Maestrichtian Micro flora of the Miyadani-gawa Formation in the Hida District, Central Japan

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Maestrichtian Microflora of the Miyadani-gawa Formation in the Hida District, Central Japan

Kiyoshi TAKAHASHI * and Hiroshi SHIMONO **
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Abstract

114 species of miospores and a freshwater alga from the Miyadani-gawa Formation in the Hida district of central Japan are systematically described and illustrated. Among the miospores 2 species belong to mosses, 24 to ferns, 13 to gymnosperms and 75 to angiosperms. Most characteristic of the assemblage and important for its age determination are the triprojectate pollen group and the genera Wodehousea and Callistopollenites.

The pollen group Triprojectacites including 10 genera and 43 species is studied in detail. Many previously described species of this group have been re-examined and recombined.

Nine species of the triprojectate pollen group, two species of Wodehousea and two of Callistopollenites, which occur characteristically in the Miyadani-gawa Formation, have previously been reported from the Maestrichtian of Siberia, North America, Hokkaido (Japan) and other regions and thus undoubtedly indicate a Maestrichtian age for the Miyadani-gawa Formation as well, contrary to the traditional assumption of Palaeogene or Neogene age.

The freshwater alga Pediastrum occurs at two horizons of the Miyadani-gawa Formation. This occurrence, in conjunction with the nature of the sediments, leads the authors to envisage the existence of a former freshwater lake, "Palaeolake Kokufu", extending about 10.5 km from east to west and about 7 km from north to south.

Key words: Miyadani-gawa Formation—Maestrichtian—triprojectate pollen group.

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Introduction

This is the first study on the palynology of the Miyadani-gawa Formation in the Hida district, central Japan.

The samples examined were collected by the authors under the guidance of Y. Kasahara and T. Ishihara.

The microflora from the Miyadani-gawa Formation consists of 114 palynomorphs and a kind of freshwater alga. The purpose of this study is to describe all palynomorphs from this formation and to determine its geologic age. *Callistopollenites*, *Wodehousea*, and some species of the triprojectate pollen group are especially effective in indicating the geologic age of this formation and prove its Maestrichtian age. The microflora may also be correlated with Maestrichtian assemblages from Siberia, North America and elsewhere.

The slides containing specimens studied are preserved in the Department of Geology, Nagasaki University (GN number) and in the Gifu Prefectural Education Center.

Acknowledgements

The authors express their gratitude to Mr. Y. Kasahara, Gifu Prefectural Museum, who is engaged in field work in the Ōamamiyama area, and Mr. T. Ishihara, Higashiyama Junior High School at Takayama, for co-operating in the field work involved in collecting the samples.

This study was finacially supported by the Ministry of Education (Monbusho) of Japan; the authors gratefully acknowledge this financial aid.

Miss Akiko Nishi has assisted in preparing the text-figures and plates.

Geological notes on the Ōamamiyama area

The Ōamamiyama extrusive volcanic rocks overlie granites, Palaeozoic formations, and the Tetori Group, and are divided into two formations, the Miyadani-gawa and Akegatani Formations.

The Akegatani Formation overlies conformably the Miyadani-gawa Formation and consists mainly of rhyolitic welded and non-welded tuffs, more than 350 m in thickness. The Miyadani-gawa Formation is composed mainly of a basal conglomerate, sandstones, shales, tuff breccias and rhyolitic tuffs, about 400 m in thickness.

Hitherto, various opinions were expressed that their geologic age might be Neogene, Palaeogene or late Cretaceous on the basis of lithology or geologic structures, but no fossil evidence was presented.
Text-fig. 1. Map showing sample collection localities.
X: Locality
1-6, A, H: Sample number

Text-fig. 2. Columnar section of the Miyadani-gawa Formation.
a: Granite
b: Mesozoic and Palaeozoic formations
c: Basal conglomerate
d: Sandstone, mudstone, and coaly shale
e: Tuff breccia
f: Tuff–tuff breccia
g: Pumice tuff
h: Biotite–ryholitic tuff
i: Dacitic tuff
j: Chalcedonic tuff
k: Dacitic welded tuff
The authors have collected and analyzed some coaly shales and mudstones from the lower parts of the Miyadani-gawa Formation outcropping in the Miyadani-gawa valley, in the small valley of Jyusanbo, and near the Kanbara pass.

Composition of the microflora

The palynomorphs from the Miyadani-gawa Formation include 114 miospore species and a freshwater alga. Among the miospores 2 species belong to mosses, 24 to ferns, 13 to gymnosperms and 75 to angiosperms.

The moss spores are trilete and Sphagnum-like forms. Stereisporites pseudo-stereoides is known already from the Campanian lower formation of the Hakobuchi Group, Hokkaido, Japan.

The trilete spores of the ferns include 19 species and Leiotriletes is most abundant. HIDaspora ishiharae is of characteristic form and occurs frequently in a restricted horizon. The monolet spores comprise five species of Laevigatosporites occurring most commonly among the ferns. L. senonicus, L. prominens, and L. probatus occur only in the Campanian-Maastrichtian Hakobuchi Group, Hokkaido, Japan.

Of the conifer group, Inaperturopollenites pseudodubius occurs with greater frequency. Psophosphaera aggereloides (MALJAVKINA) occurring in the Cenomanian-Turonian strata of the western Siberian lowland and Pinuspollenites microaliformis (TAKAHASHI) and Piceae pollenites saccellus TAKAHASHI described from the Campanian lower formation of the Hakobuchi Group of Hokkaido, appear commonly. The genus Phyllocladidites occurs in some upper Upper Cretaceous strata in Japan, but Phyllocladidites mawsonii COOKSON shows a wide distribution in the circum-Pacific regions and appears from Lower Cretaceous to Lower Oligocene in Australia, New Zealand etc.

The tricolpate and tricolporate angiospermous pollen grains are infrequent or scarce, except Pachydermipollenites miyajiensis being a singular tricolporate form with one wide and two narrow colpi and appearing abundantly in sample no. 6. Callistopollenites radiatostratus (MCHELDLISHVILI) SrIVASTAVA occurring from the Maastrichtian-Danian strata of Siberia and from the Maastrichtian Edmonton Formation of Alberta and C. cf. tumidoporus SrIVASTAVA from the Maastrichtian Edmonton Formation of Alberta appear also in the Miyadani-gawa Formation. These pollen grains are good indicators of Maastrichtian age.

The triporate pollen group is one of the most important of the angiosperms and is represented by 10 genera and 43 species: Aquilapollenites (19), Triprojectus (1), Hemicorpus (7), Mancicorpus (2), Pseudointegricorpus (4), Bratzevaea (2), Pentapollenites (3), Fibulapollis (2), Cranwellia (1), and Orbiculapollis (2). No pollen grains of Integricorpus occur in this formation. The above-mentioned genera have been re-examined, redescribed, and rearranged by one of the authors, K. TAKAHASHI, using the form and structure of the body and equatorial projections and the body (a)/projection (b) ratios applied by E. A. STANLEY (1970) as a basis for classification. One of the authors, K. TAKAHASHI, has determined the following ratios: Aquilapollenites a/b = 2.0-3.3 (including an exceptional grain of 1.7-2.0), Triprojectus a/b = 3.1-5.4, Hemicorpus a/b = 1.8-2.9,
Mancicorpus a/b = 1.0–1.5, Integricorpus a/b = 3.0–7.0, Pseudointegricorpus a/b = 3.0–6.7, Bratzevaea a/b = 3.0–4.4, Pentapollenites a/b = 1.5–1.8, Fibulapollis (including Cranwellia) a/b = 1.1–1.5, and Orbiculapollis a/b = 1.5–2.3.

Text-fig. 3. Diagrammatic sketches of the Triprojectacites pollen group.

- 1: Aquilapollenites
- 2: Triprojectus
- 3: Hemicorpus
- 4: Mancicorpus
- 5: Integricorpus
- 6: Pseudointegricorpus
- 7: Bratzevaea
- 8a-b: Fibulapollis
- 9: Pentapollenites
- 10a-b: Cranwellia
- 11a-b: Orbiculapollis

a: Length of polar axis
b: Breadth of equatorial projection
Of the triprojectate pollen group, *Aquilapollenites subtilis*, *A. pseudoaucellatus*, *A. aucellatus*, *Hemicorpus tenue*, *Pseudointegricorpus kokufuense*, *P. protrusum*, *Pentapollenites normalis*, and *P. manifestus* are most abundant and in addition, *Aquilapollenites aemulus*, *Hemicorpus trapeziforme*, and *Cranwellia striata* occur commonly.

Table 1. Occurrence of the triprojectate pollen grains, *Wodehousea*, and *Callistopollenites* from the Miyadani-gawa Formation. H: near Kanbara pass.

<table>
<thead>
<tr>
<th>Pollen</th>
<th>Samples No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td><em>Aquilapollenites kasaharae</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. doliformis</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. proprius</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. quadrilobus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. aemulus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. brevialatus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. longissimus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. subtilis</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. aemulus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. latialatus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. aucellatus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. delectus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. quadrinutus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. melior</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. melioratus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. mirus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>A. sp. a</em></td>
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</tr>
<tr>
<td><em>A. sp. b</em></td>
<td></td>
</tr>
<tr>
<td><em>Triploprojectus sp.</em></td>
<td>X</td>
</tr>
<tr>
<td><em>Hemicorpus tenue</em></td>
<td>X</td>
</tr>
<tr>
<td><em>H. trapeziforme</em></td>
<td>X</td>
</tr>
<tr>
<td><em>H. miyajense</em></td>
<td>X</td>
</tr>
<tr>
<td><em>H. tripterum</em></td>
<td>X</td>
</tr>
<tr>
<td><em>H. alienum</em></td>
<td>X</td>
</tr>
<tr>
<td><em>H. sp.</em></td>
<td>X</td>
</tr>
<tr>
<td>? <em>H. sp.</em></td>
<td></td>
</tr>
<tr>
<td><em>Mancorpus minimum</em></td>
<td>X</td>
</tr>
<tr>
<td><em>M. cf. albertense</em></td>
<td>X</td>
</tr>
<tr>
<td><em>Pseudointegricorpus kokufuense</em></td>
<td>X</td>
</tr>
<tr>
<td><em>P. protrusum</em></td>
<td>X</td>
</tr>
<tr>
<td><em>P. fragile</em></td>
<td></td>
</tr>
<tr>
<td><em>P. sp.</em></td>
<td></td>
</tr>
<tr>
<td><em>Bratzevaea amurensis</em></td>
<td>X</td>
</tr>
<tr>
<td><em>B. striatella</em></td>
<td>X</td>
</tr>
<tr>
<td><em>Pentapollenites normalis</em></td>
<td>X</td>
</tr>
<tr>
<td><em>P. miser</em></td>
<td>X</td>
</tr>
<tr>
<td><em>P. manifestus</em></td>
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</tr>
<tr>
<td><em>Fibulapollis hamulatus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>F. pusillus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>Cranwellia striata</em></td>
<td>X</td>
</tr>
<tr>
<td><em>Orbiculapollis lucidus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>O. moderatus</em></td>
<td>X</td>
</tr>
<tr>
<td><em>Wodehousea aspera</em></td>
<td>X</td>
</tr>
<tr>
<td><em>W. gracilis</em></td>
<td>X</td>
</tr>
<tr>
<td><em>Callistopollenites radiatostriatu</em></td>
<td>X</td>
</tr>
</tbody>
</table>
Table 2. Comparative occurrence of some Maestrichtian triprojectate pollen species occurring in Siberia, Japan, and Alberta.

<table>
<thead>
<tr>
<th>Species</th>
<th>USSR</th>
<th>Japan</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquilapollenites subtilis</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. asper</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. aucellatus</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>A. quadrinus</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hemicorpus tenue</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>H. trapeziforme</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mancicorpus albertense</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bratevaea amurensis</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Orbiculapollis lucidus</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Aquilapollenites subtilis, A. asper, Hemicorpus tenue, H. trapeziforme, and Orbiculapollis lucidus were originally described from the Maestrichtian-Danian strata of the western Siberian lowland. Bratevaea amurensis, which occurred only from the Maestrichtian strata in the Zeiya-Bureia depression of the Far East, is rare in the Miyadani-gawa Formation. Aquilapollenites aucellatus and Mancicorpus cf. albertense were reported from the Maestrichtian Edmonton Formation of Alberta, Canada. The above-mentioned Siberian and Canadian species of the triprojectate pollen group together appear in the Miyadani-gawa Formation, but the Siberian species are more abundant than the Canadian species.

The most important species in determining the geologic age of the microflora of the present formation are Aquilapollenites subtilis (Maestrichtian-Danian), A. asper (Maestrichtian-Danian), A. aucellatus (Maestrichtian), A. quadrinus (Maestrichtian), Hemicorpus tenue (Maestrichtian-Danian), H. trapeziforme (Maestrichtian-Danian), Mancicorpus cf. albertense (Maestrichtian), Bratevaea amurensis (Maestrichtian), Orbiculapollis lucidus (Maestrichtian-Danian) etc. together with the species of Wodehousea and Callistopollenites. These pollen grains are the main constituents in the microflora and indicate firmly that this microflora is Maestrichtian in age.

Of the triporate and polyporate angiospermous pollen grains, Anacolosidites is very rare and Wodehousea appears commonly. Wodehousea aspera occurring in the upper Maestrichtian strata of the arctic North Slope, Alaska, and in the Senonian sediments of western Siberian lowland as well as Wodehousea gracilis (Samoilovich) Pokrovskaya from the Maestrichtian Edmonton Formation of Alberta, the upper Maestrichtian strata of the arctic North Slope, Alaska, and the Maestrichtian-Danian strata of the western
Siberian lowland appear frequently in this formation.

The occurrence of *Pediastrum simplex* var. *duodenarium* proves the existence of a freshwater lake. The lower part of the Miyadani-gawa Formation yielding many spores and pollen grains has been deposited in this lake. The authors propose to call this lake "Palaeolake Kokufu", which extend about 10.5 km from east to west and about 7 km from north to south and was later buried by rhyolitic volcanic activity in the Ōamami-yama area.

The fossil genera and species of the Maestrichtian microflora from the Miyadani-gawa Formation are as follows.

**Alga:**

*Pediastrum simplex* (Meyen.) Lemmermann var. *duodenarium* (Bailey) Rabenhorst

(few)

**Trilete spores:**

*Leiotriletes rotundiformis* (Maljavkina) Chlonova

(common)

*Leiotriletes cf. convexiformis* Chlonova

(few)

*Leiotriletes* sp.

(v. rare)

*Deltoidospora cascadensis* Miner

(v. rare)

*Biretisporites incrassatus* Takahashi & Shimono n. sp.

(few)

*Triplanosporites inornatus* Takahashi n. sp.

(few)

*Triplanosporites sinuosus* Pflug

(v. rare)

*Stereisporites pseudostereoides* Takahashi

(few)

*Stereisporites* sp.

(v. rare)

*Undulatisporites unduliradius* Takahashi n. sp.

(few)

*Osmundacidites minor* Takahashi & Shimono n. sp.

(few)

*Osmundacidites wellmanii* Couper

(few)

*Trilites granatus* (Bolchovitina) Takahashi & Shimono n. comb.

(few)

*Trilites consimilis* Takahashi & Shimono n. sp.

(few)

*Echinatisporis sphaericus* Takahashi n. sp.

(rare)

*Cicatricosisporites cooksonii* Balme

(v. rare)

*Cicatricosisporites cuneiformis* Pocock

(few)

*Retitriletes cf. punctoides* Krutzsch

(v. rare)

*Retitriletes* sp.

(v. rare)

*Undulatisporis* sp.

(v. rare)

*Appendicisporites exilioides* (Bolchovitina) Takahashi n. comb.

(v. rare)

**Monolete spores:**

*Laevigatosporites dehiscens* Takahashi

(abundant)

*Laevigatosporites senonicus* Takahashi

(abundant)

*Laevigatosporites ovoides* Takahashi

(abundant)

*Laevigatosporites prominens* Takahashi

(common)

*Laevigatosporites probatus* Takahashi

(few)

**Incertae sedis:**

*Hidaspora ishiharae* Takahashi & Shimono n. sp.

(common)

*Diplosporis* sp.

(v. rare)
Pollen grains:

Inaperturate:

- *Inaperturopollenites pseudodubius* Takahashi (abundant)
- *Psophosphaera gigantica* Takahashi & Shimono n. sp. (few)
- *Psophosphaera aggregloides* (Maljavkina) Chlonova (common)

Saccate:

- *Pinuspollenites microaliformis* (Takahashi) Takahashi & Shimono n. comb. (common)
- *Pinuspollenites* sp. a (v. rare)
- *Pinuspollenites* sp. b (v. rare)
- *Piceaepollenites saccellus* Takahashi (common)
- *Podocarpidites* sp. (v. rare)
- *Phyllocladidites mawsonii* Cookson ex Couper (few)
- *Dacrydiumites punctosaccatus* Takahashi & Shimono n. sp. (few)

Polypllicate:

- *Equisetosporites ellipsoideus* (Takahashi) Takahashi n. comb. (rare)
- *Equisetosporites* sp. (v. rare)

Monocolpate:

- *Cycadopites hidaensis* Takahashi n. sp. (rare)
- *Monocolpopollenites kyushuensis* Takahashi (rare)
- *Monocolpopollenites* sp. (v. rare)

Tricolpate:

- *Cupuliferoidaepollenites cf. weylandii* (Takahashi) Takahashi (v. rare)
- *Cupuliferoidaepollenites facetus* (Takahashi) Takahashi (rare)
- *Quercoidites umiensis* (Takahashi) Takahashi (v. rare)
- *Tricolpopollenites meinohamensis* Takahashi subsp. *rotundus* Takahashi (few)
- *Tricolpopollenites cf. inamoenus* Takahashi (v. rare)
- *Striatopollis cf. striatellus* (Takahashi) Takahashi (few)
- *Tricolpites reticosus* Takahashi (few)
- *Tricolpites minutiretiformis* (Takahashi) Takahashi n. comb. (few)
- *Foveotricolpites* sp. (v. rare)

Tricolporate:

- *Tricolporopollenites punctulatus* Takahashi n. sp. (few)
- *Tricolporopollenites* sp. a (v. rare)
- *Tricolporopollenites* sp. b (v. rare)
- *Tricolporopollenites* sp. c (v. rare)
- *Tricolporopollenites* sp. d (v. rare)
- *Retitricolpites misellus* Takahashi (v. rare)
- *Foveotricolpites* sp. (v. rare)
- *Callistopollenites radiatostriatus* (Mchedlishvili) Srivastava (v. rare)
- *Callistopollenites cf. tumidoporus* Srivastava (v. rare)
- *Pachydermipollenites miyajiensis* Takahashi n. sp. (abundant)

Triprojectate:

- *Aquilapollenites kasaharae* Takahashi & Shimono n. sp. (few)
Aquilapollenites doliiformis Takahashi & Shimono n. sp.  
Aquilapollenites proprius Takahashi & Shimono n. sp.  
Aquilapollenites quadrirubus Rouse  
Aquilapollenites aemulus Takahashi & Shimono n. sp.  
Aquilapollenites brevialatus Takahashi & Shimono n. sp.  
Aquilapollenites longissimus Takahashi & Shimono n. sp.  
Aquilapollenites subtilis Mchedlishvili  
Aquilapollenites asper Mchedlishvili  
Aquilapollenites pseudoaucellatus Takahashi & Shimono n. sp.  
Aquilapollenites aucellatus Srivastava  
Aquilapollenites latialatus Takahashi n. sp.  
Aquilapollenites delectus Takahashi & Shimono n. sp.  
Aquilapollenites quadrinus Takahashi  
Aquilapollenites melior Takahashi & Shimono n. sp.  
Aquilapollenites melioratus Takahashi n. sp.  
Aquilapollenites mirus Takahashi n. sp.  
Aquilapollenites sp. a  
Aquilapollenites sp. b  
Triporetical sp.  
Hemicorpus tenue (Mchedlishvili) Krutzsch  
Hemicorpus trapeziforme (Mchedlishvili) Krutzsch  
Hemicorpus miyajense Takahashi & Shimono n. sp.  
Hemicorpus tripterum Takahashi n. sp.  
Hemicorpus alienum Takahashi n. sp.  
Hemicorpus sp.  
? Hemicorpus sp.  
Mancicorpus cf. albertense Srivastava  
Mancicorpus minimum (Chlonova) Stanley  
Pseudointegricorpus kokufuense Takahashi & Shimono n. sp.  
Pseudointegricorpus protrusum Takahashi & Shimono n. sp.  
Pseudointegricorpus fragile Takahashi n. sp.  
Pseudointegricorpus sp.  
Bratzevaea amurensis (Bratzeva) Takahashi n. comb.  
Bratzevaea striatella Takahashi n. sp.  
Pentapollenites normalis Takahashi & Shimono n. sp.  
Pentapollenites miser Takahashi n. sp.  
Pentapollenites manifestus Takahashi n. sp.  
Fibulapollis hamulatus Takahashi n. sp.  
Fibulapollis pusillus Takahashi n. sp.  
Cranwellia striata (Couper) Srivastava  
Orbiculapollis lucidus Chlonova  
Orbiculapollis moderatus Takahashi n. sp.  

Monoporate:
Graminidites sp. (v. rare)

Triporate:

Engelhardtidites cf. microcoryphaeus (Potonie) Potonie (rare)
Triporopollenites shimensis Takahashi (few)
Betulaepollenites miyadaniensis Takahashi n. sp. (rare)
Subtriporopollenites kyushuensis Takahashi (rare)
Anacolosidites sp. (v. rare)
Ulmoideipites fornicatus Takahashi n. sp. (common)

Polyporate:

Ulmipollenites undulipunctatus Takahashi n. sp. (few)
Polyvestibulopollenites eminens Takahashi (rare)
Wodehousea aspera (Samoilovich) Wiggins (few)
Wodehousea gracilis (Samoilovich) Pokrovskaya (common)

Descriptive palynology

Phylum Chlorophycophyta Papenfuss 1946.
Class Chlorophyceae Kützing 1843.
Family Hydrodictyaceae (Gray) Dumortier orth. mut. Cohn 1880.
Genus Pediastrum Meyen 1829.

Pediastrum simplex (Meyen) Lemmermann var. duodenarium (Bailey) Rabenhorst
Pl. 1, figs. 1–3.


Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 4.

Remarks: Only a few specimens were found in two samples. These algae are morphologically identified with P. simplex (Meyen) Lemmermann var. duodenarium (Bailey) Rabenhorst.

Anteturma Sporites H. Potonie 1893.
Subeturma Azonotriletes Luber 1935.
Type species: *Leiotriletes sphaerotriangulus* (Loose 1932) Potonié & Kremp 1954.

*Leiotriletes rotundiformis* (Maljavkina) Chlonova

Pl. 1, figs. 5–8; pl. 2, figs. 1–2.


*Dimensions*: Grain size 46–57 μ X 38–52 μ; exospore thin, less than 1 μ thick, chagreneate; round or elliptical in polar view.

*Occurrence*: Common, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 2, 3, and H.

*Remarks*: The present specimens are referable to *Leiotriletes rotundiformis* (Maljavkina) Chlonova from the Cenomanian to Turonian strata, Chulym, Siberia.

*Botanical affinity*: Unknown.

*Leiotriletes cf. convexiformis* Chlonova

Pl. 2, fig. 6.


*Dimensions*: Grain size 30.5–35.5 μ in equatorial diameter; exospore thin, chagreneate or smooth; round or subtriangular with round corners in polar view.

*Occurrence*: Few. Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 6 and H.

*Comparison*: The present specimens are closely similar to *Leiotriletes convexiformis* Chlonova from the Cenomanian to Turonian strata, Chulym, Siberia and from the Danian to Lower Palaeogene strata, Tenlyches, Siberia, but they are more circular than the Siberian form.

*Botanical affinity*: Unknown.

*Leiotriletes sp.*

Pl. 1, figs. 4a–b.

*Description*: Trilete spore; outline originally oval (?) in polar view. Trilete mark straight, not so strong, reaching near the equator. Exine thin, chagreneate. Grain size 73 μ in equatorial diameter.

*Occurrence*: Very rare, Miyadani-gawa Formation, near the Kanbara pass, Hida district, Gifu Prefecture; sample no. H.

*Remarks*: Only one specimen was found.

*Botanical affinity*: Unknown.


Type species: *Deltoidospora hallii* Miner 1935.

*Deltoidospora cascadensis* Miner

Pl. 2, fig. 3.
Maestrichtian Microflora of the Miyadani-gawa Formation in the Hida District, Central Japan

1935 *Deltoidospora cascadensis* MINER, Am. Midland Naturalist, vol.16, no. 4, p.618, pl. 24, figs. 9–12.

*Dimensions:* Grain size 41.5 μ in equatorial diameter; exine thin, laevigate; trilete mark extending two-thirds or more of the distance to the periphery.

*Occurrence:* Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. A.

*Remarks:* Only one specimen was found. This belongs to *Deltoidospora cascadensis* MINER from the Lower Cretaceous Kootenai Formation in the Great Falls coal-field, Cascade County, Montana, U. S. A.

*Botanical affinity:* Unknown.


*Biretisporites incrassatus* TAKAHASHI & SHIMONO n. sp.

Pl. 2, figs. 4a–b, 5.

*Description:* Spores trilete, amb subtriangular with slightly convex or concave sides. Trilete mark with the wide elevated lips on both its sides, 2.5–4.5 μ in width, reaching the equator. Exine laevigate to chagrenate, less than 2 μ thick. Grain size 26.5–30 μ in equatorial diameter.

*Holotype:* Pl. 2, fig. 5; grain size 26.5 μ in equatorial diameter; exine laevigate, 2 μ thick; Y-mark with the wide elevated lips on both its sides, 4.5 μ in width; slide GN 3883; Miyadani-gawa Formation, near the Kanbara pass; sample no. H.

*Occurrence:* Rare, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 4 and H.

*Remarks:* The present specimens are similar to *Biretisporites A* (K. TAKAHASHI, 1974, p. 542, pl. 2, fig. 2) and *Biretisporites B* (K. TAKAHASHI, 1974, p. 542–544, pl. 2, fig. 3) from the upper Aptian Tanohata Formation, Miyako Group, but differ from both forms in size.

*Botanical affinity:* Unknown.

Genus *Triplanosporites* PFLUG 1953.

Type species: *Triplanosporites sinuosus* PFLUG 1953.

*Triplanosporites inornatus* TAKAHASHI n. sp.

Pl. 2, figs. 14–15.

*Description:* Spores trilete, outline in equatorial view top-shaped or obtriangular; proximal face somewhat flattened, polar axis shorter than equatorial diameter. Trilete mark distinct, reaching the equator. Exine thin, laevigate. Grain size: polar axis 25–25.2 μ, equatorial diameter 26–28 μ.

*Holotype:* Pl. 2, fig. 14; grain size: polar axis 25.2 μ, equatorial diameter 28 μ; exine thin, smooth; slide GN 2809; Miyadani-gawa Formation, north of Miyaji; sample
no. 6.

Occurrence: Few; Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 6 and H.

Comparison: The polar axis of these specimens is shorter than the equatorial diameter. *Triplanosporites apticus* TAKAHASHI showing this character, from the upper Aptian Tanohata Formation, Miyako Group, possesses an almost semi-circular contour on the distal face in equatorial view. The present specimens differ from *Triplanosporites apticus* TAKAHASHI (1974, p. 541–542, pl. 1, figs. 8–9) in size and form.

Botanical affinity: Unknown.

*Triplanosporites sinuosus* PFLUG

Pl. 2, fig. 16.

1952 *Triplano sporites sinuosus* PFLUG, Paläont. Z., 26, 1/2, S. 113–114, Abb. 2, Taf. 6, Fig. 5.

1953 *Triplanosporites sinuosus* PFLUG, Palaeontographica, B, 94, S. 58, Taf. 3, Fig. 5–16.

Dimensions: Grain size: polar axis 41.3 μ, equatorial diameter 36 μ; exine somewhat chagrenate.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Remarks: This species occurs abundantly in the lower Palaeogene of Germany, although our material possesses a thinner exine than the German specimens.

Botanical affinity: Unknown.

Genus *Stereisporites* PFLUG 1953.
Type species: *Stereisporites stereoides* (POTONIÉ & VENITZ 1934) PFLUG 1953.

*Stereisporites pseudostereoides* TAKAHASHI

Pl. 2, figs. 7–8.


Dimensions: Grain size 28–33.5 μ in equatorial diameter; exospore 0.7–1 μ thick, laevigate or chagrenate; trilete-mark reaching the equator.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

Remarks: These specimens are compared with *Stereisporites pseudostereoides* TAKAHASHI from the Campanian lower formation of the Hakobuchi Group, Hatsune-sawa, Yubari coal-field, Hokkaido.

Botanical affinity: Sphagnum.

*Stereisporites sp.*

Pl. 2, figs. 9a–b.

Description: Spore trilete; amb triangular with slightly convex sides and rounded corners. Trilete mark simple, narrow, straight, reaching the equator. Exine chagre-
Maestrichtian Microflora of the Miyadani-gawa Formation in the Hida District, Central Japan

nate, 3 μ thick, slightly thicker at the corners, 4.5 μ thick. Grain size 22.5 μ in equatorial diameter.

Occurrence: Very rare, Miyadani-gawa Formation near the Kanbara pass, Hida district, Gifu Prefecture; sample no. H.

Comparison: This specimen is similar to Stereispontes minor (Raatz 1937) Kruitzsch 1959 (al. Sphagnum-sporites stereoides Pot. & Venitz f. minor Raatz, 1937, S. 9, Taf. 1, Fig. 5) in morphology and size, but differs from the latter in having a thicker exine.

Botanical affinity: Sphagnum.

Genus Undulatissporites Pflug 1953.

Type species: Undulatissporites microcutis Pflug 1953.

Undulatissporites unduliradius Takahashi n. sp.

Pl. 2, figs. 10–13.

Description: Spores trilete; amb triangular with convex sides and somewhat angular corners. Y-mark roughly sinuous, 0.7–2 μ in width, reaching the equator. Exine 0.6–1.3 μ thick, smooth or chagrenate. Grain size 27–30 μ X 27–28 μ in equatorial diameter.

Holotype: Pl. 2, fig. 10; grain size 30 X 28 μ in equatorial diameter; exine 0.8 μ thick, smooth; Y-mark somewhat undulate, 0.7 μ in width; slide GN 2710; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

Comparison: The present specimens are comparable with Undulatissporites afirmatus Pflug (P. W. Thomson & H. D. Pflug, 1953, S. 52–53, Taf. 1, Fig. 83) and U. microcutis Pflug (P. W. Thomson & H. D. Pflug, 1953, S. 52, Taf. 1, Fig. 81–82) from the Tertiary strata in Wehmingen, Germany, but differs from U. afirmatus in having different form of the Y-mark and from U. microcutis in having a smaller size and a thinner exospore.

Botanical affinity: Unknown.

Infraturma Apiculati (Bennie & Kidston 1886) Potonié 1956.

Genus Osmundacidites Couper 1953.

Type species: Osmundacidites wellmanii Couper 1953.

Osmundacidites minor Takahashi & Shimonono n. sp.

Pl. 2, figs. 17–19.

Description: Spores trilete; amb circular to subcircular in polar view. Y-mark straight, long, often split almost reaching the equator. Exine thin, 1 μ ± thick; sculpture of exine granular to papillate and sometimes echinate, 1.3 μ high. Grain size 33–39.5 μ X 26–34.3 μ in equatorial diameter.

Holotype: Pl. 2, fig. 18; grain size 39.5 X 34.3 μ in equatorial diameter; exine
1 μ thick, granular to papillate and sometimes echinate, 1.3 μ high; slide GN 2702; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

**Occurrence**: Few, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 2, A, and H.

**Comparison**: These small forms of *Osmundacidites* are similar to *Osmunda micanica* Verbitskaya (A. F. Chlonova, 1969, p. 45, pl. 1, figs. 7–8) and *Osmunda irregulites* Martin & Rouse (K. M. Piel, 1971, p. 1898, pl. 3, figs. 21–23), but our species possesses somewhat larger ornamentation than *O. micanica* and smaller ornamentation and more round form than *O. irregulites*.

**Botanical affinity**: Osmundaceae, Osmunda.

*Osmundacidites wellmanii* Couper

Pl. 3, figs. 1a–b, 2.


**Dimensions**: Grain size 46–57 μ in equatorial diameter; exine thin, granular to papillate. 0.9–2.4 μ high.

**Occurrence**: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and A.

**Range**: Jurassic to Cretaceous.

**Remarks**: The present specimens belong undoubtedly to *Osmundacidites wellmanii* Couper. The Y-mark of the figures 1a–b is indistinct.

**Botanical affinity**: Osmundaceae, Osmunda.

**Genus Trilites** Cookson 1947 ex Couper 1953.

Type species: *Trilites tuberculiformis* Cookson 1947.

*Trilites granatus* (Bolchovitina) Takahashi & Shimono n. comb.

Pl. 3, figs. 3–4, 5a–b.


**Dimensions**: Grain size 34–47 μ X 28–38 μ in equatorial diameter; exine with verrucate or rugulate sculpture, 2.5–7 μ in diameter, 2.2–2.5 μ in height.

**Occurrence**: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 3 and A.

**Remarks**: The present specimens are identified with *Selaginella granata* Bolchovitina from the Aptian black clays, Domitrov district, Moscow region and from the Cenomanian to Turonian strata in the Chulym-Eniseisk depression, Siberia, in morphology, size, and sculpture.

**Botanical affinity**: ? *Selaginella*.

*Trilites consimilis* Takahashi & Shimono n. sp.

Pl. 3, figs. 6–7.
Description: Trilete miospores; amb subcircular to elliptical in polar view. Y-mark narrow, somewhat slender, reaching the equator. Exine densely covered with verrucae or elongate verrucae or rugulate, 1–5 μ in diameter, 1.2–1.5 μ high. Grain size 52–53 μ X 31–40 μ in equatorial diameter.

Holotype: Pl. 3, fig. 6; grain size 52 X 31 μ; exospore densely covered with various forms of verrucae; slide GN 2818; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Comparison: This new species is superficially similar to Trilites verrucatus Couper (1953, p. 31, pl. 3, figs. 26–27) from the Jurassic to Cretaceous formations, New Zealand, but differs from the latter in having larger size and thinner exine.

Botanical affinity: Unknown.

Genus Echinatisporis Krutzsch 1959.
Type species: Echmatisporsis longechinus Krutzsch 1959.

Echinatisporis spharicus Takahashi n. sp.
Pl. 3, figs. 8–9.

Description: Trilete spores; amb circular. Exine is ornamented all over with echinate spines which are straight, curved or flexuous. 4.5–8 μ long and 4–5.5 μ wide at base. Y-mark indistinct, reaching (?) the equator. Grain size 39.5–45 μ in diameter, excluding spines.

Holotype: Pl. 3, fig. 9; grain size 45 μ in diameter; echinate spines straight, curved or flexuous. 5.5–7.5 μ long; Y-mark indistinct; slide 61003–1; Miyadani-gawa Formation, north of Miyaji; sample no. A

Occurrence: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 6 and A.

Comparison: Echinatisporis bockwitzensis Krutzsch (1963, S. 110, Taf. 36, Fig. 1–5) from the upper Oligocene strata of Bockwitz near Borna, Germany, is 37 μ in diameter excluding spines and its spines are ca. 5 μ long. The specimens of this new species possess larger, thicker and longer spines. Echinatisporis miocenicus Krutzsch (1963, S. 110, Taf. 36, Fig. 6–13) and E. wiesaensis Krutzsch (1963, S. 112, Taf. 37, Fig. 1–7) from the Miocene strata of Germany are smaller.

Botanical affinity: Unknown.

Infraturma Murornati Potonié & Kremp 1954.

Type species: Cicatricosisporites dorogensis Potonié & Gelletich 1933.

Cicatricosisporites cooksonii Balme
Pl. 3, fig. 10.

1961 *Anemia cooksonii* (BALME) BOLCHOVITINA, Trudy Geol. Inst., Acad. Sci. USSR, 40, p. 59, pl. 17, figs. 6a–e.

**Dimensions**: Grain size 35 μ; rounded ridges 3–7 μ wide and 1.5 μ high.

**Occurrence**: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. A.

**Remarks**: Only one specimen was found. This specimen coincides with the morphological characteristics of *Cicatricosisporites cooksonii* BALME from the Neocomian (?) to lower Aptian Birdlong Formation, Carnarvon Basin, Western Australia and from the Barremian to Aptian formations in the Suifunsk basin, Primorskii krai (the maritime Province of Siberia).

**Botanical affinity**: Schizaeaceae

*Cicatricosisporites cuneiformis* POCOCK

Pl. 4, figs. 1a–b, 2–3.

1964 *Cicatricosisporites cuneiformis* POCOCK, Grana Palynologica, vol. 5, no. 2, p. 158, pl. 2, fig. 17.

**Dimensions**: Grain size 50–59 μ in equatorial diameter; exine thin, 1.4 μ thick and less, canaliculate.

**Occurrence**: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. A.

**Remarks**: The present specimens are closely similar to *Cicatricosisporites cuneiformis* Pocock from the late Middle Albian Upper Mannville strata of the Saskatoon area, Saskatchewan, Canada.

**Botanical affinity**: Schizaeaceae, Mohria.


Type species: *Retitriletes globosus* PIERCE 1961.

*Retitriletes cf. punctoides* KRUTZSCH

Pl. 4, fig. 4.

1963 *Retitriletes punctoides* KRUTZSCH, Atlas, Lief. II, S. 80, Taf. 21, Fig. 1–18.

**Dimensions**: Grain size 40 μ in equatorial diameter; Y-mark indistinct; exine thin, 1 μ thick, reticulate; net-lumina polygonal. 3–5.5 μ in diameter; punctate muri at the corners of the polygonal mesh, 0.5 μ high.

**Occurrence**: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

**Remarks**: Only one specimen was found. This resembles some morphological characteristics of *Retitriletes punctoides* KRUTZSCH from the Miocene to Pliocene formations of many localities of Germany.

**Botanical affinity**: Lycopodiaceae.
Maestrictian Microflora of the Miyadani-gawa Formation in the Hida District, Central Japan

Retitriteles sp.

Pl. 6, fig. 4.

Description: Trilete spore; outline circular in polar view. Y-mark indistinct, almost reaching (?) the equator. Exine thin, reticulate; net-lumina polygonal, 5–7 μ in diameter. Grain size 49 μ in equatorial diameter.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. A.

Remarks: Only a single grain was recovered and the details are not sufficient for closer comparisons. Retitriteles and another specimen overlap each other in the middle of the photograph (see pl. 6, fig. 4).

Botanical affinity: Lycopodiaceae.


Type species: Inundatisporis plicenceus (Krutzsch 1963) Srivastava 1972.

Inundatisporis sp.

Pl. 4, fig. 5.

Description: Trilete spore; amb subtriangular with convex sides and rounded corners. Laesurae long, almost reaching the equator. Exine thin, rugulose on both proximal and distal faces; rugulae 1–3 μ wide, tortuous 1–2 μ wide. Grain size 35 μ in equatorial diameter.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no A.

Remarks: As only one specimen was found, the authors can not determine its specific identity.

Botanical affinity: Lycopodiaceae.

Turma Zonales BENNIE and KIDSTON 1886 emend. POTONIE 1956.
Subturma Auritotriteles POTONIE & KREMP 1954.
Infraturma Auriculati SCHOFF emend. POTONIE & KREMP 1954.
Genus Appendicisporites WEYLAND & KRIEGER 1953.

Type species: Appendicisporites tricuspidatus WEYLAND & GREIFELD 1953.

Appendicisporites exilioides (BOLCHOVITINA) TAKAHASHI n. comb.

Pl. 3, fig. 11.

1961 Anemia exilioides (MAL.) BOLCHOVITINA, Trudy Geol. Inst., Acad. Sci. USSR, 40, p. 51, pl. 14, figs. 2a–d; pl. 17, figs. 1a–d; pl. 40, fig. 3.

Dimensions: Grain size 60 μ in equatorial diameter; very short appendages at the corners; six ridges on the proximal face.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6
Remarks: Hitherto, *Appendicisporites exilioides* (al. *Anemia exilioides*) has been reported from the following regions of Russia: Crimea, Lower Cretaceous; Russian Platform, Aptian; Kazakhstan and central Ural, Albian; Yakut, Cenomanian to Turonian.

*Botanical affinity:* Schizaeaceae, *Anemia*.

**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 dehiscens TAKAHASHI**

*Pl. 5, figs. 6–7.*


*Dimensions*: Grain size 38.7–42.5 μ X 22.5–27.6 μ; exine thin, less than 1 μ thick, laevigate; width/length ratio 0.58–0.67.

*Occurrence*: Abundant, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 2, 5, and 6.

*Remarks*: Hitherto, this species has been reported from the Hakobuchi Group (Campanian–Maestrichtian), Palaeogene, and Miocene strata, Japan.

*Botanical affinity*: Polypodiaceae.

**Laevigatosporites senonicus TAKAHASHI**

*Pl. 5, figs. 8–13.*


*Dimensions*: Grain size 30–39 μ X 24–32.5 μ; exine 0.5–1 μ thick, slightly chagrenate; width/length ratio 0.7–0.95.

*Occurrence*: Abundant, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 2, 3, 5, and H.

*Remarks*: The senior author, K. TAKAHASHI (1964), reported and described this species from the Hakobuchi Group (Campanian–Maestrichtian), Hokkaido, Japan. The present specimens are not good in preservation.

*Botanical affinity*: Polypodiaceae.

**Laevigatosporites ovoideus TAKAHASHI**

*Pl. 5, figs. 14–16.*


*Dimensions*: Grain size 37–48.4 μ X 26–31.5 μ; exine 0.8 μ thick or less, smooth to somewhat chagrenate; width/length ratio 0.7–0.75.
Occurrence: Abundant, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 3.

Remarks: This species was described by one of the authors, K. Takahashi, from the lower Miocene strata of the Sasebo Group, Sasebo coal-field, Nagasaki Prefecture. This is similar to Laevigatosporites ovatus Wilson & Webster from the Palaeocene Fort Union Formation, Montana, U. S. A., but differs from the latter in having much thinner exine.

Botanical affinity: Polypodiaceae

Laevigatosporites prominens Takahashi

Pl. 5, fig. 17; pl. 6, figs. 3a-b.


Dimensions: Grain size 48.4–54 μ X 31–33.5 μ; exine chagrenate to smooth. 0.8 μ thick; width/length ratio 0.62–0.64.

Occurrence: Common, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 3 and 5.

Remarks: K. Takahashi (1964) described first this species from the Hakobuchi Group (Campanian-Maestrichtian), Hokkaido, Japan. This is an Upper Cretaceous species in Japan.

Botanical affinity: Polypodiaceae.

Laevigatosporites probatus Takahashi

Pl. 6, figs 1–2.


Dimensions: Grain size 50–55.5 μ X 37–39 μ; exine thin, less than 1 μ thick. chagrenate; width/length ratio 0.66–0.78.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

Remarks: The present specimens are identified with Laevigatosporites probatus Takahashi from the Hakobuchi Group (Campanian-Maestrichtian), Hokkaido, Japan. The species L. probatus is an Upper Cretaceous species in Japan.

Botanical affinity: Polypodiaceae.

Incertae Sedis

Genus Hidaspora Takahashi & Shimono n. gen.

Generic diagnosis: Relatively large trilete spores (?) with roughly reticulate sculpture consisting of wide zona and narrow, long muri which are as high as zona. Y-mark is not visible. Amb of central body is circular to oval. Grain size 140–190 μ overall, 80–130 μ excluding sculpture (zona and muri).

Remarks: The new genus Hidaspora is superficially similar to the genus Hymeno-
reticulisporites Döring, 1964, but differs from the latter in having no distinct Y-mark, much wider zona, and longer muri.

Type species: Hidaspora ishiharae Takahashi & Shimono n. gen. et sp.

Hidaspora ishiharae Takahashi & Shimono n. sp.

Pl. 4, figs. 6–10; pl. 5, figs. 1–2.

Description: Trilete spores (?) amb circular to oval. Exine 4–6 μ; zona hyaline, differentiated from inner wall, as high as muri (ca. 13–52 μ wide); muri 13–52 μ in height. Y-mark is not visible. Grain size 144–189 μ X 105–126 μ overall, 78–126 μ X 66–87 μ excluding sculpture (zona and muri).

Holotype: Pl. 4, figs. 6a–b; pl. 5, fig. 2; grain size 150 X 120 μ overall, 82 X 58 μ excluding sculpture (zona and muri); meshes polygonal. 8–15 μ in diameter; zona and muri 13–39 μ high; slide 61003–5; Miyadani-gawa Formation, north of Miyaji; sample no. A.

Occurrence: Common, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. A.

Remarks: The specimens are not complete in preservation. This new genus is monotypic.

Botanical affinity: Unknown.

Genus Duplosporis Pflug 1953.

Type species: Duplosporis stipator Pflug 1953.

Duplosporis sp.

Pl. 2, fig. 20a–b.

Description: Trilete spore (?) with well developed double Y-marks; amb triangular with convex or concave sides and more or less rounded corners. A Y-mark developed on each proximal and distal plane, reaching the equatorial corners; equatorial plane is a symmetry plane. Exine thin, smooth. Grain size 29 μ in equatorial diameter.

Occurrence: Very rare, Miyadani-gawa Formation, near the Kanbara pass; sample no. H.

Remarks: The authors can find no species comparable with the present specimen.

Botanical affinity: Unknown.

Anteturma Pollenites R. Potonie 1931.

Turma Aletes Ibrahim 1933.


Infraturma Psilonapiti Erdtman 1947.


Type species: Inaperturopollenites dubius (Potonie & Venitz 1934) Thomson & Pflug 1953.
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Inaperturopollenites pseudodubius Takahashi
Pl. 6, figs. 5–8.


Dimensions: Grain size 19–28 μ in diameter; exine thin, chagrenate or finely punctate; often split open in characteristic manner.

Occurrence: Abundant. Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture.

Remarks: This species appears in the Upper Cretaceous and Tertiary formations of Japan.

Botanical affinity: Taxodiaceae.

Genus Psophosphaera Naumova 1939 ex Ishchenko 1952.
Type species: Psophosphaera tenuis Naumova 1939 ex Bolchovitina 1953.

Psophosphaera gigantica Takahashi & Shimono n. sp.
Pl. 6, figs. 9–10.

Description: Inaperturate pollen grains. Outline circular to subcircular. Exine thin, probably smooth, often with crumpling folds. Grain size 114–144 μ X 78–120 μ in diameter.

Holotype: Pl. 6, fig. 11; grain size 144 X 120 μ; exine thin, probably smooth, with folds; slide 61003–5; Miyadani-gawa Formation, north of Miyaji, sample no. A.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. A.

Remarks: The present specimens are larger forms than Psophosphaera tenuis Naumova ex Bolchovitina (1953, p. 67, pl. 10, fig. 22) and P. aggereloides (Maljavkina) Chlonova (1960, p. 42–43, pl. 5, figs. 11–12).

Botanical affinity: Larix or Pseudotsuga.

Psophosphaera aggereloides (Maljavkina) Chlonova
Pl. 6, figs. 11–12.

1949 Bullulina aggereloides Maljavkina forma glabrescens Maljavkina, Trudy VNIGRI, no. 33, p. 133, pl. 49, fig. 7.


Dimensions: Grain size 41–58 μ X 30–51 μ in diameter; exine thin, laevigate, with crumpling folds.

Occurrence: Common, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 5.

Remarks: The present specimens belong undoubtedly to the Siberian species Psophosphaera aggereloides (Maljavkina) Chlonova from the Cenomanian to Turonian strata in the Chulym-kemi district and the Danian to lower Palaeogene strata in the Eniseisk district, western Siberia.
Botanical affinity: Larix or Pseudotsuga.

Turma Saccites ERDTMAN 1947.

Subturma Disaccites COOKSON 1947.


Type species: Pinuspollenites labdacus (POTONIÉ 1931) RAATZ 1937 ex POTONIÉ 1958.

*Pinuspollenites microaliformis* (Takahashi) Takahashi & Shimono n. comb.

Pl. 7, figs. 3-4, 7-9.


*Dimensions*: Total breadth of grain 48-65 \( \mu \); breadth of central body 31-42 \( \mu \); length of central body 31-41 \( \mu \); length of bladders 28-42 \( \mu \); breadth of bladders 21.5-25 \( \mu \); height of central body 28-32 \( \mu \); height of bladders 31-33 \( \mu \); breadth of bladders in lateral view 25-26 \( \mu \); cap thin, 1.2 \( \mu \) thick.

*Occurrence*: Common, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 2, 3, 5, and H.

*Remarks*: The present specimens are identified with Pinuspollenites (al. Pityosporites) microaliformis (Takahashi) from the Campanian lower formation of the Hakobuchi Group, Hokkaido, Japan.

Botanical affinity: Pinus.

*Pinuspollenites* sp. a

Pl. 7, fig. 11.

*Description*: Bisaccate pollen grain; central body subcircular in equatorial view. Sacci slightly shorter than central body, moderately reticulate, distally slightly pendant. Proximal cap not scabrate, thin. Exine of distal furrow smooth (?).

*Grain size*: Total breadth of grain 138 \( \mu \); breadth of central body 93 \( \mu \); height of central body 75 \( \mu \); height of bladders 81 \( \mu \); breadth of bladders in lateral view 57 \( \mu \).

*Occurrence*: Very rare, Miyadani-gawa Formation, near the Kanbara pass, Hida district, Gifu Prefecture; sample no. H.

*Remarks*: Only one specimen was found. This is a very large form. The authors can not identify it specifically.

Botanical affinity: Pinus.

*Pinuspollenites* sp. b

Pl. 7, fig. 10.


*Grain size*: Total breadth of grain 53 \( \mu \); breadth of central body 45 \( \mu \); length of central body 40 \( \mu \); length of bladders 40 \( \mu \); breadth of bladders 28 \( \mu \).
Maestrichtian Microflora of the Miyadani-gawa Formation in the Hida District, Central Japan

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. A.

Remarks: It is doubtful that a bisaccate pollen grain showing such character as the smooth exine of the central body and sacci belongs to Pinus.


Genus Piceaepollenites Potonie 1931.

Type species: Piceaepollenites alatus Potonie 1931.

Piceaepollenites saccellus Takahashi
Pl. 7, figs. 5–6.


Dimensions: Total breadth of grain 45.3–67 µ; breadth of central body 38–48 µ; length of central body 46.2 µ (fig. 6); length of bladders 45.2 µ (fig. 6); breadth of bladders 22 µ (fig. 6); height of central body 36 µ (fig. 5); height of bladders 46 µ (fig. 5); breadth of bladders in lateral view 33 µ; cap 2.4 µ thick (fig. 5).

Occurrence: Common, Miyadami-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 2, 5, and H.

Remarks: The present specimens coincide with Piceaepollenites saccellus Takahashi from the Campanian lower formation of the Hakobuchi Group, Hokkaido, Japan, in its morphological characteristics.

Botanical affinity: Picea.


Genus Podocarpidites Cookson 1947 ex Couper 1953.

Type species: Podocarpidites ellipticus Cookson 1947 ex Couper 1953.

Podocarpidites sp.
Pl. 7, fig. 12.

Description: Bisaccate pollen grain; central body elliptical in equatorial outline, surrounded by sacci. Sacci much larger than central body, moderately reticulate, distally slightly pendant. Proximal cap scabrate (?), thin. Distal furrow parallel sided. Exine of distal furrow smooth.

Size: Total breadth of grain 65 µ; breadth of central body 12 µ; length of central body 21.5 µ; length of bladders 29 µ; breadth of bladders 35 µ.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Remarks: Only one poorly preserved specimen was found.

Botanical affinity: Podocarpus.

Genus Phyllocladidites Cookson 1947 ex Couper 1953.
Type species: *Phyllocladidites mawsonii* Cookson 1947 ex Couper 1953.

*Phyllocladidites mawsonii* Cookson ex Couper

Pl. 6, figs. 13-15.


**Dimensions:** Total breadth of grain 27.5-39 µ; breadth of central body 24-39 µ; length of central body 28.5-30 µ; length of bladders 17.5-27.5 µ; breadth of bladders 8.5-11.5 µ; exine 1.5 µ thick (fig. 15).

**Occurrence:** Few, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 2, 5, and H.

**Remarks:** The present specimens undoubtedly belong to *Phyllocladidites mawsonii* Cookson ex Couper. This species ranges from Lower Cretaceous to Lower Oligocene. In Japan, this seems to appear only in upper Upper Cretaceous.

**Botanical affinity:** Phyllocladus.

Genus *Dacrydiumites* Cookson ex Harris 1965.

Type species: *Dacrydiumites florinii* Cookson & Pike 1953.

*Dacrydiumites punctosaccatus* Takahashi & Shimono n. sp.

Pl. 7, figs. 1-2.

**Description:** Bisaccate pollen grains. Body of grain spherical, circular in polar view. Exine thin, 1 µ thick (fig. 2), punctate. Bladders projecting from the body narrowly and along the sulcus, with no reticulate sculpture.

**Size range:** Total breadth of grain 47-49 µ; breadth of central body 47-49 µ; length of central body 42.5-45 µ; length of bladders 22-31 µ; breadth of bladders 5.7-13 µ.

**Holotype:** Pl. 7, fig. 2; grain size: total breadth of grain 47 µ; breadth of central body 47 µ; length of central body 45 µ; length of bladders 31 µ; breadth of bladders 5.7 µ; exine 1 µ thick, punctate; slide GN 2806; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

**Occurrence:** Few, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 6 and H.

**Comparison:** The present specimens are apparently different from *Dacrydiumites florinii* Cookson & Pike (1953, p. 479, pl. 3, figs. 20-35) and *D. ellipticus* Harris (1965, p. 87, pl. 26, figs. 20-21) in some morphological characteristics.

**Botanical affinity:** ? Dacrydium.


Subturma Polylocates Erdtman 1952.

Type species: *Equisetosporites chinleana* DAUGHERTY 1941.

*Equisetosporites ellipsoideus* (TAKAHASHI) TAKAHASHI n. comb.

Pl. 5, figs. 3–4.


*Dimensions*: Grain size 35–37.4 μ X 18–18.5 μ; ridges less than 1 μ wide.

*Occurrence*: Rare, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 2 and H.

*Remarks*: The present specimens are the same species as *Cicatricososporites? ellipsoideus* TAKAHASHI from the Campanian lower formation of the Hakobuchi Group, Hokkaido, Japan.

*Botanical affinity*: Ephedraceae.

*Equisetosporites sp.*

Pl. 5, fig. 5.

*Description*: Acolpate pollen grain; spindle shaped, breadth equal at both ends; exine two-layered, ektexine thick, endexine thin; ridges unbranched, straight, about 3 μ wide in the middle, narrowing at the ends, running obliquely in longitudinal direction, about 10 in number; furrows very narrow, unbranched. Ridges criss-crossing, coalescing at the longitudinal ends. Grain size 39 X 14 μ.

*Occurrence*: Very rare, Miyadani-gawa Formation. north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

*Comparison*: This specimen is similar to *Equisetosporites molis* SRIVASTAVA (1968, p. 217–218, pl. 1, fig. 13) from the Maestrichtian Edmonton Formation, Alberta, Canada, but the former is much smaller than the latter.

*Botanical affinity*: Ephedraceae.

Subturma Monocolpates IVERSEN & TROELS-SMITH 1950.

Genus *Cycadopites* WODEHOUSE 1933 *ex* WILSON & WEBSTER 1946.

Type species: *Cycadopites follicularis* WILSON & WEBSTER 1946.

*Cycadopites hidaensis* TAKAHASHI n. sp.

Pl. 8, figs. 1–4.

*Description*: Monosulcate pollen grains. Quadrilateral or pentagonal with rounded corners in outline; bilaterally asymmetrical. 22.5–32.5 μ X 15.2–20.5 μ. Exine thin, chagrenate to smooth. Monosulcate furrow longitudinal, somewhat curved, reaching from end to end, always gaping open at its end notwithstanding the tight closure in the middle.

*Holotype*: Pl. 8, fig. 3; grain size 32.5 X 20.5 μ; exine thin, smooth; slide GN 2730; Miyadani-gawa Formation, north of Miyaji; sample no. 3.

*Occurrence*: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 3.
Comparison: The present specimens are superficially similar to *Cycadopites microfollicularis* Krutzsch (1970, S. 94, Taf. 18, Fig. 9–12) from the Pliocene coal seam in the border district between W-Germany and Holland, but differ from the latter in pollen form. *Cycadopites cf. minimus* (Cookson) Krutzsch (1970, S. 95, Taf. 18, Fig. 13–14) is smaller than the present specimens.

Botanical affinity: Cycadaceae.


*Monocolpopollenites kyushuensis* Takahashi


Dimensions: Grain size 23.5–25 μ X 12–13 μ; exine thin, slightly chagrenate.

Occurrence: Rare, Miyadani-gawa Formation, north of Miyagi, Hida district, Gifu Prefecture; sample no. 2.

Remarks: Both figures 5 and 6 are referable to *Monocolpopollenites kyushuensis* Takahashi ranging from Upper Cretaceous to Tertiary of Japan.

Botanical affinity: Palmae.

*Monocolpopollenites sp.*

Pl. 8, fig. 7.

Description: Monocolpate pollen. Elliptical in outline; bilaterally symmetrical. 35.8 X 15.5 μ. Exine thin, chagrenate. Colpus in the plane of symmetry, i.e. located on the line bisecting the proximal face.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyagi, Hida district, Gifu Prefecture; sample no. 2.

Comparison: The present specimen is superficially similar to *Monocolpopollenites tranquillus* (Pot.) Thomson & Pflug from Eocene to Oligocene strata of Germany, but the former is different from the latter in having thinner exine and symmetric colpus.

Botanical affinity: Palmae.

Subturma Triptyches Naumova 1939.

*Cupuliferoidaepollenites cf. weylandii* (Takahashi) Takahashi

Pl. 8, fig. 19.


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Dimensions: Grain size 17.3 X 12.5 μ; exine thin, laevigate; breadth/length ratio ca. 0.72.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

Remarks: This specimen is somewhat smaller and broader than *Cupuliferoidaepollenites* (al. *Tricolpopollenites*) weylandii (Takahashi) Takahashi described by K. Takahashi (1961), but this is probably *C. weylandii* (Takahashi) Takahashi

Botanical affinity: Cupuliferae.

*Tricolpopollenites facetus* (Takahashi) Takahashi

Pl. 8, figs. 21–22.


1979 *Cupuliferoidaepollenites facetus* (Takahashi) Takahashi, Palaeontographica, B, 170, p. 37, pl. 9, fig. 6.

Dimensions: Grain size 16.5–23 μ X 15–18.5 μ; exine thin, chagrenate; breadth/length ratio 0.8–0.9.

Occurrence: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

Remarks: These specimens belong undoubtedly to *Cupuliferoidaepollenites* (al. *Tricolpopollenites*) facetus (Takahashi) Takahashi from the Palaeogene formation of west Japan.

Botanical affinity: Unknown.


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

*Quercoidites umiensis* (Takahashi) Takahashi

Pl. 8, fig. 20.


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

Dimensions: Grain size 24 X 14.4 μ; exine intrabaculate or intrarugulate, 0.9–1 μ thick; breadth/length ratio 0.6.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

Remarks: The present specimen belongs to *Cupuliferoidaepollenites* (al. *Tricolpopollenites*) umiensis (Takahashi) Takahashi from the Upper Cretaceous Hakobuchi Group and Tertiary formations of Japan and from the Miocene of Korea.

Botanical affinity: Cupuliferae.
Genus *Tricolpopollenites* Pflug & Thomson 1953.

Type species: *Tricolpopollenites parmulans* (Potonie 1934) Thomson & Pflug 1953.

*Tricolpopollenites meinohamensis* Takahashi subsp. rotundus Takahashi

Pl. 8, figs. 23–24


*Dimensions*: Grain size 22–28 μ X 18–25 μ; exine thin, intrapunctate; breadth/length ratio 0.75–0.96.

*Occurrence*: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 4.

*Remarks*: Hitherto, this subspecies appeared in the Upper Cretaceous Hakobuchi Group and Palaeogene to Miocene formations of Hokkaido and west Japan.

*Botanical affinity*: Unknown.

*Tricolpopollenites cf. inamoenus* Takahashi

Pl. 8, fig. 25


*Dimensions*: Grain size 26.5 X 15 μ; exine thin, with small verrucae, about 1 μ high; breadth/length ratio ca. 0.57.

*Occurrence*: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

*Remarks*: The present specimen is closely similar to *Tricolpopollenites inamoenus* Takahashi from the Palaeogene formations of west Japan.

*Botanical affinity*: Unknown (? Cupuliferae).

Genus *Striatopollis* Krutzsch 1959.

Type species: *Striatopollis sarstedtensis* Krutzsch 1959.

*Striatopollis cf. striatellus* (Takahashi) Takahashi

Pl. 8, figs. 26–27; pl. 9, figs. 1–2.


1979 *Striatopollis striatellus* (Takahashi) Takahashi, Palaeontographica, B, 170, pl. 9, figs. 25–29.

*Dimensions*: Grain size 19–24 μ X 12.5–17 μ; exine thin, finely striate; breadth/length ratio 0.65–0.7.

*Occurrence*: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

*Remarks*: The present specimens are smaller than *Striatopollis* (al. *Tricolpopollenites*) *striatellus* (Takahashi) Takahashi from the Palaeogene and Miocene of west Japan.

*Botanical affinity*: Unknown.

Type species: *Tricolpites reticulatus* **COOKSON** 1947 ex **COUPER** 1953.

*Tricolpites reticosus* **Takahashi**


**Dimensions:** Grain size 20–30 μ X 17–22.5 μ; exine reticulate; lumen of reticulum 1–3 μ in diameter; muri 1–1.5 μ high or less.

**Occurrence:** Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

**Remarks:** The specimens coincide with *Tricolpites reticosus* **Takahashi** in size, form, and sculpture of exine.

**Botanical affinity:** Salix or Platanus.

*Tricolpites minutiretiformis* (**Takahashi**) **Takahashi** n. comb.


**Dimensions:** Grain size 17.5 X 14.5 μ (fig. 6), 19 μ (fig. 7); exine very finely reticulate, intrabaculate, 0.5–1 μ thick.

**Occurrence:** Few, Miyadani-gawa Formation, north of Miyaji and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 6 and H.

**Remarks:** Hitherto, *Tricolpites* (al. *Tricolpopollenites*) *minutiretiformis* (**Takahashi**) was found in the Campanian and Maestrichtian Hakobuchi Group of Hokkaido and in the Lower Senonian Sawayama and Tamagawa Formations of the Kuji Group in north-eastern Honshu, Japan.

**Botanical affinity:** Salix or Platanus.


Type species: *Foveotricolpites sphaeroides* **PIERCE** 1961.  

*Foveotricolpites* sp.

*Foveotricolpites* sp.  

**Description:** Tricolpate pollen grain. Outline broad-elliptical in equatorial view. Colpi narrow, running from pole to pole. Exine foveolate and fossulate; muri 1 μ high. Grain size 45 X 38.7 μ. Breadth/length ratio 0.86.

**Occurrence:** Very rare. Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 4.

**Remarks:** Only one specimen was found. This specimen is much larger than *Foveotricolpites sphaeroides* **PIERCE** (1961, p. 49, pl. 3, fig. 95) from lower Upper Cretaceous
sediments, Minnesota, U. S. A. and *Foveotricolpites genuinus* Guzmán (1967, p. 28, pl. 8, figs. 1–16) from the pollen zones III-IV of Tibú area, Colombia, South America.

*Botanical affinity*: Unknown.

Subturma Pnychotriporines *Naumova* 1939.

Genus *Tricolporopollenites* *Pflug & Thomson* 1953.


*Tricolporopollenites punctulatus* *Takahashi* n. sp.

Pl. 9, figs. 9–11, 16–17.

*Description*: Tricolporate pollen grains. Amb circular in equatorial and polar views. Three colpi relatively narrow, converging on the poles. Equatorial pores circular or somewhat extended equatorially. Exine thin, chagrenate to punctate. Grain size 23–31 μ X 22.7–31 μ. Breadth/length ratio 0.95–1.08.

*Holotype*: Pl. 9, fig. 10; grain size 23 X 25 μ; exine chagrenate or punctate; breadth/length ratio about 1.08; slide GN 2703; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

*Occurrence*: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

*Comparison*: The present specimens are superficially similar to *Tricolporopollenites incertus* *Takahashi* and *Tricolporopollenites microporifer* *Takahashi* from the Palaeogene formations of west Japan, but differ from *T. incertus* in having circular pores and from *T. microporifer* in having much larger pores.

*Botanical affinity*: Unknown.

*Tricolporopollenites sp. a*

Pl. 9, fig. 12.

*Description*: Tricolporate pollen grain. Prolate in equatorial view. Three colpi relatively narrow, almost reaching the poles, with meridionally elongate pores. Exine thin, chagrenate. Grain size 18 X 12.5 μ. Breadth/length ratio 0.69.

*Occurrence*: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

*Comparison*: Only one specimen was found. This is similar to *Tricolporopollenites incertus* *Takahashi* (1961, p. 322–323, pl. 24, figs. 44–49) from the Palaeogene sediments of Japan and from the Miocene Groups in the Yeoungill district, Korea, but the former is smaller than the latter.

*Botanical affinity*: Unknown.

*Tricolporopollenites sp. b*

Pl. 9, fig. 13.

*Description*: Tricolporate pollen grain. Amb circular in polar view. Three colpi somewhat wide, almost reaching the poles, with somewhat equatorially elongated pores. Exine thin, 0.9 μ thick, intrabaculate. Grain size 28.5 μ in equatorial diameter.
**Occurrence:** Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

**Comparison:** This specimen resembles *Tricolporopollenites consularis* TAKAHASHI subsp. *globularis* TAKAHASHI (1979, p. 41, pl. 10, figs. 28–30; pl. 11, figs. 1, 3–10), but differs from the latter in having equatorially elongated pores.

**Botanical affinity:** Unknown.

*Tricolporopollenites* sp. c

*Pl. 9, fig. 14*

**Description:** Tricolporate pollen grain. Outline prolate in equatorial view. Three colpi extending from pole to pole, each colpus with a large round pore. Exine punctate, 0.8 μ thick. Grain size 31 X 22.5 μ. Breadth/length ratio ca. 0.73.

**Occurrence:** Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

**Comparison:** Only a single grain was found and it does not compare with any of the other fossil grains.

**Botanical affinity:** Unknown.

*Tricolporopollenites* sp. d

*Pl. 9, fig. 15*

**Description:** Tricolporate pollen grain. Outline prolate in equatorial view. Three colpi narrow, almost reaching the poles. The pores elongate somewhat meridionally. Exine thin, 1 μ thick, intrarugulate to intrabaculate. Grain size 22 X 15 μ. Breadth/length ratio 0.68.

**Occurrence:** Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 5.

**Remarks:** Only one specimen was found. This differs from *Tricolporopollenites satzveyensis* PFLUG (THOMSON & PFLUG, 1953, S. 103, Taf. 13, Fig. 10–13) in having smaller size.

**Botanical affinity:** Unknown.


*Retitricolporites misellus* TAKAHASHI

*Pl. 9, fig. 8*

1979 *Retitricolporites misellus* TAKAHASHI, Palaeontographica, B, 170, p. 48, pl. 15, figs. 12–17.

**Dimensions:** Grain size 18 X 18 μ; exine very finely reticulate; lumen of reticulum less than 1 μ in diameter; muri 0.7 μ high; pores small and round; breadth/length ratio 1.0.

**Occurrence:** Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

**Remarks:** Only one specimen was found. The authors can not distinguish this
specimen from *Retitrilocolporites misellus* Takahashi from the Miocene Changgi and Yonil Groups in Korea.

*Botanical affinity*: Caprifoliaceae.

Genus *Foveotricolporites* Pierce 1961.

Type species: *Foveotricolporites rhombohedralis* Pierce 1961.

*Foveotricolporites* sp.

Pl. 9, fig. 18.

*Description*: Tricolporate pollen grain. Outline subcircular in approximately polar view. Colpus with rounded (?) pore relatively narrow, extending almost from pole to pole. Exine thin, foveolate; lumina less than 1 μm in diameter. Grain size 41.3 μm in equatorial diameter.

*Occurrence*: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

*Remarks*: Only one specimen was found. This is similar to *Foveotricolporites foveolatus* Takahashi from the Eocene Concepción Formation, Chile, but the former is much larger in size.

*Botanical affinity*: Unknown.

Genus *Callistopollenites* Srivastava 1969.


*Callistopollenites radiatostratiatus* (Mchedlishvili) Srivastava

Pl. 9, figs. 20.

1961 *Tricolporites radiatostratiatus* Mchedlishvili, Trudy VNIGRI, no. 177, p. 249–250, pl. 81, figs. 1a–g, 2a–b.

1965 *Tricolporo-pollenites radiatostratiatus* (Mchedlishvili) Bratzeva, Trudy Geol. Inst., Acad. Sci. USSR, 129, p. 26–27, pl. 10, figs. 4–8; pl. 11, figs. 1–7; pl. 12, figs. 1–6 (p. p.).


*Dimensions*: Tricolporate pollen grain; grain size 38 X 33.5 μm in equatorial diameter; exine striae, striae radially dispersed from three centers on one hemisphere; muri 1.7 μm high.

*Occurrence*: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

*Remarks*: This species has been reported from the Maestrichtian formations of Canada and the Far East (USSR).

*Botanical affinity*: Uncertain.

*Callistopollenites* cf. *tumidoporpus* Srivastava

Pl. 9, figs. 19a–b.


**Dimensions:** Tricolporate pollen grain; grain size 34 μ in equatorial diameter; pores oncuate, equatorial; exine striate, 1.2 μ thick; striae radially dispersed from a few centers.

**Occurrence:** Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu prefecture; sample no. 5.

**Remarks:** The present specimen is closely similar to *Callistopollenites tumidoporus* Srivastava, in spite of its bad preservation and smaller size. Hitherto, this species was found from the Maestrichtian Edmonton Formation of Canada and a few forms of *Tricolporopollenites radiatostriatus*, which are identical to *Callistopollenites tumidoporus*, were known from the Maestrichtian deposits of the Far East (USSR).

**Botanical affinity:** Unknown.

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**Genus Pachydermipollenites Takahashi n. gen.**

**Description:** Tricolporate pollen grain. Figura spheroidal to subprolate in equatorial view. Three colpi long, almost reaching poles; two colpi narrow and one colpus wide, strong. Pores equatorial, large, circular, inconspicuous. Exine very thick (3–5.5 μ thick); sculpture of exine finely striate. Surface of pollen grain relatively smooth or uneven.

**Remarks:** Genus *Pachydermipollenites* is hereby proposed to include tricolporate pollen grain with one wide and two narrow colpi almost reaching the poles, large pores, and thick exine with finely striate sculpture.

**Type species:** *Pachydermipollenites miyajiensis* Takahashi n. sp.

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**Pachydermipollenites miyajiensis** Takahashi n. sp.

**Pl.** 8, figs. 8–17.

**Description:** Tricolporate pollen grain. Figura spheroidal to subprolate in equatorial view. Three colpi long, meridional, almost reaching the poles; one main colpus wide, strong, 2.5–3.5 μ wide; two colpi narrow. Pores equatorial, large, circular, inconspicuous, 3–4 μ in diameter. Exine very thick, 3–5.5 μ thick, finely striate. Surface of grain relatively smooth or uneven. Grain size 32–39 μ X 24–40 μ. Breadth/length ratio 0.74–1.15.

**Holotype:** Pl. 8, figs. 8a–b; grain size 33 X 38 μ; exine 3.3 μ thick, finely striate; one colpus wider and two colpi narrower; pores inconspicuous, large circular, about 4 μ in diameter; slide GN 2806; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

**Occurrence:** Abundant, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 5 and 6.

**Remarks:** *Pachydermipollenites miyajiensis* Takahashi n. sp. can be distinguished by a main colpus and two narrow colpi, finely striate thick exine and inconspicuous
Botanical affinity: Unknown.


Synonymy:
Type species: Aquilapollenites quadrilobus Rouse 1957.

Diagnosis: Heteropolar or isopolar and triprojectate pollen garins. Body cylindrical or ellipsoidal in shape. Polar projections present on both apocolpia, in case of heteropolar pollen the length from the center of equatorial axis to the tip of the reduced polar projection is half or more than half the similar length of the other polar projection (Srivastava 1968, p. 668; Srivastava and Rouse 1970, p. 1592). Three or sometimes more than three equatorial projections located equatorially, oriented and flattened meridionally to form wing-like structures; body/projection ratio (STANLEY 1970, text-fig. 9) 2.0 to 3.3 (including exception of 1.7 to 2.0). Three colpi running meridionally through the projections, sometimes gaping; exine-fissures moderate in length extending to the base of the projections. Endexinous thickening long or short, usually well-developed. Ornamentation variable.

Remarks: S. K. Srivastava (1968) and S. K. Srivastava & G. E. Rouse (1970) proposed to exclude the following pollen from the genus Aquilapollenites: (1) pollen without polar projections but possessing the equatorial projections. (2) pollen with heteropolar projections where the length from the center of the equatorial diameter to the tip of the reduced polar projection is less than half of the similar length of the other polar projection. (3) porate pollen possessing polar and (or) equatorial
projections. In the case (2), SRIVASTAVA (1968) proposed to transfer such pollen to the genus Mancicorpus Mchedlishvili emend. SRIVASTAVA, but one of the present authors, K. TAKAHASHI, proposes that such pollen belongs to the genus Hemicorpus Krutzsch emend.

S. K. SRIVASTAVA and G. E. ROUSE (1970) stated that the essential diagnostic characteristics of Aquilapollenites and Pentapollenites are the same and thus the two generic names are synonyms. However, the authors believe that the genus Pentapollenites Krutzsch is a valid and distinct genus as mentioned below (see M. KEDVES and E. A. STANLEY, 1976).

List of previously described species of Aquilapollenites.

A. accipiteris SRIVASTAVA, 1969, p. 133, pl. 1, figs. 3–8; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = [2.13].


A. amplus STANLEY, 1961, p. 342, pl. 1, figs. 1–6; pl. 2, figs. 1–4; pl. 3, figs. 1–5; Hell Creek Formation (Maestrichtian), S. Dakota, U. S. A.; a/b = 2.62–3.3.

A. ascriptius SRIVASTAVA, 1969, p. 136, pl. 2, figs. 12–15; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = [2.0].

A. asper Mchedlishvili, 1961, p. 213, pl. 68, figs. 2a–c; Maestrichtian-Danian, western Siberian lowland, USSR; a/b = 2.81.

A. attenuatus Funkhouser, 1961, p. 194, pl. 2, figs. 1a–c; Lance Formation (Maestrichtian), Wyoming, U. S. A.; a/b = 2.27.

A. aucellatus SRIVASTAVA, 1969, p. 136, pl. 3, figs. 16–17; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 2.27.

A. augustus SRIVASTAVA, 1969, p. 137, pl. 3, figs. 18–21; pl. 4, figs. 22–25; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 2.52–2.63.

A. bartatus SRIVASTAVA, 1969, p. 137, pl. 4, fig. 26; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.75 (exception).

A. bullatus Bolchovitina, 1959, p. 128, pl. 8, figs. 115a–b; Upper Cretaceous, E. Siberia, USSR.

A. cruciformis Mchedlishvili, 1961, p. 211, pl. 67, figs. 5a–c; Maestrichtian-Danian, western Siberian lowland, USSR; a/b = 2.28.

A. debilis SRIVASTAVA, 1968, p. 676, pl. 2, figs. 5–7; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 2.1–2.35.

A. drumhellerensis SRIVASTAVA, 1969, p. 138, pl. 4, fig. 28; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 2.14.

A. formosus SRIVASTAVA & ROUSE, 1970, pp. 1599–1600, pl. 2, figs. 18–19; Oldman Formation, Upper Cretaceous (? Santonian), Alberta, Canada; a/b = 2.53.

A. granulatus Mchedlishvili, 1961, p. 212, pl. 68, figs. 1a–c; lower Maestrichtian, western Siberian lowland, USSR; a/b = 2.47.

A. hakobuchiensis SATO, 1961, p. 91, pl. 1, figs. 13–14; Hakobuchi Group, Hokkaido, Japan.
A. hetensis (Bondarenko, 1966) Stanley, 1970, p. 84, pl. 2, fig. 6; Danian (?), N. Siberia, USSR.
A. hispidus Srivastava, 1969, p. 139, pl. 5, figs. 31–32; Edmonton Formation (Maastrichtian), Alberta, Canada; a/b = 3.05.
A. insignis Mchedlishvili, 1961, p. 215, pl. 64, figs. 1a–c, 2–3; pl. 55, fig. 7; pl. 58, fig. 1; Upper (?) Maastrichtian, western Siberian lowland, USSR; a/b = 2.35.
A. latilobus Mchedlishvili, 1961, p. 216, pl. 69, figs. 4a–c; Senonian, western Siberian lowland, USSR; a/b = 2.14.
A. matsumotoi Takahashi, 1964, p. 252, pl. 38, figs. 1, 3; lower formation of the Hakobuchi Group (Campanian), Hokkaido, Japan; a/b = 2.47.
A. parvus Takahashi, 1970, p. 271, pl. 30, figs. 1–2; Upper Cretaceous (Maastrichtian ?), E. Hokkaido, Japan; a/b = 2.26.
A. petasus Srivastava, 1969, p. 140, pl. 6, figs. 37–39; Edmonton Formation (Maastrichtian), Alberta, Canada.
A. procerus Samoilovich, 1965, p. 126, text-figs. 4–6; pl. 2, figs. 1, 3; Senonian-Danian, E. Siberia, USSR; a/b = 2.81.
A. proteus (Simpson, 1961) Srivastava, 1975, p. 440, pl. 12, fig. 5; Maastrichtian, Mull, Scotland; a/b = 2.0–2.62.
A. pudicus Srivastava, 1969, p. 141, pl. 6, fig. 40; Edmonton Formation (Maastrichtian), Alberta, Canada; a/b = 2.0–3.09.
A. punctatus Krutzsch, 1970, p. 112, pl. 3, figs. 7–10; Lower Ob (Palaeocene), western Siberia, USSR; a/b = 2.06.
A. quadricrjetaus Chlonova, 1961, p. 84, pl. 14, figs. 108, 108a–b; Danian, western Siberian lowland, USSR; a/b = 2.82.
A. quadrilobus Rouse, 1957, p. 371, pl. 2, fig. 9; Oldman Formation (Santonian), W. Canada; a/b = 2.2.
A. quadrinus Takahashi, 1964, p. 253, pl. 41, figs. 31a–c; upper formation of the Hakobuchi Group (Maastrichtian), Hokkaido, Japan; a/b = 2.86.
A. regalis Srivastava, 1969, p. 142, pl. 6, figs. 42–43; Edmonton Formation (Maastrichtian), Alberta, Canada.
A. rigidus Tschudy & Leopold, 1970, p. 152, pl. 1, fig. 1; pl. 4, figs. 1–3; middle and lower Campanian, Montana, U. S. A.; a/b = 3.1.
A. spinulosus Funkhouser, 1961, p. 194, pl. 1, figs. 4–6; Fort Union Formation (Palaeocene), Wyoming, U. S. A.; a/b = 2.18.
A. stelchi Srivastava, 1968, p. 683, pl. 5, figs. 7–9; Edmonton Formation (Maastrichtian), Alberta, Canada; a/b = 2.83.
A. stellatus Srivastava, 1969, p. 986, pl. 3, figs. 45–46; Edmonton Formation (Maastrichtian), Alberta, Canada.
A. subtilis Mchedlishvili, 1961, p. 214, pl. 68, figs. 3–4; Maastrichtian-Danian (?), N. W.

A. *unicus* (CHLONOGA, 1957) CHLONOGA, 1961, p. 44, pl. 1, figs. 1–3; Upper Cretaceous, W. Siberia, USSR; a/b = 2.45.

A. *wilfordi* MULLER, 1968, p. 16, pl. 4, fig. 6; Senonian-Palaeocene, Malasia; a/b = 2.17.

**Aquilapollenites kasaharae** TAKAHASHI & SHIMO NO n. sp.

Pl. 12, figs. 1–7.

*Description*: Pollen grains with three equatorially situated apical projections and with one projection on each apocolpium; para-isopolar; one polar projection well-developed, broadly rounded; the other polar projection narrower than the former.

Equatorial projections well-developed, meridional apices rounded or sometimes more or less truncate, much narrower than the polar projections.

Tricolpate, colpi across equatorial projections long, extending up to polar projections.

Exine tectate, meridional areas thickened at the contact regions; sexine very finely reticulate with scattered spines; spinule bases broad, apices acute, 2.4 μ high; on polar projections; spinules coarser, closely packed and directed polewards; on equatorial projections; spinules arranged on meridional marginal areas of projections and between the equatorial projections and recurved toward polar axis, more numerous on equatorial apical regions.

*Size range*: Length of the polar axis 65–87.5 μ; length of the developed polar projection 20–30 μ; length of the reduced polar projection 13–22 μ; length of the equatorial projections 17–35 μ; breadth of the developed polar projection 30–40 μ; breadth of the reduced polar projection 22–30 μ; breadth of the equatorial projections 22–24 μ; a/b = 2.2–3.23.

*Holotype*: Pl. 12, fig. 1; length of the polar axis 71 μ; length of the equatorial projections 30 μ; breadth of the developed polar projection 40 μ; breadth of the reduced polar projection 30 μ; breadth of the equatorial projections 19.3 μ; a/b = 3.23; slide GN 2808; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

*Occurrence*: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 6 and A.

*Comparison*: The present specimens are similar to *Aquilapollenites augustus* Srivastava from the Maestrichtian Edmonton Formation, Alberta, Canada, but differ from the latter in having larger size and larger spines.

*Botanical affinity*: Unknown.

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**Aquilapollenites doliiformis** TAKAHASHI & SHIMO NO n. sp.

Pl. 12, figs. 8a–b; pl. 13, fig. 1.

*Description*: Pollen grains with three equatorially situated apical projections and with one projection each on the proximal and distal polar regions; subcircular, polar projections slightly angular with a barrel-form, well-developed, equatorial projec-
tions meridional, long apices (?), almost of equal breadth throughout the length of equatorial projections (?).

Exine tectate, echinate, thickens meridionally at the contact of polar and equatorial projections; ornamentation very finely infrareticulate; spinules scattered on the polar and equatorial projections, acuminate, falcate, 2 μ high; on polar projections: spinules directed polewards; on equatorial projections, recurved toward polar axis.

Size range: Length of the polar axis 55–60 μ; length of the proximal and distal polar projection approximately equal ca. 15–22 μ; length of the equatorial projections more than 30 μ; breadth of the polar projections 30–36.5 μ; breadth of the equatorial projections 16–23 μ; a/b = 2.52.

Holotype: Pl. 12, figs. 8a–b, Pl. 13, fig. 1; grain size: length of the polar axis 58 μ; length of the proximal and distal polar projection ca. 22 μ; length of the equatorial projections more than 30 μ; breadth of the polar projections 36.5 μ; breadth of the equatorial projections 23 μ; slide GN 2808; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

Occurrence: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Remarks: No published species is comparable with this form. The barrel shape of the central body and the great length of the three equatorial projections distinguish this from all other species.

Botanical affinity: Unknown.

*Aquilapollenites proprius* Takahashi & Shimono n. sp.

Pl. 13, figs. 9a–b.

Description: Pollen grain with three equatorially situated apical projections and with one projection each on the proximal and distal polar regions; subisopolar, polar projections rounded, relatively long, well-developed; the proximal polar projection broader than the distal polar projection; equatorial projections meridional, long, broader base at the contact with polar projection, apices rounded.

Tricolpate, colpi meridional, across the apices of equatorial projections, extending full length of equatorial projections on either side; exine tectate, echinate; endexinous thickenings long, well-developed at and near the base of equatorial projections; ornamentation very finely infrareticulate; spinules acuminate, scatteringly distributed at polar projections, somewhat densely distributed at the apices of equatorial projections, sparsely distributed on equatorial regions of central body and equatorial projections; length of spinules 3–4.2 μ.

Size range: Length of the polar axis 60–65 μ; length of the broader polar projection 13–15 μ; length of the narrower polar projection 15–20 μ; length of the equatorial projections 26–37 μ; breadth of the broader polar projection 20–21.5 μ; breadth of the equatorial projections 15–25 μ; a/b = 2.52.

Holotype: Pl. 13, figs. 9a–b; grain size: length of the polar axis 63 μ; length of the broader polar projection 15 μ; length of the narrower polar projection 20 μ; length of the equatorial projections 37 μ; breadth of the broader polar projection 21.5 μ;
breadth of the equatorial projections 25 μ; slide GN 2809; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

Occurrence: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Comparison: The central body of this species is more slender than that of *A. kasaharae*, which possesses smaller spinules.

Botanical affinity: Unknown.

*Aquilapollenites quadrilobus* Rouse

Pl. 14, figs. 1a–b, 2.


Dimensions: Length of the polar axis 46.5–47 μ; length of the developed polar projection 18–20 μ; length of the reduced polar projection 8–10 μ; length of equatorial projections 15–19 μ; breadth of the developed polar projection 18–22 μ; breadth of the reduced polar projection 15–17 μ; breadth of the equatorial projections 17–20 μ; a/b = 2.25–2.76.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

Remarks: The present specimens are identified with *A. quadrilobus* which was originally described by G. E. Rouse and selected as a neotype by Srivastava and Rouse (1970).

Botanical affinity: Unknown.

*Aquilapollenites aemulus* TAKAHASHI & SHIMONO n. sp.

Pl. 13, figs. 2–6.

Description: Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium. Body of grain oval to broad-ellipsoidal in equatorial view.

Isopolar; polar projections well-developed, rounded apices; equatorial projections meridional, relatively long, rounded apices; tricolpate, colpi extending entire length of equatorial projections and for only a very short distance onto body; exine two-layered; axillary endexinous costae as much as 3 μ thick in thickest part, extending half the distance to free ends of equatorial projections, occupying axillae, and extending only a short distance onto body of grain; ektexine 1.5 μ thick or less on polar projections, very thin at colpal margins at free ends of equatorial projections, very finely infrareticulate; conical spinules ± 1 μ long, ornamenting apical regions of equatorial and polar projections and equatorial regions of equatorial projections and body of grain; on equatorial projections spinules usually oriented toward polar axis of grain; on polar projections spinules directed polewards.

Size range: Length of the polar projections 12–14 μ; length of the equatorial
projections 17–20 μ; breadth of the polar projections 20–26 μ; breadth of the equatorial projections 15–18.5 μ; a/b = 2.22–2.59.

**Holotype:** Pl. 13, figs. 2a–c; length of the polar axis 43 μ; length of the polar projections 13 μ; length of the equatorial projections 17 μ; breadth of the polar projections 26 μ; breadth of the equatorial projections 18.5 μ; a/b = 2.59; slide GN 2705; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

**Occurrence:** Common, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

**Comparison:** The present specimens are closely similar to *A. augustus* Srivastava (1969, p. 137, pi. 4, figs. 22–25) from the Maestrichtian Edmonton Formation, Alberta, Canada, but differ from the latter in having much smaller size and finer spinae.

**Botanical affinity:** Unknown.

*Aquilapollenites brevialatus* Takahashi & Shimono n. sp.

**Description:** Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium. Body of grain oval to ellipsoidal in equatorial view.

Isopolar; polar projections well-developed, rounded apices; equatorial projections meridional, short, rounded apices; tricolpate, colpi extending full length of equatorial projections and for a short distance onto body; exine two-layered; axillary endexinous costae 3 to 4 μ thick in thickest part, occupying axillae and extending a short distance onto bases of polar and equatorial projections; ektexine 0.5 μ ± thick on polar projections; conical spinae 0.5–1 μ long. ornamenting apical regions of equatorial and polar projections and equatorial regions of equatorial projections and body of grain; on equatorial projections spinae usually oriented toward polar axis of grain; on polar projections spinae directed polewards.

**Size range:** Length of the polar axis 41–43.7 μ; length of the polar projections 13–16 μ; length of the equatorial projections 10–17 μ; breadth of the polar projections 19–30 μ; breadth of the equatorial projections 14–16.5 μ; a/b = 2.65–2.96.

**Holotype:** Pl. 14, figs. 4a–c; length of the polar axis 43.7 μ; length of the polar projections 13 μ; length of the equatorial projections 13–17 μ; breadth of the polar projections 30 μ; breadth of the equatorial projections 16.5 μ; a/b = 2.65; slide GN 2706; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

**Occurrence:** Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 3.

**Comparison:** These specimens resemble closely *A. aemulus* n. sp., but the equatorial projections of the former are much shorter than that of the latter.

**Botanical affinity:** Unknown.

*Aquilapollenites longissimus* Takahashi & Shimono n. sp.

**Description:** Pollen grains with three equatorial projections and with one projection
each on the proximal and distal polar region. Body of grain long-cylindrical with rounded apices in equatorial view.

Isopolar to subisopolar; polar projections well-developed, rounded apices; equatorial projections meridional, relatively long, somewhat truncated apices, narrow at apex and broader at base; tricolpate, colpi extending full length of equatorial projections and for some distances onto body; exine two-layered; axillary endexinous costae 4 to 6 μ thick in thickest part, occupying most of the length of equatorial projections and some distance of body of grain; ektexine thin, ca. 1 μ thick on polar projections; spinules small, sparsely scattered on the apical regions of body of grain and on the equatorial projections.

Size range: Length of the polar axis 65–82.5 μ; length of the polar projections 20–25 μ; length of the equatorial projections 17.5–30 μ; breadth of the polar projections 22.5–25 μ; breadth of the equatorial projections 22.5–25 μ; a/b = 2.6–3.3.

Holotype: Pl. 13, fig. 7; length of the polar axis 65 μ; length of the polar projections 20 μ; length of the equatorial projections 17.5 μ; breadth of the polar projections 22.5 μ; breadth of the equatorial projections 25 μ; a/b = 2.6; slide 61003–3; Miyadani-gawa Formation, north of Miyaji; sample no. A.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. A.

Comparison: The present specimens are morphologically similar to A. rigidus Tschudy & Leopold from the Campanian Cloggett Shale and Eagle Sandstone, Montana, but differ from the latter in size and sculpture.

Botanical affinity: Unknown.

Aquilapollenites subtilis Mchedlishvili

Pl. 14, figs. 6–8; pl. 15, figs. 1–3.

1961 Aquilapollenites subtilis Mchedlishvili, in Samoilovich et al., Trudy VNIGRI no. 177, p. 214, pl. 68, figs. 3a–c, 4.

Dimensions: Length of the polar axis 44.5–56 μ; length of the polar projections 11–14 μ; length of the equatorial projections 10.7–22.5 μ; breadth of the polar projections 12–20 μ; breadth of the equatorial projections 15–24 μ; a/b = 2.14–3.27.

Occurrence: Abundant, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

Remarks: N. Mchedlishvili originally described Aquilapollenites subtilis from the Maestrichtian–Danian (?) strata (borehole K–1 sample 4313), village of Novye Port, northwest Siberian lowlands.

Botanical affinity: Unknown.

Aquilapollenites asper Mchedlishvili

Pl. 14, fig. 3.

1961 Aquilapollenites asper Mchedlishvili, in Samoilovich et al., Trudy VNIGRI, no. 177, p. 213, pl. 68, figs. 2a–c.

Dimensions: Length of the polar axis 52 μ; length of the proximal polar projection
18 μ; length of the distal polar projection 14 μ; length of the equatorial projections 24 μ; breadth of the proximal polar projection 20 μ; breadth of the distal polar projection 16 μ; breadth of the equatorial projections 21 μ; a/b = 2.48.

Occurrence: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 5.

Remarks: The present specimen is identified with Aquilapollenites asper Mchedlishvili from the Maestrichtian–Danian upper Symsk subseries, Brusov Yar, Sym River, western Siberian lowland.

Botanical affinity: Unknown.

Aquilapollenites pseudoaucellatus Takahashi & Shimono n. sp.

Pl. 15, figs. 4–7; pl. 16, figs. 1–2.

Description: Pollen grains with three equatorial projections and with one projection each on the proximal and distal polar region. Central body of grain long-ellipsoidal with rounded apices in equatorial view and triangular with concave sides and with somewhat rounded corners in polar view.

Isopolar; polar projections well-developed, rounded apices; equatorial projections meridional, well-developed, shape almost similar to polar projections, size slightly longer than polar projections, somewhat broader at the base than apex; tricolpate, colpi extending entire length of equatorial projections and for a short distance onto body; exine two-layered; axillary endexinous costae 2 to 4 μ thick in thickest part, occupying more than half the length of equatorial projections and a short distance of body of grain; ektexine thin; spinules small, scattered all over the surface, especially densely scattered on the apical regions of equatorial projections and on a equatorial zone of equatorial projections and body; on equatorial projections spinules usually oriented toward polar axis of grain; on polar projections spinules directed polewards.

Size range: Length of the polar axis 44–52 μ; length of the proximal polar projection 14.6–18 μ; length of the distal polar projection 11–16 μ; equatorial diameter 47–65 μ; length of the equatorial projections 15–24 μ; breadth of the proximal polar projection 17.7–25 μ; breadth of the distal polar projection 15–20 μ; breadth of the equatorial projections 20–21 μ; a/b = 2.14–2.65.

Holotype: Pl. 15, figs. 5a-b; length of the polar axis 51 μ; length of the proximal polar projection 18 μ; length of the distal polar projection 14 μ; equatorial diameter 57 μ; length of the equatorial projections 16 μ; breadth of the proximal polar projection 22 μ; breadth of the distal polar projection 20 μ; breadth of the equatorial projections 20 μ; a/b = 2.6; slide GN 2708; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

Occurrence: Abundant, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2, 5, 6, and A.

Comparison: The present specimens are closely similar to Aquilapollenites aucellatus Srivastava from the Maestrichtian Edmonton Formation, Alberta, Canada, but differ from the latter in having larger size.

Botanical affinity: Unknown.
**Aquilapollenites latialatus** TAKAHASHI n. sp.

Pl. 16, figs. 3a–b, 4, 5a–b.

**Description:** Pollen grains with three equatorial projections and with one polar projection on each apocolpium.

Isopolar to subsisopolar; polar projections not well-developed, rounded apices; equatorial projections meridional, well-developed, much broader at base, narrow at the apex; apices rounded or somewhat truncated; tricolpate, colpi extending full length of equatorial projections; exine two-layered; axillary endexinous costae as much as 3 μ thick in thickest part, confined to equatorial projections, extending two-thirds to three-quarters the distance to free ends of equatorial projections; ektexme thin; spinules small, mostly concentrated at apical regions of equatorial projections; spinules on equatorial projections usually oriented towards polar axis of grain; spinules on polar projections directed polewards.

**Size range:** Length of the polar axis 36.5–43 μ; length of the proximal polar projection 7–13 μ; length of the distal polar projection 7–9 μ; equatorial diameter 40–50 μ; length of the equatorial projections 15–20 μ; breadth of the proximal projection 11.5–17.5 μ; breadth of the distal polar projection 11–14 μ; breadth of the equatorial projections 19–25 μ; a/b = 1.72–2.11.

**Holotype:** Pl. 16, figs. 3a–b; length of the polar axis 36.5 μ; length of the polar projections 9 μ; equatorial diameter 40 μ; length of the equatorial projections 16 μ; breadth of the polar projections 11.5 μ; breadth of the equatorial projections 21 μ; a/b = 1.86; slide GN 2709; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

**Occurrence:** Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and A.

**Comparison:** The present specimens are similar to *Aquilapollenites latilobus* MCHEDLISHVILI from the Senonian lower Symsk subseries, Kolokonikov Yar, Sym River, western Siberian lowland and *Aquilapollenites cruciformis* MCHEDLISHVILI from the Maestrichtian–Danian upper Symsk subseries, Brusov Yar, Sym River, western Siberian lowland, but the former differs from *A. latilobus* in form and size of the equatorial projections and *A. cruciformis* in form and breadth of the equatorial projections. Especially, the figures 5a and 5b are closely similar to two Siberian species above-mentioned. This species shows a ratio between length of polar axis and breadth of equatorial projection of 1.72 to 2.11. The author, K. TAKAHASHI, accepts this as an exceptional species of *Aquilapollenites*.

**Botanical affinity:** Unknown.

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*Aquilapollenites aucellatus* SRIVASTAVA

Pl. 16, figs. 6–7; pl. 17, figs. 1–4.


**Dimensions:** Length of the polar axis (31.5)–46 μ; length of the equatorial diameter 44.3–56 μ; length of the equatorial projections 17.5–22 μ; breadth of the proximal polar projection 17.5–19 μ; breadth of the distal polar projection 13–15 μ; breadth of
the equatorial projections 15–21 μ; a/b = 2.0–2.43.

Occurrence: Abundant, Miyajdani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

Remarks: The present specimens are identified with Aquilapollenites aucellatus Srivastava from the Maestrichtian Edmonton Formation, Alberta, Canada, in the morphological characteristics of the central body and the equatorial projections.

Botanical affinity: Unknown.

Aquilapollenites delectus Takahashi & Shimono n. sp.

Pl. 17, figs. 5a–b.

Description: Pollen grains with three equatorially situated apical projections and with one projection each on the proximal and distal polar regions. Central body cylindrical, apices rounded.

Isopolar; polar projections well-developed, rounded apices; equatorial projections meridional, well-developed; apices rounded; tricolpate, colpi extending entire length of equatorial projections and two-thirds the distance of polar projections; exine twolayered; axillary endexinous costae as much as 2.5 μ thick in thickest part, extending two-thirds the distance to free ends of equatorial projections and two-thirds the distance to apices of polar projections; ektexine thin, finely striate; striae on polar body and equatorial projections usually directed polewards.

Size range: Length of the polar axis 48–49.5 μ; length of the polar projections 17 μ; length of the equatorial projections 15–15.5 μ; breadth of the polar projections 16–17.5 μ; breadth of the equatorial projections 15 μ; a/b = 2.91.

Holotype: Pl. 17, figs. 5a-b; length of the polar axis 49.5 μ; length of the equatorial projections 15.5 μ; breadth of the polar projections 17 μ; breadth of the equatorial projections 15 μ; slide GN 2702; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

Occurrence: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

Comparison: This species is similar to Aquilapollenites quadrinus Takahashi from the Maestrichtian upper formation of the Hakobuchi Group, Hokkaido, Japan, but differs from the latter in having smaller size and much shorter equatorial projections.

Botanical affinity: Unknown.

Aquilapollenites quadrinus Takahashi

Pl. 17, fig. 6.


Dimensions: Length of polar axis 58 μ; length of polar projections 20 μ; length of equatorial projections 25 μ; breadth of polar projections 14 μ; breadth of equatorial projections 22 μ; a/b = 2.64.

Occurrence: Very rare, Miyadni-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.
Remarks: This specimen is somewhat larger than *Aquilapollenites quadrinus* Takahashi from Hokkaido, but belongs to this species.

Botanical affinity: Unknown.

*Aquilapollenites melior* Takahashi & Shimono n. sp.

Pl. 17, figs. 7–8.

Description: Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium.

Subisopolar; polar projection developed, rounded apices; equatorial projections meridional, well-developed; apices rounded; tricolpate, colpi extending full length of equatorial projections and for a short distance on the polar projections; exine two-layered; axillary endexinous costae as much as 2 μ thick in thickest part, extending two-thirds to three-quarters the distance to free ends of equatorial projections and for a short distance to apices of polar projections; ektexine thin, finely striate; striae on polar body and equatorial projections usually arranged polewards.

Size range: Length of the polar axis 32–36.7 μ; length of the proximal polar projection 10.5–11 μ; length of the distal polar projection 10–14 μ; equatorial diameter 38–48 μ; length of the equatorial projections 15.5–17 μ; breadth of the polar projections 11–16 μ; breadth of the equatorial projections 11–13 μ; a/b = 2.82–2.91.

Holotype: Pl. 17, figs. 8; length of the polar axis 32 μ; length of the polar projections 10 μ; breadth of the polar projections 11 μ; breadth of the equatorial projections 11 μ; a/b = 2.91; slide GN 2806; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Comparison: The present specimens are closely similar to *Aquilapollenites melioratus* Takahashi n. sp., but differ from it in having longer equatorial projections.

Botanical affinity: Unknown.

*Aquilapollenites melioratus* Takahashi n. sp.

Pl. 18, figs. 1a-b, 2a-b, 3.

Description: Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium.

Isopolar to subisopolar; polar projection developed, rounded apices; equatorial projections meridional, well-developed; apices rounded; tricolpate, colpi extending full length of equatorial projections and for a short distance on the polar projections; exine two-layered; axillary endexinous costae as much as 2 μ thick in thickest part, extending three-quarters the distance to free ends of equatorial projections; ektexine thin, finely striate; striae on all surface of grain usually directed polewards.

Size range: Length of the polar axis 27.5–30.5 μ; equatorial diameter 34 μ; length of the proximal polar projection 8–12 μ; length of the distal polar projection 6–11 μ; length of the equatorial projections 10.5–14.5 μ; breadth of the polar projections 12.5–16.5 μ; breadth of the equatorial projections 10–12 μ; a/b = 2.55–2.75.
Kiyoshi Takahashi and Hiroshi Shimono

Holotype: Pl. 18, figs. 2a-b; length of the polar axis 28 μ; length of the equatorial projections 10.5 μ; breadth of the polar projections 14 μ; breadth of the equatorial projections 11 μ; a/b = 2.55; slide GN 2817; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Comparison: The specimens with fine striae are closely similar to Aquilapollenites melior Takahashi & Shimono n. sp., but differ from the latter in having shorter equatorial projections.

Botanical affinity: Unknown.

Aquilapollenites mirus Takahashi n. sp.

Pl. 18, figs. 4, 5a-b.

Description: Pollen grains with three equatorial projections and with one projection each on the proximal and distal polar region. Central body cylindrical with rounded apices.

Isopolar; polar projections well-developed, rounded apices; equatorial projections meridional, well-developed; apices rounded; tricolpate, colpi extending entire length of equatorial projections and for a short distance to poles; exine two-layered; axillary endexinous costae as much as 2 to 3 μ thick, extending four-fifths the distance of free ends of equatorial projections and a short distance to poles; ektexine thin, finely striate; striae on all surface of grain usually directed polewards.

Size range: Length of the polar axis 28.4–(29) μ; length of the polar projections 9.5–15 μ; length of the equatorial projections (7+)–14.5 μ; breadth of the polar projections 7.5–11 μ; breadth of the equatorial projections 9–13 μ; a/b = 3.16.

Holotype: Pl. 18, fig. 4; length of the polar axis 28.4 μ; length of the proximal polar projection 9.5 μ; length of the distal polar projection 11 μ; length of the equatorial projections more than 7 μ; breadth of the polar projections 7.5 μ; breadth of the equatorial projections 9 μ; slide GN 2807; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

Occurrence: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Comparison: The present specimens are different from Aquilapollenites melioratus in having narrower breadth of the equatorial projections and from A. melior in having shorter length of the polar axis and the equatorial projections.

Botanical affinity: Unknown.

Aquilapollenites sp. a

Pl. 17, fig. 10.

Description: Pollen grain with three equatorial projections and with one polar projection on each apocolpium.

Isopolar or subisopolar; polar projection developed, rounded apices; equatorial projections meridional; apices rounded; tricolpate, colpi extending full length of equa-
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Toriorial projections and for the most part of polar projections; exine two-layered; axillary endexinous costae 1.5–2 μ thick, well-developed in spite of its small body and equatorial projections; ektexine thin, punctate.

**Size range**: Length of polar axis 16 μ; equatorial diameter 20 μ; length of equatorial projections 4–6 μ; breadth of polar projection 6 μ; breadth of equatorial projections 6 μ; a/b = 2.67.

**Occurrence**: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

**Remarks**: Only one specimen was found. This is the smallest form of *Aquilapollenites*.

**Botanical affinity**: Unknown.

*Aquilapollenites* sp. b

Pl. 17, fig. 9.

**Description**: Pollen grain with three equatorial projections and with one projection each on the proximal and distal polar region.

Heteropolar, one polar projection well-developed, somewhat rounded; the other polar projection much narrower than the former. Equatorial projections well-developed, meridional, apices rounded, broader and longer than the polar projections.

Tricolpate, colpi extending full length of equatorial projections and for a short distance to poles of body; exine two-layered; axillary endexinous costae as much as 2 μ thick in thickest part, extending three-fourths the distance to free ends of equatorial projections and for a short distance to poles of polar projections; ektexine thin, finely striate; striae directed polewards.

**Size range**: Length of the polar axis 30.5 μ; length of one polar projection 8 μ; length of the other polar projections 10 μ; length of the equatorial projections 15.5 μ; breadth of the polar projection 8 μ; breadth of the equatorial projections 12 μ; a/b = 2.54.

**Occurrence**: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 5.

**Botanical affinity**: Unknown.


**Synonymy**:

1961 *Triprojectus* Mchedlishvili, in Samoilovich et al., Trudy VNIGRI, no. 177, p. 204.
1961 *Projectoporites* Mchedlishvili, in Samoilovich et al., Trudy VNIGRI, no. 177, p. 227.

**Type species**: *Triprojectus dispositus* Mchedlishvili 1961.

**Diagnosis**: Isopolar to subisopolar, triprojectate pollen grains. Central body cylindrical, ellipsoidal or barrel-shaped, with three long or moderately long and narrow equatorial projections. Tricolpate, colpi meridionally oriented, extending entire length
of equatorial projections and sometimes only some distance onto body of grain. Length of body (a)/breadth of projection (b) ratio = 3.1–5.4. Endexinous thickenings well-developed, long, extending in some cases slightly onto body of grain beyond the equatorial projections. Exine thin or thick; sculpture variable.

Remarks: N. Mchedlishvili (1961) described first the genus Triprojectus and designated T. dispositus Mchedlishvili as a type species. When Stanley emended this genus, he showed its body (a)/projection (b) ratio to be 3.7 to 5.4, but the author, K. Takahashi, proposes that its ratio (a/b) is 3.1 to 5.4. T. dispositus possesses three well-developed equatorial projections and is closely similar to Aquilapollenites. Accordingly, T. dispositus has a possibility to be replaced with the genus Aquilapollenites. However, the authors use the genus Triprojectus in this paper.

List of previously described species of Triprojectus.


T. crassus Mchedlishvili, 1961, p. 207, pl. 66, figs. 2a–c, 3; pl. 58, fig. 4; pl. 62, fig. 1; upper (?) Maestrichtian, western Siberian lowland, USSR; a/b = 3.17–4.07.

T. dispositus Mchedlishvili, 1961, p. 205, pl. 65, figs. 1–2; Maestrichtian-Danian, western Siberian lowland, USSR; a/b = 3.13.

T. echinatus Mchedlishvili, 1961, p. 208, pl. 67, figs. 1a–c, 2a–b; Maestrichtian-Danian (?), northwest Siberian lowland, USSR; a/b = 3.91–4.73.

T. magnus (Mchedlishvili, 1961) Stanley, 1970, p. 227, pl. 74, figs. 1a–c; pl. 55, fig. 13; lower (?) Maestrichtian, western Siberian lowland, USSR; a/b = 4.62.

T. ovalis (Mchedlishvili, 1961) Stanley, 1970, p. 228, pl. 74, 2a–c; 3; pl. 58, fig. 6; lower (?) Maestrichtian, western Siberian lowland, USSR; a/b = 4.33–4.45.

T. sentus (Srivastava, 1969) Stanley, 1970, p. 142, pl. 7, figs. 44–48; pl. 8, figs. 49–53; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 4.79–5.29.

T. spinulosus (Mchedlishvili, 1961) Stanley, 1970, p. 229, pl. 74, figs. 4a–c, 5; pl. 65, figs. 18–19; upper Palaeocene, western Siberian lowland, USSR; a/b = 4.38–5.33.

Triprojectus sp.
Pl. 21, figs. 7a–b.

Description: Pollen grain with three equatorial projections and with one polar projection on each apocolpium. Central body of grain broad-ellipsoidal or barrel-shaped in equatorial view.

Isopolar; polar projections well-developed, with rounded apices; equatorial projections meridional, well-developed, with rounded apices; tricolpate, colpi extending full length of equatorial projections and half the distance to poles of body; exine two-layered; axillary endexinous costae 1–1.5 μ thick, extending two-thirds the distance to apices of equatorial projections and half the distance to poles of body; ektexine thin; spinules small, scattered all over the surface, especially densely scattered on the apical regions of equatorial projections and polar projections; on equatorial projections spinules usually oriented towards polar axis of grain; on polar projections spinules directed
polewards.

Size range: Length of the polar axis 24.5 μ; length of the polar projections 7 μ; equatorial diameter 36.5 μ; length of the equatorial projections 11.4 μ; breadth of the polar projections 16.3 μ; breadth of the equatorial projections 8 μ; a/b = 3.5.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no.- 2.

Remarks: Only one specimen was found. This specimen belongs undoubtedly to the genus Triprojectus.

Botanical affinity: Unknown.

Genus **Hemicorpus** Krutzsch 1970 emend. Takahashi (herein)

Synonymy:
1961 Mancicorpus Mchedlishvili in Samoilovich et al., Trudy VNIGRI, no. 177, p. 218, (p.p.).


Emended diagnosis: Heteropolar and triprojectate pollen grains. Central body cylindrical or ellipsoidal with rounded apices, conical or truncated conical; polar projection developed on one pole only, whereas in the other hemisphere the polar projection is either absent or developed as a small protuberance; the length from the center of the equatorial axis to the tip of the undeveloped polar projection less than half the length of the developed polar projection from the center of the equatorial axis to the tip of that pole; equatorial projections subequatorial, normally three in number, long or short, broad or somewhat narrow, flattened meridionally, forming a right or an obtuse angle at the junction with the body; length of polar axis/breadth of equatorial projection ratio 1.8–2.9.

Tricolpate, colpi meridional, narrow, long. Exine two-layered, with the ektexine thicker or equal in thickness to the endexine. Axillary endexinous costae usually short or long, well to poorly developed and confined primarily to the base of the projections. Sculpture variable; ornamentation of the polar projections often different from that of the equatorial projections.

Remarks: N. Mchedlishvili (1961) established the genus Mancicorpus and designated Mancicorpus anchoriforme as a type species. Subsequently, S. K. Srivastava (1968) and E. A. Stanley (1970) emended her original description of the genus Mancicorpus. However, their descriptions are essentially the same, and include triploprojectate pollen grains with two different characteristics. W. Krutzsch (1970) divided
the genus *Mancicorpus* into two genera, that is, *Mancicorpus* with the type species *M. ancoriforme* and *Hemicorpus* with the type species *H. pulchrum* (Funkhouser) Krutzsch. The author, K. Takahashi, supports Krutzsch's proposal.

List of previously described species of *Hemicorpus*.

H. *aequum* (Bolchovitina, 1959) Krutzsch, 1970, p. 128, pl. 8, fig. 116; Upper Cretaceous, Yakut, N. Central Siberia, USSR.

H. *boreale* (Srivastava, 1968) Takahashi n. comb. = (*Mancicorpus boreale* Srivastava), p. 1486, pl. 1, figs. 6–8; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 2.79.


H. *gibbum* (Srivastava, 1968) Takahashi n. comb. = (*Mancicorpus gibbus* Srivastava), p. 1487, pl. 1, figs. 3–5; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 2.86.

H. *hirsutum* (Srivastava, 1969) Takahashi n. comb. = (*Aquilapollenites hirsutus* Srivastava), p. 139, pl. 5, fig. 30; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 2.28.


H. *paplionis* (Srivastava, 1969) Takahashi n. comb. = (*Aquilapollenites paplionis* Srivastava), p. 140, pl. 5, figs. 33–36; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.8–2.11.


H. *pulvinum* (Stanley, 1961) Krutzsch, 1970, p. 347, pl. 7, figs. 1–12; Hell Creek Formation (Maestrichtian), S. Dakota, U. S. A.; a/b = 2.06.

H. *rostratum* (Srivastava, 1968) Takahashi n. comb. = (*Mancicorpus rostratus* Srivastava), p. 1487, pl. 2, figs. 11–12; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 2.87.

H. *senonicum* (Mchedlishvili, 1961) Krutzsch, 1970, p. 224, pl. 72, figs. 2a–c, 3; Senonian, western Siberian lowland, USSR; a/b = 2.54.

H. *solidum* (Mchedlishvili, 1961) Krutzsch, 1970, p. 223, pl. 72, figs. 1a–c; lower (?) Maestrichtian, western Siberian lowland, USSR; a/b = 2.03.


H. *tenue* (Mchedlishvili, 1961) Krutzsch, 1970, p. 222, pl. 71, figs. 4a–c; Maestrichtian-Danian, western Siberian lowland, USSR; a/b = 2.0–2.42.

H. *trapeziforme* (Mchedlishvili, 1961) Krutzsch, 1970, p. 221, pl. 71, figs. 3a–d; Maestrichtian-Danian, western Siberian lowland, USSR; a/b = 2.0.

H. *vancampeoi* (Srivastava, 1968) Takahashi n. comb. = (*Mancicorpus vancampeoi* Srivastava), p. 1488, pl. 1, figs. 4–9; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 2.17.
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Hemicorpus tenue (Mchedlishvili) Krutzsch

1961 Mancicorpus tenue Mchedlishvili, in Samoilovich et al., Trudy VNIGRI, no. 177, p. 222, pl. 71, figs. 4a-c; pl. 62, fig. 7.


Dimensions: Length of the polar axis 22–26.5 μ; length of the developed polar projection 11–14.5 μ; length of the equatorial projections 9–15 μ; length of the equatorial diameter 33–34 μ; breadth of the developed polar projection 9–15 μ; breadth of the equatorial projections 10–13 μ; a/b = 1.84–2.6.

Occurrence: Abundant, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

Remarks: The present specimens are identified clearly with Hemicorpus tenue (Mchedlishvili) Krutzsch described originally from the Maestrichtian to Danian upper Symsk subseries, Brusov Yar, Sym River, western Siberian lowland, USSR.

Botanical affinity: Unknown.

Hemicorpus trapeziforme (Mchedlishvili) Krutzsch

1961 Mancicorpus trapeziforme Mchedlishvili, in Samoilovich et al., Trudy VNIGRI, no. 177, p. 222, pl. 71, figs. 3a–d. pl. 62, fig. 6.


Dimensions: Length of the polar axis 19–26 μ; length of the developed polar projection 11–15 μ; length of the equatorial projections 10–16 μ; equatorial diameter 32–40 μ; breadth of the developed polar projection 13–20 μ; breadth of the equatorial projections 9–12 μ; a/b = 2.11–2.5.

Occurrence: Common, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

Remarks: The present specimens belong to Hemicorpus trapeziforme (Mchedlishvili) Krutzsch originally described from the Maestrichtian to Danian upper Symsk subseries, Brusov Yar, Sym River, western Siberian lowland, USSR.

Botanical affinity: Unknown.

Hemicorpus miyajiense Takahashi & Shimono n. sp.

Pl. 19, figs. 1–3.

Description: Pollen grains with three equatorially situated apical projections and with one projection each on the proximal and distal polar region.

Heteropolar; one polar projection well-developed, narrow, slightly bent, with rounded apex; the reduced polar projection is like a small hump; equatorial projections

...
developed, meridionally broad, relatively short, arising from the neck region of developed polar projection and tip of reduced polar projection, with rounded apices, oriented at right angles to polar axis or inclined very slightly toward reduced pole.

Tricolpate, colpi spanning entire length of equatorial projections, appearing to extend one half to two-thirds the distance to pole of developed polar projection and near tip of reduced polar projection. Exine two-layered, axillary endexinous costae 1–1.5 µ thick, bow-shaped, occupying inner two-thirds of the length of the equatorial projections, extending one half to two-thirds the distance to pole of the developed polar projection, reaching almost to pole of the reduced polar projection; ekntexine thin; on equatorial projections ekntexinal spinae closely spaced, surface sculpture finely echi-nate; surface sculpture smooth on polar region of the developed polar projection; on neck region of the developed polar projection surface sculpture more or less coarsely granulate (appearing to form a fine reticulum under the microscope); colpal margins bordered by a row of closely spaced conical spinae, which are usually retroflexed.

Size range: Length of the polar axis 19–25.5 µ; length of the developed polar projection 15 µ; length of the equatorial projections 12–15 µ; equatorial diameter 30–39.4 µ; breadth of the developed polar projection 6.5–10 µ; breadth of the equatorial projections 7–12 µ; a/b = 1.833–2.43.

Holotype: Pl. 19, fig. 3; length of the polar axis 25.5 µ; length of the developed polar projection 15 µ; length of the equatorial projections 15 µ; equatorial diameter 30 µ; breadth of the equatorial projection 12 µ; a/b = 2.13; slide GN 2703; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

Comparison: The present specimens are similar to Hemicorpus tenue (Mchedlishvili) Krutzsch from the Miyadani-gawa Formation in the Hida district, central Japan, but differ from the latter in having a narrower polar projection.

Botanical affinity: Unknown.

Hemicorpus tripterum Takahashi n. sp.

Pl. 19, figs. 4a-b.

Description: Pollen grains with three equatorially situated apical projections and with one projection each on the proximal and distal polar region.

Heteropolar; one polar projection well-developed, long, apex broadly round, broader than central region of polar projection; other polar projection very small, short, protruding very slightly; equatorial projections well-developed, meridional, arising from the neck region of developed polar projection and tip of reduced polar projection, with rounded apices, inclined very slightly toward reduced pole.

Tricolpate, colpi apparently extending over the entire of equatorial projections, spanning one half of the distance to pole of developed polar projection and approximate tip of reduced polar projection. Exine two-layered; axillary endexinous costae as much as 1 µ thick, occupying inner three-quarters the length of the equatorial projections,
extending one half the distance to pole of the developed polar projection and the approximate tip of the reduced polar projection; ektexine thin; on developed polar projection ektexine smooth or very finely punctate; on equatorial projections ektexine punctate and sparsely scattered fine granula; colpal margins bordered by a row of closely spaced conical spinae, which are usually retroflexed.

**Size range:** Length of the polar axis 30–35 μ; length of the developed polar projection 15–18 μ; equatorial diameter 38–42 μ; length of the equatorial projections 21–25 μ; breadth of the developed polar projection 12–16 μ; breadth of the equatorial projections 15–17 μ; a/b = 2.33.

**Holotype:** Pl. 19, figs. 4a-b; length of the polar axis 35 μ; length of the developed polar projection 18 μ; length of the equatorial projections 21 μ; breadth of the developed polar projection 16 μ; breadth of the equatorial projections 15 μ; a/b = 2.33; slide GN 2703; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

**Occurrence:** Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

**Comparison:** The present figures of *Hemicorpus tripterum* TAKAHASHI n. sp. are different from *H. tenue* (Mchedlishvili) KRUTZSCH in size and ornamentation of the developed polar projection.

**Botanical affinity:** Unknown.

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**Hemicorpus alienum** TAKAHASHI n. sp.

Pl. 19, figs. 5–6.

**Description:** Pollen grains with three equatorially situated apical projections and with one projection developed on one pole, the other pole reduced without any suggestion of polar projection.

Heteropolar; the developed polar projection broad, barrel-shaped, with rounded apex; the reduced polar area straight at right angles to polar axis, almost aligned equatorially with one side of equatorial projections; equatorial projections well-developed, meridional, long, apices round.

Tricolpate, colpi meridional, long, extending entire length of equatorial projection and one half of the distance to apex of developed polar projection. Exine two-layered; axillary endexinous costae as much as 3 μ thick in thickest part, extending three-quarters the length to free ends of equatorial projections and one half the distance to apex of the developed polar projection; ektexine thin, finely reticulate; spinules distributed on the polar regions of the developed polar projection and the equatorial projections, 3–4.5 μ long, 2.5 μ ± wide at base; spinules on colpal margins of the equatorial projections usually retroflexed.

**Size range:** Length of the polar axis 41–50 μ; length of the equatorial projections 26–35 μ; equatorial diameter (86)–118 μ; breadth of the developed polar projection 34–44 μ; breadth of the equatorial projection 22–24 μ; a/b = 1.83–2.27.

**Holotype:** Pl. 19, fig. 5; length of the polar axis 50 μ; length of the equatorial projection 35 μ; length of the equatorial diameter 118 μ; breadth of the developed polar projection 44 μ; breadth of the equatorial projections 22 μ; a/b = 2.27; slide GN
2811; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

**Occurrence:** Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

**Comparison:** *H. alienum* can be distinguished from other similar species by reticulate and echinate ornamentation and large central body developed only in one direction.

**Botanical affinity:** Unknown.

*Hemicorpus* sp.

Pl. 18, fig. 14.

**Description:** Pollen grain with three equatorially situated apical projections and with one projection developed on one pole, the other pole reduced without any suggestion of polar projection.

Heteropolar; the developed polar projection broad, barrel-shaped (?); the reduced polar area straight at right angles to polar axis, aligned equatorially with one side of equatorial projections; equatorial projections well-developed, meridional, moderately long, apices round.

Tricolpate, colpi meridional, long, extending full length of equatorial projections and a short distance of the developed polar projection. Exine two-layered; axillary endexinous costae as much as 2 μ thick in thickest part, extending one half of the length to free ends of the equatorial projections and a short distance onto the body. Ektexine thin, echinate; on the apices of the developed polar projection and the equatorial projections and on an equatorial belt of the equatorial projections spinules distributed closely; on the equatorial projections spinules usually oriented towards polar axis of grain; on polar projection spinules directed polewards.

**Size:** Length of the polar axis 32 μ; length of the equatorial projections 20 μ; breadth of the developed polar projection 23 μ; breadth of the equatorial projections 17 μ; a/b = 1.88.

**Occurrence:** Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

**Remarks:** Only one poorly preserved specimen was found. The authors cannot identify it specifically.

**Botanical affinity:** Unknown.

? *Hemicorpus* sp.

Pl. 18, fig. 15.

**Description:** Pollen grain with three equatorially situated apical projections and with one projection developed on one pole (?); triangular, with concave sides in polar view.

Heteropolar (?); equatorial projections well-developed, paddle-like in polar view. Tricolpate, colpi meridional, long, extending entire length of equatorial projections. Axillary endexinous costae (?). Conical spinae scattered over polar projection and over surface of equatorial projections, tending to point towards polar axis of grain.

**Size:** Length of the equatorial projections 20 μ; equatorial diameter 50 μ; breadth
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of the developed polar projection 14 μ.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. A.

Remarks: Only one specimen was found. A complete description cannot be given, because there is no specimen in equatorial view.

Botanical affinity: Unknown.

Genus Mancicorpus Mchedlishvili 1961 emend. TAKAHASHI (herein)

Synonymy:
1961 Mancicorpus Mchedlishvili, in Samoilovich et al., Trudy VNIGRI, no. 177, p. 218, (p. p.).

Type species: Mancicorpus anchoriforme Mchedlishvili 1961.

Emended diagnosis: Heteropolar, tripolar with three well-developed equatorial projections and without any polar projection or with only a dome-like polar projection. Shape of grains tripodal, junction of polar projection with equatorial projections forming plane of slightly concave surface; equatorial projections meridional, with broadly rounded apices, nearly uniform in width throughout their length or some slightly or gradually broadened or narrowed near apices, directed towards minor pole.

Tricolpate, colpi extending entire length of equatorial projections. Length of polar axis (a)/breadth of equatorial projection (b) ratio 1.0–1.5. Exine two-layered, thin; endexinous costae long, well- or poorly developed, extending onto equatorial projections for one half to three-quarters of the length of the projections. Ornamentation variable.

Remarks: In 1961, N. Mchedlishvili established the genus Mancicorpus, which includes all forms having both or one polar projections and three equatorial projections, and designated M. ancoriforme as a type species. Afterwards, S. K. Srivastava (1968) and E. A. Stanley (1970) succeeded Mancicorpus defined by Mchedlishvili, in spite of their emendation. W. Krutzsch (1970) divided it into two genera, namely Mancicorpus and Hemicorpus, and restricted Mancicorpus to pollen forms lacking expansion of the polar regions along the polar axis and Hemicorpus to pollen forms expanded along the polar axis on one side and with long germinals.

In this paper, the author, K. TAKAHASHI, proposes to restrict Mancicorpus to pollen forms with only a small polar projection or without any polar projection and with three equatorial projections directed towards a minor pole.
List of previously described species of *Mancicorpus*.

**M. albertense** Srivastava, 1968, p. 1486, pl. 1, figs. 1–2; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.23–1.26.

**M. ancoriforme** Mchedlishvili, 1961, p. 219, pl. 70, figs. 3a–e, 4a–b; pl. 55, figs. 8–9; Maestrichtian–Danian, western Siberian lowland, USSR; a/b = 1.21.


**M. canadianum** (Srivastava, 1969) Takahashi n. comb. = (*Mchedlishvilia canadiana* Srivastava), p. 616–618, pl. 1, figs. 1–8; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.0.

**M. glabrum** (Chlonova, 1961) Stanley, 1970, p. 86, pl. 15, fig. 111; Upper Cretaceous, western Siberia, USSR; a/b = 1.33.

**M. minimum** (Chlonova, 1961) Stanley, 1970, p. 86, pl. 15, fig. 112; Upper Cretaceous, western Siberia, USSR; a/b = 1.2.


**M. unicum** (Chlonova, 1961) Stanley, 1970, p. 86, pl. 15, fig. 110; Upper Cretaceous, western Siberia, USSR; a/b = 1.5.

**Mancicorpus minimum** (Chlonova) Stanley

Pl. 23, fig. 17.


Dimensions: Length of polar axis 12.5 μ; height of pollen grain 16.5 μ; equatorial diameter 25 μ; length of equatorial projection 15 μ; breadth of equatorial projection 10 μ; exine smooth; a/b = 1.25.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Remarks: Only one specimen was found. This is identified with *Mancicorpus (al. Tricerapollis) minimum* (Chlonova) Stanley from the upper Upper Cretaceous strata, western Siberia.

Botanical affinity: Unknown.

**Mancicorpus cf. albertense** Srivastava

Pl. 23, figs. 18a–b.


Dimensions: Length of polar axis 14.5 μ; length of equatorial diameter 27 μ; length
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of equatorial projections 15 μ; height of pollen grain 18 μ; breadth of equatorial projections 10 μ; exine finely reticulate; a/b = 1.45.

Occurrence: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Remarks: The present specimen is somewhat smaller than *Mancicorpus albertense* Srivastava from the Maestrichtian Edmonton Formation, Alberta, Canada.

Botanical affinity: Unknown.

Genus *Integricorpus* Mchedlishvili 1961 emend. Takahashi (herein)

Synonymy:
1961 *Parviprojectus* Mchedlishvili, in Samoilovich et al., Trudy VNIGRI, no. 177, p. 225.

Type species: *Integricorpus* helium Mchedlishvili.

Emended diagnosis: Isopolar to subisopolar, triprojectate pollen grains with three well- or poorly developed equatorial projections and with one well-developed projection on each apocolpium. Central body elliptical to sub-elliptical in equatorial view.

Equatorial projections meridional or equatorial, normally three in number, long to short, more or less circular or bilobed in cross-section. with their distal ends very thin, delicate and often destroyed. Lenght of body (a)/breadth of equatorial projections (b) ratio 3.0–7.0.

Colpi meridional, long to short, distinct or indistinct. Equatorial exine fissure (or colpus) never present.

Exine two-layered, ektexine thicker than endexine. Endexinous thickenings usually weakly to well-developed, long, extending onto both the body and the projection. Ornamentation variable.

Remarks: N. Mchedlishvili (1961) first established the genus *Integricorpus* and designated *Integricorpus bellum* Mchedlishvili as a type species. Afterward, S. R. Samoilovich (1965) and E. A. Stanley (1970) included pollen grain with three meridional and three equatorial furrows in the genus *Integricorpus*. The author, K. Takahashi, proposes to separate such pollen grains from the genus *Integricorpus*. Accordingly, the genus *Integricorpus* is restricted to pollen grains with three meridional colpi and without any equatorial furrow (or colpus).

List of previously described species of *Integricorpus*.


I. *amygdaloides* (Srivastava, 1968) Stanley, 1970, p. 671, pl. 1, figs. 3–5; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 6.61.

I. *antigonei* (Srivastava, 1968) Stanley, 1970, p. 672, pl. 1, fig. 6; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 3.07.

I. *bellum* Mchedlishvili, 1961, p. 217, pl. 70, figs. 1a–d, 2a–b; Senonian, western Siberia, USSR; a/b = 3.25–5.43.

I. *bertillonites* (Funkhouser, 1961) Stanley, 1970, p. 196, pl. 2, figs. 5a–c; Lance Formation (Maestrichtian), Wyoming, U.S.A.

I. *boreale* (Takahashi, 1964) Stanley, 1970, p. 251, pl. 37, figs. 3a–d, 4a–b; Lower Hakobuchi Group (Campanian), Hokkaido, Japan; a/b = 3.1.

I. *catenireticulatum* (Srivastava, 1968) Stanley, 1970, p. 674, pl. 37, figs. 7–9; Edmonton Formation (late Campanian – Maestrichtian), Alberta, Canada; a/b = 3.67.

I. *ceriocorpus* (Srivastava, 1968–676, pi. 2, figs. 1–4; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 3.73.


I. *funkhouseri* (Srivastava, 1966) Stanley, 1970, p. 541, pl. 9, figs. 5–8, 10; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 4.5.

I. *leucocephalus* (Srivastava, 1968) Stanley, 1970, p. 677–678, pl. 3, figs. 1–5; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 5.45.


I. *mtchedlishvilii* (Srivastava, 1968) Takahashi n. comb. = (Parviprojectus reticulatus Mched. → Aquilapollenites mtchedlishvilii Sriv.); Mchedlishvili, p. 226, pl. 73, figs. 2a–c, 3; pl. 62, fig. 10; Maestrichtian–Danian, western Siberian lowland, USSR; Srivastava, p. 692–693; a/b = 5.43–6.0.

I. *murus* (Stanley, 1961) Stanley, 1970, p. 347, pl. 5, figs. 1–8; pl. 6, figs. 1–9; Hell Creek Formation (Maestrichtian), S. Dakota, U. S. A.; a/b = 5.85.

I. *obesum* (Ke et Shi, 1978) Takahashi n. comb. = (Aquilapollenites obesus Ke & Shi), p. 158, fig. 26; Kongdian Formation (Eocene), Bohai, China.


I. *striatum* (Mchedlishvili, 1961) Stanley, 1970, p. 225, pl. 73, figs. 1a–c; Maestrichtian–Danian (?), northwest Siberian lowland, USSR; a/b = 5.1.


I. *triauritum* (Takahashi, 1964) Stanley, 1970, p. 250, pl. 37, figs. 1a–c, 2a–c; Lower Hakobuchi Group (Campanian), Hokkaido, Japan; a/b = 4.13–5.0.

I. *venustum* (Srivastava, 1968) Stanley, 1970, p. 686–688, pl. 6, figs. 2–6; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 4.27.
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**Genus Pseudointegricorpus TAKAHASHI** n. gen.

**Synonymy:**

**Type species:** *Pseudointegricorpus novacolpites* (FUNKHOUSER, 1961) TAKAHASHI n. comb.

**Generic diagnosis:** Isopolar to subisopolar, triprojectate pollen grains with well-or poorly developed equatorial projections and with one well-developed polar projection each on the proximal and distal polar region. Central body cylindrical or elliptical to sub-elliptical in equatorial view.

Three equatorial projections meridional or equatorial, moderately long to short, narrow, wider towards the base with their edges slightly sharpened or rounded, with their distal ends very thin, delicate and often destroyed. Length of body (a)/breadth of equatorial projections (b) ratio 3.0–6.7. Three meridional colpi (triloculate) across equatorial projections, long, narrow, distinct or indistinct, often gaping. Equatorial exine fissures (or colpi), short, restricted within the equatorial projections or long, narrow, running on the equator or the body and projections as if they divide the pollen grain into two parts.

Exine two-layered. Endexinous thickenings usually weakly to well-developed, long, extending onto both the body and projections. Sculpture of exine variable; often reticulate or striate.

**Remarks:** N. Mchedlishvili (1961) first described pollen grains with three equatorial projections and meridional colpi as *Integricorpus*. J. W. FUNKHOUSER (1961) and A. F. CHLONOVA (1961) described pollen grains with three meridional and three equatorial furrows respectively as *Aquilapollenites novacolpites* FUNKHOUSER and *Aquilapollenites reticulatus* CHLONOVA. S. R. SAMOLOVICH (1965) described such a pollen grain as *Integricorpus clarireticulum* SAMOLOVICH and subsequently E. A. STANLEY (1970) wrote distinctly in the description of *Integricorpus* that some species of *Integricorpus* may possess equatorial exine fissures. However, in this paper the author, K. TAKAHASHI, proposes to distinguish such pollen grains from the genus *Integricorpus* and to establish a new genus *Pseudointegricorpus*.

List of previously described species here assigned to *Pseudointegricorpus*.

*P. clarireticulatum* (SAMOLOVICH, 1965) TAKAHASHI n. comb. = (*Integricorpus clarireticulatus* SAMOLOVICH), p. 123, text-fig. 2; pl. 1, figs. 2a–g; Maestrichtian–Danian, eastern Siberia, USSR; a/b = 5.0.

Pseudointegricorpus kokufuense Takahashi & Shimono n. sp.
Pl. 26, figs. 2-6.

Description: Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium.

Isopolar to subisopolar; one pole broad, with rounded or truncate apex; other pole somewhat narrow, with rounded or conical apex.

Equatorial projections relatively large, prominent, triangular in equatorial view; three meridional colpi across equatorial projections, long, narrow, reaching polar regions; equatorial exine fissures (or colpi) surrounding equatorially central body and projections.

Endexinous thickenings poorly developed. Ornamentation of the central body reticulate; lumen of reticulum 1–3 μ in diameter; muri baculate or clavate, 1–3.2 μ high. Ornamentation of the equatorial projections striate; in equatorial view fine striae approximately perpendicular to the margins of the equatorial projections and running to the margin of the equatorial exine fissures (or colpi). The tip region of the equatorial projections finely punctate.

Size range: Length of the polar axis 50–63 μ; length of the equatorial projections 11–13 μ; equatorial diameter 40–50 μ; breadth of the body 19.5–27.4 μ; breadth of the base of the equatorial projections 15–18 μ; a/b = 3.13–4.2.

Holotype: Pl. 21, figs. 2a–b; length of the polar axis 50 μ; length of the equatorial projections 11 μ; breadth of the body 19.5 μ; breadth of the base of the equatorial projections 16 μ; lumen of reticulum 1–2 μ; muri 1.5 μ high; a/b = 3.13; slide GN 2806; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

Occurrence: Abundant, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 4 and 6.

Comparison: Apparently similar grains have been described by S. R. Samoilovich (1965) as Integricorpus clarireticulatus Samoilovich and later have been illustrated by her (1967) as I. sp. 1 and I. sp. 2. The present specimens differ from I. clarireticulatus
in morphological forms of the central body and the equatorial projections.

Botanical affinity: Unknown.

Pseudointegricorpus protrusum Takahashi & Shimono n. sp.
Pl. 19, figs. 11–14; pl. 20, figs. 1–5.

Description: Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium.

Isopolar to subisopolar; one pole well-developed, with rounded or somewhat truncate apex; other pole well-developed, often narrower, with rounded apex.

Three equatorial projections large, remarkable, lozenge-shaped in lateral view; projecting with triangular outline from the body; three meridional colpi across equatorial projections, long, narrow, often gaping, reaching polar regions; equatorial exine fissures (or colpi) narrow, 1–1.5 μ wide, dividing equatorially the body and equatorial projections into two parts.

Exine two-layered; endexinous thickenings poorly developed. Ornamentation of the body reticulate, lumina 1–5 μ in diameter, muri baculate to verrucate, 1–2 μ high. Ornamentation of the equatorial projection consists of fine striae, which are running to the equatorial furrows to meet approximately at right angles with the margins of the equatorial projections. The apex region of the equatorial projections finely punctate.

Size range: Length of the polar axis 73–100 μ; length of the equatorial projections (parts out of the body) 11.5–14 μ; equatorial diameter 34–56 μ; breadth of the body 21–38 μ; breadth of the equatorial projections 19–29 μ; a/b = 3.19–4.33.

Holotype: Pl. 19, figs. 14; pl. 20, figs. 2a–b; length of the polar axis 79 μ; length of the equatorial projections 11.5 μ; equatorial diameter 43 μ; breadth of the body 22 μ and 27 μ; breadth of the equatorial projections 22 μ; a/b = 3.59; slide GN 2808; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

Occurrence: Abundant, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 5 and 6.

Comparison: The present specimens are closely similar to Integricorpus sp. 1 (S. R. Samoilovich, 1967, pl. 3, fig. 16). They can be distinguished from Pseudointegricorpus kokufuense in its large size.

Botanical affinity: Unknown.

Pseudointegricorpus fragile Takahashi n. sp.
Pl. 20, figs. 6a–b; pl. 21, fig. 1.

Description: Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium.

Subisopolar; one pole well-developed, broad, with rounded apex; other pole well-developed, somewhat narrower than the former, with rounded apex.

Equatorial projections relatively large, prominent, triangular in lateral view, broad at base; three meridional colpi across equatorial projections, moderately long, narrow, partly gaping, extending one half the length to poles; equatorial exine fissures (or colpi) running equatorially across the body and equatorial projections. Endexinous thickenings
poorly developed. Exine two-layered (?); ornamentation of the body and projections very finely punctate or chagrenate.

**Size range:** Length of the polar axis 53–75 μ; length of the equatorial projections 9–16 μ; breadth of the body 19–31 μ; breadth of the equatorial projections 13.5–18 μ; a/b = 3.93–4.16.

**Holotype:** Pl. 21, fig. 1; length of the polar axis 75 μ; length of the equatorial projections 12–16 μ; breadth of the body 24 μ and 31 μ; breadth of the equatorial projections 18 μ; a/b = 4.16; slide 61003–5; Miyadani-gawa Formation, north of Miyaji; sample no. A.

**Occurrence:** Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 6 and A.

**Remarks:** The present grains differ from the other species mainly in having punctate or chagrenate ornamentation of exine.

**Botanical affinity:** Unknown.

*Pseudointegricorpus sp.*

Pl. 19, fig. 10.

**Description:** Pollen grains with three equatorially situated apical projections and with one projection each on the proximal and distal polar regions. Subisopolar; one pole with somewhat truncate apex. other pole with narrowly rounded apex. Equatorial projections somewhat long, apex rounded; three meridional colpi across equatorial projections, long, narrow, reaching polar regions; three equatorial exine fissures (or colpi) short, narrow, restricted within equatorial projections.

Exine two-layered. 1 μ thick, thin on equatorial projection; endexinous thickenings as much as 1 μ thick in thickest part, extending from the base of the equatorial projections to the polar regions. Ornamentation finely punctate. Fine puncta arranged in striae. On the equatorial projection striae running polewards.

**Size range:** Length of polar axis 30–33 μ; length of equatorial projections 6–7 μ; breadth of central body 20–22 μ; breadth of equatorial projections 9–11 μ; a/b = 3.0–3.67.

**Occurrence:** Rare, Miyadani-gawa Formation, near the Kanbarra pass, Hida district, Gifu Prefecture; sample no. H.

**Comparison:** This species is similar to *Pseudointegricorpus (al. Aquilapollenites) validum* (Srivastava) Takahashi from the Edmonton Formation (Maestrichtian), Drumheller, Alberta, Canada, but differs from the latter in size and ornamentation.

**Botanical affinity:** Unknown

Genus *Bratzevaea* Takahashi n. gen.

**Generic diagnosis:** Isopolar, triprojectate pollen grains with well-developed equatorial projections and with one polar projection on each apocolpium. Body cylindrical to elongate-ellipsoidal.

Three equatorial projections protruding from an equatorial zone with breadth of one half to one-third the length of the polar axis and bordered with bamboo-like joint
between the equatorial zone and the polar projections, moderately long, narrow, slightly or gradually widened towards the base with rounded apices. Length of body \((a) / \text{breadth of equatorial projections } (b)\) ratio 3.0–4.4.

Tricolpate; colpi across equatorial projections, meridional, long, narrow, distinct, not extending onto the polar projections. Exine two-layered. Endexinous thickenings well-developed in equatorial projections. Ornamentation of body striate; striae directed towards the poles. Ornamentation of equatorial projections smooth or striate; striae directed parallel to the body.

**Remarks:** G. M. Bratzeva (1965) first described *Parviprojectus amurensis* Bratzeva from the Maestrichtian deposits in the Zeia-Bureia depression, the Far East (USSR). The genus *Parviprojectus* is included in the genus *Integricorpus*. However, *P. amurensis* is different from the genus *Integricorpus* in its morphological characteristics. Accordingly, the author, K. Takahashi, proposes to establish a new genus *Bratzevaea* in honor of Dr. G. M. Bratzeva.

Type species: *Bratzevaea amurensis* (Bratzeva, 1965) Takahashi n. comb.

List of previously described species of *Bratzevaea*.

*B. amurensis* (Bratzeva, 1965) Takahashi n. comb., p. 17, pl. 5, figs. 1–5; Maestrichtian, Zeia-Bureia depression, USSR; \(a/b = 3.72\).

**Bratzevaea amurensis** (Bratzeva) Takahashi n. comb.

Pl. 19, figs. 7a–c.


**Dimensions:** Length of polar axis 56 \(\mu\); breadth of polar projections 20 \(\mu\); length of equatorial zone 22.5 \(\mu\); breadth of equatorial zone 23 \(\mu\); length of equatorial projection 16.5 \(\mu\); breadth at base of equatorial projections 12.5 \(\mu\); \(a/b = 4.48\).

**Occurrence:** Very rare, Miyadani-gawa Formation, near the Kanbara pass, Hida district, Gifu Prefecture; sample no. H.

**Remarks:** Only one specimen was found. This is identified with *Parviprojectus amurensis* Bratzeva here assigned to a new genus *Bratzevaea*.

**Botanical affinity:** Unknown.

*Bratzevaea striatella* Takahashi n. sp.

Pl. 19, figs. 8a–b, 9.

**Description:** Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium.

Isopolar; one pole with rounded apex; other pole with rounded apex. Three equatorial projections long, broader at base and narrower at tip; three meridional colpi across equatorial projections, long, narrow, not extending onto the polar projections. An equatorial zone is about half the length of the polar axis, bordered with bamboo-like joints.

Exine two-layered. Endexinous thickenings as much as 4 \(\mu\) thick in thickest part,
restricted to the projections. Ornamentation of grain striated toward the poles.

**Size range**: Length of the polar axis 40–43 μ; breadth of the body 14.5–20.5 μ; length of the equatorial projections 30 μ (?); breadth of the equatorial projections 10–14 μ; a/b = 3.0–4.3.

**Holotype**: Pl. 19, figs. 8a-b; length of the polar axis 40 μ; breadth of the body 14.5 μ; length of the equatorial projections 30 μ (?); breadth of the equatorial projections 14 μ; a/b = 3.0 Slide GN 3885; Miyadani-gawa Formation, near the Kanbara pass; sample no. H.

**Occurrence**: Rare, Miyadani-gawa Formation, near the Kanbara pass, Hida district, Gifu Prefecture; sample no. H.

**Comparison**: The present specimens are superficially similar to *Bratzevaea (al. Parviprojectus) amurensis* (Bratzeva) Takahashi, but differ from the latter in having smaller size, larger equatorial projections and a longer equatorial zone.

**Botanical affinity**: Unknown.

Genus *Pentapollenites* Krutzsch 1958 emend. TAKAHASHI (herein)

**Synonymy**


**Type species**: *Pentapollenites pentangulus* (Pflug, 1953) Krutzsch 1958.

**Emended diagnosis**: Isopolar to heteropolar and tripolar pollen grains with well- or moderately developed equatorial projections and with one poorly developed polar projection on each apocolpium.

Equatorial projections three in number, meridional, well-developed, broader at base and narrower towards the rounded apex. Length of polar axis (a)/breadth of equatorial projections (b) ratio 1.5–1.8. Tricolpate; three meridional colpi across equatorial projections, long, narrow, appearing to extend for a short distance onto body; some colpi gaping at free ends of equatorial projections. Exine two-layered; endexinous thickenings well- or poorly developed, occupying axillae and extending a short distance onto body and one half to one-third the length of equatorial projections. Sculpture of body and equatorial projections variable.

**Remarks**: The genus *Pentapollenites* described from the western and central European lower Tertiary deposits, differs from the genera *Aquilapollenites* and *Hemicorpus* in having a different ratio of length of polar axis/breadth of equatorial projections.

List of previously described species of *Pentapollenites*.

*P. argutus* (Srivastava, 1969) Takahashi n. comb. = (*Aquilapollenites argutus* Srivastava), p. 135, pl. 2, fig. 11; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.63.

*P. comosus* (Srivastava, 1969) Takahashi n. comb. = (*Aquilapollenites comosus* Srivastava), p. 138, pl. 4, fig. 26; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.55.

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987, pl. 3, figs. 47–49; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.59.

P. firmus (Srivastava, 1969) Takahashi n. comb. = (Aquilapollenites firmus Srivastava), p. 138–139, pl. 4, fig. 29; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.69.

P. laevigatus Krutzsch, 1962, p. 88, pl. 1, figs. 1–2; middle and upper Eocene, Geiseltal, Germany; a/b = 1.7–1.8.

P. macroreticulatus Krutzsch, 1962, p. 94, pl. 7, figs. 182–186; middle and upper Eocene, Geiseltal, Germany.

P. minimus (Jard. & Magl., 1965) Takahashi n. comb. = (Aquilapollenites minimus Jard. & Magl.), pl. 9, figs. 31–33; upper Maestrichtian, Senegal; a/b = 1.6–1.67.

P. pentangulus (Pflug, 1953) Krutzsch, 1958, p. 112, pl. 15, figs. 62–64; Palaeogene, Germany; a/b = 1.53–1.61.

P. punctoides Krutzsch, 1962, p. 94, pl. 8, figs. 201–226; middle and upper Eocene, Geiseltal, Germany; (probably Orbiculapollis).

P. pumilis (Srivastava, 1969) Takahashi n. comb. = (Aquilapollenites pumilis Srivastava), p. 141, pl. 6, fig. 41; Edmonton (Maestrichtian), Alberta, Canada; a/b = 1.78.

P. regulatus Krutzsch, 1962, p. 89, pl. 2, figs. 29–57; middle and upper Eocene, Geiseltal, Germany; (probably Orbiculapollis).

P. retangulus Krutzsch, 1962, p. 93, pl. 7, figs 176–181; middle and upper Eocene, Geiseltal, Germany.

P. rombicus (Samoilovich, 1965) Takahashi n. comb. = (Aquilapollenites rombicus Samoilovich), p. 124, text-fig. 3; pl. 1, figs. 3a–g; Maestrichtian–Danian, Eastern Siberia, USSR; a/b = 1.6.

P. semistriatus Krutzsch, 1962, p. 92, pl. 6, figs. 158–169; middle and upper Eocene, Geiseltal, Germany; a/b = 1.56.

P. triangulus Krutzsch, 1962, p. 93, pl. 7, figs. 170–175; middle and upper Eocene, Geiseltal, Germany.

P. striatus Krutzsch, 1962, p. 92–93, pl. 6, figs. 146–157; middle and upper Eocene, Geiseltal, Germany; a/b = 1.66.

P. triangulus Krutzsch, 1962, p. 90, pl. 2, figs. 58–67; middle and upper Eocene, Geiseltal, Germany.

P. verrucatoides Krutzsch, 1962, p. 90, pl. 3, figs. 68–79; middle and upper Eocene, Geiseltal, Germany.

Pentapollenites normalis Takahashi & Shimono n. sp.
Pl. 22, figs. 1–12.


Description: Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium.

Isopolar; proximal and distal polar projections poorly developed, of equal length and breadth, with rounded apices. Three equatorial projections remarkable, tapering from
the broad base to the rounded apex with some spines lined up in two meridional rows in equatorial view; three meridional colpi across equatorial projections, long, narrow, extending at most only a very short distance onto body.

Exine two-layered; axillary endexinous costae poorly developed, occupying axillae and extending about one half to two-thirds the distance to apices of equatorial projections; ektexine thin, punctate to finely granulate; spines on the apical regions of equatorial projections lined up in two meridional files in equatorial view, six to nine in number, 1.5–3 μ long, 1.5–2 μ wide at base, usually oriented towards polar axis of grain. Exine of both polar regions rather smooth.

Size range: Length of the polar axis 24.5–37 μ; breadth of the polar projections 10–18 μ; length of the equatorial projections 8–11 μ; breadth of the equatorial projections 8–11 μ; breadth of the equatorial projections 16–22 μ; equatorial diameter 22.5–36.7 μ; a/b = 1.59–1.69.

Holotype: Pl. 22, figs. 2a–b; length of the polar axis 30.5 μ; breadth of the polar projections 15 μ; length of the equatorial projections 8.5 μ; breadth of the equatorial projections 19 μ; equatorial diameter 35 μ; spines 1.5–2.5 μ long, 1.5–2 μ wide at base; a/b = 1.6; slide GN 2703; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

Occurrence: Abundant. Miyadani-gawa Formation, north of Miyaji, and near the Kanbara pass, Hida district, Gifu Prefecture; samples no. 2, 3, and H.

Remarks: The present specimens are identified with some figures illustrated by G. M. Bratzeva (1965, pi. 2, figs. 4, 7–9) as Aquilapollenites quadrilobus and are closely similar to Aquilapollenites rombicus Samoilovich described and illustrated by S. R. Samoilovich (1965, text-fig. 3; pl. 1, figs. 3a–g; 1967, pl. 3, fig. 22) and G. M. Bratzeva (1969, pl. 27, fig. 7).

Botanical affinity: Unknown.

Pentapollenites miser Takahashi n. sp.

Pl. 22, figs. 13a–b, 14.

Description: Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium.

Isopolar to subisopolar; proximal and distal polar projections more or less well-developed, with rounded or tapered apex. Equatorial projections remarkably developed, with broad base and rounded apex; three meridional colpi across equatorial projections, long, narrow, extending for a short distance onto body.

Exine two-layered; axillary endexinous costae poorly developed, as much as 1 μ thick, extending one half the distance to free ends of equatorial projections, only a short distance onto body of grain; ektexine thin, punctate to finely granulate, but smooth on both polar regions.

Size range: Length of the polar axis 20–22.6 μ; breadth of the polar projections 7–12.5 μ; length of the equatorial projections 5–7.5 μ; breadth of the equatorial projections 13 μ; equatorial diameter 20–26.5 μ; a/b = 1.69–1.77.

Holotype: Pl. 22, figs. 13a–b; length of the polar axis 22.6 μ; breadth of the polar
projections 10 μ and 12.5 μ; length of the equatorial projections 7.5 μ; breadth of the equatorial projections 13 μ; a/b = 1.77; slide GN 2706; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

**Occurrence**: Few. Miyadani-gawa Formation, north of Miyaji. Hida district. Gifu Prefecture; samples no. 2 and 5.

**Comparison**: These specimens are smaller than *P. normalis*.

**Botanical affinity**: Unknown.

*Pentapollenites manifestus* Takahashi & Shimono n. sp.

PI. 23, figs 1–12.

**Description**: Pollen grains with three equatorially situated apical projections and with one projection each on proximal and distal polar region.

Heteropolar; one polar projection well-developed, rounded; other polar projection very much reduced, bluntly conical or dome-shaped.

Equatorial projections developed, with broad base and semicircularly protruded apex. Tricolpate, colpi extending entire length of equatorial projections, apparently extending only a short distance onto body of grain.

Exine two-layered; axillary endexinous costae poorly developed, as much as 1 μ thick in thickest part, extending from the axillae to the neck of semicircularly protruded apical regions, extending only a short distance onto body of grain; ektexine thin, punctate or finely granulate, spines on the apical regions of equatorial projections lined up in two or sometimes three files in equatorial view, six to nine in number, 2–3 μ long, 1.5–2 μ wide at base, usually oriented towards polar axis of grain. Exine of both polar regions smooth.

In polar view: grains triangular, with extended corners, with concave or convex sides; outer ends of equatorial projections slightly flattened in plane parallel to polar axis.

**Size range**: Length of the polar axis 22–29 μ; breadth of the developed polar projection 12–18 μ; length of the equatorial projections 7–14 μ; breadth of the equatorial projections 13–19 μ; equatorial diameter 28–40 μ; semicircularly protruded apical regions 8–13 μ X 5–7 μ; a/b = 1.53–1.79.

**Holotype**: Pl. 23, figs. 2a–b; length of the polar axis 29 μ; breadth of the developed polar projection 18 μ; length of the equatorial projections 13 μ; breadth of the equatorial projections 19 μ; equatorial diameter 33 μ; a/b = 1.53; slide GN 2703; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

**Occurrence**: Abundant. Miyadani-gawa Formation, north of Miyaji, and near the Kanbara pass. Hida district, Gifu Prefecture; samples no. 2, 6, and H.

**Comparison**: The present specimens are similar to *Pentapollenites normalis*, but differ from the latter in having heteropolar form.

**Botanical affinity**: Unknown.


**Synonymy**: 


Diagnosis: Isopolar to subisopolar and triprojectate pollen grains with well- or poorly developed equatorial projections and with undeveloped or only very slightly developed polar projections.

Equatorial projection three in number, long to short, flattened in plane parallel to polar axis. Length of polar axis (a)/breadth of equatorial projections (b) ratio 1.1–1.5. Tricolpate, colpi across equatorial projections, long, narrow, extending, if at all, only a short distance onto polar projections.

Exine two-layered axillary endexinous costae long or short, poorly or well-developed, extending one half to two-thirds the distance to apices of equatorial projections, extending a short distance onto polar projections or not. Sculpture of exine variable.

Remarks: The author, K. Takahashi, separates the genus Fibulapollis from the other genera according to Stanley’s description (1970). However, it seems to him that the genus Cranwellia may represent forms of the genus Fibulapollis.

List of previously described species of Fibulapollis.

F. aptus (Srivastava, 1969) Takahashi n. comb. = (Aquilapollenites aptus Srivastava), p. 134–135, pl. 2, figs. 9–10; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.32.

F. belgicus (Krutzsch & Vanhoorne, 1977) Takahashi n. comb. = (Accuratipollis belgicus Kr. & Vanh.), p. 37, pl. 17, figs. 1–6; upper Landenian, Belgium; (polar view).

F. macgregorii (Srivastava, 1966) Takahashi n. comb. = (Aquilapollenites macgregorii Srivastava), p. 541–542, pl. 9, figs. 9, 15, 16; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b = 1.09.

F. mirificus (Chlonova, 1957) Chlonova, 1961, p. 45, pl. 1, figs. 4–6; Danian–Palaeocene, western Siberian lowland, USSR; a/b = 1.33.

F. enodatus (Chlonova; 1961) Takahashi n. comb. = (Accuratipollis enodatus Chlonova), p. 91, pl. 16, fig. 126; Late Upper Cretaceous, western Siberian lowland, USSR; (polar view).

F. evanidus (Chlonova, 1961) Takahashi n. comb. = (Accuratipollis evanidus Chlonova), p. 91–92, pl. 16, fig. 125; Maestrichtian–Danian, western Siberian lowland; (polar view).

F. plicatilis (Chlonova, 1961) Stanley, 1970, p. 89, pl. 16, figs. 121–122; Late Upper Cretaceous, western Siberian lowland, USSR; a/b = 1.5.

F. psilatus (Srivastava, 1966) Takahashi n. comb. = (Aquilapollenites psilatus Srivastava), p. 542–543, pl. 9, fig. 14; Edmonton Formation (Maestrichtian), Alberta, Canada; a/b
Maestrichtian Microflora of the Miyadani-gawa Formation in the Hida District, Central Japan

F. punctatus Chlonova, 1961, p. 87, pl. 15, fig. 114; Maestrichtian, western Siberian lowland, USSR; a/b = 1.33.

F. pyriformis (Norton, 1965) Takahashi n. comb. = (Aquilapollenites pyriformis Norton), p. 136–140, pl. 1, figs. 1–3; pl. 2, fig. 4; Hell Creek Formation (Maestrichtian), Montana, U. S. A.; a/b = 1.3–1.43.

Fibulapollis hamulatus Takahashi n. sp.

Pl. 23, figs. 13a–b.

Description: Pollen grains with three equatorially situated apical projections and with one very slightly developed projection each on proximal and distal polar region. Isopolar; both polar projections swelling very slightly, dome-shaped. Equatorial projections large, with broad base, narrower gradually to the apex. Tricolpate, colpi across equatorial projections, long, narrow, extending only a short distance onto body of grain.

Exine two-layered; endexinous thickenings poorly developed, occupying axillae and extending about two-thirds the distance to apices of equatorial projections; ectexine thin, punctate or finely granulate; spines on the apical regions of equatorial projections lined up in two meridional files in equatorial view, about seven in number, 1.5–2.5 µ long, 1.5–2 µ wide at base, usually oriented towards polar axis of grain.

Size range: Length of the polar axis 20–21 µ; breadth of the polar projections 11–12 µ; length of the equatorial projections 9–11 µ; breadth of the equatorial projections 18–19 µ; a/b = 1.11.

Holotype: Pl. 23, figs. 13a–b; length of the polar axis 20 µ; breadth of the polar projections 11 µ; length of the equatorial projections 18 µ; equatorial diameter 30.5 µ; a/b = 1.11; slide GN 2707; Miyadani-gawa Formation, north of Miyaji; sample no. 2.

Occurrence: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

Comparison: This species can be distinguished from Pentapollenites normalis in having only very slightly developed polar projections and from Fibulapollis mirificus and F. punctatus in having large spines on the apical regions of equatorial projections.

Botanical affinity: Unknown.

Fibulapollis pusillus Takahashi n. sp.

Pl. 23, figs. 14–16.

Description: Pollen grains with three equatorially situated apical projections and with very slightly developed projection each on proximal and distal polar region. Isopolar to subisopolar; both polar projections swelling very slightly, small conical or dome-shaped. Equatorial projections small, triangular with rounded or somewhat angular apex. Tricolpate, colpi extending full length of equatorial projections, extending a short distance (?) onto polar projections.

Exine two-layered; axillary endexinous costae developed, as much as 2 µ thick in
thickest part, extending full length of equatorial projections excepting apical regions, extending a short distance onto polar projections; ektexine thin, poorly preserved, smooth (?) to finely punctate.

**Size range:** Length of the polar axis 16.5–23 μ; breadth of the polar projections 7–12 μ; length of the equatorial projections 7–12 μ; breadth of the equatorial projections 13–18 μ; equatorial diameter 19.5–24.5 μ; a/b = 1.31–1.5.

**Holotype:** Pl. 23, figs. 14a–b; length of the polar axis 20.5 μ; breadth of the polar projections 10 μ; length of the equatorial projections 7 μ; breadth of the equatorial projections 14 μ; equatorial diameter 20 μ; a/b = 1.5; slide GN 2764; Miyadani-gawa Formation, north of Miyaji; sample no. 4.

**Occurrence:** Few. Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 4 and 5.

**Comparison:** This species is smaller than *Fibulapollis mirificus* and *F. punctatus*.

**Botanical affinity:** Unknown.

**Genus Cranwellia Srivastava 1966 emend. Srivastava 1969.**

**Type species:** *Cranwellia striata* (Couper 1953) Srivastava 1969.

List of previously described species of *Cranwellia*.

C. *edmontonensis* Srivastava, 1966, p. 538, pl. 11, fig. 9, Edmonton Formation (Maestrichtian), Alberta, Canada.

C. *rumeyensis* Srivastava, 1966, p. 538, pl. 11, figs. 3, 7; Edmonton Formation (Maestrichtian), Alberta, Canada.


**Cranwellia striata** (Couper Srivastava)

Pl. 10, figs. 16–23.

1966 *Cranwellia striata* (Couper Srivastava), Pollen et Spores, vol. 8, no. 3, p. 537–538, pl. 11, figs. 1, 4.

**Dimensions:** Isopolar, tricolpate pollen grains; grain size 21.5–31 μ in equatorial diameter (figs. 16–17), 21–28 μ X 17–25 μ (equatorial diameter X polar axis) (figs. 18–23); exine with striae rectangular to the equatorial outline in polar view.

**Occurrence:** Common. Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 3 and 6.

**Remarks:** R. A. Couper (1953) described *Elytranthe striatus* Couper from lower Oligocene to upper Miocene of New Zealand. The genus *Cranwellia* was proposed by S. K. Srivastava (1966) to accommodate all such fossil pollen grains which show a similarity or affinity with the pollen of the extant genus *Elytranthe*. However, the morphological characteristics of *Cranwellia* are very closely similar to that of the genus *Fibulapollis*.

**Botanical affinity:** Loranthaceae.
Genus *Orbiculapollis* CHONNOVA 1961 emend. TAKAHASHI (herein)

**Synonymy:**


**Type species:** *Orbiculapollis globosus* (CHONNOVA, 1957) CHONNOVA 1961.

**Emended diagnosis:** Isopolar to subisopolar or heteropolar and triprojectate pollen grains with slightly or poorly developed equatorial projections and with well-developed polar projections or with one developed polar projection and other reduced polar projection.

Equatorial projections three in number, small, semicircular, dome-shaped in equatorial view or small tubercle-shaped, flattened in plane parallel to polar axis. Length of polar axis (a)/breadth of equatorial projections (b) ratio 1.4–2.2. Tricolpate, colpi across equatorial projections, extending in some cases onto body of grain. Exine thin; endexinous thickenings poorly or well-developed, long or short, may extend onto body and equatorial projections. Ornamentation of grain variable.

**Remarks:** The genus *Orbiculapollis* showing occurrence restricted stratigraphically and geographically, must belong to the Triprojectacites pollen group, as it possesses three equatorial projections and three meridional colpi.

List of previously described species of *Orbiculapollis*.

O. *faber* CHONNOVA, 1961, p. 88–89, pl. 15, fig. 117; Late Upper Cretaceous, western Siberian lowland, USSR; a/b = 2.0.

O. *globosus* (CHONNOVA, 1957) CHONNOVA, 1961, p. 46, pl. 1, fig. 7; upper Senonian-Palaeocene, Siberia-Saghalien, USSR; (polar view).

O. *latus* CHONNOVA, 1961, p. 88, pl. 15, fig. 116; Late Upper Cretaceous, western Siberian lowland, USSR; a/b = 1.73.

O. *lucidus* CHONNOVA, 1961, p. 89, pl. 15, fig. 118; Maestrichtian–Danian, western Siberian lowland, USSR; a/b = 2.13.

O. *minutus* (MCHELEISHVILI, 1961) KRUTZSCH, 1970, p. 246, pl. 80, figs. 4a–b, 5a–b; Maestrichtian, western Siberian lowland, USSR; a/b = 1.59.

*Orbiculapollis lucidus* CHONNOVA

Pl. 10, figs. 24–26.


**Dimensions:** Length of polar axis 26.4–36.5 μ; breadth of polar projections 17–19.5 μ; length of equatorial projections 3.3–9 μ; breadth of equatorial projections 12.5–20 μ; equatorial diameter 23–28.5 μ; a/b = 1.63–2.11.

**Occurrence:** Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

**Remarks:** The present specimens belong to *Orbiculapollis lucidus* CHONNOVA from
Maestrichtian–Danian strata, western Siberian lowland, in spite of its somewhat larger size.

*Botanical affinity:* Unknown.

*Orbiculapollis moderatus* **Takahashi** n. sp.

Pl. 10, figs. 27a–b, 28.

*Description:* Pollen grains with three equatorially situated apical projections and with one polar projection on each apocolpium.

Isopolar to subisopolar; proximal and distal polar projections well-developed, with rounded apices. Equatorial projections small, dome-shaped. Tricolpate, colpi across equatorial projections, relatively long, narrow, extending one half to two-thirds the distance to poles of body.

Exine two-layered; axillary endexinous costae developed, as much as 1 \(\mu\) thick, occupying axillae and extending one half to two-thirds the distance to poles of body; ektexine thin, finely punctate to chagrenate.

*Size range:* Length of the polar axis 22–29 \(\mu\); breadth of the polar projections 13–16.5 \(\mu\); length of the equatorial projections 3–4 \(\mu\); breadth of the equatorial projections 10–13 \(\mu\); equatorial diameter 21–22 \(\mu\); \(a/b\) = 2.2–2.23.

*Holotype:* Pl. 10, figs. 27a–b; length of the polar axis 29 \(\mu\); breadth of the polar projections 16.5 \(\mu\); length of the equatorial projections 4 \(\mu\); breadth of the equatorial projections 13 \(\mu\); equatorial diameter 22 \(\mu\); \(a/b\) = 2.23; slide GN 2818; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

*Occurrence:* Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

*Comparison:* The present specimens are similar to *Orbiculapollis lucidus* Chlonova, but differ from the latter in having finely punctate exine.

*Botanical affinity:* Unknown.

**Turma Poroses Naumova 1937 emend. Potonie 1960.**

**Subturma Monoporines Naumova 1937 emend. Potonie 1960.**

**Genus Graminidites Cookson 1947 ex Potonie 1960.**

Type species: *Graminidites media* **Cookson** 1947 ex **Potonie** 1960.

*Graminidites sp.*

Pl. 9, fig. 21.

*Description:* Monoporate pollen grain. Figura subcircular in outline. Pore single, 3.5 \(\mu\) in diameter, surrounded by annulus (?). Exine thin, chagrenate, with secondary folds. Grain size 24 X 21 \(\mu\).

*Occurrence:* Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 2.

*Remarks:* Only one specimen was found.

*Botanical affinity:* Gramineae.

Type species: Engelhardtioidites microcoryphaeus (POTONIE 1931) POTONIE 1960.

Engelhardtioidites cf. microcoryphaeus (POTONIE) POTONIE
Pl. 9, figs. 22–23.

1931 Pollenites microcoryphaeus POTONIE, Z. Braunkohle, H. 16, 30 Jahrg., S. 332, Taf. 2, Fig. 13.

1950 Engelhardtioidites microcoryphaeus (POTONIE) POTONIE, THOMSON & THIERGART, Geol. Jb., 65, S. 51, Taf. B, Fig. 8; Taf. C, Fig. 16.

1953 Triatriopollenites coryphaeus (POTONIE) THOMSON & PFLUG, Palaeontographica, B, 94, S. 81, Taf. 8, Fig. 38–63.

Dimensions: Grain size 16.3–16.5 μ in equatorial diameter; exine thin, smooth or chagrenate; pores small.

Occurrence: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

Comparison: The present specimen are smaller in size than Engelhardtioidites (al. Pollenites) microcoryphaeus described first by R. POTONIE (1931) from the Miocene lignite, near Senftenberg, Germany.

Botanical affinity: Engelhardtia.

Type species: Triporopollenites coryloides PFLUG 1953.

Triporopollenites shimensis TAKAHASHI
Pl. 9, figs. 24–26.


Dimensions: Grain size 20–25 μ in equatorial diameter; exine thin, chagrenate; labrum absent or weak; one pore always subequatorial.

Occurrence: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2, 3, and 5.

Remarks: This species was reported and described abundantly from the Palaeogene formations of west Japan and rarely from the Miocene formations of Japan and Korea. A. MIKI (1972) reported only one specimen of this species from the Sawayama Formation of the Kuji Group (Upper Cretaceous), northeast Japan.

Botanical affinity: Betulaceae.

Genus Betulaepollenites POTONIE 1934 ex POTONIE 1960.
Type species: Betulaepollenites microexcelsus (POTONIE 1931) POTONIE 1934.

Betulaepollenites miyadaniensis TAKAHASHI n. sp.
Pl. 9, fig. 27–28.
**Description**: Triporate pollen grains. Equatorial outline triangular with concave or convex sides. Pores small, somewhat protruding with strong labrum, meridionally elongated, interconnected by arci. Exine thin, chagrenate. Grain size 29–30.5 μ in equatorial diameter.

**Holotype**: Pl. 9, fig. 27; grain size 30.5 μ in equatorial diameter; exine thin, chagrenate, labrum; slide GN 2810; Miyadani-gawa Formation, north of Miyaji; sample no. 6.

**Occurrence**: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

**Comparison**: These specimens are superficially similar to *Betulaepollenites normahs* Takahashi from the Campanian and Maestrichtian Hakobuchi Group of Hokkaido, but differ from the latter in having stronger labrum and small and meridionally elongated pores.

**Botanical affinity**: Betulaceae.

Genus *Subtriporopollenites* Pflug & Thomson 1953.

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

*Subtriporopollenites kyushuensis* Takahashi

Pl. 10, figs. 8–9.


**Dimensions**: Grain size 20–32 μ in equatorial diameter; exine thin, chagrenate, without labrum and annulus.

**Occurrence**: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2 and 6.

**Remarks**: The present specimens belong undoubtedly to *Subtriporopollenites kyushuensis* Takahashi from the Paleogene and Miocene formations of west Japan and from the Campanian lower formation of the Hakobuchi Group, Hokkaido.

**Botanical affinity**: Juglandaceae.


Type species: *Anacolosidites luteoides* Cookson & Pike 1954.

*Anacolosidites* sp.

Pl. 10, fig. 7.

**Description**: Triporate pollen grain. Figura round-triangular in polar view, with convex or concave sides. Three pores usually close to the angles, 1.4 μ in diameter. Exine thin, chagrenate. Grain size 24.5 μ in equatorial diameter.

**Occurrence**: Very rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.
Remarks: Only one specimen was found. This belongs apparently to the genus *Anacolosidites*. However, the authors cannot assign it to any described species.

*Botanical affinity:* Olacaceae. *Anacolosa.*


Type species: *Ulmoidieipites krempi* Anderson 1960.

*Ulmoidieipites fornicatus* Takahashi n. sp.

Pl. 10. figs 1–6.

*Description:* Pollen grains with three and occasionally four pores. Figura triangular to round-triangular in polar view. Pores equatorial or slightly subequatorial, circular or elliptical in outline, about 2 μ in diameter, and with a slight annulus; annuli continuous with distinct arci. Exine thin, with ulmoid sculpture. Grain size 17–25.5 μ in equatorial diameter.

*Holotype:* Pl. 10, fig. 5; grain size 21 μ in equatorial diameter; exine thin, with ulmoid sculpture; annulus continuous with distinct arci; slide GN 2806; Miyadan-gawa Formation, north of Miyaji; sample no. 6.

*Occurrence:* Common, Miyadan-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

*Comparison:* The present ulmoid specimens are similar to *Ulmoidieipites krempi* Anderson from the Uppermost Cretaceous (?) to lowermost Palaeocene Ojo Alamo Sandstone, New Mexico, U. S. A. and *Betulaepollenites minutulus* Takahashi from the Maestrichtian Sandstones of the upper formation of the Hakobuchi Group of Hokkaido, but differ from *U. krempi* in having smaller pores and thinner exine and from *B. minutulus* in having ulmoid sculpture of exine.

*Botanical affinity:* Ulmaceae.

Genus *Ulmipollenites* Wolff 1934.

Type species: *Ulmipollenites undulosus* Wolff 1934.

*Ulmipollenites undulipunctatus* Takahashi n. sp.

Pl. 10. figs. 12–15.

*Description:* Polyporate pollen grains. Figura circular to round-quadrilateral in polar view. Pores usually four (occasionally five), equatorial or subequatorial, circular or elliptical in outline, 2 μ or less in diameter, with a slight annulus; annuli connected with distinct or indistinct arci (or folds). Exine thin, with such fine ulmoid sculpture as granule. Grain size 24–27 μ in equatorial diameter.

*Holotype:* Pl. 10, fig. 14; grain size 24.3 μ in equatorial diameter; four pores; slide GN 2806; Miyadan-gawa Formation, north of Miyaji; sample no. 6.

*Occurrence:* Few, Miyadan-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; sample no. 6.

*Remarks:* This new species is similar to *Ulmipollenites undulosus* Wolff, but pos-
sesses finer ulmoid sculpture than the latter.

**Botanical affinity**: Ulmaceae, *Ulmus*.

**Genus Polyvestibulopollenites** Pflug 1953.

Type species: *Polyvestibulopollenites verus* (Potonié 1931) Thomson & Pflug 1953.

**Polyvestibulopollenites eminens** Takahashi

Pl. 10, figs. 10–11.


**Dimensions**: Grain size 22–25.5 µ in equatorial diameter; four pores, with labrum and vestibulum, interconnected by arc; exine thin, chagrenate.

**Occurrence**: Rare, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no 2 and 6.

**Remarks**: The present specimens are identified with *Polyvestibulopollenites eminens* Takahashi from the Palaeogene and Miocene formations of west Japan and the Upper Cretaceous and Palaeogene strata of Hokkaido.

**Botanical affinity**: Alnus.

**Genus Wodehousea** Stanley 1961.

Type species: *Wodehousea spinata* Stanley 1961.

**Wodehousea aspera** (Samoilovich) Wiggins

Pl. 11, figs. 1–3.

1961 *Kryshtofoviana aspera* Samoilovich, Trudy VNIGRI no. 177, p. 234, pl. 75, figs. 4a–c, 5.


**Dimensions**: Grain size 28.5–36.5 µ X 25–36 µ; figs. 1a–b: 34 X 36 µ, fig. 2: 28.5 X 25 µ, fig. 3: 36.5 X 30.5 µ; breadth/length ratio ca. 0.84–1.06.

**Occurrence**: Few, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no 2, 5, and 6.

**Remarks**: The genus *Wodehousea* was proposed by E. A. Stanley (1961). However, *Wodehousea* was corrected by S. K. Srivastava (1969) as *Wodehousea* [I.C.B.N. Rec. 73 B (1956)]. Accordingly, *Kryshtofoviana aspera* must be named as *Wodehousea aspera*.

**Age and distribution**: Upper Maestrichtian, arctic North Slope, Alaska; Maestrichtian, Siberia.

**Botanical affinity**: Unknown.
Wodehousea gracilis (Samoilovich) Pokrovskaya

Pl. 11, figs. 4–14.

1961 Kryshtofoviana gracile Samoilovich, Trudy VNIGRI, no. 177, p. 236, pl. 62, fig. 12; pl. 76, figs. 1a–c.


Dimensions: Grain size 39–50 μ X 26.5–38 μ; pores elliptical, 4–8 μ X 2–3 μ in diameter; many spines.

Occurrence: Common, Miyadani-gawa Formation, north of Miyaji, Hida district, Gifu Prefecture; samples no. 2, 3, 4, 5, and 6.

Comparison: Wodehousea gracilis possesses many spines on the body and a wider flange. Morphologically the present specimens appear to be closely comparable to those of W. gracilis (Samoilovich) Pokrovskaya from the Maestrichtian–Danian sediments of western Siberian lowland (USSR), the Edmonton Formation (Maestrichtian) of Canada, and the Upper Maestrichtian sediments of arctic North Slope (Alaska).

Age and distribution: Maestrichtian–Danian, western Siberian lowland; Maestrichtian, Edmonton Formation, Canada; Upper Maestrichtian, arctic North Slope, Alaska.

Botanical affinity: Unknown.

References


Kiyoshi Takahashi and Hiroshi Shimono


Sung, T. C. et al. (1978) : Early Tertiary spores and pollen grains from the coastal region


Explanation of plate 1
(All figures magnified X 1000 unless otherwise mentioned)

Figs. 1–3. *Pediastrum simplex* (Meyen) Lemmermann var. *duodenarium* (Bailey) Rabenhorst
Figs. 1a, 2, 3a: X 400; figs. 1a–b: slide GN 2703; fig. 2: slide GN 2707; figs. 3a–b: slide GN 2708.

Figs. 4a–b. *Leiotriletes* sp.
Fig. 4a: X 400; slide GN 3881.

Figs. 5–8. *Leiotriletes rotundiformis* (Maljavkina) Chlonova
Fig. 5: slide 61003-2; figs. 7, 8: slide GN 2702; fig. 6: slide GN 2706.
Explanation of plate 2
(All figures magnified X 1000)

Figs. 1–2. *Leiotrilletes rotundiformis* (Maljavkina) Chlonova
   Fig. 1: slide GN 2728; fig. 2: slide GN 3896.

Fig. 3. *Deltoidospora cascadenisis* Miner Slide 61003–2.

Figs. 4–5. *Biretisporites incrassatus* Takahashi & Shimono n. sp.
   Figs. 4a–b: slide GN 2768; fig. 5: holotype, slide GN 3883.

Fig. 6. *Leiotrilletes cf. convexiformis* Chlonova Slide GN 3883.

Figs. 7–8. *Stereisporites pseudostereoides* Takahashi
   Fig. 7: slide GN 2811; fig. 8: slide GN 2702.

Figs. 9a–b. *Stereisporites* sp. Slide GN 3899.

Figs. 10–13. *Undulatisporites unduliradius* Takahashi n. sp.
   Fig. 10: holotype, slide GN 2710; fig. 11: slide GN 2702; fig. 12: slide GN 2705; fig. 13: slide GN 2706.

   Fig. 14: holotype, slide GN 2809; fig. 15: slide GN 3883.

Fig. 16. *Triplanosporites sinuosus* Pflug Slide GN 2806.

Figs. 17–19. *Osmundacidites minor* Takahashi & Shimono n. sp.
   Fig. 17: slide GN 3885; fig. 18: holotype, slide GN 2702; fig. 19: slide 61003–1.

Figs. 20a–b. *Duplosporis* sp. Slide GN 3882.
Explanation of plate 3
(All figures magnified X 1000)

Figs. 1–2. *Osmundacidites wellmanii* Couper
Figs. 1a–b: slide GN 2706; fig. 2: slide GN 61003–2.

Figs. 3–5. *Trilites granatus* (Bolchovitina) Takahashi & Shimono n. comb.
Fig. 3: slide GN 2728; fig. 4: slide 61003–2; figs. 5a–b: slide 61003–5.

Figs. 6–7. *Trilites consimilis* Takahashi & Shimono n. sp.
Fig. 6: holotype, slide GN 2818; fig. 7: slide GN 2813.

Figs. 8–9. *Echinatisporis sphaericus* Takahashi n. sp.
Fig. 8: slide GN 2806; fig. 9: holotype, slide 61003–5.

Fig. 10. *Cicatricosisporites cooksonii* Balme Slide 61003–5.

Fig. 11. *Appendicisporites exilioides* (Bolchovitina) Takahashi n. comb.
Slide GN 2806.
Explanation of plate 4
(All figures magnified X 1000 unless otherwise mentioned)

Figs. 1–3. *Cicatricosisporites cuneiformis* Pocock
Figs. 1a–b: slide 61003–1; fig. 2: slide 61003–5; fig. 3: slide 61003–2.

Fig. 4. *Retitriletes cf. punctoides* Krutzsch Slide GN 2818.

Fig. 5. *Inundatisporis* sp. Slide 61003–5.

Figs. 6–10. *Hidaspora ishiharae* Takahashi & Shimono n. gen. et sp.
Slide 61003–5; figs. 6a–b: holotype; figs. 6a, 7–10: X 400.
Explanation of plate 5
(All figures magnified X 1000)

Figs. 1–2. *Hidaspora ishiiharae* Takahashi & Shimono n. gen. et sp.
Slide 61003-5.

Fig. 3: slide 3883; fig. 4: slide GN 2710.

Fig. 5. *Equisetosporites* sp. Slide GN 2704.

Figs. 6–7. *Laevigatosporites dehiscens* Takahashi
Fig. 6: slide GN 2702; fig. 7: slide GN 2808.

Figs. 8–13. *Laevigatosporites senonicus* Takahashi
Fig. 8: slide GN 2726; fig. 9: slide GN 2728; fig. 10: slide GN 3883; fig. 11
slide GN 2787; fig. 12: slide GN 2791; fig. 13: slide GN 2708.

Figs. 14–16. *Laevigatosporites ovoides* Takahashi
Fig. 14: slide GN 2703; fig. 15: slide GN 2730; fig. 16: slide GN 2728.

Fig. 17. *Laevigatosporites prominens* Takahashi Slide GN 2730.
Explanation of plate 6
(All figures magnified X 1000 unless otherwise mentioned)

Figs. 1–2. *Laevigatosporites probatus* Takahashi
Fig. 1: slide GN 2818; fig. 2: slide GN 2703.

Figs. 3a–b. *Laevigatosporites prominens* Takahashi Slide GN 2786.

Fig. 4. *Retitriletes* sp. Slide 61003–5.

Figs. 5–8. *Inaperturopollenites pseudodubius* Takahashi
Fig. 5: slide GN 2790; fig. 6: slide GN 2703; fig. 7: slide GN 2702; fig. 8 slide GN 2706.

Figs. 9–10. *Psophosphaera gigantica* Takahashi & Shimono n. sp.
X 400, slide 61003–5, fig. 10: holotype.

Figs. 11–12. *Psophosphaera aggereloides* (Maljavkina) Chlonova
Fig. 11: slide GN 2790; fig. 12: slide GN 2787.

Figs. 13–15. *Phyllocladidites mawsonii* Cookson ex Couper
Fig. 13: slide GN 2708; fig. 14: slide GN 3882; fig. 15: slide GN 2786.
Explanation of plate 7
(All figures magnified X 1000 unless otherwise mentioned)

Figs. 1–2. *Dacrydiumites punctosaccatus* **Takahashi & Shimono** n. sp.
Fig. 1: slide GN 3884; fig. 2: holotype, slide GN 2806.

Figs. 3–4. *Pinuspollenites microaliformis* (Takahashi) **Takahashi & Shimono** n. comb.
Fig. 3: slide GN 2729; fig. 4: slide GN 2710.

Figs. 5–6. *Piceaepollenites saccellus* **Takahashi**
Fig. 5: slide GN 2790; fig. 6: slide GN 2703.

Figs. 7–9. *Pinuspollenites microaliformis* (Takahashi) **Takahashi & Shimono** n. comb.
Fig. 7: slide GN 3882; fig. 8: slide GN 3884; fig. 9: slide GN 2702.

Fig. 10. *Pinuspollenites* sp. b. Slide 61003–2.

Fig. 11. *Pinuspollenites* sp. a. Slide GN 3886, X 400.

Fig. 12. *Podocarpidites* sp. Slide GN 2811.
Explanation of plate 8  
(All figures magnified X 1000)

Figs. 1–4.  *Cycadopites hidaensis* Takahashi n. sp.  
Figs. 1, 2: slide GN 2704; fig. 3: holotype, slide GN 2730; fig. 4: slide GN 2703.

Figs. 5–6.  *Monocolpopollenites kyushuensis* Takahashi  
Fig. 5: slide GN 2702; fig. 6: slide GN 2703.

Fig. 7.  *Monocolpopollenites* sp.  Slide GN 2703.

Figs. 8–17.  *Pachydermipollenites miyajiensis* Takahashi n. gen. et sp.  
Figs. 8a–b: holotype; figs. 8, 9, 11, 13: slide GN 2806; fig. 14: slide GN 2791;  
fig. 12: slide GN 2815; fig. 10: slide GN 2809; fig. 15: slide GN 2817; fig. 16:  
slide GN 2808; fig. 17: slide GN 2811.

Fig. 18.  *Foveotricolpites* sp.  Slide GN 2767.

Fig. 19.  *Cupuliferoidaepollenites* cf. weylandii (Takahashi) Takahashi  
Slide GN 2819.

Fig. 20.  *Quercoidites umiensis* (Takahashi) Takahashi  
Slide GN 2702.

Figs. 21–22.  *Cupuliferoidaepollenites facetus* (Takahashi) Takahashi  
Fig. 21: slide GN 2703; fig. 22: slide GN 2709.

Figs. 23–24.  *Tricolporopollenites meinohamensis* Takahashi subsp. rotundus Takahashi  
Fig. 23: slide GN 2706; fig. 24: slide GN 2710.

Fig. 25.  *Tricolpopollenites* cf. inamoenus Takahashi  
Slide GN 2702.

Figs. 26–27.  *Striatopollis* cf. striatellus (Takahashi) Takahashi  
Fig. 26: slide GN 2820; fig. 27: slide GN 2811.
Explanation of plate 9
(All figures magnified X 1000)

Figs. 1–2. Striatopollis cf. striatellus (Takahashi) Takahashi
Fig. 1: slide GN 2707; figs. 2a–b: slide GN 2706.

Figs. 3–5. Tricolpites reticosus Takahashi
Fig. 3: slide GN 2707; figs. 4a–b: slide GN 2806; fig. 15: slide 2702.

Figs. 6–7. Tricolpites minutiretiformis (Takahashi) Takahashi n. comb.
Fig. 6: slide GN 2813; fig. 7: slide GN 3883.

Fig. 8. Retitricolporites misellus Takahashi: Slide GN 2806.

Figs. 9–11. Tricolporopollenites punctulatus Takahashi n. sp.
Figs. 9, 11: slide GN 2806; fig. 10: holotype, slide GN 2703.

Fig. 12. Tricolporopollenites sp. a. Slide GN 2806.

Fig. 13. Tricolporopollenites sp. b. Slide GN 2703.

Fig. 14. Tricolporopollenites sp. c. Slide GN 2806.

Fig. 15. Tricolporopollenites sp. d. Slide GN 2706.

Figs. 16–17. Tricolporopollenites punctulatus Takahashi n. sp.
Fig. 16: slide GN 2706; fig. 17: slide GN 2818.

Fig. 18. Foveotricolporites sp. Slide GN 2806.

Figs. 19a–b. Callistopollenites cf. tumidoporus Srivastava
Slide GN 2790.

Fig. 20. Callistopollenites radiatostriatus (Mchedlishvili) Srivastava
Slide GN 2806.

Fig. 21. Graminidites sp. Slide GN 2706.

Figs. 22–23. Engelhardtiodites cf. microcoryphaeus (Potonie) Potonie
Fig. 22: slide GN 2815; fig. 23: slide GN 2808.

Figs. 24–26. Triporopollenites shemensis Takahashi
Fig. 24: slide GN 2703; fig. 25: slide GN 2729; fig. 26: slide GN 2791.

Figs. 27–28. Betulaepollenites miyadaniensis Takahashi n. sp.
Fig. 27: holotype, slide GN 2810; figs.: slide GN 2812.
Figs. 1–6. *Ulmoideipites fornicatus* Takahashi n. sp.
Fig. 1: slide GN 2816; figs. 2, 3: slide GN 2809; fig. 4: slide GN 2817; fig. 5: holotype, slide GN 2806; fig. 6: slide GN 2811.

Fig. 7. *Anacolosidites* sp. Slide GN 2806.

Figs. 8–9. *Subtriporopollenites kyushuensis* Takahashi
Fig. 8: slide GN 2706; fig. 9: slide GN 2807.

Figs. 10–11. *Polyvestibulopollenites eminens* Takahashi
Fig. 10: slide GN 2707; fig. 11: slide GN 2808.

Figs. 12–15. *Ulmipollenites undulipunctatus* Takahashi n. sp.
Figs. 12a–b: slide GN 2806; fig. 13: slide GN 2811; fig. 14: holotype, slide GN 2806; fig. 15: slide GN 2810.

Figs. 16–23. *Cranwellia striata* (Couper) Srivastava
Figs. 16, 20: slide GN 2808; fig. 17: slide GN 2809; figs. 18a–b, 21a–b: slide GN 2811; figs. 19a–b: slide GN 2813; fig. 22: slide GN 2728; fig. 23: slide GN 2726.

Figs. 24–26. *Orbiculapollis lucidus* Chlonova
Figs. 24, 25: slide GN 2807; figs. 26a–b: slide GN 2811.

Figs. 27–28. *Orbiculapollis moderatus* Takahashi n. sp.
Figs. 27a–b: holotype, slide GN 2818; fig. 28: slide GN 2806.
Plate 10
Explanation of plate 11
(All figures magnified X 1000)

Figs. 1–3.  *Wodehousea aspera* (Samoilovich) Wiggins
Figs. 1a–b: slide GN 2811; fig. 2: slide GN 2791; fig. 3: slide GN 2708.

Figs. 4–14.  *Wodehousea gracilis* (Samoilovich) Pokrovskaya
Fig. 4: slide GN 2791; fig. 5: slide GN 2806; fig. 6: slide GN 2786; fig. 7: slide GN 2789; fig. 8: slide GN 2792; fig. 9: slide GN 2770; fig. 10: slide GN 2768; fig. 11: slide GN 2702; fig. 12: slide GN 2703; fig. 13a–b: slide GN 2707; fig. 14: slide GN 2706.
Explanation of plate 12
(All figures magnified X 1000 unless otherwise mentioned)

Figs. 1–7. *Aquilapollenites kasaharae* Takahashi & Shimono n. sp.
Figs. 1, 2, 3: slide GN 2808; fig. 4: slide GN 2807; fig. 5: slide 61003–5; figs 6a–b: slide GN 2806; fig. 7: slide GN 2812; fig. 1: holotype; fig. 2, 5: X 400.

Figs. 8a–b. *Aquilapollenites doliiformis* Takahashi & Shimono n. sp.
Holotype, slide GN 2808; fig. 8a: X 400.
Explanation of plate 13
(All figures magnified X 1000 unless otherwise mentioned)

Fig. 1. *Aquilapollenites doliiformis* TAKAHASHI & SHIMONO n. sp.
Holotype, slide GN 2808.

Figs. 2–6. *Aquilapollenites aemulus* TAKAHASHI & SHIMONO n. sp.:
Figs. 2a–c: holotype, slide GN 2705; figs. 3a–c: slide GN 2806; fig. 4: slide GN 2703; fig. 5: slide GN 2704; fig. 6: slide GN 2706.

Figs. 7–8. *Aquilapollenites longissimus* TAKAHASHI & SHIMONO n. sp.
X 400; fig. 7: holotype, slide 61003–3; fig. 8: slide 61003–5.

Figs. 9a–b. *Aquilapollenites proprius* TAKAHASHI & SHIMONO n. sp.
Holotype, slide GN 2809; fig. 9b: X 400.
Explanation of plate 14
(All figures magnified X 1000)

Figs. 1–2. *Aquilapollenites quadrilobus* Rouse
Figs. 1a–b: slide GN 2702; fig. 2: slide GN 2703.

Fig. 3. *Aquilapollenites asper* McEdlshvili Slide GN 2793.

Figs. 4–5. *Aquilapollenites brevialatus* Takahashi & Shimono n. sp.
Figs. 4a–c: holotype, slide GN 2706; fig. 5: slide GN 2727.

Figs. 6–8. *Aquilapollenites subtilis* McEdlshvili
Fig. 6: slide GN 2703; figs. 7a–c: slide GN 2709; fig. 8: slide GN 2816.
Explanation of plate 15
(All figures magnified X 1000)

Figs. 1–3. *Aquilapollenites subtilis* MChEdlishvili
Figs. 1a–b: slide GN 2706; figs. 2a–b: slide GN 2808; fig. 3: slide GN 2806.

Figs. 4–7. *Aquilapollenites pseudoaucellatus* Takahashi & Shimono n. sp.
Figs. 4a–c: slide GN 2703; figs. 5a–b: holotype, slide GN 2708; figs. 6a–b: slide GN 2791; fig. 7: slide 61003–5.
Explanation of plate 16
(All figures magnified X 1000)

Figs. 1–2. *Aquilapollenites pseudoaucellatus* TAKAHASHI & SHIMONO n. sp.
Figs. 1a–b: slide GN 2807; figs. 2a–c: slide GN 2811.

Figs. 3–5. *Aquilapollenites latialatus* TAKAHASHI n. sp.
Figs. 3a–b: holotype, slide GN 2709; fig. 4: slide 61003–3; figs. 5a–b: slide GN 2703.

Figs. 6–7. *Aquilapollenites aucellatus* SRIVASTAVA
Figs. 6a–b: slide GN 2812; figs. 7a–b: slide GN 2703.
ExPlanation of plate 17
(All figures magnified X 1000)

Figs. 1–4. Aquilapollenites aucellatus Srivastava
Figs. 1a–b: slide GN 2704; figs. 2a–b: slide GN 2812; figs. 3a–b: slide GN 2706; figs. 4a–b: slide GN 2702.

Figs. 5a–b. Aquilapollenites delectus Takahashi & Shimono n. sp.
Holotype, slide GN 2702.

Fig. 6. Aquilapollenites quadrinus Takahashi Slide GN 2820.

Figs. 7–8. Aquilapollenites melior Takahashi & Shimono n. sp.
Fig. 7: slide GN 2815; fig. 8: holotype, slide GN 2806.

Fig. 9. Aquilapollenites sp. b. Slide GN 2788.
Fig. 10. Aquilapollenites sp. a. Slide GN 2817.
Explanation of plate 18
(All figures magnified X 1000)

Figs. 1–3. *Aquilapollenites melioratus* Takahashi n. sp.
Figs. 1a–b: slide GN 2811; figs. 2a–b: holotype, slide GN 2817; fig. 3: slide GN 2808.

Figs. 4–5. *Aquilapollenites mirus* Takahashi n. sp.
Fig. 4: holotype, slide GN 2807; figs. 5a–b: slide GN 2811.

Figs. 6–10. *Hemicorpus tenue* (Mchedlishvili) Krutzsch
Figs. 6a–b, 8: slide GN 2708; fig. 7: slide GN 2705; fig. 9: slide GN 2702; fig. 10: slide GN 2704.

Figs. 11–13. *Hemicorpus trapeziforme* (Mchedlishvili) Krutzsch
Figs. 11a–b: slide GN 2703; fig. 12: slide GN 2811; fig. 13: slide GN 2702.

Fig. 14. *Hemicorpus sp.* Slide GN 2816.

Fig. 15. ? *Hemicorpus sp.* Slide 61003–3.
Explanation of plate 19
(All figures magnified X 1000 unless otherwise mentioned)

Figs. 1–3. *Hemicorpus miyajiense* Takahashi & Shimono n. sp.
Figs. 1, 3: slide GN 2703; fig. 3: holotype; fig. 2: slide GN 2808.

Figs. 4a–b. *Hemicorpus tripterum* Takahashi n. sp.
Holotype, slide GN 2703.

Figs. 5–6. *Hemicorpus alienum* Takahashi n. sp.
Fig. 5: holotype, slide GN 2811; fig. 6: slide GN 2813.

Figs. 7a–c. *Bratzevaea amurensis* (Bratzeva) Takahashi n. comb.
Slide GN 3883.

Figs. 8–9. *Bratzevaea striatella* Takahashi n. sp.
Figs. 8a–b: holotype, slide GN 3885; fig. 9: slide GN 3881.

Fig. 10. *Pseudointegricorpus* sp. Slide GN 3883.

Figs. 11–14. *Pseudointegricorpus protrusum* Takahashi & Shimono n. sp.
X 400; figs. 11, 13: slide GN 2810; figs. 12, 14: slide GN 2808; fig. 14 holotype.
Explanation of plata 20
(All figures magnified X 1000)

Figs. 1–5. *Pseudointegricorpus protrusum* Takahashi & Shimono
Fig. 1: slide GN 2813; figs. 2a–b: holotype; figs. 2a–b, 3: slide GN 2808;
fig. 4: slide GN 2807; fig. 5: slide GN 2792.

Figs. 6a–b. *Pseudointegricorpus fragile* Takahashi n. sp.
Slide GN 2816.
Explanation of plate 21
(All figures magnified X 1000)

Fig. 1. *Pseudointegricorpus fragile* Takahashi n. sp.
Holotype, slide 61003-5.

Figs. 2–6. *Pseudointegricorpus kokufuense* Takahashi & Shimono n. sp.
Figs. 2a–b: holotype; figs. 2a–b, 3a–b: slide GN 2806; figs. 4a–b: slide GN 2769; fig. 5: slide GN 2813; fig. 6: slide GN 2816.

Figs. 7a–b. *Triprojectus sp.* Slide GN 2702.
Explanation of plate 22
(All figures magnified X 1000)

Figs. 1–12. *Pentapollenites normalis* Takahashi & Shimono n. sp.
Figs. 1a–c: slide GN 2706; figs. 2a–b, 3, 12: slide GN 2703; figs. 2a–b: holotype; fig. 4: slide GN 2726; figs. 5a–b: slide GN 2727; figs. 6a–b: slide GN 2707; figs. 7a–b, 8: slide GN 2708; fig. 9: slide GN 2710; fig. 10: slide GN 2728; figs. 11a–b: slide GN 3884.

Figs. 13a–c: holotype, slide GN 2706; fig. 14: slide GN 2789.
Explanation of plate 23
(All figures magnified X 1000)

Figs. 1–12. *Pentapollenites manifestus* TAKAHASHI & SHIMONO n. sp.
Figs. 1a–b, 2a–b, 4a–b, 8a–b, 9: slide GN 2703; figs. 2a–b: holotype; fig. 3: slide GN 2707; fig. 5: slide GN 2706; fig. 6: slide GN 3894; fig. 7: slide GN 2705; fig. 10: slide GN 2818; figs. 11a–b: slide GN 2813; fig. 12: slide GN 2730.

Figs. 13a–b. *Fibulapollis hamulatus* TAKAHASHI n. sp.
Holotype, slide GN 2707.

Figs. 14–16. *Fibulapollis pusilus* TAKAHASHI n. sp.
Figs. 14a–b: holotype, slide GN 2768; figs. 15a–b: slide GN 2769; fig. 16: slide 2789.

Fig. 17. *Mancicorpus minimum* (CHLONOVA) STANLEY
Slide GN 2806.

Figs. 18a–b. *Mancicorpus cf. albertense* SRIVASTAVA
Slide GN 2811.