INTRODUCTION AND ACKNOWLEDGEMENTS

For many years ago it is known that many fine specimens of later Palaeozoic Calcareous algae occur in association with many fusulinids at the so-called Sashizawa Stage, Sakamotozawa, Hikoroichi-mura, Kesen-gun, Iwate Pref. 1) formerly also reported its occurrence in the Japanese Jour. of Geol. Soc. Japan. However, unfortunately as far as I know now no body studied in detail, these calcareous algae up to date. Since, lately I have a good chance to study these specimens under the kind suggestion of Prof. Hisakatsu YABE, described some of them as follows.

I take this opportunity to express my hearty thanks to Prof. J. Harlan JOHNSON, Colorado School of Mines, for his helpful suggestions and criticisms. I express also my gratitude for the financial help provided by the Educa-

Stratigraphy

The so-called Sashizawa Stage at the Sakamotozawa valley consists of thick grey to black limestone with thin shales at irregular intervals, and it forms very steep cliffs. Its total thickness is about 200 m. I studied this locality in detail and made two north and south sections which are separated 800 m apart for which I want to give the name of Sakamotozawa sections. Fifty fossil zones for each section were observed.

The North Section.

The North Section begins at the northwest side of Yubanosawa mineral spring in the middle part of Sakamotozawa and extends northwestwardly and ascends to the top of a steep cliff. The beds dip 25° to 30° to the northwest. Fifty fossil zones are distributed as in table 1. The South Section.

The South Section is located southwest of Yubanosawa mineral spring and extends up the steep southeastern slope of the 551 meter hill. In this section the strata of the so-called Sashizawa...
Stage are well exposed, all dipping monoclinally 25° to 30° to the northwest. Fifty fossil zones occur as shown in Table 1.

Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Limestone</th>
<th>Description</th>
<th>Clayslate</th>
<th>Alternation</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 m.</td>
<td><em>Anthracoporella spectabilis</em> PIA. <em>Hikorocodium elegantae</em> n. sp.</td>
<td>6 m. Fault.</td>
<td>Clayslate and limestone 5.3 m.</td>
<td>12.5 m.</td>
</tr>
<tr>
<td>2</td>
<td>3 m.</td>
<td><em>Teutroporella</em> cfr. <em>triasina</em> SCHAUROTH.</td>
<td>2 m.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2 m.</td>
<td><em>Mizzia velebitana</em> SCHUBERT.</td>
<td>5 m.</td>
<td>Alternation of clayslate and limestone</td>
<td>16.5 m.</td>
</tr>
<tr>
<td>4</td>
<td>5 m.</td>
<td><em>Mizzia velebitana</em> SCHUBERT.</td>
<td>5 m.</td>
<td>Alternation of clayslate and limestone</td>
<td>39.1 m.</td>
</tr>
<tr>
<td>5</td>
<td>1 m.</td>
<td><em>Mizzia velebitana</em> SCHUBERT.</td>
<td>5 m.</td>
<td>Dyke of hornblende lamprophyre 1 m.</td>
<td>10.1 m.</td>
</tr>
<tr>
<td>6</td>
<td>1 m.</td>
<td><em>Schwagerina kraffli</em> (SCHUELLWEN)</td>
<td></td>
<td>Alternation of clayslate &amp; limestone</td>
<td>12.5 m.</td>
</tr>
<tr>
<td>7</td>
<td>2 m.</td>
<td><em>Hikorocodium elegantae</em> n. sp. <em>Anchicodium magnus</em> n. sp.</td>
<td></td>
<td></td>
<td>20 m.</td>
</tr>
<tr>
<td>8</td>
<td>1.5 m.</td>
<td>One species of <em>Dasycladaceae</em>, indet.</td>
<td></td>
<td>Alternation of clayslate &amp; limestone</td>
<td>20 m.</td>
</tr>
<tr>
<td>9</td>
<td>1 m.</td>
<td><em>Epimastopora japonica</em> n. sp. <em>Quasifusulina longissima</em> (LEE)</td>
<td>2 m.</td>
<td></td>
<td>10.1 m.</td>
</tr>
<tr>
<td>10</td>
<td>2 m.</td>
<td><em>Hikorocodium elegantae</em> n. sp. <em>Epimastopora japonica</em> n. sp.</td>
<td>5 m.</td>
<td></td>
<td>13.5 m.</td>
</tr>
<tr>
<td>11</td>
<td>3 m.</td>
<td><em>Anchicodium magnus</em> n. sp. <em>Macroporella</em> sp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2 m.</td>
<td><em>Anchicodium magnus</em> n. sp.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.

<table>
<thead>
<tr>
<th>No.</th>
<th>Limestone</th>
<th>Description</th>
<th>Clayslate</th>
<th>Alternation of clayslate and limestone</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 m.</td>
<td><em>Siphonodendron densitabulata</em> (YABE &amp; HAYASAKA).</td>
<td></td>
<td>Clayslate, limestone and sandstone</td>
<td>12.5 m.</td>
</tr>
<tr>
<td>2</td>
<td>2 m.</td>
<td><em>Mizzia velebitana</em> SCHUBERT.</td>
<td></td>
<td>Atractylopsis (?) sp.</td>
<td>10.6 m.</td>
</tr>
<tr>
<td>3</td>
<td>1.7 m.</td>
<td>Some algal remains.</td>
<td></td>
<td>Alternation of clayslate and limestone</td>
<td>23.5 m.</td>
</tr>
<tr>
<td>4</td>
<td>2 m.</td>
<td><em>Macrosporella</em> sp.</td>
<td></td>
<td>Alternation of clayslate and limestone, with sandstone in the lower part</td>
<td>6.3 m.</td>
</tr>
<tr>
<td>5</td>
<td>0.8 m.</td>
<td><em>Gyroporella</em> (?) longipora n. sp. <em>Mizzia velebitana</em> SCHUBERT.</td>
<td></td>
<td>Alternation of clayslate and limestone, with sandstone in the lower part</td>
<td>32.4 m.</td>
</tr>
<tr>
<td>6</td>
<td>2 m.</td>
<td><em>Anthracoporella magnipora</em> n. sp. <em>Gyroporella</em> (?) longipora n. sp.</td>
<td></td>
<td>Limestone 15 m.</td>
<td>20 m.</td>
</tr>
<tr>
<td>7</td>
<td>1 m.</td>
<td><em>Anchicodium magnus</em> n. sp. <em>Anchicodium magnus</em> n. sp.</td>
<td></td>
<td>Limestone 6 m.</td>
<td>10 m.</td>
</tr>
<tr>
<td>8</td>
<td>1 m.</td>
<td>Some algal remains.</td>
<td></td>
<td>Limestone 1.5 m.</td>
<td>10 m.</td>
</tr>
<tr>
<td>9</td>
<td>1.5 m.</td>
<td><em>Anchicodium magnus</em> n. sp. <em>Epimastopora japonica</em> n. sp. <em>Hikorocodium elegantae</em> n. sp.</td>
<td></td>
<td>Limestone 4 m.</td>
<td>10 m.</td>
</tr>
<tr>
<td>10</td>
<td>2 m.</td>
<td><em>Epimastopora japonica</em> n. sp. <em>Hikorocodium elegantae</em> n. sp.</td>
<td></td>
<td>Limestone 2 m.</td>
<td>10 m.</td>
</tr>
<tr>
<td>11</td>
<td>1 m.</td>
<td><em>Anchicodium magnus</em> n. sp. <em>Epimastopora japonica</em> n. sp. <em>Hikorocodium elegantae</em> n. sp.</td>
<td></td>
<td>Limestone 4 m.</td>
<td>10 m.</td>
</tr>
</tbody>
</table>
| 12  | 2 m.      | *Diplopora phanerospora* PIA *Epimastopora japonica* n. sp. *Anchicodium magnus* n. sp. *Hikorocodium
As will be seen from the above tables inserted, the uppermost fossil zone (No. 1) in these two sections contain noticeable fossils of the Lower Carboniferous Onimaru Series namely, *Siphonodendron multitubulatum* (YABE, and HAYASAKA), *Anthracoporella spectabilis* PI and *Hikorocodium elegantiae*, n. sp. On the contrary, the underlying fossil zones (from No. 2 to No. 6) yield *Mizizia velebitana* SCHUBERT which is the leading fossil of the Middle and Upper Permian ages. Moreover, we can find a good stratigraphical fault evidences between these No. 1 and No. 2 fossil zones in the field. So, it is rather interesting matter to be able to find fault evidences in these two sections from the both paleontological and stratigraphical sides.

Near the bottom of this section, namely from fossil zones No. 7 to No. 15, *Hikorocodium elegantiae* is always found associated with *Epinastopora japonica*, *Anthracoporella magnipora*, *Anchicodium magnum* and *Osagia sp.* It is noticeable that these fossils are never found in the upper zones (No. 2 to No. 6) of this section.

**SYSTEMATIC DESCRIPTION**

The symbols used for the measurements in the following description are
listed in below, as followed the examples of J. V. Pia and J. Harlan Johnson.

D—Outer diameter of calcareous body. d—Inner diameter of calcareous body. p—Diameter of pores. w—Number of verticillatae in a single member. h—Distance between centers of verticillatae. st—Diameter of stem cell. s—Thickness of calcareous wall.

Class Chlorophylta

Subclass Chlorophyceae

Order Siphonocladales

Family Dasycladaceae

Genus Anthracoporella Pia, 1929

*Anthracoporella Magnipora*, new species

Plate 10, Figures 5.

Descriptions:—The present species show characteristic features of genus *Anthracoporella* in having remarkably well bifurcated pores which are arranged perpendicularly to both inner and outer surfaces of the calcareous wall, numerous pores in a whorl and some rounded protuberances on the surface of thalli.

Comparisons:—The larger pores and the presence of a smaller number of pores in a whirl serve readily to distinguish this species from *A. spectabilis*.

Remarks:—Observed specimens are found in associated with *Hikorocodium elegangetae, Anchicodium magnum, Epinastopora japonica*, and *Osagia* sp.

Occurrence:—Lower Permian: In the banded limestone in the lower part of north and south Sakamotozawa sections.

Genus *Epinastopora* Pia, 1922

*Epinastopora Japonica*, new species

Plate 11, Figures 1, 2.

Descriptions:—This species is based on numerous fragments. However, the specimens shown in Plate may represent the thalli which are long and somewhat undulating cylindrical forms. The calcareous walls are perforated by numerous, rather large pores. The pores are characteristic in having rather peculiar features, namely, some of them given off from the stem cell at rather narrower pedicel like filament which expand into the ball-like globule at its midway and narrow again forwards exterior while the others open to exterior with the state of ball-like expansion. Pores are nearly perpendicular to the exterior or
slightly ascending. Ball-like expanded portion of pores may represent the sporangia.

Comparison:—This species differs from all the species of this genus formerly described in having larger size of pores and thicker calcareous walls.

Remarks:—This alga is associated with Anchicodium magnum, Anthracoporella magnipora, Hikorocodium elegante, Macroporella sp., Osagia sp. and Quasi-fusulina longissima (Lee).

Occurrence:—Lower Permian: The specimens are found at the several horizons ranging from No. 9 downwards to No. 15 in the middle and lower parts of the Sakamotozawa section.

Colotypes:—L.E.S., Saitama Univ. Slides 14, 81, Specimen 10763.

Genus Gyroporella Gümbr. em. Benecke, 1876

Gyroporella (?) Longipora, new species.

Plate 10, Figures 6; Plate 11, Figures 6, 7.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Gyroporella (?) Longipora (Endo)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
</tr>
<tr>
<td>No. 8. (Cross section)</td>
<td>4.8 mm</td>
</tr>
<tr>
<td>No. 34. (Cross section)</td>
<td>8.8</td>
</tr>
<tr>
<td>No. 32. (Longitudinal fragment)</td>
<td></td>
</tr>
</tbody>
</table>

Descriptions:—Thallus long, cylindrical and slightly undulating; circular or oval in cross-section. Pores may consist of very slender, longer pedicel-like filaments with ball-like expansions at its ends. Pores may be nearly perpendicular to the exterior or slightly ascending and open to the exterior. Central stem cylindrical and relatively narrow in proportion to the entire thallus. Sporangia may be developed in the ball-like ends of the branches. The development of the calcified portions are relatively thin and may cover only the outer parts of central stem and the terminal portions of the branches but not the area between.

Remarks:—The relatively narrower central stem and longer branches (pores) serve to distinguish the present species from any other described species of Gyroporella. All described European species of Gyroporella were reported only from rocks of Triassic age while one species, G. symetrica Johnson, was found in the Permian strata in the United States. Thus, this species becomes the second recorded from Permian strata. This species is associated with Anthracoporella magnipora, Anchicodium magnum, and Osagia sp.

Occurrence:—Middle and Lower Permian: In the banded limestone of the middle and upper parts of Sakamotozawa section.

Colotypes:—L. E. S., Saitama Univ., Slides 8, 32, 34, Specimen 10765.

FAMILY, CODIACEAE

Genus Anchicodium J. H. Johnson, 1946

Anchicodium Magnum, new species

Plate 11, Figures 3—5.
Descriptions:—Thalli long, relatively slender, cylindrical, and slightly undulating. One specimen (Pl. 11, Fig. 4,) indicates the presence of a crusty base from which cylindrical thalli develop. Center of thallus is poorly organized, and it is composed of a spongelike mass of very fine thread-like filaments. Toward outer margins of thalli, branches tend to become parallel and end in tufts of fine branches that usually are almost perpendicular to outer surface of thallus. Outer part of thallus rather slightly calcified. No spongia observed. Diameter of thallus ranges from 0.4689 mm. to 2.1882 mm. Thallus to 1.5 cm. long is observed. Diameter of ordinary pores are from 0.0521 to 0.0782 mm., and that of fine terminal branches about 0.02 mm.

Comparison:—This species differs from all other described species of Anchicodium in its longer thalli with broader diameters of thalli and branches.

Remarks:—Observed specimens are associated with Quasifusulina longissima (Lee), Hikorocodium elegantae and Epimastopora japonica.

Occurrence:—Lower Permian: abundant in the middle and lower parts of the banded limestone beds of the Sakamotozawa section.

Cotypes:—L.E.S., Saitama Univ., Slides 2, 18, 20, Specimen 10768.

Genus Hikorocodium, new genus.

Diagnosis:—Thalli cylindrical, rather straight or undulating with rounded end. It may branch or develop rounded protuberances. Some are irregularly constricted. Each thallus is composed of a poorly organized, pith like, central stem and branched, anastomosing, tubular pores in the peripheral part. The central stems are seen in a width of 0.9899 to 2.2403 mm. in each cross section, and usually it consists of one stem. However, some specimen shows two central stems, as if the section should have cut two bifurcating central stems near in the point of division (Pl. 10, Fig. 3). The central stem may be composed of a sponge-like mass of very fine rounded thread-like filaments. Outer part of thallus are well calcified, but the thickness of calcification varies from 0.2084 mm. to 0.6773 mm. The radiating and anastomosing tubular pores 0.2081 to 0.2605 mm. wide, are given off from the central stem at about right angles or slightly ascending towards one end of the thallus, which may consequently be regarded as the apical end. Where the point of connection between the central stem and radiating pores is visible, no cross-walls are to be observed, the cavities corresponding freely. The radiating pores are usually undulating, and more or less distinctly dichotomously branched. The pores usually run with the same width from the central stem to near the surface of thallus where they end blingly with rounded terminations apparently nearer opening on the exterior surfaces of the thallus. Sometimes, however, one may find the peculiar
mode of branching, with a small number of minute pores from the rounded end of a radiating pore and the latter minute pores appear to open to the exterior surface. It is, however, most unlikely that they really do so. Reproductive organs not observed.

Comparison:—From the above description it can be seen that this new genus is allied to Gymnocodium, but differs in having more finely anastomosing, outwardly blinded pores, relatively thick calcification of the outer part of thallus and larger sizes of every organs.

Genotype:—Hikorocodium Elegantae, new species.

Hikorocodium Elegantae, new species

Plate 10, Figures 1—3.

As there is only one species in this genus at present the generic description will suffice, with the addition of the measurements given below.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Hikorocodium Elegantae ENDO</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 41 mm.</td>
<td>Length 6.5 mm</td>
</tr>
<tr>
<td></td>
<td>d 2.2403 mm</td>
</tr>
<tr>
<td></td>
<td>s 0.9899</td>
</tr>
<tr>
<td></td>
<td>p 0.7294</td>
</tr>
<tr>
<td></td>
<td>0.2084</td>
</tr>
<tr>
<td>No. 50.</td>
<td>3.2 2.3448</td>
</tr>
<tr>
<td></td>
<td>0.9899</td>
</tr>
<tr>
<td></td>
<td>0.7294</td>
</tr>
<tr>
<td></td>
<td>0.2084</td>
</tr>
<tr>
<td>No. 60.</td>
<td>3.2 2.8657</td>
</tr>
<tr>
<td></td>
<td>1.2504</td>
</tr>
<tr>
<td></td>
<td>0.6774</td>
</tr>
<tr>
<td></td>
<td>0.2084</td>
</tr>
</tbody>
</table>

Remarks:—The present species is found associated with Anchicodium magnatum, Anthracoporella magnipora, and Epimastopora japonica in the Permian strata, while it also collected with Anthracoporella spectabilis Pia from the Lower Carboniferous formation.

Occurrence:—Lower Carboniferous and Lower Permian: Limestones in the uppermost and lower parts of the north and south Sakamotozawa sections.

Genotypes:—L. E. S., Saitama Univ., Slides No. 41, 59, 60, Specimen, 10769.

SELECTED BIBLIOGRAPHY

27. — 1949—*Ibid II*, *ibid Vol. 25, No. 7*, pp. 40-44, 2 Figs.
R. Endo, Hikorocodium, Anthracoporella and Gyroporella

Plate 10
Explanation of Plates 10—11

The symbols used for the explanation of these plates are as follows.

H. no. = Fossil horizon number  
N. = North section  
S. no. = Slide number

Plate 10.—*Hikoreodium, AnthrocaPorella and Gyroporella*

Figs. 1-3. *Hikoreodium eleganteae*, new species (*× 9*).

Figs. 1-2. Two longitudinal sections showing undulated outlines, rounded protuberances, and branched, anastomosing, tubular pores which end blindly near the outer surface. (S. nos. 59, 60).

Fig. 3. A specimen of cross section showing a just dividing point of bifurcating central stem, coated with dark layers of some kind of sponge. (S. no. 41).

Lower Carboniferous and Lower Permian: Limestone in the lower parts of the north and south Sakamotozawa sections. (H. no. N. 1, 10, 14, S. 9, 13, 14 etc.).

Figs. 4-5. *AnthrocaPorella magnipora*, new species (*×15*).

Two imperfect specimens of cross section showing well bifurcated pores. (S. nos. 32 and 62).

Lower Permian: Limestone in the lower part of the Sakamotozawa section. (H. nos. S. 6, 15, N. 14).

Fig. 6. *Gyroporella (?) longipora*, new species (*×9*).

Cross section showing central stem and character of pores. (S. no. 34).

Middle and Lower Permian: Limestone in the middle and lower parts of the Sakamotozawa section. (H. no. S. 5 and 9).

Plate 11.—*Epimastopora, Anchicodium, and Gyroporella.*


Longitudinal sections showing character of wall and outlines of pores. (S. nos. 14 and 81).


Figs. 3-5. *Anchicodium magnum*, new species. (*×15*).

Fig. 3. Longitudinal section, showing undulating outlines of walls, characters of thread like filaments and fine branches. (S. no. 20).

Fig. 4. Specimen showing a crusty base and dichotomously bifurcating, cylindrical thalli. (S. no. 18).

Fig. 5. Tangential section, showing branches and its tufts. (S. no. 2).

Lower Permian: Limestone in the lower part of the north and south Sakamotozawa sections (H. no. N. 7 ( ?) 11, S. 7).

Figs. 6-7. *Gyroporella (?) longipora*, new species. (*×9*).

Fig. 6. Cross sections showing central stem and characters of pores. (S. no. 8).

Fig. 7. A longitudinal section of fragmental walls. (S. no. 32).

Middle and Lower Permian: Limestone in the middle and lower parts of the south Sakamotozawa section. (H. no. S. 5 and 9).