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# Microscopic Remains from the Miné Group (Upper Triassic), Yamaguchi Prefecture, Southwest Japan.

By

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**Abstract**

Abundant microscopic remains were revealed from the upper Triassic Miné Group (Carnian) in Yamaguchi Prefecture. The morphological varieties of them were decsribed. It was suggested that the remains will be of a fragment of plant tissues. Their botanical affinities were not known, but the occurrence in certain layers were characteristic.

## Introduction

The Miné Group distributed in Omine-Cho, Miné City and Toyota Town, Toyoura Gun, Yamaguchi Prefecture, is one of the typical deposits of the upper Triassic (mostly Carnian) in the southwestern Japan. This group is well known to the geologists by the fact that it contains many coal layers on the one hand and that distributed closely to the west of the famous Akiyoshi Limestone on the other. The

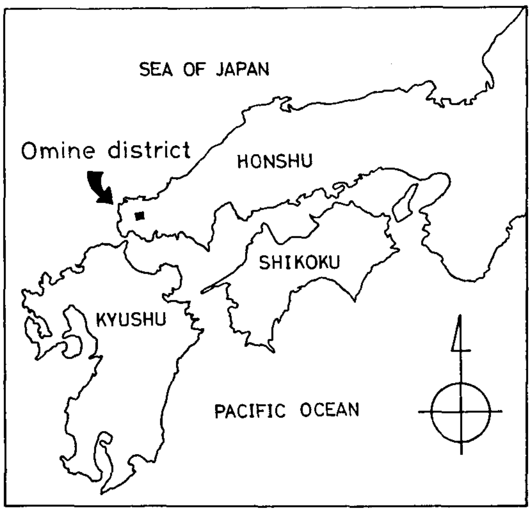


Fig. 1. Index map.

geology of this area, therefore, has been studied extensively by many researchers (SUZUKI, 1904; KATAYAMA, 1939; HASE, 1950 and 1951; KONO, 1951; MURATA, 1961; KAWAI, 1963; TAKAHASHI *et al.*, 1965a, b and c; SAKAMOTO, 1969).

From this group many plant fossils have been reported and the catalog of them was compiled and published (OKAFUJI, 1971). The entire assemblage is called the Miné flora, which belongs to so-called "the Rhaeto-Liassic flora" and is comparable to the lower Taedong flora in Korea, the Mongugai flora in Siberia and the Hongay flora in Vietnam (TAKAHASHI, 1959). The result of these researches have been based principally on megafossils, and no microfossil has so far been reported.

In this investigation thirty samples were obtained from this group in the Omine district, where the contact metamorphism by the granitic rock is not effective, and they were transferred to the author for palynological studies. These were treated as usual for palynological investigation, *i.e.*, with hydrofluoric acid followed by acetolysis. In the smear many organic remains were revealed under the microscope, which have no characteristics to determine definitely them as pollen and/or spore, dinoflagellate and other microfossils hitherto reported. In this paper the author describes and illustrates them for future studies of the area.

## Acknowledgement

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## Geology

The Triassic system in Yamaguchi Prefecture is distributed in three districts, the Asa, the Atsu and the Omine districts respectively (HASE, 1950 and 1951). The Triassic system in the eastern part of the Omine district is in the fault contact with the Limestone breccia, which runs from north to south. The Limestone breccia is contiguous to the Tsunemori Formation (Permian) with the fault of the same direction. In the western part the Nagato tectonic belt running NE-SW direction separates the Triassic system from the Jurassic Toyora Group and the Cretaceous

Kanmon Group.

The followings are the lithologic nature and stratigraphic relation of the Permian and Triassic sequences observed along the road from Aigyo to Mitsusugi through Hirabara and Momonoki (Text-figs. 2 and 3, Table 1).

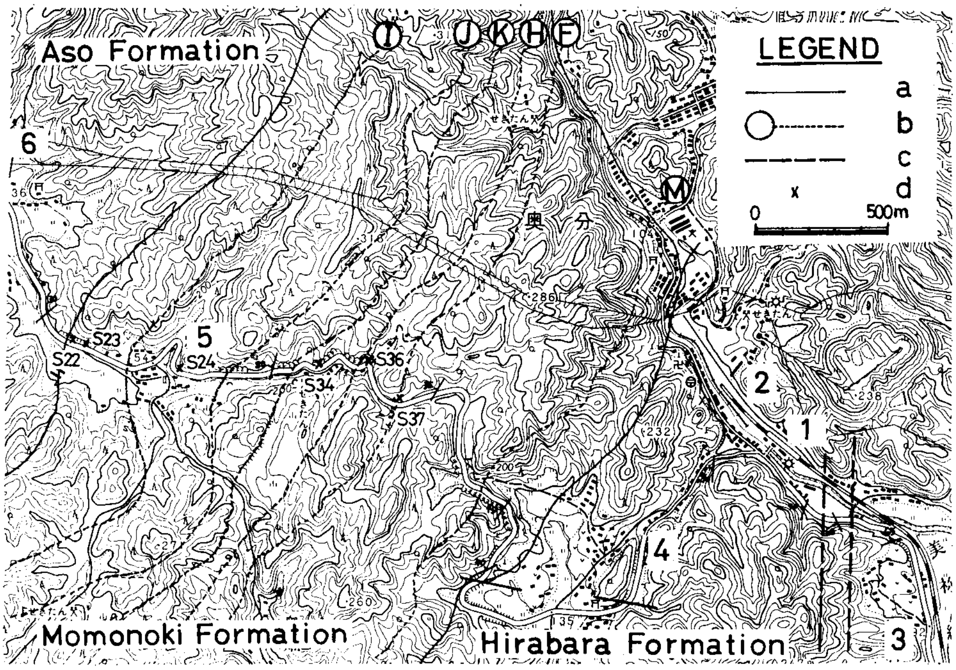



Fig. 2. Locality map. a: bcundary of formation; b: main coal layer; I: Inoki-so; J: Jo-so; K: Ka-so; H: Hazegatani-so; F: Fujigagochi-so; M: Mugikawa-so; c: fault; d: sample locality ; 1: Omine Station; 2: Mugikawa; 3: Aigyo; 4: Hirabara; 5: Momonoki; 6: Mitsusugi.

| Geological age | | Stratigraphical division | | Thickness |
|---|---|---|---|---|
| Cretaceous | | Kanmon Group | | 150m |
| | | Fault | | |
| Triassic | Carnian | Mine Group | Aso Formation | 1500m |
| | | | Momonoki Formation | 750m |
| | | | Hirabara Formation | 400m |
| | | Fault | | |
| uncertain | | Limestone breccia | | 80m |
| | | Fault | | |
| Permian | | Tsunemori Formation | | 200m+ |

Table 1. Stratigraphical successions along the Miné-Hohoku Prefedtural road.

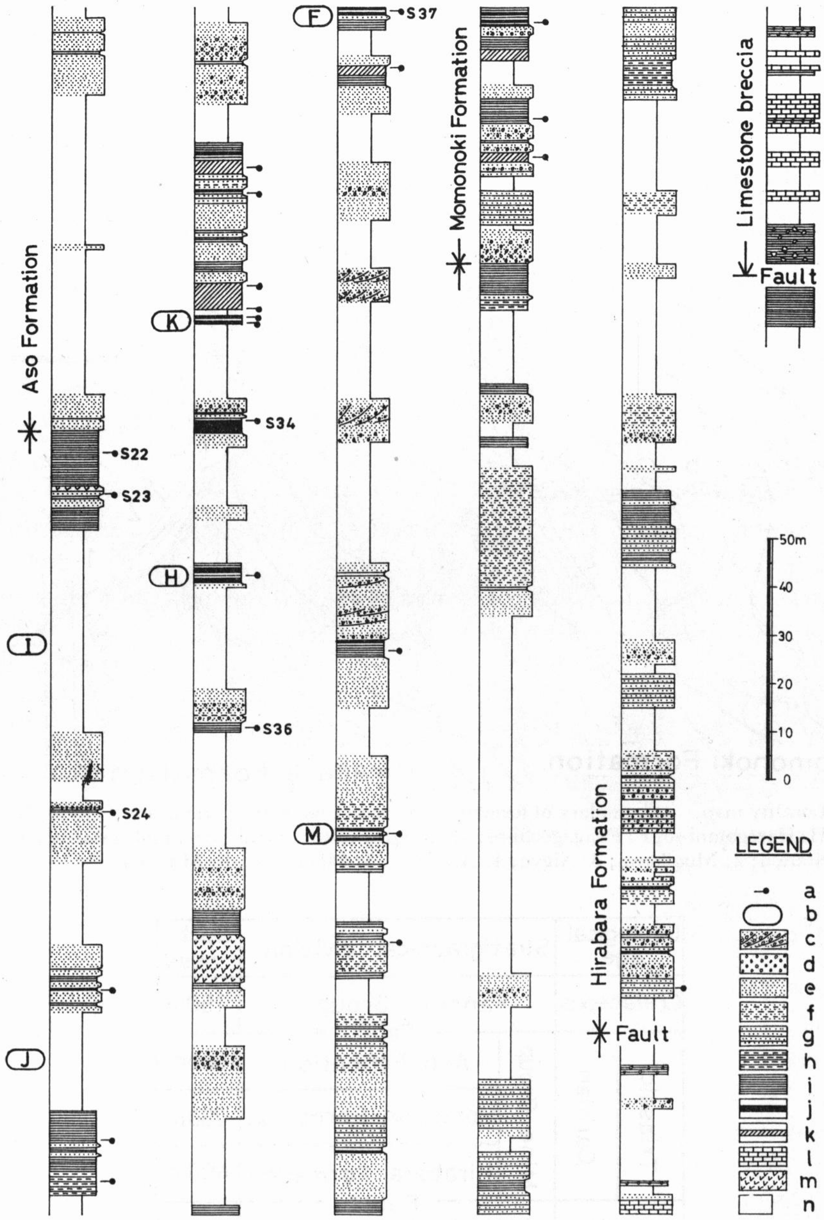



Fig. 3. Columnar section along the Miné-Hohoku Prefectural road. a: sample point; b: main coal layer, about whose name refer to the legend of Text-figure 2; c: cross-bedding; d: conglomerate; e: sandstone; f: sandstone intercalated with shale layers; g: banded alternation of sandstone and shale; h: shale intercalated with sandstone layers; i: shale; j: coal; k: shale intercalated with thin coal layers; l: brecciated limestone; m: dyke rock; n: no exposure.

**Tsunemori Formation:**

This formation consists mainly of black shale near Aigyo and extends to cover all over its southern and eastern regions. Most of shales are massive and its bedding is not clear, but at the part of banded alternation of sandstone and shale the strike is ENE-WSW and the dip is 65° north. This formation is considered to range from the middle to the upper Permian based on fusulinacean fossils in the other area.

**Limestone breccia:**

This bed crops out near the Kamiaigyo bus-stop. The lower part consists of cobble-sized limestone breccias in the black shale matrix. The upper part consists mainly of brecciated limestone intercalated with small pebble-bearing black shale layers in a few centimeters thick, whose pebbles consist of limestone, chert, sandstone, shale and others. Although SAKAMOTO (1969) reported that there is a unconformable relation between the Tsunemori Formation and this Limestone breccia, it is actually not so clear as shown in his figure owing to the suffering from a tectonic shear at that place. The black shale of the Tsunemori Formation is sheared only near the contact point by this Limestone breccia, so the author considers that there is a fault between them.

From a breccia in the lowermost part of this bed the following fusulinids were obtained. All of them are identified by Dr. Y. NOGAMI.

*Pseudofusulina vulgaris* (SCHELLWIEN)
*Pseudofusulina kraffti magna* TORIYAMA
*Pseudofusulina kraffti* (SCHELLWIEN)
*Pseudofusulina* spp. indet.
*Profusulinella beppensis* TORIYAMA
*Profusulinella* sp. indet.
*Pseudostaffella* spp. indet.
*Millerella* spp. indet.

This Limestone breccia has been considered as the basal conglomerate of the Hirabara Formation of the Miné Group by HASE (1950 and 1951), SAKAMOTO (1960) and others. The Hirabara Formation differs from the Limestone breccia in lithofacies remarkably and also they differ in the dip and strike at their respective outcrops. From the muddy matrix of the Limestone breccia no fossil except crinoids has been known, and the age is uncertain. But the author considers that this Limestone breccia is a member of the Tsunemori Formation by the lithologic similarity, as was reported by MURATA (1961).

**Miné Group:**

This group has been divided into three formations, the Hirabara, the Momonoki and the Aso Formations in ascending order (KATAYAMA, 1939). Based on the abundant fossils of molluscs, brachiopods and plant fossils, the main part of this group is referred to the Carnian of the upper Triassic.

**Hirabara Formation:**

This crops out on a route from the south of the Omine Railway station to Hirabara. This consists of conglomerate, sandstone, shale and their alternation, and is intercalated with thin coal layers. In the lower part the conglomerates are dominant, in the middle part the alternations of them are characteristic, and in the upper part there are sandstones. The lower boundary of the formation is not certain because of the fault between the Limestone breccia and this formation as mentioned above. From this formation rich bivalves, such as *Minetrigonia, Palaeopharus, Oxytoma, Halobia* have been reported by HASE (1950 and 1951), TOKUYAMA (1958) and others. Judging from the lithofacies and fossils this formation was deposited under condition of shallow sea water.

**Momonoki Formation:**

This formation crops out between the west of Hirabara and the west of Momonoki, consisting of conglomerate, sandstone, shale and many coal layers. Cross-bedding is observed at several horizons. The relation with the Hirabara Formation to this formation was considered to be a disconformity by HASE (1950 and 1951) and others. From this formation the so-called Rhaeto-Liassic flora, represented by *Neocalamites, Dcityophyllum, Cladophlebis, Podozamites, Taeniopteris etc.*, has been reported (TAKAHASHI, 1959). As indicated by many plant fossils, the main part of this formation is considered to be lacustrine or lagoonal deposits.

**Aso Formation:**

This formation crops out along a route between the east of Mitsusugi and the west of Aso, and consists mainly of massive sandstone with only a few layers of thin shale. The relation between this formation, and the Momonoki Formation is conformable. This formation has a synclinal structure with the axis of NE-SW direction (HASE, 1950 and 1951; KONO, 1951; TAKAHASHI *et al.*, 1965a and b). The upper part of this formation yields *Tosapecten* and *Anodontophora* (HASE, 1950 and 1951; TOKUYAMA, 1958), and at least the upper part of this formation was of a shallow sea origin. TOKUYAMA (1957) suggested that the uppermost part of the formation is the Norian in age based on the occurrence of the species of *Rhynchonella*.

## Materials

The materials treated here are collected from 29 different horizones mainly

of carbonaceous shale and black shale, but some coal and sandy shale are included too. The hornfels as observed in the Atsu district is avoided. In the field work of the sample collection from outcrops, a special attention was taken to the following four items to avoid various contaminated samples;
1) weathered part, 2) sheared part, 3) part suffered cleavage, 4) surface of the outcrop.

Many organic remains have been revealed from the following six horizons, all of which belong to the Momonoki Formation and they are in the middle to upper parts of the formation (Text-fig. 3).

S22: 6 m below the upper boundary of the black shale of 16 m thick (top of the Momonoki Formation).

S23: 12 m below the upper boundary of the same shale, where it is intercalated with sandstone bands.

S24: 50 cm thick shale intercalated between conglomerate above and sandstone below which is 10 m in thickness.

S34: 20 m thick carbonaceous shale in the alternation of coal, shale and sandstone. There is 3 m thick conglomerate 1 m above this site.

S36: Top of 2 m thick shale underlain by the alternation of sandstone and conglomerrate.

S37: 60 cm thick shale between two coal layers which are included in the Fujigagochi coal member.

## Analytical Method

All samples used in this investigation were treated with the HF-KOH-Acetolysis method. The single mount preparation was used exclusively. The procedure will be described in the following lines. Throughout the treatment all the windows and doors were shut, and the samples in process were covered.

1) Clean the sample with water*, and dry.
2) Break sample into particles smaller than 5 mesh in size in a iron mortar.
3) Put about 50 g into the polyethylene beaker.
4) Add 55% hydrofluoric acid slowly and stand for a week in the draft with stir once a day.
5) Transfer the residue to the polyethylene centrifuge tube** and centrifugalize***.
6) Add 10% hydrochloric acid, heat****, and centrifugalize***.
7) Wash***** a few times.
8) Transfer the residue to glass centrifuge tube**.
9) Add 10% potassium hydroxide, heat**** and centrifugalize***.
10) Wash***** until supernatant liquid becomes clear.
11) Add glacial acetic acid, stir and centrifugalize***.

12) Add the solution which consists of nine part of concentrated sulfic acid, stir, heat**** and centrifugalize***.
13) Add glacial acetic acid, stir and centrifugalize***.
14) Wash***** a few times.
15) Transfer the residue to the sample tube, add a few drop of phenol and glycerine, and label.
16) Let fall a drop of safranine solution on the slide glass.
17) Transfer very small quantity of the residue to the slide glass, mix with the safranine solution, and spread.
18) Examine with the microscope of 100 and/or 500 magnifications.
19) Pick up a remain with a small lump of glycerine-jelly, and transfer it to another slide glass.
20) Put a glass fiber of a few millimeters length beside the remain.
21) Put a cover glass on them, seal with paraffine, and label.

Notice:

* Throughout the discussion reference to the water means distilled water.

** The capacity of the centrifuge tube is 50 ml and the volume of its content is always three-fourths of it.

*** Reference to centrifugalize means centrifugalize at 2,000 r.p.m. for 10 minutes and decant supernatant liquid.

**** Reference to heat means to heat in the water bath at about 90°C, and stir frequently.

***** Reference to wash means to add distilled water, stir and centrifugalize***.

## Fossils

Microscopic remains revealed from the samples are not alike at all any fossil pollen or spores since they have no apertures. Moreover, the sculptures and structure of the wall do not show any indication to define as fossil pollen or spores so far as the author awares. They also have no characteristic to assign with some member of fossil dinoflagellate or other microfossils known from published literatures previously. Some of them have a similarity with the sclereid seen in plant tissues in terms of the thick wall, and the wall is assumed to be a cell wall in size and shape. Further study may be necessary to ascertain whether the remains are to be of sclereid. In the present paper, therefore, the author tentatively describes some of them as microscopic fossil fragments of plant tissues.

Based on the shape and wall thickness they are divided mainly into four types. Their stratigraphical distribution is shown in Table 2.

**Type A:** Remains cylindrical with thick wall; size 60–123$\mu$ in length, 15–36$\mu$ in width; wall 3–10$\mu$ in thickness; sculpture of wall smooth or corrugate to rugulate; inner cavity cylindrical with rounded to blunt apex.
Frequency of occurrence: abundant (S22 and S36) common (S37).

| Type / Sample | A | B | C | D |
|---|---|---|---|---|
| S 22 | a | | c | + |
| S 23 | | a | | c |
| S 24 | | a | | c |
| S 34 | | | | a |
| S 36 | a | c | a | c |
| S 37 | c | a | c | a |

Table 2. Stratigraphical distribution of each type of remains. a: abundant; c: common; +: present.

See Plate 1, Figs. 1, 2 and 3.

**Type B:** Remains cylindrical with thin wall; size 80–138$\mu$ in length, 17–30$\mu$ in width; sculpture of wall corrugate to rugulate; apex rounded to blunt. Some specimens of this type show a crossed shape at an angle 60°–90°.
Frequency of occurrence: abundant (S23, S24 and S37) common (S36).
See Plate 1, Figs. 4, 5 and 6.

**Type C:** Remains fusiform with thick wall; size 60–106$\mu$ in length, 18–35$\mu$ in width; wall 3–10$\mu$ in thickness; sculpture of wall smooth or corrugate to rugulate; apex acute to blunt; inner cavity fusiform or elliptical with acute to blunt apex.
Frequency of occurrence: abundant (S36) common (S22 and S37).
See Plate 1, Figs. 7, 8 and 9.

**Type D:** Remains fusiform with thin wall; size 30–112$\mu$ in length, 8–36$\mu$ in width: sculpture of wall smooth or corrugate to rugulate; apex acute in a small size, blunt in a large size.
Frequency of occurrence: abundant (S34 and S37) common (S23, S24 and S36).
See Plate 1, Figs. 10, 11, 12a, 12b, 13a and 13b.

There are some other remains which do not definitely belong to the respective type mentioned above on account of low frequency of occurrence (Plate 1, Figs. 14, 15 and 16).

## Discussion

The largest remain is seen in the Type B, and the Type B is of the largest in average size among the remains observed. On the other hand the smallest remain is seen in the Type D, and the size-variation of the Type D has the widest range amongst the types.

The wall thickness varies continuously, and it might be possible to suggest that the wall of the Type B or D may be eroded to form that of the Type A and C.

The crossing form of the remains seen in the Type B and other may not be derived secondarily. Their shape and structures suggest that these are some other type of fragments.

Special attention should be paid to the remains of the small size of the Type D (Plate 1 F gs. 12a, 12b, 13a and 13b). They are similar to one another in size, shape and sculpture, and are abundant only in S34. They are somewhat similar to *Lancettopsis lanceolate* MÄDLER (1963), a questionable spore, in general form, but the remains mentioned here are much smaller than it.

It may be presumed that the remains are of a fragment of a tissue of plant which has not been known certainly, though there is still a doubt why the unseparated tissues have not been revealed.

### References

HASE, A. (1950), The Stratigraphy of the Triassic System in the Southwesttern Part of Yamaguchi prefecture. *Sci. Rep. Kyushu Univ. (Geol.)*, **2** (2), p. 101–128, 4 text-figs., 4 figs. (in Japanese)

————, (1951), The Triassic System in Yamaguchi Prefecture. in Triassic Stratigrapjhy of Japan. Report Special Number, p. 72–89, 1 fig., 3 tabs., 1 map, Geol. Surv. Japan, Kawasaki, Japan. (in Japanese)

KATAYAMA, M. (1939), Stratigraphical Study on the Mine Series. *Jour. Geol. Soc. Japan*, **46** (546), p. 127–141, 2 figs., 3 tabs., 1 pl. (in Japanese with English abstract)

KAWAI, K. (1963), On the Deformation of the Mesozoic and Paleozoic System in the Mine District, Yamaguchi Prefecture, Japan. (Late Mesozoic Crustal Movement in the Chugoku Province, the Inner Zone of South-west Japan. Part 2) *Bull. Geol. Surv. Japan*, **14** (10), p. 701–724, 2 maps. (in Japanese with English Abstract)

KONO, M. (1951), Geology of the Southwestern District in Omine Coalfield, Yamaguchi Prefecture. *Bull. Geol. Surv. Japan*, **2** (8), p. 395–397, 1 map. (in Japanese with English Abstract)

MURATA, M. (1961), On the Geological Structure of the Akiyoshi Plateau. *Contr. Inst. Geol. Paleont. Tohoku Univ.*, (53), p. 1–46, 10 figs, 9 tabs., 1 map. (in Japanese with English Abstract)

OKAFUJI, G. (1971), Fossil Monograph of Akiyoshi-dai and its Neibourhood, Yamaguchi Prefecture, Japan. (Carboniferous, Late Triassic and Pleistocene) 147 p., 4 maps, 52 pls. (in Japanese)

SAKAMOTO, T. (1969), On the Base and Sedimentary Cycles of the Mine Group. *Sic. Rep. Kyushu Univ. (Geol.)*, **10** (1), p. 25–30, 4 figs. (in Japanese with English Abstract)

SUZUKI, T. (1904), Geology of the Mine-Hohoku Coal Field in Nagato Province. *Bulletines*, **17** (2), p. 167–197, 8 figs., 1 map. Geol. Surv. Japan, Kawasaki, Japan. (in Japanese)

TAKAHASHI, E. (1959), Floral Changes since the Mesozoic Age of Western Honshu, Japan. *Sci. Rep. Yamaguchi Univ.*, **10**, p. 181–237, 21 tabs. (in Japanese with English Abstract)

———— and KIMURA, H. (1965a), Paleozoic and Mesozoic Formations of the Dai-Tashiro District of the Nagato Tectonic Zone. *ibid.*, **15**, p. 21–31, 2 figs., 1 map. (in Japanese with English Abstract)

————, UTO, S., MIHARA, A. and TAKAHASHI, H. (1965b), Paleozoic and Mesozoic Formations of the Eastern and Southern Parts of the Tabe Basin, Yamaguchi Prefecture. *ibid.*, **15**, p. 33–49, 3 Figs. 4 tabs., 1 map. (in Japanese with English Abstract)

——————, UCHIDA, M., YAMANE, T. and MATSUSHIGE, K. (1965c), Palozoic and Mesozoic Formations of the Southern Part of the Omine District and of the Atsu District, Yamaguchi Precture. *ibid.*, **15**, p. 51–61, 1 tab., 1 map. (in Japanese with English Abstract)

TOKUYAMA, A. (1957), On the Late Triassic Rhynchonellids of Japan. *Japan Jour. Geol. Geogr.*, **29** (1–3), p. 121–137, 2 pls.

—————— (1958), Die Obertriadische Molasse im Mine-Gebiet Westjapans. 1 Teil Stratigraphie und Werdegang. 2 Teil Ablagerungseigenchaften und Bodenbewegungen. *Jour. Geol. Soc. Japan*, **64** (756 and 757), pp. 454–463, 537–550, 6 Figs., 2 tabs., 1 pl. (in Japnese with German Abstract)

TRAVERSE, A. and AMES, H. T. ed. (1968), Mesozoic and Cenozoic Spores, Pollen and Other Microfossils. *Catalog of Fossil Spores and Pollen*, **29**, Palyno. Lab. Pennsylvania State Univ., Pennsylvania.

Aigyo 相行
Asa 厚狭
Aso 麻生
Atsu 厚保
Fujigagochi-so 藤ケ河内層
Hazegatani-so 櫨ケ谷層
Hirabara 平原
Hohoku 豊北
Inoki-so 猪木層
Jo-so 上層
Kamiaigyo 上相行
Ka-so 下層
Miné 美禰
Mitsusugi 三ツ杉
Momonoki 桃木
Mugikawa-so 麦川層
Omine 大嶺
Toyota 豊田
Tsunemori 常森
Tsutsumi 堤

## Explanation of Plate

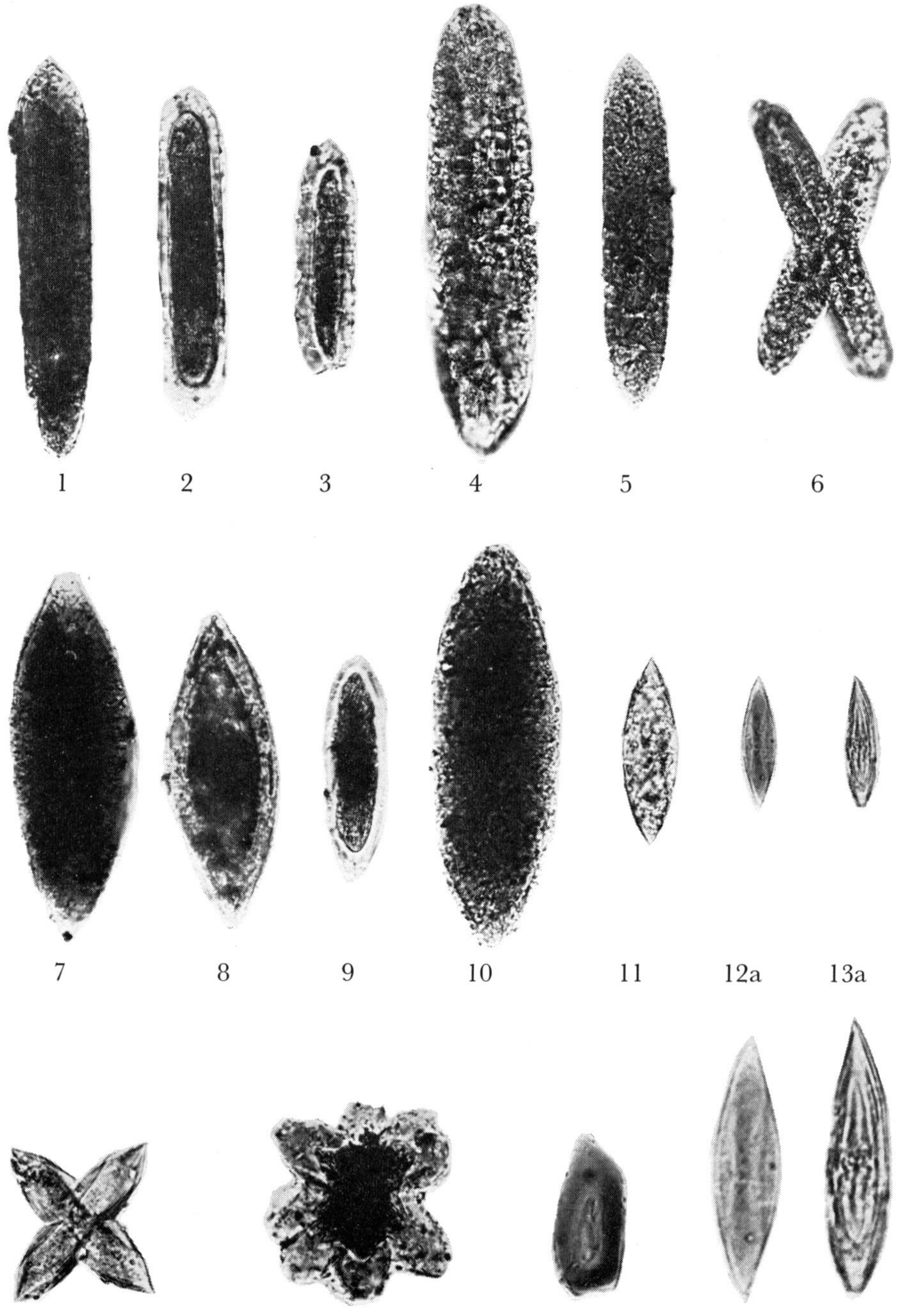
### Plate 1.

Tissue Fragments of Unknown Plant from the Miné Group.

| | |
|---|---|
| Fig. 1. Remain of the Type A. | Sample: S37. |
| Figs. 2, 3. Remains of the Type A. | Sample: S22. |
| Fig. 4. Remain of the Type B. | Semple: S23. |
| Fig. 5. Remain of Type B. Sample: S37. | |
| Fig. 6. Remain of the Type B showing crossed shape. | Sample: S23. |
| Fig. 7. Remain of the Type C. | Sample: S37. |
| Fig. 8. Remain of the Type C. | Sample: S36. |
| Fig. 9. Remain of the Type C. | Sample: S22. |
| Fig. 10. Remain of the Type D. | Sample: S37. |
| Fig. 11. Remain of the Type D. | Sample: S23. |
| Figs. 12, 13. Small remains of the Type D. | Sample: S34. (a: $\times 500$, b: $\times 1{,}000$) |
| Fig. 14. One other remain. | Sample: S23. |
| Fig. 15. One other remain. | Sample: S22. |
| Fig. 16. One other remain. | Sample: S37. |

* All figures enlarged $\times 500$ unless otherwise stated.

** About the horizons and localities refer to Text-figs. 2 and 3.



1 2 3 4 5 6 7 8 9 10 11 12a 13a 14 15 16 12b 13b

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