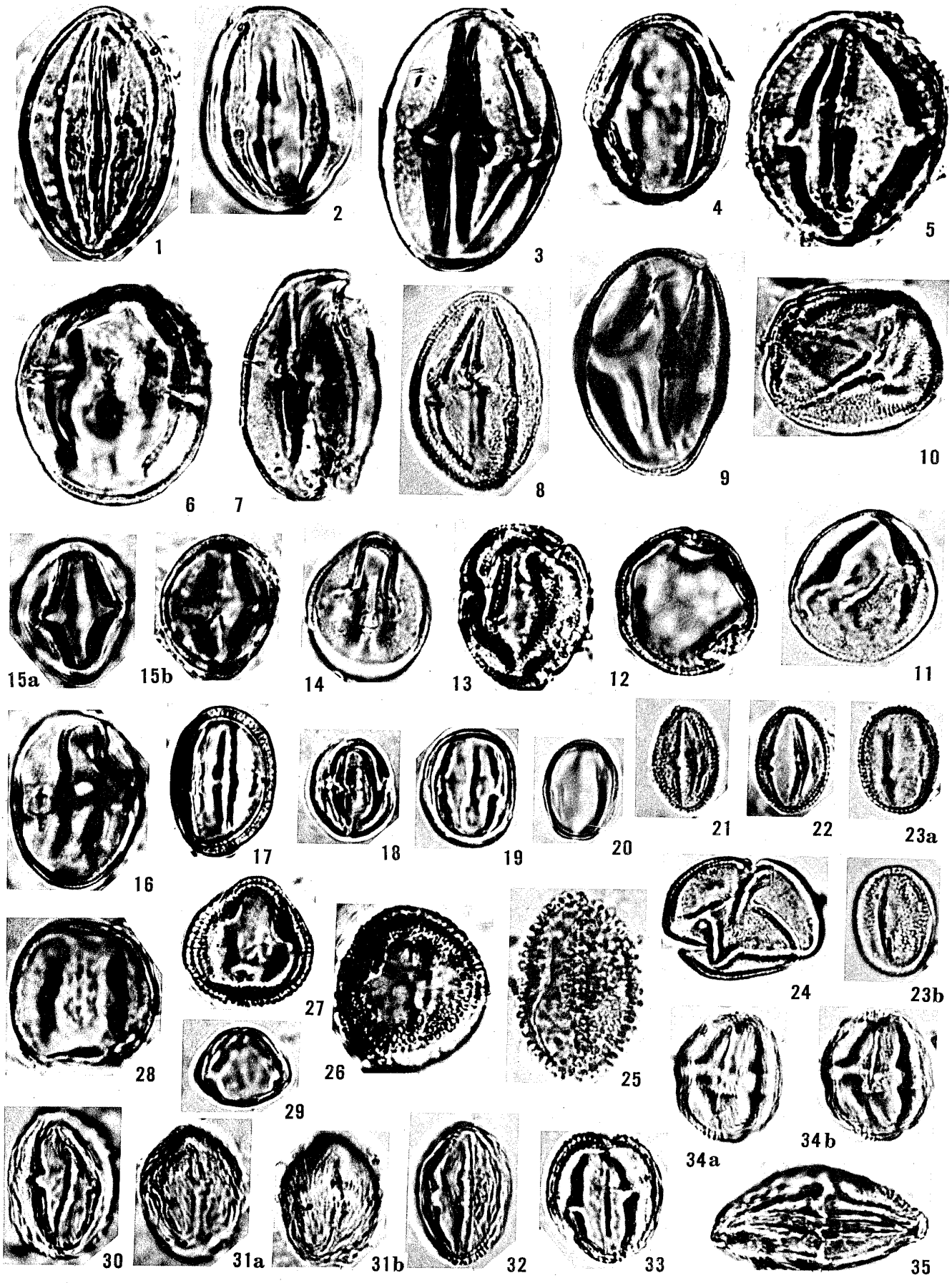
Explanation of Plate 51

(All figures $\times$1000)

Figs. 1-5. *Tricolporopollenites javanensis* n. sp.
Fig. 1: holotype, slide GN 4656; Fig. 2: slide GN 4653; Figs. 3-5: slide GN 4655.
Fig. 6. *Cupuliferoipollenites* sp. Slide GN 4655.
Figs. 7-9. *Tricolporopollenites consularis* Takahashi subsp. *consularis* Slide GN 4654.
Figs. 10-14. *Tricolporopollenites marginatus* n. sp.
Figs. 10, 13: slide GN 4657; Figs. 11, 12: slide GN 4655; Fig. 11: holotype; Fig. 14: slide GN 4654.
Figs. 15a-b. *Tricolporopollenites* sp. a Slide GN 4653.
Fig. 16. *Tricolporopollenites* sp. d Slide GN 4654.
Fig. 17. *Tricolporopollenites* sp. b Slide GN 4657.
Figs. 18-20. *Tricolporopollenites rasus* n. sp.
Figs. 18, 19: slide GN 4656; Fig. 19: holotype; Fig. 20: slide GN 4653.
Figs. 21-23. *Retitricolporites protensus* n. sp. Slide GN 4653; Fig. 22: holotype.
Fig. 24. *Tricolporopollenites ovatorotundus* Takahashi Slide GN 4656.
Figs. 25-27. *Ilexpollenites tertiarius* (Takahashi) Takahashi
Fig. 25: slide GN 4654; Fig. 26: slide GN 4657; Fig. 27: slide GN 4656.
Fig. 28. *Tricolporopollenites* sp. c Slide GN 4656.
Fig. 29. *Cyrillaceaepollenites minor* (Takahashi) Takahashi Slide GN 4653.
Figs. 30-32. *Striatricolporites striolatus* n. sp. Slide GN 4653; Fig. 32: holotype.
Figs. 33-34. *Striatricolporites agustinus* González Guzmán
Fig. 33: slide GN 4657; Figs. 34a-b: slide GN 4655.
Fig. 35. *Striatricolporites* sp. Slide GN 4654.



finely reticulate, 1 μm thick; lumina less than 1 μm. Grain size 28–31 μm×27.5–30 μm in equatorial diameter.

Holotype: Pl. 53, Figs. 24a–b; grain size 28×27.5 μm in equatorial diameter; exine finely reticulate, 1 μm thick, with postvestibulum around the pore; slide GN 4657.

Occurrence: Rare.

Comparison: *Tiliaepollenites tropicus* is comparable with *Tiliaepollenites paucus* Sah (1967, p. 116–117, pl. 10, fig. 15) from the Neogene sediments of Rusizi valley, Burundi, but the former differs from the latter in having much smaller grain.

The general form, pore character and exine ornamentation of the grains strongly suggest affinity with Tiliaceae.

Botanical affinity: Tiliaceae.

Tiliaepollenites cf. *punctulosus* Takahashi

Pl. 53, Figs. 14a-b.

1979. *Tiliaepollenites punctulosus* Takahashi, Takahashi & Kim, *Palaeontographica*, B, 170, p. 56, pl. 20, figs. 10–16.

Dimensions: Grain size 27 μm in eqatorial diameter; exine finely punctate, 1 μm thick, with postvestibulum around the pore; germinals somewhat protruded, equatorial.

Occurrence: Very rare.

Comparison: The present specimen is closely similar to the grain of *Tiliaepollenites punctulosus* Takahashi from the Miocene Changgi and Yonil Groups of Korea, with exception of its smaller size.

Botanical affinity: Tiliaceae.

?*Tiliaepollenites* sp.

Pl. 53, Fig. 22.

Description: Tetraporate pollen grain. Equatorial contour circular. Pore circular, relatively small, somewhat protruded; three pores subequatorial and one pore equatorial, with postvestibulum(?). Exine laevigate, 0.5 μm thick. Breadth of pore rim about 3 μm. Grain size 28 μm in equatorial diameter.

Occurrence: Very rare.

Remarks: Only one specimen was found. This tetraporate grain belongs doubtfully to the genus *Tiliaepollenites*.

Botanical affinity: ?Tiliaceae.

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Explanation of Plate 52

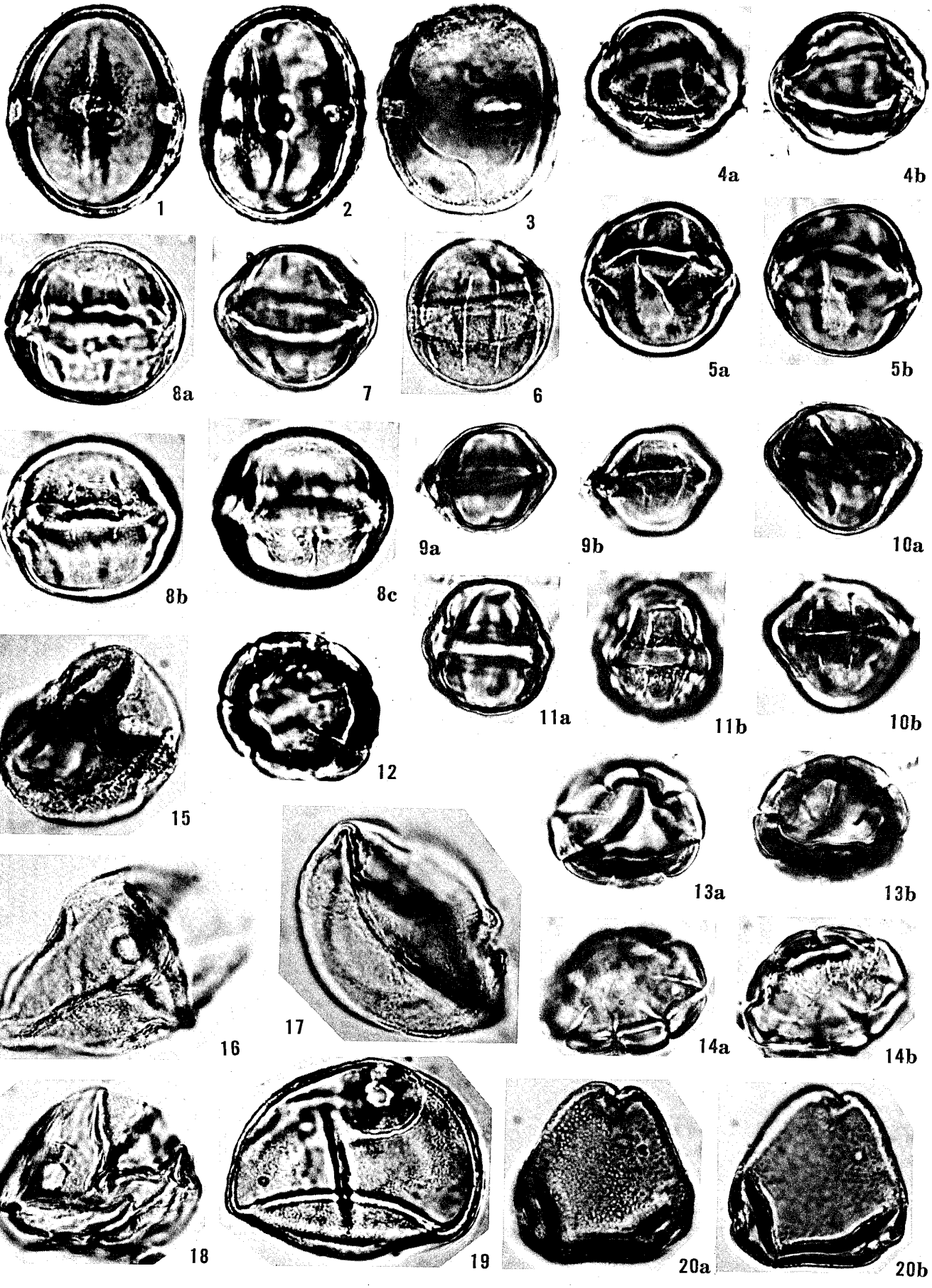
(All figures ×1000)

Figs. 1-3. *Tetracolporopollenites obscurus* Pflug & Thomson
Fig. 1: slide GN 4655; Fig. 2: slide GN 4657; Fig. 3: slide GN 4654.

Figs. 4-14. *Polygalacidites speciosus* n. sp.
Figs. 4-5: slide GN 4655; Figs. 5a-b: holotype; Figs. 6-9, 13-14: slide GN 4654; Figs. 10-11: slide GN 4653; Fig. 12: slide GN 4656.

Figs. 15-19. *Graminidites punctulosus* n. sp.
Figs. 15-18; slide GN 4654; Fig. 19: holotype, slide GN 4656

Figs. 20a-b. *Proteacidites mollis* Samoilovitch Slide GN 4653.



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中部ジャワ，ジョクジャカルタ地方の始新世ナングラン層産胞子・花粉：筆者は，中部ジャワ，ジョクジャカルタ地方の始新世ナングラン層の亜炭から，胞子4種と花粉44種，合計48種を識別し，記載した。48種中17種が新種である：*Laevigatosporites javanicus* n. sp., *Smilacipites spinulifer* n. sp., *Magnoliaepollenites ellipticus* n. sp., *Quercoidites ellipsodeus* n. sp., *Tricolpopollenites elongatus* n. sp., *Brevitricolpites circularis* n. sp., *Tricolporopollenites javanensis* n. sp., *T. marginatus* n. sp., *T. rasus* n. sp., *Retitricolporites protensus* n. sp., *Striatricolporites triolatus* n. sp., *Polygalacidites speciosus* n. sp., *Graminidites punctulosus* n. sp., *Proteacidites matsuokae* n. sp.,

Subtriporopollenites minutulus n. sp., *Subtriporopollis specialis* n. sp., *Tiliaepollenites tropicus* n. sp.

ナングラン花粉群集は *Dicolpopollis malesianus*, *Polygalacidites speciosus*, *Striatricolporites* spp., *Proteacidites* spp., *Graminidites punctulosus* 等の主要花粉によって特徴付けられており，他の地域の若干の始新世花粉群集との比較研究がなされた。 高橋 清

Explanation of Plate 53

(All figures ×1000)

Figs. 1–2. *Proteacidites mollis* Samoilovitch
Fig. 1: slide GN 4655; Fig. 2: slide GN 4654.

Figs. 3–7. *Proteacidites matsuokae* n. sp.
Fig. 3: slide GN 4654; Fig. 4: slide GN 4657; Figs. 5a–b: holotype, slide GN 4653; Figs. 6–7: slide GN 4655.

Fig. 8. *Proteacidites* cf. *annularis* Cookson Slide GN 4655.

Figs. 9a–b. *Proteacidites similis* Harris Slide GN 4655.

Figs. 10–13(?), 18–19. *Subtriporopollenites minutulus* n. sp.
Figs. 10, 13: slide GN 4654; Fig. 10: holotype; Figs. 11, 18: slide GN 4653; Fig. 12: slide GN 4657; Fig. 19: slide GN 4656.

Figs. 14a–b. *Tiliaepollenites* cf. *punctulosus* Takahashi Slide GN 4654.

Fig. 15. *Subtriporopollenites* sp. Slide GN 4653.

Fig. 16. *Triporopollenites* sp. a Slide GN 4653.

Fig. 17. *Triporopollenites* sp. b Slide GN 4656.

Figs. 20–21. *Subtriporopollis specialis* n. sp.
Fig. 20: holotype, slide GN 4656; Fig. 21: slide GN 4654.

Fig. 22. ?*Tiliaepollenites* sp. Slide GN 4657.

Figs. 23–24. *Tiliaepollenites tropicus* n. sp.
Fig. 23: slide GN 4654; Figs. 24a–b: holotype, slide GN 4657