

## Fossil Algae from the Takagami Conglomerate, Choshi-shi, Chiba Prefecture

By

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**Abstract**—Fossiliferous limestone blocks from the Takagami Conglomerate (late Permian) in Choshi, central Japan are examined on the basis of 57 thin sections. Fossils of calcareous algae are unexpectedly abundant and 39 species distributed in 6 families and 17 genera are described. Seven species are described as new species.

Atagoyama is a dome-shaped hill, 73.6 m above sea level, located in the southern part of the Choshi Peninsula that occupies an eastern area of Choshi-shi, Chiba Prefecture. The Atagoyama Formation of late Paleozoic age is exposed in small area around this hill.

The Takagami Conglomerate is probably a part of the Atagoyama Formation, being an intraformational conglomerate, although the direct relation between the two is not observed (OZAKI, 1959). Previously this conglomerate was exposed at a quarry of Takagami about 450 m northwest of Atagoyama. Since the quarrying was stopped, the locality has become a water hole, making the observation of the outcrops impossible. The conglomerate is made up of various kinds of blocks such as limestone, gabbro, diorite, granodiorite, clay slate, chert and hornfels, with sandy matrix.

Limestone blocks are rich in fossils, among which fusulinids assigned to the late Permian are especially abundant (OZAKI, 1959; CHISAKA, 1960; SAKAGAMI, 1965). Corals, bryozoa and algae have also been reported but they are small in number.

On the calcareous algae, *Eogoniolina johnsoni* ENDO was reported by OZAKI (1959), and *Solenopora choshiensis* Ishijima, *Epimastopora hexagona* ISHIJIMA, *Gyroporella* sp. and *Koninckopora* sp. were described by ISHIJIMA (1975). Only these five species have been reported up to now.

The present authors have lately borrowed from Mr. Sadao WATANABE 57 thin sections of limestone blocks from the Takagami Conglomerate, and examined the fossils contained therein. As a result, the following fusulinids have been confirmed: *Rausenella* sp., *Chusenella choshiensis* CHISAKA, *Pseudodoliolina pseudolepida gravitesta* KANMERA, *Kahlerina* sp., *Neoschwagerina takagamiensis* CHISAKA, *N.* sp., *Yabeina shiraiwensis* OZAWA, *Y. gubleri* KANMERA, *Y. probosices* CHEN, *Y.* cf. *Y. tobleri* (LANGE) and *Y.* sp. Algae were unexpectedly abundant, and 17 genera and 39 species have been identified as shown in Table 1. These fossil algae are described in this paper.

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As indicated in the list, specimens belonging to the Diploporeae are rather few, represented by three genera, *Macroporella*, *Gyroporella* and *Clavaphysoporella*, and the number of species is also small. Designated as new species are the following

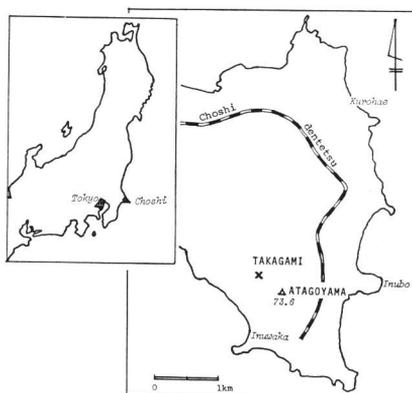


Fig. 1. Index map showing the fossil locality.

Table 1. Calcareous algae from the limestone blocks of the Takagami Conglomerate.

Class Rhodophycophyta	<i>E. sp.</i>
Family Solenoporaceae	Subfamily Diploporeae
<i>Solenopora choshiensis</i> ISHIJIMA	<i>Macroporella atagoyamensis</i> sp. nov.
<i>Petrophyton yabei</i> sp. nov.	<i>M. sp.</i>
Family Chaetangiaceae	<i>Gyroporella igoi</i> ENDO
<i>Gymnocodium kanmerai</i> KONISHI	<i>G. nipponica</i> ENDO et HASHIMOTO
<i>Permocalculus fragilis</i> (PIA) ELLIOT	<i>G. omensis</i> ENDO
<i>P. tenellus</i> (PIA) ELLIOT	<i>G. praturloni</i> ISHIJIMA, OZAKI et NAKAMURA
<i>P. sp. A</i>	<i>G. watanabei</i> sp. nov.
<i>P. sp. B</i>	<i>Clavaphysoporella kittakai</i> sp. nov.
Class Chlorophycophyta	Family Siphonocladaceae
Family Dasycladaceae	<i>Pycnoporidium concentricum</i> ENDO
Subfamily Dasyporelleae	<i>P. lobatum</i> YABE et TOYAMA
<i>Vermiporella nipponica</i> ENDO	Family Udoteaceae
<i>Anthracoporella spectabilis</i> PIA	<i>Succodium multipilularum</i> KONISHI
<i>A. sp. A</i>	<i>Hikorocodium elegantae</i> ENDO
<i>A. sp. B</i>	<i>Eugonophyllum johnsonii</i> KONISHI et WRAY
Subfamily Cyclocrineae	<i>E. magnum</i> (ENDO) KONISHI et WRAY
<i>Mizzia velebitana</i> (SCHUBERT) ENDO	Family Codiaceae
<i>M. yabei</i> (KARPYNSKY) ENDO	<i>Ortonella akasakensis</i> ENDO
<i>Eogoniolina endoi</i> sp. nov.	<i>O. cf. O. coloradoensis</i> JOHNSON
<i>Epimastopora choshiensis</i> sp. nov.	<i>O. furcata</i> GARWOOD
<i>E. densipora</i> ENDO	<i>O. morikawai</i> ENDO
<i>E. hexagona</i> ISHIJIMA	<i>O. takagamiensis</i> sp. nov.
<i>E. kanumai</i> ENDO	
<i>E. kosakiensis</i> KONISHI	

species; *Petrophyton yabei*, *Eogoniolina endoi*, *Epimastopora choshiensis*, *Macroporella atagoyamensis*, *Gyroporella watanabei*, *Clavaphysoporella kittakai* and *Ortonella takagamiensis*.

There are several species that are not specifically determined, on which the authors intend to report later when further examinations are made.

The authors express their deep gratitude to Mr. Sadao WATANABE, teacher of Chiba Prefectural Minami High School, for kindly lending the thin sections of limestone blocks. The authors are deeply indebted to Prof. Kenji KONISHI of Kanazawa University, who gave us many valuable suggestions and their sincere thanks are extended to Dr. Hideyuki NAGASHIMA, Faculty of Science, Science University of Tokyo, for taking photographs of the specimens. The authors are grateful to Dr. Shigeyoshi KITAKA, Chief Director of Tokyo Butsuri Gakuen, for giving constant encouragement and every faculty to this study.

### Systematic description

The symbols used for the measurements in the following descriptions are listed below.

- D- Outer diameter of calcareous body.
- d- Inner diameter of calcareous body.
- s- Thickness of calcareous wall.
- p- Diameter of pore (primary branch).
- h- Distance between centers of verticillatae.
- w- Number of verticillatae in a single member.

Measurements are in micron.

Repository: National Science Museum, Tokyo.

Registered numbers: NSM-PP 7900 to 7956.

Class Rhodophycophyta  
Family Solenoporaceae  
*Solenopora choshiensis* ISHIJIMA

Pl. 1, Figs. 1-5

*Solenopora choshiensis* ISHIJIMA, 1975, pp. 121-122, pl. 1, figs. 1, 2. NAKAMURA, 1981, p. 31, pl. 1, fig. 5.

*Material and measurements*: Three longitudinal and one cross sections were selected from a number of specimens.

Specimen	Thallus (mm)	Diameter of tube ( $\mu$ )	Distance between cross-partitions ( $\mu$ )
NSM-PP 7948a	3.6×9.7	7-9	10-16
NSM-PP 7948b	1.9×2.3	8-14	9-12
NSM-PP 7948c	2.0×1.3	7-12	10-17
NSM-PP 7942a	1.8×1.3	8-12	

Thallus irregular in form, subspherical to funnel-shaped, composed of closely

packed slender tubes which are commonly radially arranged from an area near the center of the basal portion. Tubes circular in cross section; cross partitions are well developed and irregularly spaced; cell wall relatively thick.

The present specimens are identical with the type specimen of *Solenopora choshiensis* ISHIJIMA from the same locality as in this report, so far as the shape, size and arrangement of the tubes are concerned.

*Illustrated specimens:* NSM-PP 7948a, b, c, 7942a.

***Petrophyton yabei* sp. nov.**

Pl. 2, Figs. 1-4; Pl. 3, Figs. 1-4

*Material:* Each one longitudinal, cross and oblique sections were selected from several specimens.

*Description:* Thallus probably nodular in form, about 18 mm broad and 15 mm high, composed of a large number of long and fine filaments which are arranged in parallel. Filaments are circular in cross section, 15  $\mu$  to 20  $\mu$  in diameter, and uniform in thickness throughout the length. Cross partitions are notable, nearly same distance between them, about 60  $\mu$  long in average. Walls of the filaments are relatively thick, 5  $\mu$  in average. It is noteworthy that there is a trace of curved structure in the rows of filaments toward the margin of the thallus. No definite reproductive organs were observed.

*Remarks:* This new species may be compared with *Petrophyton miyakoense* YABE from the Lower Cretaceous of the Miyako district, Iwate Prefecture and *P. tenue* YABE from the Torinosu Limestone in the Sakamoto district, Kumamoto Prefecture which are similar to it in the shape of the thallus and arrangement of the filaments, but it is distinguished from them by the remarkably fine filaments. *P. penetrans* ENDO with the peculiar features, consisting of broader filaments with other organic remains together, is easily beyond the present comparison.

The specific name was given in honor of Hisakatsu YABE who established the genus *Petrophyton* in 1912.

*Syntype:* NSM-PP 7907a, 7947a, 7955a.

Family Chaetangiaceae  
***Gymnocodium kanmerai* KONISHI**

Pl. 4, Figs. 1-7

*Gymnocodium kanmerai* KONISHI, 1954a, pp. 8-17, pl. 1, figs. 1-6; pl. 2, figs. 17, 19, 20. ENDO, 1957, p. 294, pl. 41, fig. 7; pl. 42, fig. 1.

*Material and measurements:* Four longitudinal, two cross and one oblique sections were selected from a number of specimens. All specimens are however fragmentary.

Specimen	I	D'	d'	P (average)	F (average)
NSM-PP 7915a	1675	382	145	19	24

NSM-PP 7936b	1872	363	143	24	26
NSM-PP 7945a		648	238	28	24
NSM-PP 7912a		534	212	28	24
NSM-PP 7925a		582	238	23	25
NSM-PP 7925b		525	238	28	24
NSM-PP 7903a		477	248	26	20

Abbreviations for measurements: I, Length of an internode (at the largest); D', Diameter of an internode (at the largest); d', Diameter of medulla of an internode (at the largest); P, Diameter of utricles on the surface; F, Diameter of medullary filaments.

Thallus probably cylindrical and constricted, with swelling internodes. Internodes are circular to subcircular in cross section, 350  $\mu$  to 650  $\mu$  in diameter at proximal part, 60  $\mu$  to 140  $\mu$  in distal part, composed of feebly calcified medulla and well calcified cortex. Medulla consists of ramifying medullary filaments, 20  $\mu$  to 30  $\mu$  thick, which run longitudinally throughout the constrictions. Cortex is composed of utricles which branch off from the medullary filaments. Utricles bifurcate twice or thrice and expand gradually toward the exterior and show 20  $\mu$  to 26  $\mu$  in diameter on the surface.

As seen in the above description and measurements the present specimens may be identified with the type specimen of *Gymnocodium kanmerai* KONISHI from the Kosaki Formation of Southern Kyushu.

*Illustrated specimens*: NSM-PP 7903a, 7912a, 7915a, 7925a, 7925b, 7936b, 7945a.

#### *Permocalculus fragilis* (PIA) ELLIOT

Pl. 4, Figs. 8–10

*Gymnocodium fragile* PIA, 1937, p. 834, pl. 12, figs. 1, 2.

*Permocalculus fragilis* (PIA) ELLIOT, 1955, p. 86, pl. 1, figs. 1, 2. HERAK and KOCHANSKY, 1960, pp. 188–191, pl. 2, figs. 1–4; pl. 3, figs. 1–8. FLÜGEL, 1963, p. 90, pl. 1, fig. 4. JOHNSON, 1963, p. 81, pl. 21, figs. 1–4. ENDO, 1969, p. 42, pl. 7, fig. 7.

*Material and measurements*: A number of specimens were found, from them two longitudinal and one cross sections were chosen for illustration.

Specimen	D	d	p	w
NSM-PP 7900a	1326	238	20	
NSM-PP 7920a	902	504	24	
NSM-pp 7940a	1486	663	28	36 $\pm$

Thallus subspherical to elongated oblong, composed of pith-like central cavity and calcified cortex which is variable in thickness and penetrated by numerous ramified branches. Branches are flexuous, bifurcating three or four times, diminish width gradually toward exterior and expand slightly at the ends.

From the above description and measurement these specimens may be identified with the type specimen of *Permocalculus fragilis* from Europe and resemble most of Japanese specimens reported up to date.

*Illustrated specimens*: NSM-PP 7900a, 7920a, 7940a.

#### *Permocalculus tenellus* (PIA) ELLIOT

Pl. 4, Figs. 11–13

*Permocalculus tenellus* (PIA) ELLIOT, 1955, p. 86, pl. 3, fig. 1. ENDO, 1969, pp. 42–43, pl. 8, figs. 2, 3,

6; pl. 9, figs. 3–6.

*Material and measurements:* Two longitudinal and one cross sections were selected from a number of specimens.

Specimen	D	d	s	p	w
NSM-PP 7903b	716	396	106–212	38	
NSM-PP 7937a	902	372	238–292	33	
NSM-PP 7916a	1473	362	391–406	38	35±

Thallus is probably composed of elongate to ovoid shaped segments. Calcified cortical layer is variable in thickness and pierced by numerous pores. Pores bifurcate thrice or four times, diminish width gradually outward and slightly expand at the ends.

As seen in the above description, measurement and other details these specimens are identified as *Permocalculus tenellus* (PIA) ELLIOT.

*Illustrated specimens:* NSM-PP 7903b, 7916a, 7937a.

#### *Permocalculus* sp. A

Pl. 4, Fig. 14

*Material:* One longitudinal section, fragmental.

Though the specimen is fragmental it is clear to belong to the genus *Permocalculus*. Thallus presumably barrel-shaped, composed of broad central hollow and thin cortical layer, 210  $\mu$  thick in average, which is penetrated by ramified pores. Pores are slender, 28  $\mu$  wide in average, bifurcate a few times and slightly widen outward. It resembles the Thailand specimen, shown in fig. 5 on pl. 8 of ENDO (1969), but the data are insufficient to assign a name.

*Illustrated specimen:* NSM-PP 7954a.

#### *Permocalculus* sp. B

Pl. 5, Fig. 1

*Material and measurements:* One longitudinal section.

Specimen	D	d	s	p
NSM-PP 7901a	558	265	132–265	23–27

Thallus is 1.4 mm broad and 2.5 mm high and composed of irregularly formed segments. Each segment consists of central hollow and calcified cortical layer. Cortical layer is variable in thickness and pierced by numerous slender filaments which bifurcate twice or thrice and increase width gradually outward and terminate with small ball-like rounded expansions, 34  $\mu$  thick in average. It seems to represent a new species in having characteristic features, but the data are not sufficient to assign a specific name.

*Illustrated specimen:* NSM-PP 7901a.

Class Chlorophycophyta  
Family Dasycladaceae

*Vermiporella nipponica* ENDO

Pl. 5, Figs. 2-7

*Vermiporella nipponica* ENDO, 1954a, pp. 191-192, pl. 13, figs. 2-5. ENDO, 1969, p. 46, pl. 10, fig. 6; pl. 11, figs. 1-3 (see synonymy).

*Material and measurements*: Each three longitudinal and cross sections were selected from numerous specimens.

Specimen	D	d	p	w
NSM-PP 7952g	424	212	23	35±
NSM-PP 7928a	573	276	20	35±
NSM-PP 7905a	391	172	21	40±
NSM-PP 7912b	398	212	18	
NSM-PP 7918a	318	146	20	
NSM-PP 7911a	273	170	18	

Thallus is small, cylindrical, slightly undulating, branched irregularly and sometimes constricted, composed of uncalcified central stem and a well calcified cortex in which numerous branch hollows are enclosed. Branches are slender, circular to subcircular in cross section, expanding gradually toward the exterior, perpendicular or slightly inclined to the central stem and arranged regularly on a whorl. As seen in the above description, measurement and other details the present specimens are identified with the type specimen of *Vermiporella nipponica* ENDO from the Kuchibora Formation, Upper Permian in Hachiman-machi, Gifu Prefecture.

*Illustrated specimens*: NSM-PP 7905a, 7911a, 7912b, 7918a, 7928a, 7952g.

*Anthracoporella spectabilis* PIA

Pl. 5, Figs. 8-12

*Anthracoporella spectabilis* PIA, 1920, pp. 15-18, pl. 1, figs. 7-11. ENDO, 1952a, pp. 139-140, pl. 12, figs. 6, 7. MASLOV, 1956, p. 56, pl. 12, figs. 1-3. HORIGUCHI, 1958, pp. 134-135, pl. 27, figs. 1, 2, 5. ENDO, 1969, pp. 46-47, pl. 9, figs. 1, 2.

*Material and measurements*: Four cross and one longitudinal sections.

Specimen	D	d	p	w
NSM-PP 7910a	2016	637	46	32±
NSM-PP 7953a	1645	628	37	35±
NSM-PP 7953b	1539	663	42	32±
NSM-PP 7910b	1326	530	46	30±
NSM-PP 7908a			54	

Thallus presumably cylindrical, circular to subcircular in cross section. Branches are long, slender, bifurcating, nearly uniform in thickness throughout and perpendicular to the central stem. These specimens are identified as *Anthracoporella spectabilis* PIA.

*Illustrated specimens*: NSM-7908a, 7910a, 7910b, 7953a, 7953b.

*Anthracoporella* sp. A

Pl. 6, Fig. 1

*Material and measurements:* One longitudinal section.

Specimen	D	d	s	p
NSM-PP 7915b	1963	1726	212-372	33

Central stem is extremely thick and calcified cortex very thin. Branches are slender, disposed nearly perpendicularly from the central stem and bifurcating a few times. This specimen resembles *A. spectabilis* reported by R. ENDO in 1952 from the Sakamotozawa section, Kitakami, but differs in small thallus and slender branches. At present the data are insufficient to assign a specific name.

*Illustrated specimen:* NSM-PP 7915b.

***Anthracoportella* sp. B**

Pl. 6, fig. 2

*Material and measurements:* One longitudinal section.

Specimen	D	d	p
NSM-PP 7901b	525	315	24

Thallus is small and undulating. Central stem is rather thick. Branches are slender, nearly uniform in diameter and bifurcating a few times. They are arranged nearly perpendicularly to the central stem. As seen in the above description the present specimen seems to belong to the genus *Anthracoportella*, but it is imperfect for specific determination.

*Illustrated specimen:* NSM-PP 7901b.

***Mizzia velebitana* (SCHUBERT) ENDO**

Pl. 6, Figs. 3, 4

*Mizzia velebitana* (SCHUBERT), ENDO, 1952a, p. 140. 1956, pp. 227-229, pl. 22, figs. 3-8 (see synonymy). ENDO, 1957, pp. 283-284, pl. 37, figs. 4, 5; pl. 44, fig. 3. ENDO, 1959, p. 183, pl. 30, fig. 2; pl. 31, figs. 1. ENDO, 1961b, p. 85, pl. 4, figs. 1-3. ENDO, 1961c, p. 124, pl. 4, fig. 5. ENDO, 1969, pp. 47-48, pl. 9, figs. 7-9; pl. 10, figs. 4, 5. NAKAMURA, 1981, p. 46, pl. 10, fig. 4.

*Material and measurements:* Each one longitudinal and oblique sections were chosen from a number of specimens.

Specimen	D	d	p
NSM-PP 7949a	1687	1290	95
NSM-PP 7903e	1087	765	124

Though the specimens are incomplete they are clear to belong to the genus of *Mizzia*. Thallus is composed probably of a chain of bead-like members. Spherical shaped member of a chain, broad central stem, simple and stout branches with bluntly rounded ends and other details agree with character of the type specimen of *Mizzia velebitana* (SCHUBERT) from Europe.

*Illustrated specimens:* NSM-PP 7903e, 7949a.

***Mizzia yabei* (KARPINSKY) ENDO**

Pl. 6, Figs. 5-7

*Stolleyella yabei* KARPINSKY 1908, pp. 268-269.

*Mizzia yabei* (KARPINSKY) ENDO, 1969, p. 48 (see synonymy). ISHIJIMA *et al.*, 1971, p. 105, pl. 3, figs. 1-3. NAKAMURA, 1981, p. 46, pl. 7, figs. 1, 2.

*Material and measurements*: Three longitudinal sections were chosen from numerous specimens.

Specimen	D	d	p
NSM-PP 7927a	648	286	95
NSM-PP 7901c	763	429	86
NSM-PP 7919a	1270	716	143

Thallus is composed probably of bead-like members. Ellipsoidal barrel-shaped member of a chain, broad central stem, somewhat slender branches with bluntly rounded or slightly expanded ends and other details agree that the present specimens may be identified with the type specimen of *M. yabei* (KARPINSKY) from Akasaka, Central Japan.

*Illustrated specimens*: NSM-PP 7901c, 7919a, 7927a.

#### *Egoniolina endoi* sp. nov.

Pl. 6, Figs. 8, 9

*Material and measurements*: Two longitudinal sections.

Specimen	D	d	s	p
NSM-PP 7910c (glove)	1588	1231	143	47
(stalk)	992	804		
NSM-PP 7953c (glove)	1084	830	134	42

*Description*: Thallus drumstick-like in form, composed of cylindrical stalk and ball-shaped expanded head; central hollow broadly cylindrical with ball-like glove on the top. Calcareous cortex thin and nearly uniform in thickness. Branches simple, slender and short, nearly uniform in thickness throughout the length. They are perpendicular or slightly inclined to the central stem and do not branch. No definite reproductive organs were observed.

*Remarks*: Regarding the form of the thallus as well as the central stem and shape of the branches, this species differs from all species of this genus described up to now. This species may, however, be compared with *Egoniolina johnsoni* ENDO (1953b) and *E. undulata* ENDO (1957), but differs in the features of the thallus and shape of the branches, namely in the latter the thalli are club-shaped and the branches are stout and large. The specific name was given in honor of Ryuji ENDO who established *Egoniolina* as the new genus in 1953.

*Holotype*: NSM-PP 7910c.

*Illustrated specimen*: NSM-PP 7953c.

#### *Epimastopora choshiensis* sp. nov.

Pl. 7, Figs. 12-14

*Epimastopora* sp., NAKAMURA, 1981, pp. 50-52, pl. 2, fig. 7.

*Material and measurements*: Three longitudinal sections from several specimens.

Specimen	Thallus (mm)	p ( $\mu$ )	Distance between pores ( $\mu$ )
NSM-PP 7919a	1.2×0.3	18	36
NSM-PP 7949b	1.5×0.4	16	34
NSM-PP 7916c	3.0×0.3	20	44

*Description*: Thallus small, fragmental, slightly undulating and somewhat bended. Pores slender and straight, usually uniform in diameter throughout the length, nearly perpendicular to both surfaces of the thallus and distributed sparsely. No definite reproductive organs were observed.

*Remarks*: The specimens in exam. are characteristic enough and can be easily distinguished from most other species described up to now, for the small dimensions and long intervals between pores. It may, however, be compared with *Epimastopora densipora* ENDO which is approximate in shape and size of the pores, but differs in longer distance between pores. The new species resembles *E. sp. A* described by M. HORIGUCHI in 1958, in the size and intervals of the pores, but differs in the shape of the pores, namely in HORIGUCHI's specimen the pores are irregular in form.

*Holotype*: NSM-PP 7919a.

*Illustrated specimens*: NSM-PP 7916c, 7949b.

#### *Epimastopora densipora* ENDO

Pl. 7, Figs. 3–6

*Epimastopora densipora* ENDO, 1969, pp. 80–81, pl. 42, figs. 1, 2.

*Material and measurements*: Four longitudinal sections.

Specimen	Thallus (mm)	p ( $\mu$ )	Distance between pores ( $\mu$ )
NSM-PP 7910d	1.6×0.4	28	10
NSM-PP 7904a	3.0×0.3	28	12
NSM-PP 7929a	1.9×0.4	23	16
NSM-PP 7915d	2.8×0.4	18	16

Thalli are fragmental, somewhat undulating and bended. Pores are slender, nearly perpendicular to both inner and outer surfaces and sometimes bifurcating. The size, shape and arrangement of the pores indicate that these specimens are identical with the type specimen of *Epimastopora densipora* ENDO from the Khao Phlong Phrab district, Thailand.

*Illustrated specimens*: NSM-PP 7904a, 7910d, 7915d, 7929a.

#### *Epimastopora hexagona* ISHIJIMA

Pl. 7, Figs. 7–11

*Epimastopora hexagona* ISHIJIMA, 1975, pp. 123–125, pl. 2, figs. 1–3.

*Material and measurements*: Five longitudinal sections were chosen from a number of specimens.

Specimen	Thallus (mm)	p ( $\mu$ )	Distance between pores ( $\mu$ )
NSM-PP 7941a	3.0×0.8	186	12

NSM-PP 7908b	3.6×0.8	106	14
NSM-PP 7919b	1.5×0.4	64	14
NSM-PP 7931a	0.9×0.2	41	8
NSM-PP 7933a	1.0×0.5	76	5

Thalli are fragmental; somewhat bended and undulating. Pores are hexagonal with rounded corners or somewhat ellipsoidal in longitudinal section and probably circular to subcircular in cross section. They are arranged regularly on the closely spaced whorls. The present specimens are identical with the type specimen of *Epimastopora hexagona* ISHIJIMA from the Takagami Conglomerate.

*Illustrated specimens*: NSM-PP 7908b, 7919b, 7931a, 7933a, 7941a.

### *Epimastopora kosakiensis* KONISHI

Pl. 6, Figs. 11–12

*Epimastopora kosakiensis* KONISHI, 1954a, pp. 5–6, pl. 2, figs. 23–25.

*Material and measurements*: Two longitudinal sections.

Specimen	Thallus (mm)	p ( $\mu$ )	Distance between pores ( $\mu$ )
NSM-PP 7925c	1.8×0.7	143	114
NSM-PP 7903f	2.6×1.3	162	153

Large diameter of the pores and long intervals between the pores and other aspects of the specimens show that they are identical with *Epimastopora kosakiensis* KONISHI described from the Kosaki Formation in Southern Kyushu.

*Illustrated specimens*: NSM-PP 7903f, 7925c.

### *Epimastopora kanumai* ENDO

Pl. 7, Figs. 1, 2

*Epimastopora kanumai* ENDO, 1954a, p. 195, pl. 13, figs. 8–10. ENDO, 1969, p. 80, pl. 41, figs. 2, 3 (see synonymy).

*Material and measurements*: Two longitudinal sections.

Specimen	Thallus (mm)	p ( $\mu$ )	Distance between pores ( $\mu$ )
NSM-PP 7915c	2.4×0.9	143	32
NSM-PP 7916b	1.6×0.8	124	28

Thalli are fragmental and somewhat bended. Pores are usually thick, nearly perpendicular to both surfaces and arranged closely. The present specimens are identified with the type specimen of *Epimastopora kanumai* ENDO from the Oppara Formation in Okumyogata-mura, Gifu Prefecture, so far as the shape, size and arrangement of the pores are concerned.

*Illustrated specimens*: NSM-PP 7915c, 7916b.

### *Epimastopora* sp.

Pl. 6, Fig. 10

*Material*: One longitudinal section.

This fragment is broad and somewhat bended, 2.4 mm long and 0.8 mm wide. Pores relatively large, 136  $\mu$  to 190  $\mu$  broad and the intervals are 200  $\mu$  to 286  $\mu$ , and inclined to the surfaces of the thallus. This specimen is referable to *E. kosakiensis* KONISHI, but differs in the larger pores and their oblique arrangement. It seems to represent a new species, but the data available are insufficient to assign a specific name.

*Illustrated specimens*: NSM-PP 7919d.

*Macroporella atagoyamensis* sp. nov.

Pl. 7, Figs. 15–19

*Material and measurements*: One oblique and each two longitudinal and cross sections were chosen from several specimens.

Specimen	D	d	p	h	w
NSM-PP 7901d	238	105	21	37	
NSM-PP 7908c	318	252	27		35+
NSM-PP 7915e	311	128	23		
NSM-PP 7901e	305	196	23	46	
NSM-PP 7908d	329	211	27		35±

*Description*: Very small, cylindrical, circular to subcircular in cross section. Calcareous wall is relatively thick. Branches are phloiphoric and thick in proportion to the length, perpendicular or slightly inclined to the central stem and open to the exterior. Branches are arranged somewhat closely. No definite reproductive organs were observed.

*Remarks*: In the general appearance of the thallus this new species may be compared with *Macroporella mina* ENDO from Taishaku, Hiroshima Prefecture and *M. affinis* ENDO from Thailand which are rather small in size, but it is distinguished from them by the more minute thallus and branches.

*Syntype*: NSM-PP 7901d, 7908c.

*Illustrated specimens*: NSM-PP 7901e, 7908d, 7915e.

*Macroporella* sp.

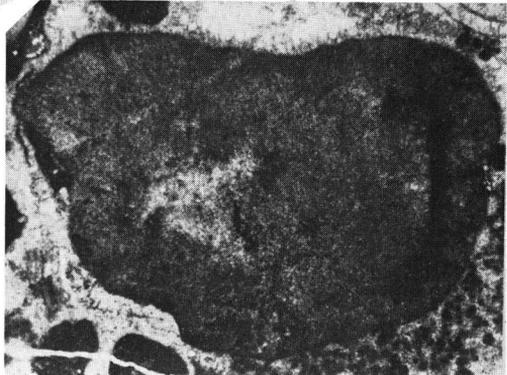
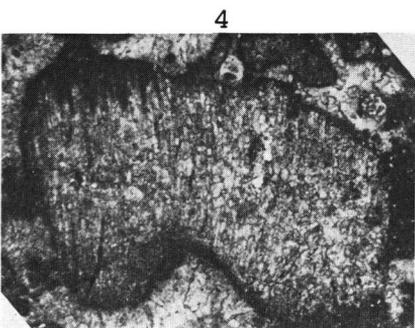
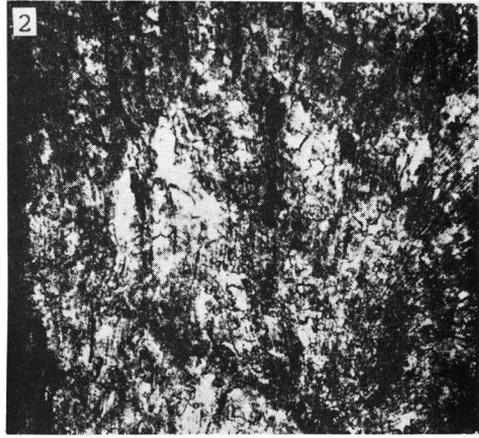
Pl. 8, Fig. 1

*Material*: One oblique section.

Thallus probably cylindrical, 1.4 mm in diameter; central stem relatively thick, 1.1 mm broad; calcified wall very thin; branches short and slender and phloiphoric in form, 28  $\mu$  thick in average. This specimen resembles *Macroporella tenuimarginata* ENDO from the Ominagahama district, Shiga Prefecture which has thin calcareous wall and small branches, but differs in large thallus with short and slender branches.

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**Plate 1.** Figs. 1–5. *Solenopora choshiensis* ISHIJIMA. 1. longitudinal section,  $\times 15$  (NSM-PP 7948a). 2. Enlarged view of the middle portion of the upper part in the above figure.  $\times 25$ . 3. Longitudinal section,  $\times 35$  (NSM-PP 7948b). 4. Another longitudinal section, partly frayed,  $\times 35$  (NSM-PP 7948c). 5. Cross section,  $\times 25$  (NSM-PP 7942a).



It seems to represent a new species but the data are not sufficient to warrant an exact specific name.

*Illustrated specimen*: NSM-PP 7951a.

***Gyroporella igoi* ENDO**

Pl. 8, Figs. 4, 5

*Cyroporella igoi* ENDO, 1959, pp. 190–191, pl. 34, figs. 1–5; pl. 35, figs. 1–5; pl. 40, fig. 3; pl. 41, figs. 7, 8. ENDO, 1961b, pp. 92–93, pl. 8, figs. 5, 6; pl. 9, figs. 1–3. JOHNSON and DANNER, 1966, p. 428, pl. 55, figs. 1–3. ENDO, 1968b, p. 3, pl. 1, fig. 1. ENDO, 1969, pp. 54–55, pl. 15, fig. 5; pl. 16, figs. 1–4. ISHIJIMA *et al.*, 1971, p. 118, pl. 10, figs. 8, 9.

*Material and measurements*: Each one longitudinal and cross sections were selected from several specimens.

Specimen	D	d	p	w
NSM-PP 7925d	1262	868	152	
NSM-PP 7916d	1612	1048	172	25±

Thallus is short, cylindrical, with slight undulation, curcular to subcircular in cross section. Branches are stout, composed to thick stalks and large rounded expansions and arranged nearly perpendicularly to the central stem.

As seen in the above description and measurement these specimens are identified as *Gyroporella igoi* ENDO from Nyugawa-mura, Gifu prefecture, Central Japan.

*Illustrated specimens*: NSM-PP 7916d, 7925d.

***Gyroporella nipponica* ENDO et HASHIMOTO**

Pl. 8, Figs. 2, 3

*Cyroporella nipponica* ENDO et HASHIMOTO, 1955, p. 705, fig. 1. ENDO, 1969, pp. 55–56, pl. 15, fig. 6; pl. 16, figs. 5–7; pl. 17, figs. 1–7 (see synonymy). ISHIJIMA *et al.*, 1971, pp. 117–118, pl. 10, figs. 1–3.

*Material and measurements*: Each one longitudinal and cross sections were chosen from a number of specimens.

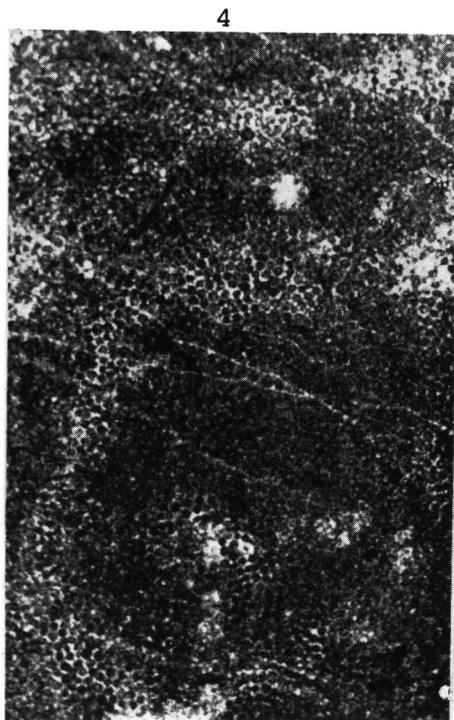
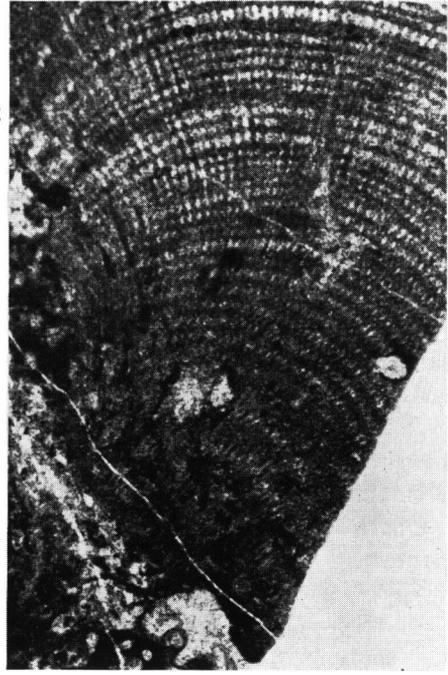
Specimen	D	d	p	w
NSM-PP 7923a	1554	1068	182	22±
NSM-PP 7929b			212	

Thallus is probably broadly cylindrical, circular to subcircular in cross section. Branches are stout, composed of thick stalks and expanded large gloves, nearly perpendicular to the central stem. In the general appearance of the thallus and shape, size and arrangement of the branches the present specimens can be identified with the type specimen of *Gyroporella nipponica* ENDO et HASHIMOTO from the Nakaokoppe Formation in the Nakaokoppe district, Monbetsu-gun, Hokkaido.

*Illustrated specimens*: NSM-PP 7923a, 7929b.

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**Plate 2.** Figs. 1–4. *Petrophyton yabei* sp. nov. 1. Longitudinal section, ×5 (NSM-PP 7955a).  
2. Enlarged view of the basal part of fig. 1, ×40. 3. Cross section, ×5 (NSM-PP 7907a).  
4. Enlarged view of the central portion of the basal part in the above section (fig. 3), ×40.



*Gyroporella omensis* ENDO

Pl. 8, Figs. 6, 7

*Cyroporella omensis* ENDO, 1961b, pp. 93–94, pl. 10, fig. 1; pl. 12, figs. 1–4; pl. 19, figs. 1–3. ENDO, 1969, pp. 56–57, pl. 15, fig. 7; pl. 18, figs. 2, 3, 7–9; pl. 19, figs. 1–3. ISHIJIMA *et al.*, 1971, p. 119, pl. 10, figs. 1–4. NAKAMURA, 1981, p. 54, pl. 7, figs. 5, 6.

*Material and measurements*: Each one cross and oblique sections, fragmental.

Specimen	D	d	p	w
NSM-PP 7900b			95	
NSM-PP 7912c	943	743	98	20

Thallus is probably cylindrical and subcircular in cross section; central stem relatively broad and calcified cortex thin. Branches are rather long and slender, and terminate with small egg-shaped gloves.

From the general appearance of the thallus and the features of the branches these specimens are identified with the type specimen of *Gyroporella omensis* ENDO from the Ominagahama district, Shiga Prefecture, Central Japan.

*Illustrated specimens*: NSM-PP 7900b, 7912c.

*Gyroporella praturloni* ISHIJIMA, OZAKI et NAKAMURA

Pl. 8, Figs. 8–10

*Cyroporella praturloni* ISHIJIMA *et al.*, 1971, p. 121, pl. 11, figs. 3–6.

*Material and measurements*: Three cross sections.

Specimen	D	d	p	w
NSM-PP 7902a	717	398	132	11
NSM-PP 7927b	511	225	102	8
NSM-PP 7901f	545	2226	109	8

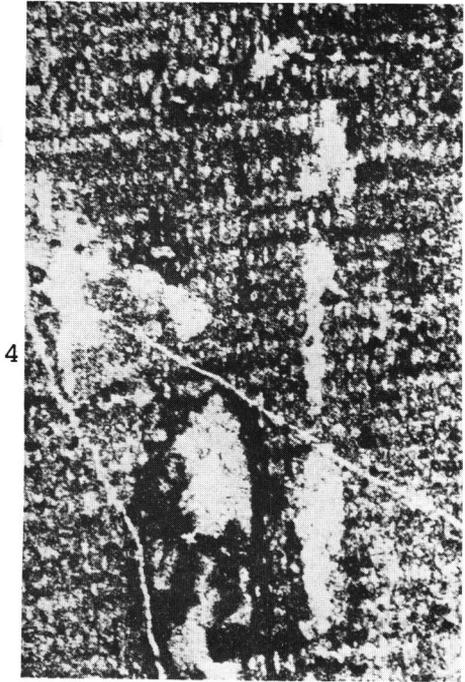
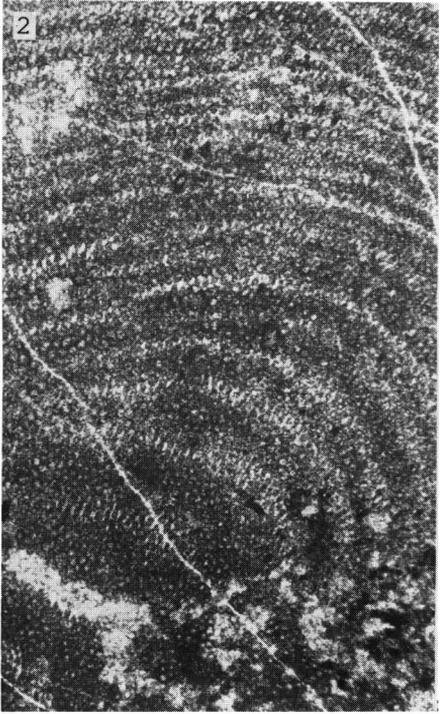
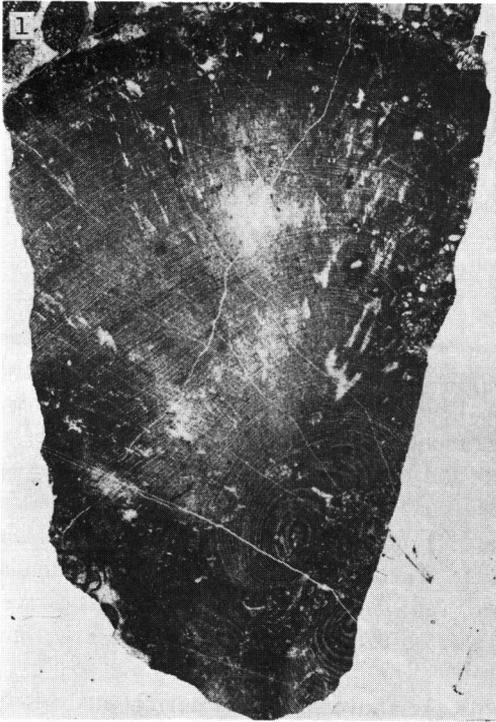
Thalli are nearly circular in cross section; branches are composed of slender stalks and relatively large ball-shaped expansions, somewhat inclined to the central stem. They are arranged sparsely and regularly on a whorl. The present specimens may be identified with the type specimen of *Gyroporella praturloni* ISHIJIMA *et al.* from the Limestone of Sakaishimachibun, Hanno-shi, Saitama Prefecture so far as the shape, size and arrangement of the branches are concerned.

*Illustrated specimens*: NSM-PP 7901f, 7902a, 7927b.

*Gyroporella watanabei* sp. nov.

Pl. 8, Figs. 11–17

**Plate 3.** Figs. 1–4. *Petrophyton yabei* sp. nov. 1. Oblique section,  $\times 5$  (NSM-PP 7947a). 2, 3. Enlarged views of the above specimen. 2. Near the central portion of the basal part,  $\times 35$ . 3. Central portion of the basal part,  $\times 40$ . 4. Enlarged view of the left side of the upper part in fig. 1 on pl. 3,  $\times 60$ .



*Material and measurements:* Four longitudinal, two oblique and each one cross and tangential sections.

Specimen	D	d	p	h	w
NSM-PP 7950a	344	184	52	66	
NSM-PP 7956a	364	182	66	76	
NSM-PP 7911b	334	192	58	82	
NSM-PP 7911c	492	286	46	74	
NSM-PP 7910e	344	202	48		
NSM-PP 7950b	344	212	58		20±
NSM-PP 7956b	318	212	34		
NSM-PP 7956c	344		38		

*Description:* Thallus small, cylindrical, with a slight undulation, nearly circular in cross section. Central stem rather thick and calcified cortex relatively thin. Branches short, consist of short and slender stalks, 17  $\mu$  long and 12  $\mu$  thick in average, and relatively large rounded expansions. Branches are disposed perpendicularly or slightly ascendingly from the central stem and arranged regularly on a whorl. No definite reproductive organs were observed.

*Remarks:* The specimens examined are characteristic in having small thalli and short branches with large gloves at the ends. These features may serve to distinguish this new species from most other species of this genus. This species may, however, be allied to the following species: *G. microporosa* ENDO, *G. tenuimarginata* ENDO and *G. mina* ENDO.

The new species may be compared with the above species in having small thalli, but it is distinguished from them by more minute thalli and relatively large gloves of the branches.

The specific name was given in honor of Sadao WATANABE who kindly forwarded all materials to us for study.

*Syntype:* NSM-PP 7910e, 7950a, 7950b.

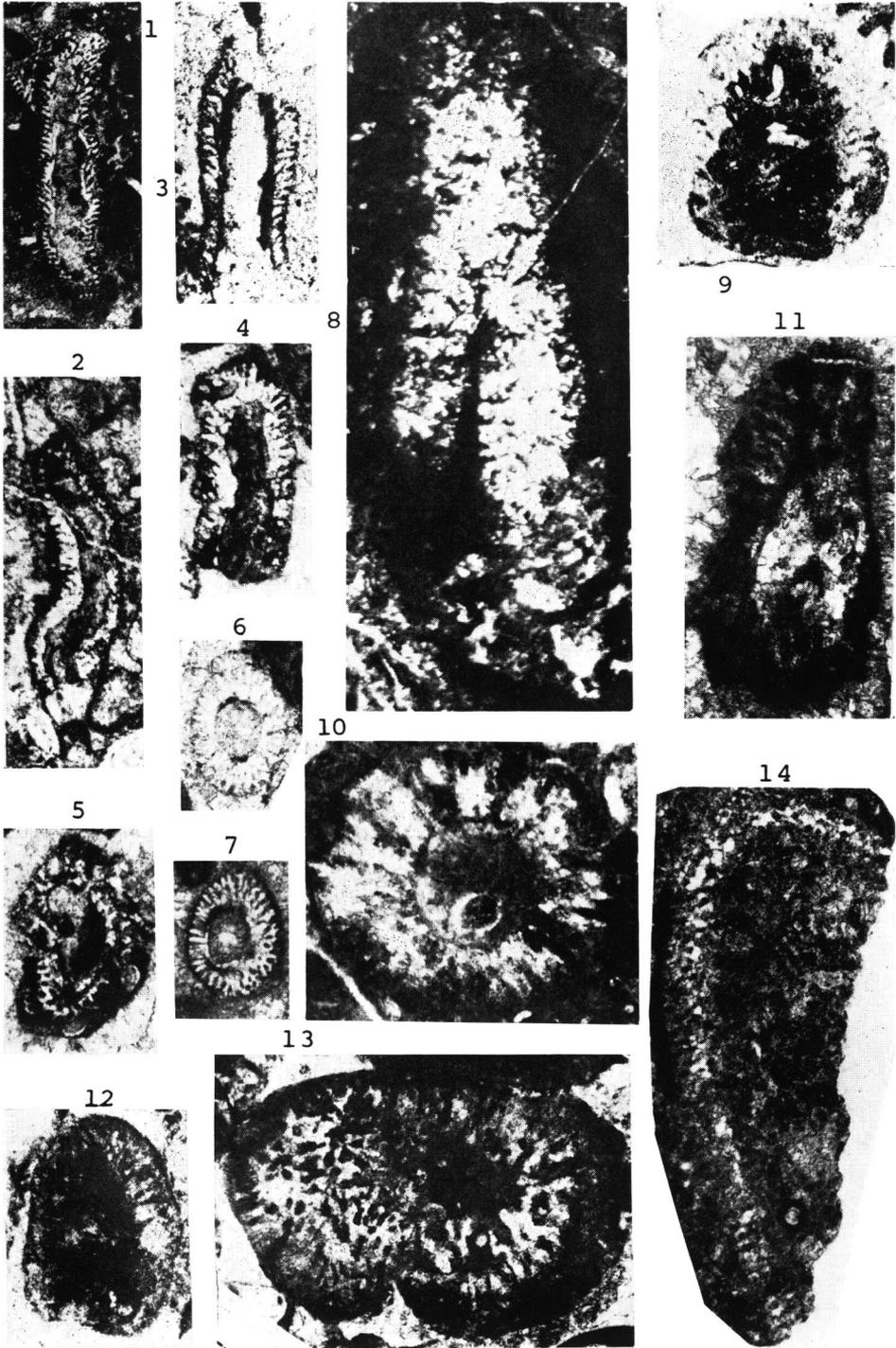
*Illustrated specimens:* NSM-PP 7911b and c; 7956a, b and c.

### *Clavaphysoporella kittakai* sp. nov.

Pl. 9, Figs. 1–12

*Material and measurements:* Six longitudinal, two oblique and four cross sections were selected from a large number of specimens.

**Plate 4.** Figs. 1–7. *Gymnocodium kanmerai* KONISHI. 1, 2. Longitudinal sections of internodes,  $\times 25$  (NSM-PP 7915a, 7936b). 3, 4. Longitudinal sections of internodes, partly frayed,  $\times 25$  (NSM-PP 7945a, 7912a). 5. Oblique section of internode  $\times 25$  (NSM-PP 7925a). Cross sections of internodes,  $\times 30$  (NSM-PP 7925b, 7903a). Figs. 8–10. *Permocaulculus fragilis* (PIA). 8. Longitudinal section,  $\times 25$  (NSM-PP 7900a). 9. Longitudinal section,  $\times 30$  (NSM-PP 7920a). 10. Cross section,  $\times 25$  (NSM-PP 7940a). Figs. 11–13. *Permocaulculus tenellus* (PIA). 11. Longitudinal section,  $\times 30$  (NSM-PP 7903b). 12. Longitudinal section,  $\times 25$  (NSM-PP 7937a). 13. Cross section,  $\times 25$  (NSM-PP 7916a). Fig. 14. *Permocaulculus* sp. A. Longitudinal section, partly frayed,  $\times 30$  (NSM-PP 7954a).



Specimen	D	d	p	h	w
NSM-PP 7904b	573	229	48	716	
NSM-PP 7903g	293		27	620	
NSM-PP 7915f	531	211	32	725	
NSM-PP 7923b	584	238	37	573	
NSM-PP 7901g	424	212	36	573	
NSM-PP 7922a	420	191	32	572	
NSM-PP 7922b	476	274	46		
SNM-PP 7902c			46		
NSM-PP 7918b		345	45		
NSM-PP 7915g	525	267	52		20±
NSM-PP 7930a	531	265	42		
NSM-PP 7906a	525	305	37		20±

*Description:* Thallus small, straight, broadly cylindrical, finely annulated, circular to subcircular in cross section, composed of an uncalcified central stem and a well calcified cortex which is segmented by wide and narrow furrows distributing alternatively. Central stem cylindrical and segmented by ring-like projecting whorls which are connected with furrows of the calcareous wall. Branches phloiphoric in shape, given off radially from every other whorls at small bases and gradually increase diameter toward the exterior and do not branch. In the wide furrows branches are arranged upward, downward and horizontally from the whorls on the central stem, assembling three to four lines to make cluster. They are enclosed in thick lime deposit which is fan-shaped in longitudinal section. Neither branches nor lime deposit are found on the other whorls. Lime deposit is relatively thick between wide furrows and divided into two parts by the narrow furrows. No reproductive organs were observed.

*Remarks:* The most remarkable peculiarity of this species is in its annulating form of the thallus, rings on the surface of the central stem and arrangement of the branches on every other whorls through which *C. kittakai* is separable from other species of this genus described up to now.

The specific name was given in honor of Dr. Shigeyoshi KITAKA, Chief Director of Tokyo Butsuri Gakuen.

*Syntype:* NSM-PP 7903g, 7904b, 7906a.

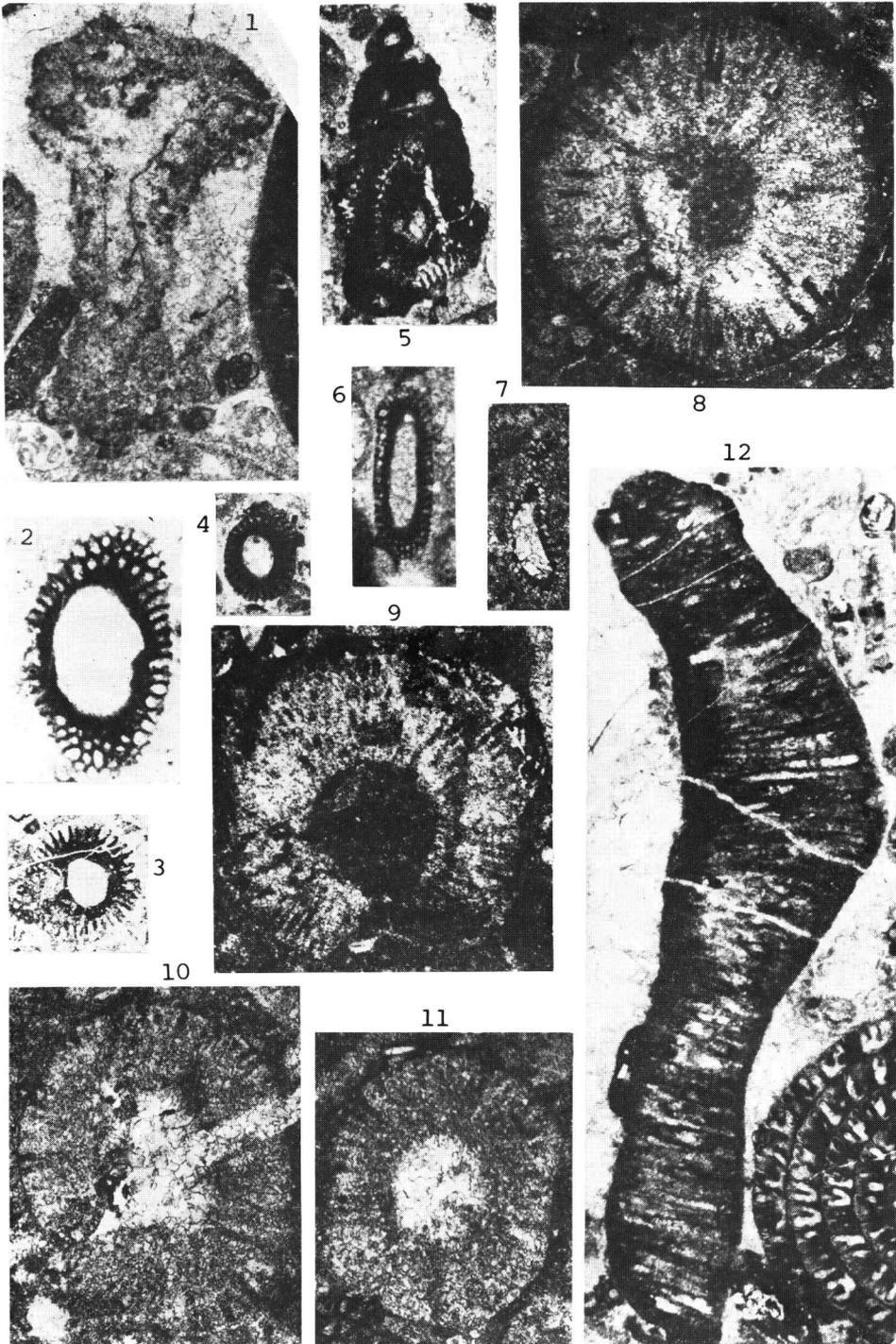
*Illustrated specimens:* NSM-PP 7901g, 7902c, 7915f, g, 7918b, 7922a, b, 7923b, 7930a.

Family Siphonocladaceae  
*Pycnoporidium concentricum* ENDO

Pl. 10, Figs. 1, 2

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**Plate 5.** Fig. 1. *Permocalculus* sp. B. Obliquely longitudinal section,  $\times 25$  (NSM-PP 7901a). Figs. 2-7. *Vermiporella nipponica* ENDO. 2-4. Cross sections. 2,  $\times 50$  (NSM-PP 7952g). 3, 4,  $\times 25$  (NSM-PP 7928a, 7905a). 5-7. Longitudinal sections.  $\times 25$  (NSM-PP 7912b, 7918a, 7911a). Figs. 8-12. *Anthracoporella spectabilis* PIA. 8-11. Cross sections,  $\times 25$  (NSM-PP 7910a, 7953a, 7953b, 7910b). 12. Longitudinal section of the calcified wall, fragment,  $\times 15$  (NSM-PP 7908a).



*Pycnoporidium concentricum* ENDO, 1969, p. 36, pl. 5, fig. 6.

*Material and measurements*: Each one longitudinal and cross sections were chosen from several specimens.

Specimen	Thallus (mm)	Diameter of tube ( $\mu$ )
NSM-PP 7949c	1.5 × 2.2	41
NSM-PP 7927c	1.1 × 2.3	47

Thallus is probably nodular, composed of ramifying tubes which are arranged radially from an area near the center of the basal part. Tubes are flexuous, bifurcating, circular in cross section, nearly uniform in diameter throughout the length and tapered at the periphery. Cross partitions are developed at regular intervals and show a feeble trace of concentric structure.

The general appearance of the thallus and shape, size and arrangement of the tubes indicate that the present specimens are identifiable as *Pycnoporidium concentricum* ENDO from the Khao Phlong Phrab district, Thailand.

*Illustrated specimens*: NSM-PP 7927c, 7949c.

### *Pycnoporidium lobatum* YABE et TOYAMA

Pl. 9, Fig. 13

*Pycnoporidium lobatum* YABE and TOYAMA, 1928, pp. 146–147, pl. 20, fig. 3; pl. 21, figs. 1–5; pl. 22, fig. 1. ENDO, 1960, pp. 271–272, pl. 45, figs. 1, 2. ENDO, 1961a, pp. 58–59, pl. 1, figs. 1–3. ENDO, 1961c, pp. 122–123, pl. 7, fig. 6. NAKAMURA, 1981, p. 36, pl. 6, fig. 1; pl. 9, fig. 9.

*Material and measurements*: One longitudinal section was selected from several specimens.

Specimen	Thallus (mm)	Diameter of tube ( $\mu$ )
NSM-PP 7918c	2.1 × 4.3	25–31

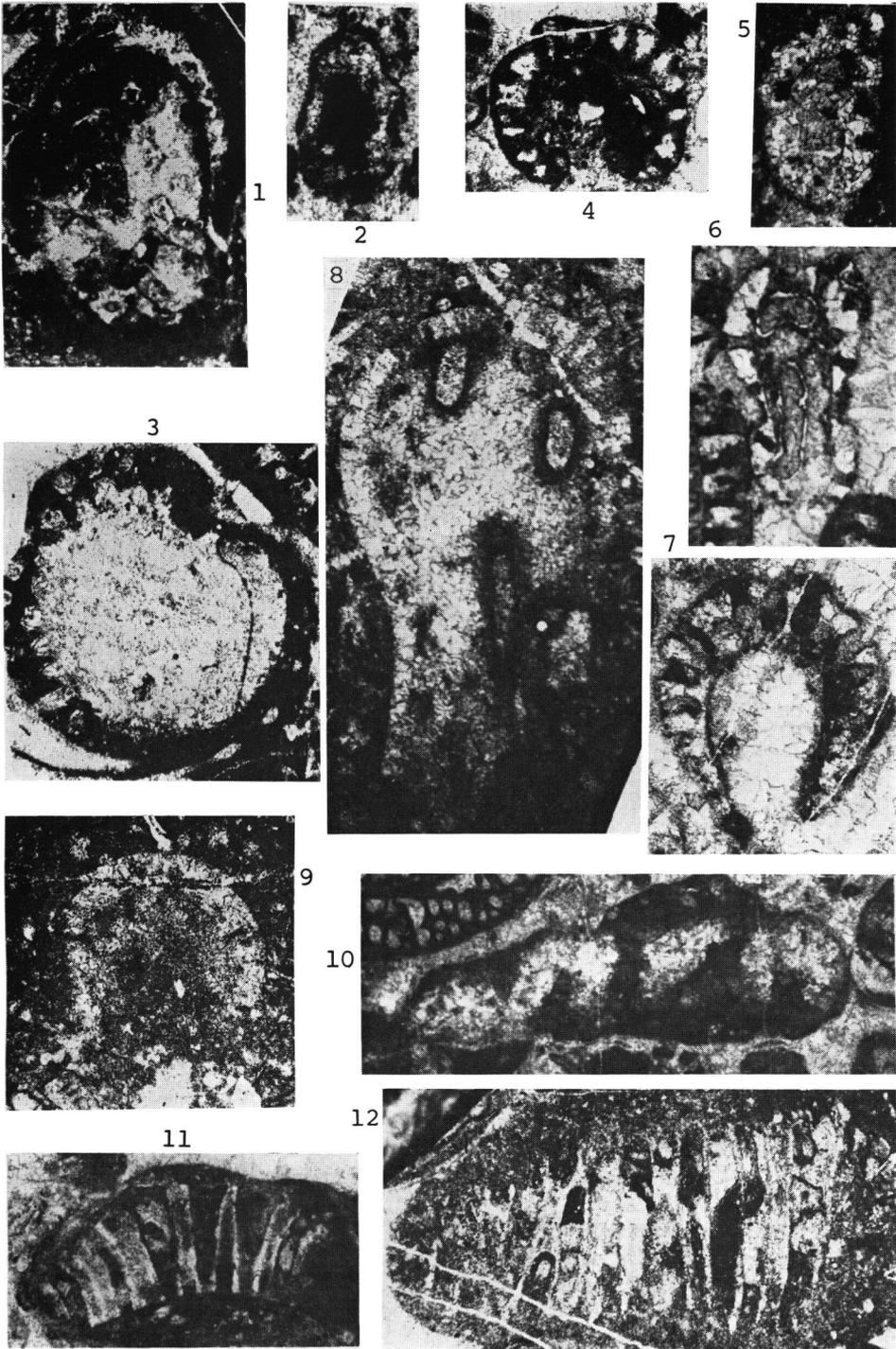
Thallus is probably subspherical, composed of closely packed slender tubes. Tubes are arranged radially from an area near the center of the basal portion, circular to subcircular in cross section, branching dichotomously, slightly flexuous and provided with cross partitions. A feeble trace of a curved structure in the rows of tubes is observed.

In the general appearance of the thallus and the features of the tubes this specimen can be identified with the type specimen of *Pycnoporidium lobatum* YABE and TOYAMA from Soma, Abukuma and Mitoda, Shikoku.

*Illustrated specimen*: NSM-PP 7918c.

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**Plate 6.** Fig. 1. *Anthracoporella* sp. A. Longitudinal section, ×15 (NSM-PP 7915b). Fig. 2. *Anthracoporella* sp. B. Longitudinal section, ×35 (NSM-PP 7901b). Figs. 3, 4. *Mizzia veletana* (SCHUBERT). 3. Oblique section, ×25 (NSM-PP 7949a). 4. Longitudinal section of a member of chain-like beads of thallus, ×25 (NSM-PP 7903e). Figs. 5–7. *Mizzia yabei* (KARPINSKY). Longitudinal sections, ×35 (NSM-PP 7927a, 7901c, 7919a). Figs. 8, 9. *Eogoniolina endoi* sp. nov. ×25. 8. Holotype, longitudinal section, showing drum-stick formed thallus and thin calcified wall (NSM-PP 7910c). 9. Longitudinal section of the head (NSM-PP 7953c). Fig. 10. *Epimastopora* sp. ×25 (NSM-PP 7919d). Figs. 11, 12. *Epimastopora kosakiensis* KONISHI. ×25 (NSM-PP 7925c, 7903f).



Family Udotaceae  
*Succodium multipilularum* KONISHI

Pl. 9, Figs. 14–17

*Succodium multipilularum* KONISHI, 1954b, pp. 233–234, pl. 1, figs. 1–11.

*Material and measurements*: Two longitudinal and each one oblique and tangential sections were chosen from a number of specimens.

Specimen	D''	d''	dmf	du	dg
NSM-PP 7925f	823	425	24–32	31	42
NSM-PP 7903i	398	173	24	18	23
NSM-PP 7956d	318		24–28	27	46
NSM-PP 7925g	478			18	37

D'', Outer diameter of segment; d'', Diameter of central medulla; dmf, Diameter of medullary filament; du, Diameter of utricle; dg, Diameter of gametangium-like expansion of utricle.

Thallus probably dendroid, composed of articulating segments and constricted in some parts to form nodes. Each segment is cylindrical, consists of central medulla and calcified cortex. Medulla is feebly calcified and composed of tangled filaments which are irregularly dichotomized and sometimes constricted. Cortex is segregated into two cortical layers; both are defined by gametangium-like expansions of utricles which are distributed at the same distance from the surface. The inner layer is composed of dichotomizing and irregularly interwoven utricles which are issued from the medullary filaments. The outer layer is usually thin, composed of minute filaments from the gametangium-like expansions.

As seen in the above description and measurement the present specimens are identified as *Succodium multipilularum* KONISHI from the Kuma Formation, Southern Kyushu.

*Illustrated specimens*: NSM-PP 7903i, 7925f, 7925g, 7956d.

*Hikorocodium elegantae* ENDO

Pl. 10, Fig. 3

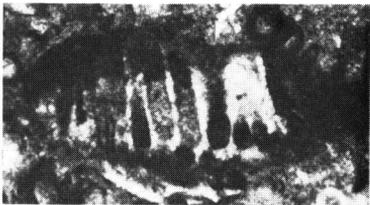
*Hikorocodium elegantae* ENDO, 1951, p. 127, pl. 10, figs. 1–3. ENDO, 1953a, p. 124, pl. 12, fig. 8. ENDO, 1954c, pp. 218–219, pl. 19, figs. 1–3. ENDO, 1957, pp. 297–298, pl. 42, figs. 5, 6. ENDO

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**Plate 7.** Figs. 1, 2. *Epimastopora kanumai* ENDO. Longitudinal sections,  $\times 25$  (NSM-PP 7915c, 7916b). Figs. 3–6. *Epimastopora densipora* ENDO. 3. Longitudinal section,  $\times 35$  (NSM-PP 7910d). 4, 5, 6. Longitudinal sections,  $\times 25$  (NSM-PP 7904a, 7929a, 7915d). Figs. 7–11. *Epimastopora hexagona* ISHIJIMA. 7, 8, 9.  $\times 25$  (NSM-PP 7941a, 7908b, 7919b). 10.  $\times 30$  (NSM-PP 7931a). 11.  $\times 25$  (NSM-PP 7933a). Figs. 12–14. *Epimastopora choshiensis* sp. nov.  $\times 25$ . 12. Holotype, longitudinal section, showing broadly interspaced slender pores. (NSM-PP 7919a). 13, 14. Longitudinal sections NSM-PP 7949b, 7916c). Figs. 15–19. *Macroporella atagoyamensis* sp. nov.  $\times 25$ . 15. Longitudinal section of syntype, showing small thallus and relatively broad branches (NSM-PP 7901d). 16. Cross section of syntype (NSM-PP 7908c). 17. Oblique section (NSM-PP 7915e). 18. Longitudinal section (NSM-PP 7901e). 19. Cross section (NSM-PP 7908d).



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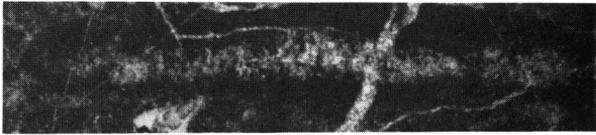


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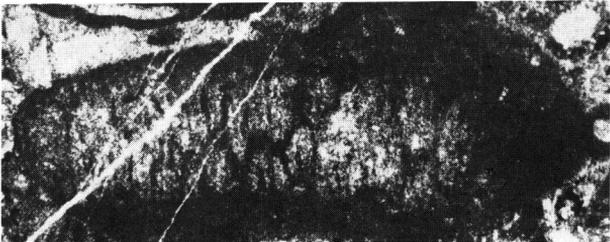
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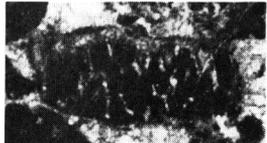


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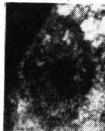
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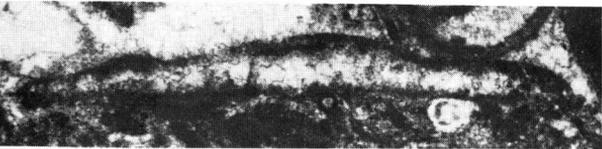
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and Horiguchi, 1957, p. 176, pl. 14, fig. 3. ENDO, 1961c, p. 135, pl. 4, fig. 7. NAKAMURA, 1981, p. 58, pl. 10, figs. 5-7.

*Material and measurements*: One cross section was selected from several specimens.

Specimen	Thallus (mm)	p (u)
NSM-PP 7916e	3.2 × 3.6	124

Thallus probably cylindrical and undulating, composed of feebly calcified pith-like central stem and calcified cortex which is pierced by numerous tubular pores. Pores are given off from the central stem nearly perpendicularly, branch dichotomously and anastomose frequently.

This specimen is identical with the type specimen of *Hikorocodium eleganta* ENDO from the Kitakami Mountainland so far as the general appearance of the thallus and shape, size and arrangement of the pores are concerned.

*Illustrated specimens*: NSM-PP 7916e.

### *Eugonophyllum johnsonii* KONISHI et WRAY

Pl. 10, Figs. 4-6

*Eugonophyllum johnsonii* KONISHI et WRAY, 1961, pp. 661-663, pl. 75, figs. 4, 5 and 7-18.

*Material and measurements*: Three transverse sections were selected from numerous specimens.

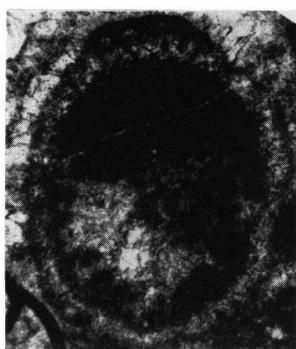
Specimen	Width of blade	Diameter of filament	Diameter of utricle
NSM-PP 7949d	315	28	38
NSM-PP 7950c	802	40	36
NSM-PP 7949f	302	24	36

Thallus is probably composed of a calcified undulating blade. Blade consists of medulla, subcortex and outer cortex. Medulla is composed of slender filaments. Subcortex is composed of prominent layer of anastomosing utricles extending parallel to the surface. Outer cortex is relatively thin and composed of fine branchlets which are given off perpendicularly from the subcortical utricles. Reproductive organs are probably spheroidal in shape, 80  $\mu$  to 100  $\mu$  in diameter, and developed over the surface.

As seen in the above description and measurement the present specimens are

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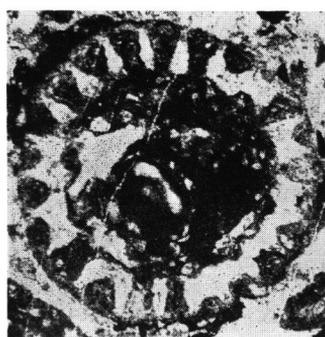
**Plate 8.** Fig. 1. *Macroporella* sp. Obliquely cross section, showing broad central stem and thin calcareous wall,  $\times 25$  (NSM-PP 7951a). Figs. 2, 3. *Gyroporella nipponica* ENDO and HASHIMOTO. 2. Longitudinal section, partly frayed,  $\times 25$  (NSM-PP 7929b). 3. Cross section,  $\times 25$  (NSM-PP 7923a). Figs. 4, 5. *Gyroporella igoi* ENDO. 4. Longitudinal section,  $\times 25$  (NSM-PP 7925d). 5. Cross section,  $\times 25$  (NSM-PP 7916d). Figs. 6, 7. *Gyroporella omensis* ENDO. 6. Longitudinal section, fragment,  $\times 25$  (NSM-PP 7900b). 7. Cross section,  $\times 25$  (NSM-PP 7912c). Figs. 8-10. *Gyroporella praturloni* ISHIJIMA, OZAKI and NAKAMURA. Cross sections,  $\times 25$  (NSM-PP 7902a, 7927b, 7901f). Figs. 11-17. *Gyroporella watanabei* sp. nov. 11. Longitudinal section of syntype, showing small thallus and characteristic branches,  $\times 25$  (NSM-PP 7950a). 12, 13, 14. Longitudinal sections,  $\times 25$  (NSM-PP 7956a, 7911b, 7911c). 15. Oblique section of syntype,  $\times 25$  (NSM-PP 7910e). 16. Cross section of syntype,  $\times 25$  (NSM-PP 7950b). Fig. 17. A, B. Oblique and tangential sections,  $\times 25$  (NSM-PP 7956b, c).



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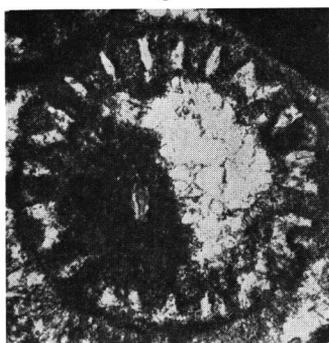


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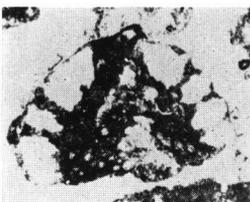
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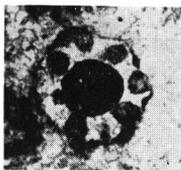
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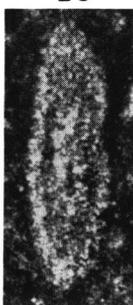
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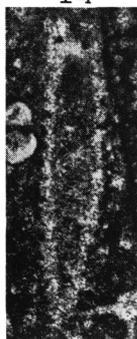
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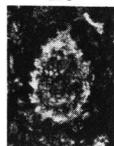
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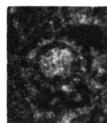
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identical with the type species of *Eugonophyllum johnsonii* KONISHI and WRAY from Otero County, New Mexico.

*Illustrated specimens*: NSM-PP 7949d, 7949f, 7950c.

*Eugonophyllum magnum* (ENDO) KONISHI et WRAY

Pl. 10, Fig. 7

*Anchicodium magnum* ENDO, 1951, pp. 125–126, pl. 11, figs. 3–5. ENDO, 1952c, p. 247, pl. 23, figs. 6, 7. ENDO, 1954c, p. 218, pl. 19, fig. 4. ENDO, 1957, pp. 292–293, pl. 41, fig. 4; pl. 42, fig. 2. ENDO 1961c, pp. 134–135, pl. 6, figs. 4–6.

*Eugonophyllum magnum* (ENDO) KONISHI et WRAY, 1961, p. 663, pl. 75, fig. 6.

*Material*: One transverse section.

Thallus is probably undulating blade in form, about 1 mm thick, consisting of medulla, subcortex and outer cortex. Medulla is composed of slender filaments with a diameter of 37  $\mu$  in average; subcortex is composed of prominent layer of anastomosing utricles, 105  $\mu$  in average diameter, extending parallel to the surface; outer cortex is relatively thick, consisting of fine branchlets given off perpendicularly from the subcortical utricles; dimensions of probable reproductive organs are 200  $\mu$  by 350  $\mu$  in average.

As seen in the above description the present specimen is identified as *Eugonophyllum magnum* (ENDO) from Kitakami so far as the general features of the structure are concerned.

*Illustrated specimen*: NSM-PP 7928b.

Family Codiaceae

*Ortonella akasakensis* ENDO

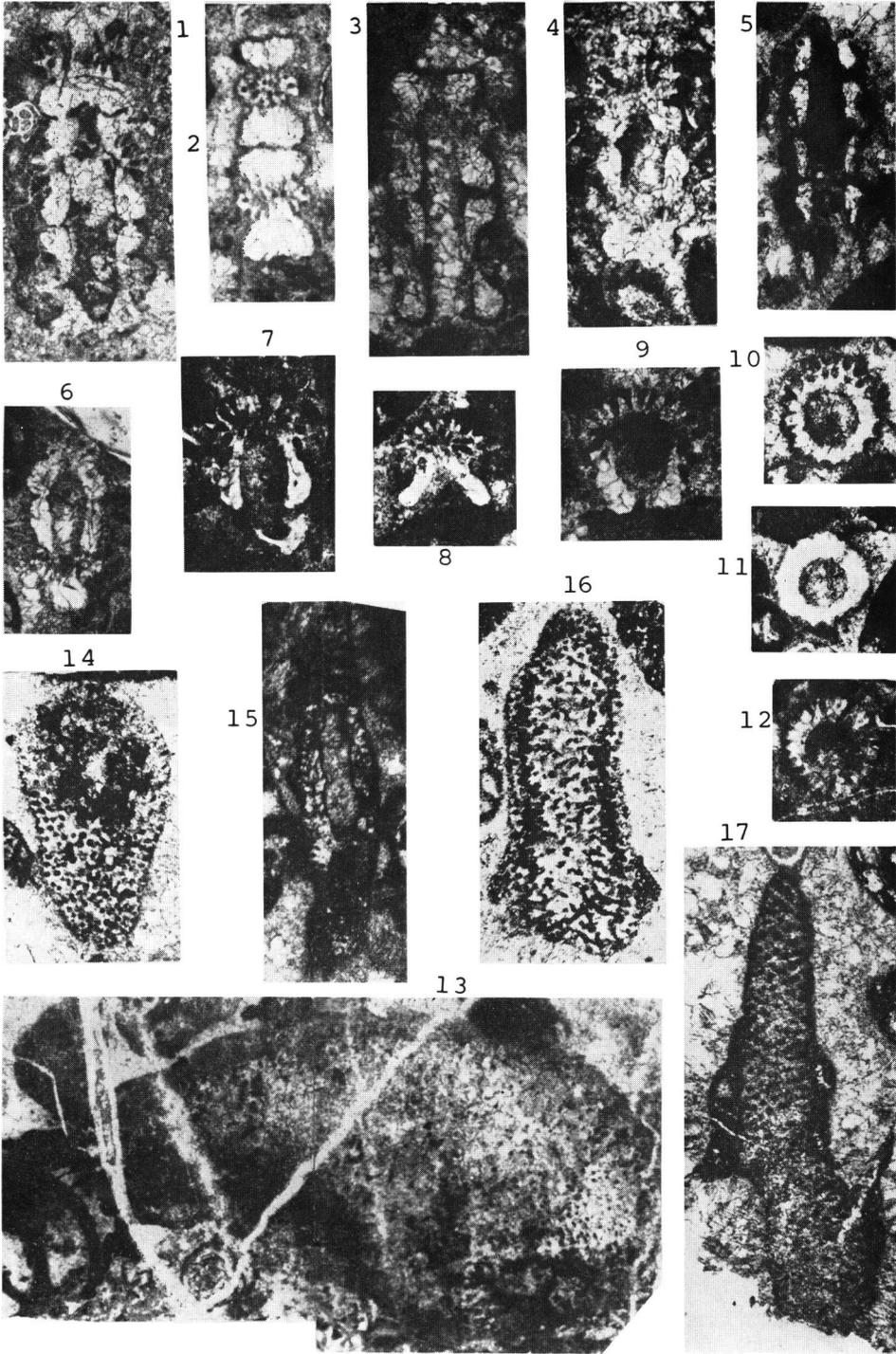
Pl. 11, Fig. 4

*Ortonella akasakensis* ENDO, 1954b, pp. 215–216, pl. 18, figs. 10, 11. ENDO, 1956, p. 242, pl. 30, figs. 2–4. ENDO, 1957, p. 297, pl. 43, fig. 8.

*Material*: One longitudinal section.

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**Plate 9.** Figs. 1–12. *Clavaphysoporella kittakai* sp. nov.  $\times 25$ . 1. Longitudinal section of syntype, showing characteristic undulating feature of the calcified wall, projects on the central stem and arrangement of the branches (NSM-PP 7904b). 2. Tangential section of syntype, showing narrow and wide furrows and characteristic arrangement of the branches (NSM-PP 7903g). 3–6. Longitudinal section (NSM-PP 7915f, 7923b, 7901g, 7922a). 7, 8. Oblique sections (NSM-PP 7922b, 7902c). 9. Obliquely cross section (NSM-PP 7918b). 10, 11. Cross sections, showing different aspects due to cutting portions (NSM-PP 7915g, 7930a). 12. Cross section of syntype, showing radial arrangement of the phloiphoric branches (NSM-PP 7906a). Fig. 13. *Pycnopodium lobatum* YABE and TOYAMA. Longitudinal section,  $\times 20$  (NSM-PP 7918c). Figs. 14–17. *Succodium multipilularum* KONISHI. 14. Oblique section,  $\times 25$  (NSM-PP 7925f). 15. Longitudinal section,  $\times 25$  (NSM-PP 7903i). 16. Longitudinal section, cut through the calcified cortex,  $\times 25$  (NSM-PP 7956d). 17. Tangential section,  $\times 25$  (NSM-PP 7925g).



Thallus is small, 1.1 mm broad and 1.4 mm high, probably spherical, composed of ramified tubes which are arranged radially from an area near the center of the basal portion and branch four or five times at an angle of  $10^\circ$  to  $15^\circ$ . In the general appearance of the thallus and size, shape and bifurcating form of the tubes this specimen is identical with the type specimen of *Ortonella akasakensis* ENDO from Kinsho-zan, Gifu Prefecture.

*Illustrated specimen*: NSM-PP 7949e.

*Ortonella* cf. *O. coloradoensis* JOHNSON

Pl. 11, Fig. 3

*Compare*: *Ortonella coloradoensis* JOHNSON, 1945, p. 840, pl. 2, fig. 2. JOHNSON and KONISHI, 1956, pp. 95–97, pl. 4, figs. 1–3.

*Material*: One longitudinal section.

Thallus is small, probably subspherical, 0.8 mm broad and 0.6 mm high, composed of ramified tubes which are arranged radially from an area near the center of the basal portion. Tubes are relatively small in diameter,  $27\ \mu$  in average, uniform throughout the length and bifurcate three or four times at an angle of  $50^\circ$  to  $55^\circ$ .

Though the data available are not sufficient the present specimen is closely related to *Ortonella coloradoensis* JOHNSON.

*Illustrated specimen*: NSM-PP 7912f.

*Ortonella furcata* GARWOOD

Pl. 11, Figs. 1, 2

*Ortonella furcata* GARWOOD, 1914, pp. 265–266, pl. 20, figs. 1–4. GARWOOD, 1931, pp. 130–132, pl. 14, fig. 1. JOHNSON, 1945, p. 839, pl. 4, fig. 6. JOHNSON and KONISHI, 1956, p. 97, pl. 4, fig. 3.

*Material and measurements*: Two longitudinal sections.

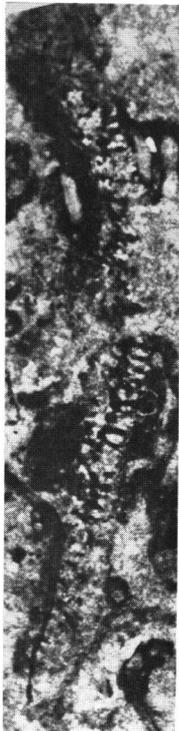
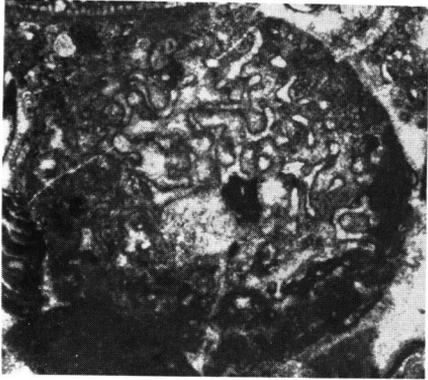
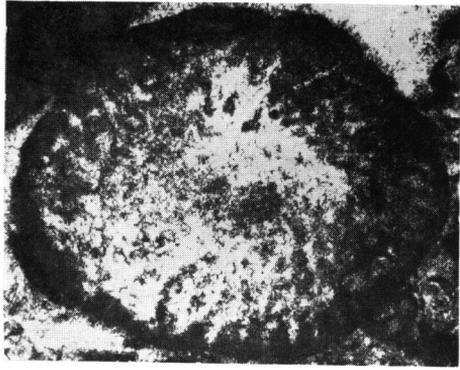
Specimen	Thallus (mm)	Diameter of tube ( $\mu$ )	Angle of divergence
NSM-PP 7922f	$1.3 \times 0.8$	37	$35^\circ$
NSM-PP 7925h	$0.9 \times 0.5$	35	$37^\circ$

Thalli are small, spherical and composed of loosely packed tubular filaments which are  $35\ \mu$  to  $37\ \mu$  in diameter and bifurcate three to five times. The present specimens are identified with the type specimen of *Ortonella furcata* GARWOOD so far as the shape, size and diverging form of the tubes are concerned.

*Illustrated specimens*: NSM-PP 7922f, 7925h.

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**Plate 10.** Figs. 1, 2. *Pycnopodium concentricum* ENDO. 1. Longitudinal section,  $\times 35$  (NSM-PP 7949c). 2. Cross section,  $\times 25$  (NSM-PP 7927c). Fig. 3. *Hikorocodium elegantae* ENDO. Cross section,  $\times 15$  (NSM-PP 7916e). Figs. 4, 5, 6. *Eugonophyllum johnsonii* KONISHI and WRAY. Transverse sections. 5.  $\times 25$  (NSM-PP 7950c). 4, 6.  $\times 30$  (NSM-7949d, 7949f). Fig. 7. *Eugonophyllum magnum* (ENDO) KONISHI and WRAY. Transverse section,  $\times 12$  (NSM-PP 7928b).



*Ortonella morikawai* ENDO

Fig. 11, Fig. 5

*Ortonella morikawai* ENDO, 1954c, pp. 219–220, pl. 19, figs. 8, 9. ENDO, 1957, p. 296, pl. 43, figs. 4, 5. ISHIIIMA *et al.*, 1971, pp. 129–130, pl. 16, figs. 1, 2.

Thallus is probably subspherical, 4.5 mm broad and 2.3 mm high, composed of ramified tubes which are arranged radially from an area near the center of the basal portion. Tubes relatively thick, 82  $\mu$  thick in average, gradually widen toward the distal ends and bifurcate three to five times at an angle of 30° in average.

This form described above is identical in every respect with *Ortonella morikawai* described by Riuji ENDO from the Yayamadake Limestone, Kumamoto Prefecture.

*Illustrated specimen*: NSM-PP 7947b.

*Ortonella takagamiensis* sp. nov.

Pl. 11, Figs. 6, 7

*Material*: Each one longitudinal and oblique sections.

*Description*: Thallus probably subspherical in form, composed of closely packed tubes which are arranged from an area near the center of the basal portion. Tubes are rather thick, 85  $\mu$  to 100  $\mu$  in diameter, bifurcating three or four times at an angle of 5° to 7° and curved outward. No reproductive organs were observed.

*Remarks*: The most remarkable peculiarity of this new species is in its shape and bifurcating form of the tubes, through which it is separable from most other species of this genus. It is, however, allied to the following species: *O. morikawai* ENDO and *O. pertituba* ENDO.

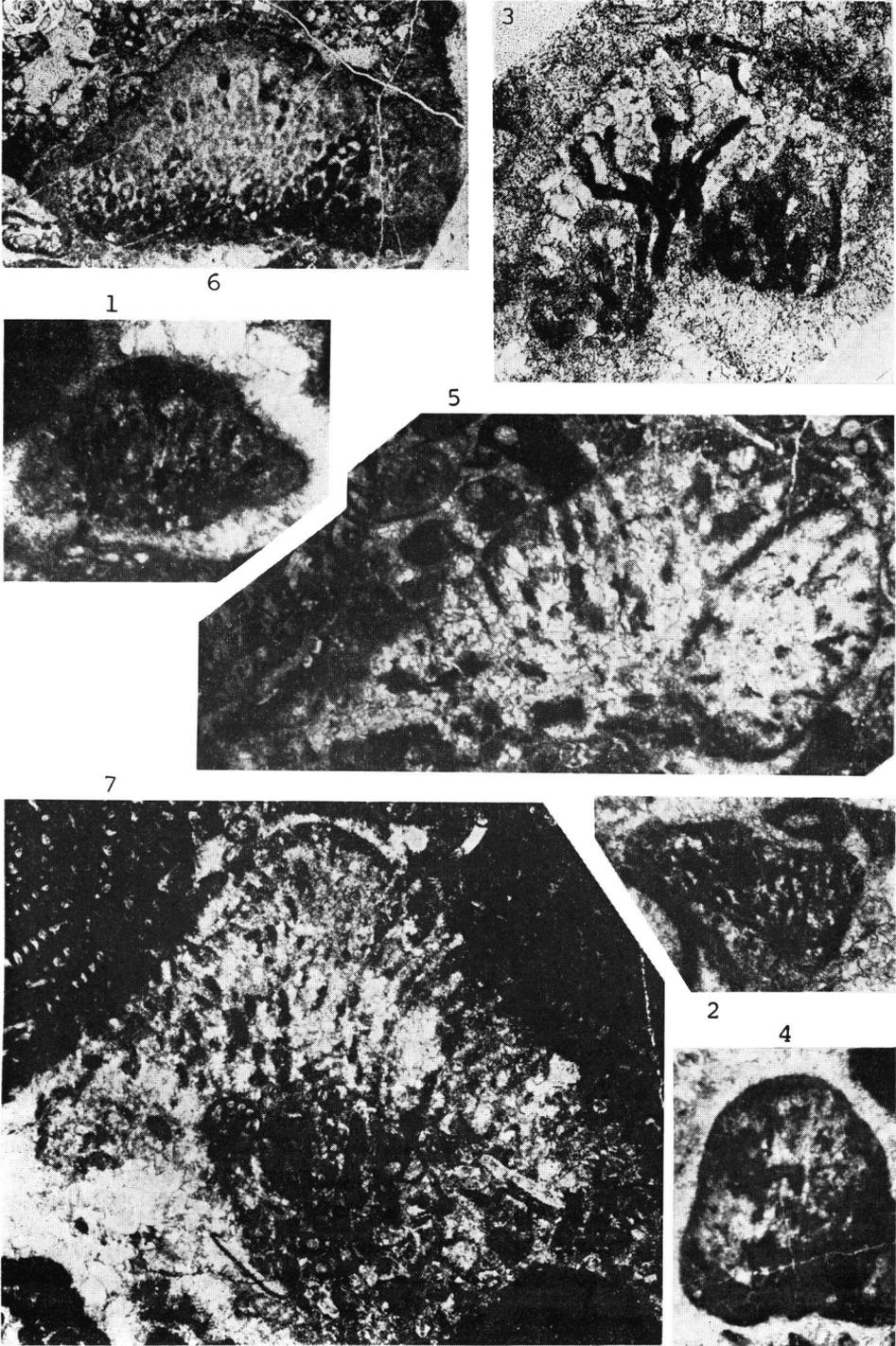
The general form of this species may be referable to *O. morikawai* which is approximate in size of the thallus and arrangement of the tubes, but it is distinguished by the curved tubes and the smaller angle of bifurcation. The second ally is *O. pertituba* which resembles it in the arrangement and bifurcating angle of the tubes, but differs in curved and thicker tubes.

*Holotype*: NSM-PP 7927d.

*Illustrated specimen*: NSM-PP 7936b.

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**Plate 11.** Figs. 1, 2. *Ortonella furcata* GARWOOD. Longitudinal sections,  $\times 30$  (NSM-PP 7922f, 7925h). Fig. 3. *Ortonella cf. coloradoensis* JOHNSON. Longitudinal section,  $\times 60$  (NSM-PP 7912f). Fig. 4. *Ortonella akasakensis* ENDO. Longitudinal section,  $\times 25$  (NSM-PP 7949e). Fig. 5. *Ortonella morikawai* ENDO. Longitudinal section,  $\times 20$  (NSM-PP 7947b). Figs. 6, 7. *Ortonella takagamiensis* sp. nov. 6. Oblique section,  $\times 15$  (NSM-PP 7936b). 7. Longitudinal section of the holotype, showing curved thick tubes and small angle of divergence,  $\times 15$  (NSM-PP 7927d).



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