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JAPANESE CARBONIFEROUS AND PERMIAN CORALS

BY

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Resume

The specimens of Japanese Carboniferous and Permian corals here treated, are now deposited in the collections of the Universities of Tokyo, Tohoku (Sendai) and Hokkaido (Sapporo). The majority have been previously reported by H. YABE, I. HAYASAKA, T. SUGIYAMA and others, also by the writer himself. However, with the finding of additional specimens it has become necessary to make some revisions of previous works. The writer also feels it necessary to revise the formerly reported stratigraphical position of some corals in the light of recent researches in the Palaeozoic stratigraphy of Japan.

1. Introduction

Among the corals at hand, Tetracorals are represented by twelve families, fifty-two genera, and one hundred and three species, of which six families range from the Carboniferous to the Permian, three families are restricted to the Carboniferous, while three families are confines to the Permian. The Aseptata include four families, six genera and ten species, of which two genera are limited to the Carboniferous and the others to the Permian. Besides these, two species of Hexacorals are known from the Upper Palaeozoic of Japan, viz: *Omphalophyllia yamanbaensis* YABE et SUGIYAMA and *Pseudopavona taisyakuana* YABE, SUGIYAMA and EGUCHI.

The corals showed most luxuriant growth during the Onimaru epoch (Upper Viséan in age) throughout Japan; these corals show affinity with those of Southern China. In the Middle Carboniferous, they became less numerous in Japan, and some of them, found especially in the Northeastern parts of the country have some resemblance to those of North China. In the Upper Carboniferous, no trace of corals has been found up to the present.

In the early Permian the Sakmarian transgression brought a new coralline fauna. Of this, *Waagenophyllum, Wentzelella, Yatsengia, Iranophyllum, Lophophyllidium,* and *Verbeekiella* were the leading types; they may be the most characteristic representatives of the corals of the Tethys Sea. The Upper Permian deposits throughout Japan are almost barren of any megascopic organisms, excepting a few species.

Certain morphological changes can be observed in some corals, ranging from the Carboniferous to the Permian, particularly in the corallum with cerioid wall. Such corals were always antecedent to those of plocoidal types as seen in *Stylidophyllum* to *Polythecalis*, or of *Wentzelella* to *Wentzelloides* as well as in *Lonsdaleiastraea*.

Some peculiar groups of corals, Geyerophyllidae, a newly proposed family, are also treated with much detail in this report, especially with reference to their development of skeletal elements through ontogenesis.

2. *Acknowledgments*

Acknowledgments are made by the writer to the following: the late Dr. T. NAGAO and the Dr. S. OISHI, formerly Professors of Hokkaido Univ., for their supervision and encouragement; Dr. I. HAYASAKA, Professor of Hokkaido Univ., for his kindness in giving valuable advice; Dr. J. SUZUKI, Professor of the Hokkaido Univ. also Prof. T. WATANABE for their encouragement; Dr. H. YABE, Prof. emeritus of Tohoku Univ. and Dr. S. IJIRI for advice and encouragment during the course of his study; Prof. S. HANZAWA (Tohoku Univ.), K. ASANO (Tohoku Univ.) and T. KOBAYASHI (Tokyo Univ.) for kindly permitting the writer freely to use some valuable specimens there preserved; Mr. S. KUMANO for taking photographs; Mr. K. YOKOTA, for the preparation of thin sections of coralline fossils; Messrs E. TAKAHASHI, R. TORIYAMA, K. ICHIKAWA, R. TANAKA and T. YOSHIDA for submitting some corals for the writer's study; Messers K. SUYAMA, H. TAKEDA, K. YAMADA, T. KAKIMI, H. SUETOMI, S. HASHIMOTO and Y. SUZUKI, for their cooperation during the field work of recent years in the Kitakami mountain region. Particular thanks are also due to the Ministry of Education for a grant of aid for publishing research result which has rendered possible the publication of this paper.

3. *Stratigraphy of the Japanese Upper Palaeozoic, with special reference to the stratigraphical and geographical distributions of corals*

In this chapter the stratigraphy of the Japanese Upper Palaeozoic is briefly dealt with. Descriptions are given for each district from north to south.

Hokkaido: In Hokkaido no fossils from the Palaeozoic have yet been found, but this does not mean that there is no existent Palaeozoic formation in this island. Everywhere in Hokkaido, especially in the Hidaka mountain range, one finds a series of various kinds of formations of considerable thickness comprising schalsteins, limestones, thick-bedded shales and cherts, developing conformably under the fossiliferous Upper Jurassic deposits; that whole series is now known under the name of the Hidaka system. The upper half

of it may perhaps correspond in age to the formations from the Lower Jurassic to Upper Triassic. The lithologic nature of these formations remind one strongly of the so-called Sanposan-group of Shikoku island, which is widely traceable through the outer zone of Shikoku island and is now believed to be Triassic in age. The lower half of the Hidaka system may be correlated to the Lower Triassic or Upper Permian in age, although quite barren in fossils. The lithologic character of this part is quite similar to the Lower Triassic Inai as well as Upper Permian Toyoma slate formations developing in the Southern part of the Kitakami Mountain region.

Moreover in the northern end of Hokkaido (Esashi Mountain region) as well as in the southwestern part of this island as in the Oshima district, there are found also thick formations, composed mainly of schalstein, limestone, chert and slate, which may be also Palaeozoic and probably represent the Upper Palaeozoic in age; the lithologic nature and succession of rocks are quite similar to those of the Palaeozoic formations in northern Kitakami mountain region, as well as in the Inner zone of northeastern Honsyu, facing the Japan Sea.

Kitakami Mountain region: Kitakami Mountain region is situated in the NE portion of Honsyu, the main island of Japan. It covers the area of all Iwate, the southern part of Aomori as well as the northern Miyagi Prefectures, the southern half of the whole area being one of the most classical regions for the study of Palaeozoic and Mesozoic stratigraphy in Japan. In particular, the Upper Palaeozoic deposits have been recognized there for a long time; their stratigraphical succession has been investigated in much detail within these ten years. Although some classical notes regarding the Upper Palaeozoic stratigraphy of this area have already been published by Em. Prof. H. YABE (1937, 1938, 1939), it is now necessary to modify some of his former statements on account of the recent advance of study. A stratigraphical account regarding the Permian and the Carboniferous deposits is presented below, in ascending order:*

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*The fusulinid zones proposed by M. L. THOMPSON are adopted here in this paper for the major divisions of the Upper Palaeozoic of Japan with foraminiferous limestones. His fusulinid zones are as follows:

Zone of *Millerella*
Zone of *Profusulinella*
Zone of *Fusulinella*
Zone of *Fusulina*
Zone of *Triticites*
Zone of *Pseudoschwagerina*
Zone of *Parafusulina*
Zone of *Polydiexodina*
Zone of *Verbeekina-Neoschwagerina*
Zone of *Yabeina*

Tobigamori-Series: Uppermost Devonian; develops in the districts of Ichinoseki, Setamai and Hizume, all in southwestern and southeastern districts of the southern Kitakami mountainarea. Type locality: Tobigamoriyama, west of the Town of Ichinoseki. Consists of various kinds of shales, slates, sandstones, variegated tufaceous rocks and intraformational conglomerates. Characteristic in almost complete absence of the calcareous rocks and by predominance of reddish or purplish rocks consisting of porphyroid tuff. Conglomerate with pebbles of various kinds of crystalline schists and gneissose rocks. Exact thickness unknown, but it may be more than 1000 m. Of the geological age of this formation, opinions are divergent in geological circles, but the existence of a *Spirifer* in this formation bearing definite triplicate sinal formula, cannot be disregarded.

H. YABE and M. NODA (1933) have already reported this fossil as *Spirifer* (*Trigonotreta*) *verneuili* MURCHISON, in association with *Rhynchonella pleruродon* PHILLIPS, *Chonetes hardrensis* PHILLIPS, *Aviculopecten* cf. *losseni* (KOENEN), *Murchisonia* sp., and Fenestellids. Besides this, the writer has found from this series such fossil remains as, *Amplexus* sp., *Brachthyris* ? sp., *Camarotoechia* sp., Nautilus ? *Orbiculoidea* sp., *Schizophoria* sp., *Spirifer* sp., sp., and *Spiriferina* sp., while K. TACHIBANA (1950) found such plant remains from this formation in association with *Cyrtospirifer*, as *Leptopholeum* cf, *australe* (M'COY) and *Cyclostigma* sp.

Very recently the writer studied the spiriferoid Brachiopoda to have been collected from the Tobigamori series until present day, which were determined as: *Cyrtospirifer* cf. *kindeli* STAINBROOK, *Cyrotospirifer* cf. *brevipositicus* STAINBROOK, *Cyrtospirifer* sp.= *Spirifer* (*Trigonotreta*) *verneuili* MURCHISON of YABE and NODA, besides *Sinospirifer sinense* var. *australis* MAXWELL. The former three species were reported by the writer under the leadership of I. HAYASAKA (I. HAYASAKA & M. MINATO, 1954), while the last one was figured by him in other paper (1955).

Carboniferous deposits in the Kitakami mountain area, are divisible into five series, viz., Hikoroiti-, Arisu-, Ohdaira-, Onimaru-, and Nagaiwa-series in ascending order. They may probably correspond in rough estimation, to Etroeungtian (Km, K_1, K_2), Tournaisian (Z_1, Z_2, C_1), Lower Viséan (C_2, S_1, S_2), Upper Viséan (D_1, D_2, D_3) and Moscovian respectively, (M. MINATO, 1953, M. MINATO et al, 1953).

Of these, the zone of *Polydiexodina* may be almost equivalent with the zone of *Verbeekina-Neoschwagerina* in its stratigraphical position. In Japan, almost all THOMPSON's fusulinid faunal zones have been already established.

M. L. THOMPSON: Studies of American Fusulinids, Univ. Kansas Publ., Contrib. Pal., Protozoa, Art. 1, 1948.

Hikoroichi (Hikoroiti) *-series: Develops in the districts of Hikoroichi-mura, Setamai-, Shimoarisu- and Nagasaka-mura. Whole thickness more than 750 m. It consists chiefly in gray or black slate and alternation of green schalstein and slate, while lenticular limestone and less reddish schalstein develop also in this series, especially in its lower part. The lowest part is composed of conglomerate, about 10 m in thickness.

The succession of these rocks has been discussed already in a series of the writer's previous papers; also see fig. 1. Four important fossil horizons are found in this series, viz., A_0, A_1, A_2 and B_0 in ascending order.

From horizon A_0 such fossils are known:

Conularia tyoanjiensis SUGIYAMA
Palaeophyllipsia japonica SUGIYAMA and OKANO
Actinocrinus ohmoriensis MINATO
Amphoracrinus sp.
Leptaena convexa WELLER
Leptaena cf. *convexa* WELLER
Schellwienella izirii MINATO
Schellwienella ? sp.
Productella aff. *caperata* (SOWERBY)
Spirifer cf. *loganii* HALL
Kitakamithyris tyoanjiensis (MINATO)
Kitakamithyris hikoroitiensis (MINATO)
Brachythyris kitakamiensis MINATO
Brachythyris ? sp.
Actinoconochus planosulcata (PHILLIPS)
Delthyris aff. *clarksvilensis* (WINCHEL)
Lithophaga sp.
Schizophoria sp.
Spiriferina paratransversa MINATO
Leptaena analoga (PHILLIPS)
Spirifer ultratarnsversa MINATO
Spirifer ohmoriensis MINATO
Phillipsia ohmoriensis OKUBO
Cliothyridina royssii (L'EVILLÉ)
Spiriferina octoplicata SOWERBY
Kitakamithyris semicircularis MINATO

* In transliterating local names and personal names into the Occidental alphabet, there is much confussion in Japan; many of the older and more familiar spellings are now little in use. The writer wishes here, that the readers of this paper will be advised that Tu, Zu and Tsu are the same. Ti and Chi, Fu and Hu, Si and Shi and so forth. H. HUZIMOTO and H. FUJIMOTO is also the same author; while Hikoroiti is same as Hikoroichi.

Actinocrinus higuchisawaensis MINATO
Planoproductus gigantoides MINATO
Fenestella sp.

Fossil horizon A_1 lies above A_0, and between these two there is a formation about 200 m in thickness, while A_2 is found in a horizon higher by about 70 m than A_1. These two horizons are also fossiliferous, but their fossils have not been investigated in detail.

Separated by about 300 m, fossil horizon B_0 lies on A_2, from where the following species are found:

Derbya depressa DEMANET var. *transversa* MINATO
Leptaena analoga (PHILLIPS)
Spirifer ultratransversa MINATO
Spirifer ohmoriensis MINATO
Syringothyris sp.
Schizophoria sp.
Kitakamithyris ? sp.

Arisu-Series: Arisu-series is divisible into two stages, the lower part, Hinozuti stage, and the upper, Jumonji stage.

The Hinozuti stage develops in the area surrounding Setamai and Shimoarisu-villages, and is mainly composed of schalstein and slate. Whole thickness less than 200 m. Succession is diagramatically given in text-fig. 1.

The very important fossil horizon B_1 is found in the middle portion of this series. Fossils are:

Actinoconchus lamellosa (L'EVILLÉ)
Schumardella cf. *missouriensis* (SCHUMARD)
Brachythyris sp.
Productus sp. *a.*
Syringothyris sp.
Actinocrinus higutisawaensis MINATO
Planoproductus gigantoides MINATO
Fenestella sp.

Jumonji stage develops more widely than the preceding stage, and is found in Yokota-, Setamai- and Shimoarisu-villages. Whole thickness more than 500 m. Schalstein, alternations of schalstein and slate, impure limestone are also most common elements in this series. Fossils are rather numerous, especially at three fossil horizons, C_0, D_0, and D_1, in ascending order.

From C_0:

Camarotoechia sp.
Brachythyris aff. *pinguis* (SOWERBY)
Productus sp. *b.*

Fusella nipponotrigonalis MINATO
Amplexus sp. *a.*
Phillipsia ohmoriensis OKUBO
Spiriferina octoplicata SOWERBY

From D_0:

Schizophoria resupinata (MARTIN)
Fusella nipponotrigonalis MINATO
Amplexus sp. *b.*
Syringothyris transversa MINATO
Fusella nipponotrigonalis var. *minor* MINATO
Kitakamithyris semicircularis MINATO
Platycrinus asiatica MINATO
Syringothyris kitakamiensis MINATO
Orthotetes keokuk (HALL)
Pustula cf. *tenuipustulata* THOMAS
Spririfer kozuboensis MINATO*
Plicatosyrinx singulare MINATO
Plicatosyrinx ? *kumanoi* MINATO

From D_1:

Derbya depressa var. *transversa* MINATO
Schizophoria resupinata (MARTIN)
Productus sp. *b.*

Ohdaira series, very thick, but less rich in fossils; divisible into two stages; the lower, Maide-stage and the upper, Kozubo-stage. Succession of each member of these two stages is shown diagramatically in fig. 1.

The Maide stage develops also in the area surrounding Setamai, Shimo-arisu-, and Yokota-villages, while outside of this area, nowhere to date has this formation been found yielding fossils. The lower part of this stage consists mainly of slate, while the upper is made of thick schalstein. There are two important fossil horizons, E_0 and E_1, both of which are situated in the relatively lower part of this formation.

From E_0:

Brachythyrina nagaoi MINATO
Amplexus nipponensis OISHI et MINATO
Syringopora sp.
Productus sp. *b.*
Amplexus sp. *a.*

* Very recently this species has been found also in the A_0 horizon of the Hikoroichi series, and accordingly the geological range of the species is here shown in the text-fig. 1 so as to denote from the A_0 to D_0 horizon.

Amplexus sp. *b.*
Cliothyridina royssii (L'EVILLÉ)
Spiriferina octoplicata SOWERBY
Syringothyris transversa MINATO
Fusella nipponotrigonalis var. *minor* MINATO
Brachythris aff. *pinguis* (SOWERBY)
Syringothyris sp.

From E_1:

Brachythris aff. *pinguis* (SOWERBY)

The Kozubo stage develops also in the same area as the preceding stage; the lower part of it is composed mainly of alternations of schalstein and slate, while the upper part is mainly of sandstone.

Fossils very rare. Only in the two fossil layers, F_0 and F_1, has the writer found a few species up to the present day.

From F_0:

Sugiyamaella carbonarium YABE et MINATO
Pustula sp.
Spirifer sp. *c.*
Chonetes sp.

While from F_1 there has been found:

Spirifer sp. *d.*

To sum up the description above presented, the formations from the Hikoroichi, through Arisu to the Ohdaira series, mainly consist of schalstein, slate, and sandstone, these formations being very poor in limestone facies. The corals are comparatively rare throughout these formations, either in number of species or individuals. Especially, compound forms of Tetracorals are wholy lacking. Tabulata are also wanting except *Syringopora* sp. derived from E_0 horizon of the Maide stage in association with *Amplexus nipponensis.*

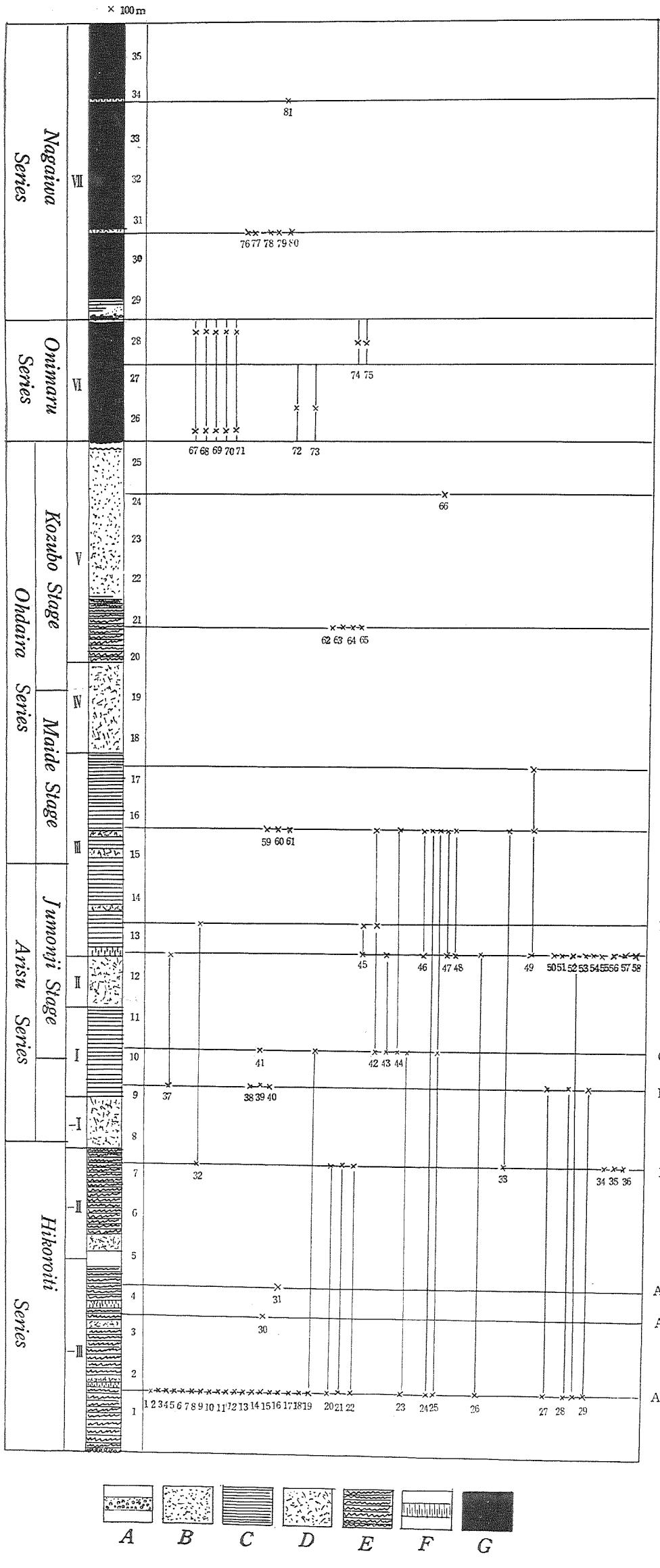
Amplexus sp. *a* and sp. *b* seem to be relatively abundant in individuals among these coralline fauna, these two species are found in the formations from Jumonji to the Maide stage, but they are unfortunately in bad state of preservation.

Thus, no characteristic horizon marker has been discovered among corals in these Lower Carboniferous deposits from Hikoroichi to the Ohdaira series. As the exceptional case to this statement, there are only two solitary corals *Sugiyamaella carbonarium* YABE et MINATO and *Amplexus nipponensis* OISHI et MINATO; the former is derived from F_0, Kozubo stage, while the latter from E_0, the Maide stage.

Onimaru series develops widely throughout the Kitakami mountain region, viz., in Nagasaka-mura in the west, and Setamai-, Shimoarisu-, Kamiarisu-,

Text-fig. 1. Columnar geological section of the Lower Carboniferous deposits in the Kitakami district, showing the stratigraphical distribution of the leading fossils.

A: Conglemerate facies
B: Sandstone facies
C: Slate facies
D: Schalstein facies
E: Salte, Sandstone and Schalstein in alternation
F: Impure limeston
G: Limestone facies



1 *Conularia tyoanjiensis* SUGIYAMA
2 *Palaeophyllipsia japonica* SUGIYAMA et OKANO
3 *Actinocrinus ohmoriensis* MINATO
4 *Amphoracrinus* sp.
5 *Leptaena convexa* WELLER
6 *Leptaena* cf. *convexa* WELLER
7 *Schellwienella izirii* MINATO
8 *Schellwieuella* ? sp.
9 *Productella* aff. *caperata* (SOWERBY)
10 *Spirifer* cf. *loganii* HALL
11 *Kitakamithyris tyoanjiensis* (MINATO)
12 *Kitakamithyris hikoroitiensis* (MINATO)
13 *Brachythris kitakamiensis* MINATO
14 *Brachythyris* ? sp.
15 *Actinoconchus planosulcata* (PHILLIPS)
16 *Delthyris* aff. *clarksvielensis* (WINCHEL)
17 *Lithophaga* sp.
18 *Schizophoria* sp.
19 *Spiriferina paratransversa* MINATO
20 *Leptaena analoga* (PHILLIPS)
21 *Spirifer ultratransversa* MINATO
22 *Spirifer ohmoriensis* MINATO
23 *Phillipsia ohmoriensis* OKUBO
24 *Cliothyridina royssii* (L'EVILLÉ)
25 *Spiriferina octoplicata* SOWERBY
26 *Kitakamithyris semicircularis* MINATO
27 *Actinocrinus higuchisawaensis* MINATO
28 *Planoproductus gigantoides* MINATO
29 *Fenestella* sp.
30 *Spirifer* sp. a
31 *Spirifer* sp. b
32 *Derbya depressa* DEMANET var. *transversa* MINATO
33 *Syringothyris*
34 *Schizophoria* sp.
35 *Syringothyris* sp.
36 *Kitakamithyris* ? sp.
37 *Actinoconchus lamellosa* (L'EVILLÉ)
38 *Schumardella* cf. *missouriensis* (SCHUMARD)
39 *Brachythyris* sp.
40 *Productus* sp. a
41 *Camarotoechia* sp.
42 *Productus* sp. b
43 *Fusella nipponotrigonalis* MINATO
44 *Amplexus* sp. a
45 *Schizophoria resupinata* (MARTIN)
46 *Amplexus* sp. b
47 *Syringothyris tranrversa* MINATO
48 *Fusella nipponotrigonalis* var. *minor* MINATO
49 *Brachythyris* aff. *pinguis* (SOWERBY)
50 *Platycrinus asiatica* MINATO
51 *Syringothyris jumonjiensis* MINATO
52 *Spirifer kozuboensis* MINATO
53 *Orthotetes keokuk* (HALL)
54 *Pustula* cf. *tenuipustulata* THOMAS
55 *Syringothyris kitakamiensis* MINATO
56 *Plicatosyrinx singulare* MINATO
57 *Plicatsyrinx* ? *kumanoi* MINATO
58 Blastoid gen. et sp. indet.
59 *Brachythyrina nagaoi* MINATO
60 *Amplexus nipponensis* ÔISHI et MINATO
61 *Syringopora* sp.
62 *Sugiyamaella carbonarium* YABE et MINATO
63 *Pustula* sp.
64 *Spirifer* sp. c
65 *Chonetes* sp.
66 *Spirifer* sp. d
67 *Siphonodendron martini* (EDWARDS et HAIME)
68 *Siphonodendron pauciradiale* (M'COY)
69 *Dibunophyllum*
70 *Syringopora*
71 *Kueichouphyllum*
72 *Dibunophyllum bristolense* GARWOOD et GOODYEAR
73 *Palaeosmilia kitakamiensis* MINATO
74 *Stylidophyllum japonica* (YABE et HAYASAKA)
75 *Dorlodotia* sp.
76 *Profusulinella* sp.
77 *Chaetetes nagaiwaensis* MINATO
78 *Thysanophyllum aseptatum* DOBROLYUBOVA
79 *Lithostrotionella* sp.
80 *Diphyphyllum equiseptatum* YABE et HAYASAKA
81 *Spirifer* sp. e

Yokota-, and Hikoroiti-mura in the east.

The series lies unconformably on the underlying formations; Arisu or Hikoroiti-series, the Ohdaira series being locally lacking.

Speaking generally of the whole formation of this series, limestone facies is dominat in amount, while black slate and alternations of slate and limestone follow this.

Fossils are very numerous.

Foraminifera:

Saccamminopsis carteri (BRADY)
Millerella sp.
Endothyra parvra v. MÖLLER
Cribrostomum texturifrome v. MÖLLER
Cribrospira panderi v. MÖLLER

Tetracoral:

Pseudocaninia sp.
Caninia juddi (THOMSON) var. *ozawai* MINATO
Siphonodendron pseudomartini (YABE et HAYASAKA)
Siphonodendron sp. *a.*
Siphonodendron sp. *b.*
Siphonodendron martini (EDWARDS et HAIME)
Siphonodendron inugasirayamensis MINATO
Siphonodendron densitabulata (YABE et HAYASAKA)
Siphonodendron pauciradiale (M'COY)
Lithostroion hinozuchiense MINATO, sp. nov.
Pseudodorlodotia kakimii MINATO, gen, et sp. nov.
Diphyphyllum flexusosum YABE et HAYASAKA
Dibunophyllum bristolense GARWOOD et GOODYEAR
Dibunophyllum asiaticum MINATO, nom. nov.
Dibunophyllum inugasirayamensis MINATO
Rhodophyllum yokoyamai MINATO
Rhodophyllum sugiyamai MINATO
Stylidophyllum japonicum (YABE et HAYASAKA)
Setamainella hayasakai MINATO
Yuanophyllum yabei (NAGAO et MINOTO)
Amygdalophyllum setamaiensis YABE et MINATO
Cyathophyllum sp.
Palaeosmilia kitakamiensis MINATO
Kueichouphyllum yabei MINATO
Kueichouphyllum kesenense MINATO sp. nov.
Kueichuphyllum yahagiense MINATO, sp. nov.

Hexaphyllia sp.
Hexaphyllia elegans YABE et SUGIYAMA
Hexaphyllia japonica YABE et SUGIYAMA
Heterophyllia kitakamiensis YABE et SUGIYAMA

Aseptata:

Syringopora reticulata GOLFUSS
Kueichoupora setamaiensis MINATO, sp. nov.

Brachiopoda:

Products (*Dictyoclostus*) sp.
Gigantoporductus kitakamiensis MINATO, (MS)
Rhynchonella sp.
Spirifer sp.

Nagaiwa series is distributed in the same districts overlying the Onimaru formation, where the preceding series (Onimaru) develops. The stratigraphical relation between these two formations is now not clearly known in detail, but the existence of an unconformity is expected at the base of this series. Whole thickness of the Nagaiwa series attains more than 750 m; it consists mainly of white limestone, intercalated, here and there, with relatively thin schalsteine or agglomeratic layers. In the lowermost part, a member is found, composed of alternations of sandstones and conglomerates, about 20 m in thickness.

Fossils are extremely rare, but two distinct layers are found, yielding some fossils. One is horizon H_0, consisting of green schalstein with limestone lenticles; it is situated about 200 m above the base of this series. The other is H_1, composed of impure limestone which is found at a horizon about 300 m still higher than H_0.

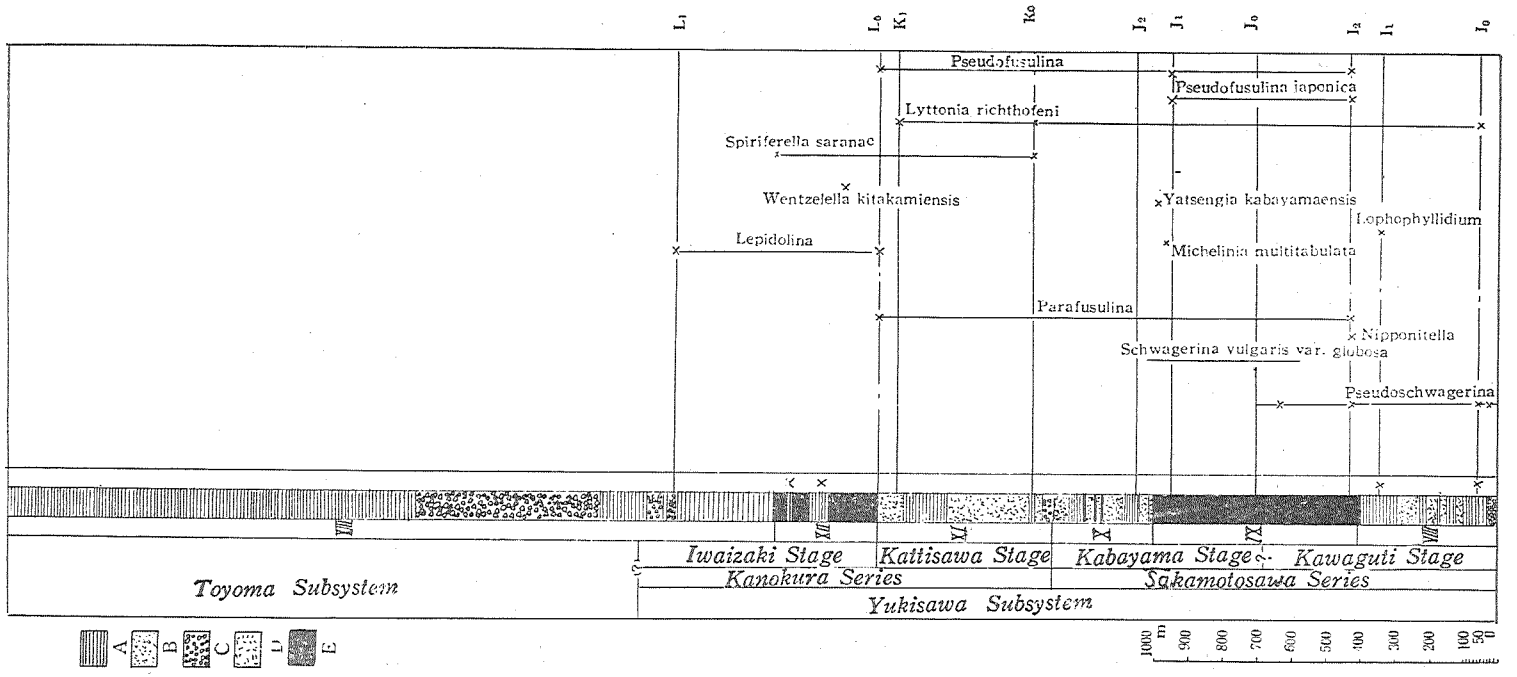
From H_0, such coralline remains are found as:

Chaetetes nagaiwaensis MINATO sp. nov.
Thysanophyllum aseptatum DOBROLYUBOVA
Lithostrotionella kitakamiensis MINATO, sp. nov.
Diphyphyllum equiseptatum YABE et HAYASAKA

Besides these, *Fusulinella* sp. is occasionally discovered in the same horizon (ONUKI, Y. 1938). From H_1, some brachiopod remains have been discovered, but they have not yet been studied in detail.

It is far from doubtful that the Onimaru series may be correlated to the *Yuanophyllum* zone of Southern China on the one side, and to the *Dibunophyllum* zone of the Viséan in Europe on the other.

The age of the Nagaiwa series is not yet exactly determined, but it may be regarded to correspond to the lower part of the Pennsylvanian from its stratigraphical position and from fossil contents, although fossils have not yet been fully investigated.



Text-fig. 2. Columnar geological section of the Permian formations in the Setamai district, Kitakami mountain region.

A.: Slate facies. B.: Sandstone focies.
C.: Conglomerate facies. D.: Schalstein facies.
E.: Limestone facies.

The Permian deposits of the Kitakami mountain region are more varied in lithologic facies than the Carboniferous, either horizontally or vertically. Accordingly it is rather difficult to divide them lithologically. Nevertheless these deposits are divisible into several formations from the major change of rock facies. The upper part of the deposit is mainly composed of clay slate, occasionally intercalated with granite conglomerate. The lower part comprises various kinds of conglomerate, sandstone, slate, schalstein and limestone. The former is now called by the name Toyoma subsystem, while the latter by the name Yukisawa subsystem.

The **Yukisawa subsystem** is now divided into two series: the lower, the Sakamotosawa series; the upper, the Kanokura series respectively.

Sakamotosawa series.

The Sakamotosawa series lies unconformably on the strongly folded Carboniferous deposits everywhere in southern Kitakami mountain area. In one district, the Sakamotosawa series covers the Nagaiwa series, while in other districts it lies directly on the Onimaru-series. In some other district, it lies directly on the Ohdaira or Arisu-series, the Onimaru as well as the Nagaiwa series being entirely lacking. In Hikoroichi-mura, and near Ohmata in Setamai district, it also covers directly the profoundly deformed Hikoroichi-series, the formations of Arisu-, Ohdaira-, Onimaru- and Nagaiwa-series not appearing at all.

Lithologically the Sakamotosawa series comprises three divisions at its type locality of Kattisawa district, Setamai-mura. The lower part begins with basal conglomerate and chiefly consists of thin schalstein, liparitic tuff, carbonaceous slate, greenish sandstone and calcareous slate and sandstone in alternation, the whole thickness being about 400 m.

The middle division is about 600 m in thickness; it is composed of limestone, while the upper part comprises variegated sandstone and slate, about 300 m in thickness.

From the fossiliferous layers, (horizon I_0), situated about 30-50 m above the base of this series, the writer has found such molluscan and molluscoidal remains as *Acanthopecten, Chonetes, Products, Marginifera.* From the other important layer (Horizon I_1), yielding numerous fossils, which lies near the top of the lower divisions of this series, the writer has collected also *Isogramma, Rhynchonella, Aviculopecten, Bellerophon,* further besides them such simple corals as *Iranophyllum permicum* MINATO and *Lophophyllidium suetomii* MINATO. The last-mentioned species is now regarded to be a good indicator of this horizon.

Also from the lower division of the Sakamotosawa series, there have been found many other brachiopod remains, although whether their stratigraphical

horizon belongs to I_0 or I_1 is not yet settled. They include *Derbya*, *Meekella*, *Streptorhynchus*, *Spirifer*, *Spiriferina* and *Lyttonia*.

Fusulinid remains have been not yet studied in detail by the writer, but *Pseudoschwagerina* begins to appear at the stratigraphical position, immediately above the basal conglomerate of this series, which is about 20 m in maximum thickness. Species of this genus are also abundantly found in both fossiliferous layers I_0 and I_1, and they continue upwards to the middle portion of the middle divisions of the Sakamotosawa series.

As already stated, the middle division of this series is chiefly composed of limestone, and is everywhere fossiliferous. From the basal part (horizon I_2), TORIYAMA (1952) reported such fusulinid species: *Pseudoschwagerina*, *Acervoschwagerina ? Parafusulina* cf. *kattaensis* (SCHWAGER), *Waeringella ?*, *Nipponitella*, *Schwagerina*, *Schwagerina* cf. *gümbeli* var. *pseudoregularis* DUNBAR and SKINNER, *Parafusulina wanneri* (SCHUBERT) *?*, *Pseudofusulina* cf. *japonica* (GÜMBEL). The present writer also found in this fossiliferous layer such a sponge as *Amblysiphonella* and such brachiopoda as *Munnella nikitini*, also such coral as *Huangia hasimotoi* (NAGAO et MINATO). The last-mentioned coral is now regarded to be an especially important horizon marker of this member of the Sakamotosawa series. Not only in the Kitakami mountain-region but also in Sikoku (Shikoku) and in the Kii peninsula, this coral has always been found in the same stratigraphical horizon.

It is a matter of great importance that *Pseudoschwagerina* becomes extinct at the middle portion of this middle division of Sakamotosawa series. As above stated, this genus begins first to appear at the very base of the Sakamotosawa series and continues upwards to I_0, I_1 and I_2; it is also found ranging into still higher horizons than I_2 but it disappears wholly above the middle portion of the middle divisions of this series.

In relation to the disappearance of *Pseudoschwagerina* it is found that *Schwagerina vulgaris* var. *globosa* begins to flourish. Near the top of the middle division of the Sakamotosawa series, there is found another layer rich in fossils; among them *Parafusulina* cf. *gigantea* (DEPRAT), *Pseudofusulina* cf. *japonica* (GÜMBEL) are very numerous. Furthermore, such coralline remains as *Michelinia* (*Protomichelinia*) *multitabulata* (YABE et HAYASAKA) and *Yatsengia kabayamensis* MINATO are now regarded to be important horizon indicators of this part. *Waagenophyllum polyseptata* is also assumed to indicate the same straigraphical horizon, although this species is taken to denote the *Yabeina* zone in the Akasaka region.

The upper division of the Sakamotosawa series conformably covers the middle division. For the most part the upper division is composed of sandstone. But several layers of thin limestones are found in the middle part and liparitic tuff and lava in the relatively lower part of this division. Slates are

also developed here and there. Fossils rather rare, and little investigated.

Thus, palaeontologically speaking, the Sakamotosawa series may be divisible into two groups. Based upon the stratigraphical distribution of fusulinid foraminifera, it may be said that the lower part is characterized by the presence of *Pseudoschwagerina*, while the upper part lacks this genus.

Pseudofusulina and *Parafusulina* already begin to appear at the I_2 horizon, that is, at the middle part of the *Pseudoschwagerina* zone, but these two genera became more flourishing later than the time of disappearance of *Pseudoschwagerina*.

Accordingly the upper part of the Sakamotosawa series is now regarded to be characterized by the absence of *Pseudoschwagerina* and the great abundance of *Pseudofusulina* and *Parafusulina*. Especially *Parafusulina* cf. *gigantea* DEPRAT is a good horizon indicator of this part; it is always accompanied by *Michelinia multitabulata* and *Yatsengia kabayamensis*.

Lithologically the limestone member of the Sakamotosawa series continues wholly conformably upwards and is never separable into any divisions. Nevertheless the writer is now inclined to suggest a division into two definite stages: *Pseudoschwagerina* zone and the *Parafusulina* zone respectively. The present writer wishes newly to propose the stage name, Kawaguti stage for the lower part and Kabayama stage for the upper division of the Sakamotosawa series, basing his suggestion upon the actual conditions in the type locality in the Setami district.

Kanokura series.

The Kanokura series covers the Sakamotosawa series with slight unconformity. This series is also divisible into two groups from the viewpoint of rock facies; the lower division begins with basal conglomerate and is mainly composed of variegated sandstones and slates which are occasionally very fossiliferous, while the upper division consists of limestone and black slate. Both of the divisions are occasionally fossliferous, conglomeratic facies is also prevalent, especially in the upper part. Such a facies is quite indistinguishable from the granite conglomerate in the Toyoma subsystem; this conglomerate also contains granite pebbles and its matrix sometimes shows that it composed of calcareous sediments, which are also fossiliferous.

From the lower division, the following fossils were found:

Lyttonia richthofeni (KAYSER)
Productus flemingii (SOWERBY) DE KONINCK
Spiriferina cristata SCHLOTHEIM
Spiriferella saranae mut. *lita* FREDERICKS
Retzia (*Hustedia*) *indica* WAAGEN
Retzia (*Hustedia*) *radialis* var. *grandicostata* DAVIDSON

Stacheoceras iwaizakiensis MABUTI
Conularia rectangularis HAYASAKA
Myophoria sub-elegans var. *tobai* HAYASAKA
Productus horridus (SOWERBY)
Dielasma biplex WAAGEN
Orthotetes rugosa FREDERICKS
Cancrinella vilersi kozlowskianus FREDERICKS
Derbya hemispharica WAAGEN
Chonetes sinuosa SCHELLWIEN
Productus gratiosus WAAGEN
Uncinulus jabiensis WAAGEN
Phricodothyris multipustulosa MINATO (MS)
Chonetes deplanata WAAGEN
Isogramma paotechowensis GRABAU et CHAO

As for the fusulinid remains from this lower division of the Kanokura series, there has been found hitherto only one species, *Parafusulina wanneri* SCHUBERT. This species is always preserved as a cast or mold in the sandstone; it takes a quite long cylindrical form, and has been customarily called by Japanese by the word of "Matsubaishi."

"Matsubaishi" means "pine leaf stone" in Japanese. The writer doubts whether this "Matsubaishi" is quite conspecific with a certain species derived from the Sakamotosawa series which was described and figured by TORIYAMA under the name of *Parafusulina wanneri* SCHUBERT. HANZAWA holds an opinion that the so-called "Matsubaishi" is nothing but *Parafusulina wanneri*. The present writer would like to be able to follow his view, but he is now inclined to consider that the specimens described by TORIYAMA as *Parafusulina wanneri* from the Sakamotosawa series are specifically different from "Matusbaishi."

Thus, *Neoschwagerina* fauna have been not found from this part, however the writer believes now that the faunal zone of the lower division of the Kanokura series may represent the so-called *Neoschwagerina* zone judging from its stratigraphical position and its brachiopod fauna as well as from its associated other molluscan fossils.

The writer formerly proposed to use the stage name "Kattisawa stage" for this zone.

The lower part of the upper division of the Kanokura series is composed of limeston or of limestone and slate in alternation. The upper part of the upper division is chiefly composed of slate, occasionally intercalated with granite conglomerate; both of these two parts yield *Yabina* (*Lepidolina*) fauna.

In this fauna the following species are more flourishing than the others:

Lepidolina gigantea TORIYAMA
Schwagerina douvillei COLANI
Wentzelella kitakamiensis YABE et MINATO
Yatsengia kiangsuensis YOH var. *mabutii* MINATO
Waagenophyllum inidcum (WAAGEN et WENTZEL)
Waagenophyllum indicum var. *usuginuensis* MINATO var. nov.
Wentzelelloides miyaensis YABE et MINATO

The writer now believes that the stratigraphical position of *Wentzelella iwaizakiensis* YABE et MINATO, and *Verbeekiella japonicum* YABE et MINATO, and two species of *Thamnopora* described by HAYASAKA (1932) may belong also to the same horizon. *Sochikinephyllum hasimotoi* which will be described later in this paper, is now also regarded to be derived from the same stratigraphical position.

The upper division of the Kanokura series has been treated for may years as the Iwaizaki stage, in one group of geologists who have studied the Kitakami mountainarea. That division may be safely correlated to the *Yabeina* zone.

Toyoma-subsystem

The Iwaizaki stage merges conformably into the Toyoma subsystem; the lithologic nature of the latter is quite indistinguishable from the upper part of the former. It consists chiefly of slate. A thick conglomerate formation is situated at relatively lower stratigraphical position, while the upper part of the Toyoma-subsystem is composed exclusively of slate which is quite barren of fossils. The whole thickness attains more than 1800 m.

The existence of thick conglomerate in the Toyoma-subsystem has been known among the Japanese geologists for many years, and it has been called by the name "Usuginu conglomerate."

However this type of conglomerate does not show any one stratigraphical position, as the writer formerly precisly discussed. The *Yabeina* zone comprises occasionally also same facies of the Usuginu conglomerate.

Hence the so-called Usuginu-conglomerate formation does not mean any one stratigraphical unit but is now regarded to be a local facies ranging from the Iwaizaki stage to the lower part of the Toyoma-subsystem.

Palaeontologically, the Toyoma formation has been and is now little investigated. Except the following named fossils including some molluscan remains formerly described and figured by HAYASAKA (1924) from Ogachi district, none of them has yet been studied.

Cycloceras sp.
Nuculites kimurai HAYASAKA
Paleoneilo ogachiensis HAYASAKA

However there are some additional collections available, which include such fossils as *Bellerophon, Pleurotmaria,* Trochoid gastropod, *Leda, Lyttonia* and some land plant remains; most of them are now under investigation.

Note: As above stated, it is believed that there exists no *Neoschwagerina* limestone with *Neoschwagerina* fauna in the Kitakami mountainregion; at least, such has not been discovered until the present day.

Nevertheless one school of geologists, believes now that the Iwaizaki limestone at Iwaizaki may be a single exceptional case to this belief.

According to them, at Iwaizaki, there develops a limestone containing such foraminifera as *Neoschwagerina, Verbeekina* and *Parafusulina,* hence this limestone may represent the faunal zone of *Neoschwagerina.*

However the writer now holds the belief that there is a sandstone formation as the lowest member at Iwaizaki yielding "Matsubaishi" *Parafusulina wanneri* SCHUBERT. This formation is nothing but the upper part of the Kattisawa stage, judging either from the viewpoint of lithology or from its fossils.

Following this sandstone formation upward there develops a member, chiefly composed of limestone, the very base of which covers conformably the underlying sandstone. This limestone member, being about 140 m in whole thickness, has several fossiliferous layers.

According to MABUTI (1936), this limestone member comprises the following three fossil zones, in descending order:

IV *Yabeina* zone
III *Verbeekina* zone
II *Waagenophyllum* zone

From this *Yabeina* zone, MABUTI reported occurrence of such fossils: *Yabeina shiraiwensis* OZAWA, *Verbeekina verbeeki* GEINITZ, *Mizzia velebitana* SCHUBERT, *Wentzelella timorica* (GERTH), *Amblysiphondella* cf. *dichotoma* (YABE). The mentioned *Wentzelella* may be a species described by YABE and the WRITER, under the name of *Wentzelella iwaizakiensis,* and also *W. subtimorica* HUANG.

From *Verbeekina* zone: *Verbeekina verbeeki* GEINITZ, *Neoschwagerina* ? sp., *Wentzelella timorica* (GERTH), *Waagenophyllum indicum* WAAGEN et WENTZEL, *Yatsengia* ? sp. Of them, *Wentzelella timorica* of MABUTI may also be *W. iwaizakiensis* YABE et MINATO and *W. subtimorica* HUANG, and *Yatsengia* sp. is *Y. kiangsuensis* YOH var. *mabutii* MINATO, which was formerly described by the present writer.

From *Waagenophyllum* zone: *Waagenophyllum indicum* WAAGEN et WENTZEL, *Wentzelella timorica* (GERTH), *Yatsengia* ? sp. *Palaeofusulina kraffti* SCHELLWIEN.

Furthermore, so-called *Yatsengia* sp. is *Yatsengia kiangsuensis* YOH var. *mabutii* MINATO, as above stated, which has also been found in the *Lepidolina* limestone developing at Kanokura, Setamai district. *Waagenophyllum indicum* is a good horizon marker of the *Yabeina* limestone, throughout the Japanese Permian, although few specimens have been found from the *Neoschwagerina* zone up to the present day. HANZAWA once reported on the occurrence of *Codonofusiella* aff. *paradoxides* DUNBAR and SKINNER and this was supposed to support the conclusion that a *Neoschwagerina* limestone develops at Iwaizaki, representing a true *Neoschwagerina*- zone; however the precise stratigraphical horizon of this species has not yet been described by HANZAWA. *Codonofusiella paradoxides* has also been found from the *Yabeina* limestone, not only in the Kitakami mountainarea but also in a few other districts in Japan.

Such being the case, the limestone member possessing three faunal zones, above stated, may represent in fact, the *Yabeina* stage. Even though one may think that the lower part of the limestone member at Iwaizaki is nothing but the *Neoschwagerina* zone, the fact must be not neglected that MABUTI once listed the occurrence of *Yabeina* sp. from the sandstone, yielding *Parafusulina wanneri*, which lies directly under the limestone yielding *Neoschwagerina*. Hence it must be regarded that *Yabeina* has already begun to appear at the later stage of the deposition of the sandstone formation.

Hence the writer is of opinion, that the most part of the sandstone formation containing *Parafusulina wanneri*-"Matsubaishi" may perhaps represent the *Neoschwagerina* zone, although it does not yield any kind of *Neoschwagerina*. The uppermost part of the sandstone formation may represent already the *Yabeina* zone. Therefore, the limestone formation (the *Waagenophyllum* zone of MABUTI), covering the sandstone formation of *Parafusulina wanneri* at Iwaizaki, doubtlessly represents the *Yabeina* zone, although it contains such foraminifera as *Neoschwagerina*, *Codonofusiella* and *Verbeekina*.

Abukuma Mountain Region

This mountain area is composed, for the most part, of metamorphosed rocks, such as gneiss and schist, Palaeozoic in origin, together with various kinds of plutonic rocks. Non-metamorphosed or slightly metamorphosed Palaeozoic sediments are found in rather limited area, such as in the Soma as well as in the Hitachi district.

Around the Soma district, Palaeozoic formation shows the following succession, in descending order: (IWAI, J. 1932).

Unenohata formation: composed mainly of slate, more than 400 m in thickness, quite barren of fossils, which may be correlated to the lower part of Toyoma subsytem of the Kitakami mountainarea.

Oashi formation: the upper half of this formation consists also of slate and impure limestone, together with conglomerate yielding such fossils as *Waagenophyllum indicum* (WAAGEN et WENTZEL), *Wentzelloides maiyaensis* YABE et MINATO, *Yabeina*, *Sumatrina* etc. The lower half of this formation is characterized by slate and sandstone facies; fossiliferous, among the fossils are: *Lyttonia*, *Derbya*, *Spiriferella*.

Lacking the formations corresponding to the Nagaiwa series and most part of the Sakamotosawa series of the Kitakami region, the Tateishi formation lies directly under the preceding Oashi formation.*

Tateishi formation: The upper part of this formation is limestone, while the lower half consists of green schistose rocks; an unconformable relation between two subdivisions may be expected. From the limestone, occurrence of *Lithostrotion somaense* was once reported by YABE and HAYASAKA (1915), while the writer found such other corals as *Kueichouphyllum*, *Siphonodendron* and Cysthophylloid species; however all of them are unfortunately in bad state of preservation and specifically undeterminable.**

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* According to verbal information from T. SATO (Tokyo Educat. Univ.), there develops locally a formation with *Pseudoschwagerina* fauna under the formation yielding *Lyttonia* fauna. SATO is now of the belief that any formation being correlable to the Nagaiwa series is wholly lacking in this district.

** T. SATO is now engaging in a stratigraphical survey in this area; he has now revised the order of the succession of the formations around this area, formerly established by IWAI.

The new established order of succession of formations is as follows:

in descending order	Correlation to the formations in the Kitakami district
Uenohata f.	
Oashi f. *Yabeina, Lyttonia*	Kanokura series
——— Unconformity? ———	
Uagaya f. *Pseudoschwagerina*	Sakamotosawa series
——— Unconformity or faulted contact? ———	
Tateishi f. *Kueichouphyllum*	Onimaru series
——— Unconformity? ———	
Ainosawa f. *Sinospirifer*	Tobigamori series.
——— Unconformity? or faulted contact ———	
Matsugadaira f.	

Some of SATO's collections of fossils derived from the Ainosawa formation were submitted for study of the present writer who found among them *Sinospirifer sinense* var. *australis* MAXWELL, *Camarotoechia*, *Chonetes* and so forth. Accordingly he declared that the Ainosawa formation can be correlated to the Tobigamori formation in the Kitakami mountain district. Later he, in cooperation with Dr. I. HAYASAKA, published a description of these fossils together with the fossils of the Tobigamori formation, based on the writer's own collection. (I. HAYASAKA and M. MINATO, 1954) The Matsugadaira formation is a member which was formerly treated by IWAI as the lower division of his Tateishi formation.

Far southward from the Soma district coral limestone is also found in the area surrounding the well-known Hitachi copper mine of Taga district, from which M. WATANABE (1920–1921) discovered for the first time numerous coralline remains more than thirty years ago. The coral limestones are found intercalated in various kinds of phyllite and green schistose rocks. The formation composed of these metamorphic rocks with fossiliferous limestones was called by M. WATANABE by the name "Ayukawa series", which has been considered by some geologists to be equivalent with the so-called Mikabu-system in respect to stratigraphical position.

Corals are:

Diphyphyllum flexuosum YABE et HAYASAKA
Siphonodendron pseudomartini (YABE et HAYASAKA)
Syringopora cf. *reticulata* GOLDFUSS
Bothrophyllum ? sp.

Besides these, the present writer found still other corals in the collections of Mr. T. KAKIMI, which were brought recently from some limestone layers of the same district, viz.,

Siphonodendron pauciradiale (M'COY)
Setamainella hayasakai MINATO
Kueichouphyllum sp.

H. YABE once described *Saccamminopsis carteri* (BRADY) from limestone, belonging to the Ayukawa series of Watanabe, developing in the area of the lower course of the Miyata river.

Around the Hitachi district, formations consisting of various kinds of metamorphic rocks, comprise, according to WATANABE, four divisions, viz. Ayukawa, Akazawa, Tamadare and Nishidodaira formations in descending order. Of them, although this order of succession may be not finally established, only the uppermost formation is fossiliferous (Ayukawa series).

Anyhow in the Abukuma mountain region, it is known at present that two fossil horizons yielding coralline remains exist: one is the Onimaru horizon and the other is the Kanokura series; that is to say, the age of them is Upper Viséan and the Middle Permian respectively.

Toriashi mountain district.

Mount Toriashi is situated about 40 km northwest from the Hitachi copper mine. Widely distributed around this mountain is a Palaeozoic formation which mainly consists of sandstone and slate, with thin layers of chert and limestone, but lacking in schalstein. According to the late Dr. K. KAWADA (1953) this formation attains as much as 8500 m in thickness and is divisible into three formations, viz., Kasana-, Nanaai- and Isehata-formations in

ascending order. From the limestone in Kasana formation, FUJIMOTO reported the fossils:

Fusulinella sp.
Ozawainella cf. *angulata* (COLANI)
Ozawainella sp.
Endothyra sp.
Pachyphloia cf. *multiseptata*
Monogerina sp.

Hence the geological age of this formation may be Middle Carboniferous. No coralline remains have been reported from this district, until the present.

Ashio Mountains

Kuzu is a small town, west of Tochigi-city, Tochigi (Totigi) Prefecture, situated at the southern end of the Ashio mountain region. Encircling the town of Kuzu, there develops a thick limestone formation, which is covered by another formation mainly composed of chert. This limestone formation is very fossiliferous everywhere.

More than fifty years ago H. YABE (1903) reported the finding of the tooth of a fish under the name of *Helicoprion bessonowi* KARPINSKY; the specimen was collected from this limestone at Hanawa, about 30 km west from Kuzu.

This limestone formation comprises, according to FUJIMOTO and his colloborators such as YAMADA, YOSHIDA and KAWADA, three distinct faunal zones, which are the *Parafusulina*-, *Neoschwagerina*- and *Yabeina*-zones in ascending order. Brachiopod fauna, described by I. HAYASAKA was once reported by him to be Carboniferous in age. However it is becoming the present view that the Brachiopoda fauna of HAYASAKA (1933) may indicate the *Parafusulina* zone, as NAGAO and the writer (1943) once pointed out.

In contrast to the relative abundance of brachiopod and foraminiferal remains, corals were rarely found in this limestone. *Pseudoyatsengia kuzensis* YABE which was found from the limestone developing at Aisawa near Kuzu is the only one record. (H. YABE, 1951) The age of this coral is now believed to be Lower Permian (*Parafusulina* zone).

Kwanto Mountain region.

Kwanto mountain area, situated west of Tokyo, is one of the most classical regions for study of Japanese geology; KOTO established there the stratigraphical order of succession concerning the older rock complex as early as 1888, as follows, (in ascending order):

1. Normal sericite-schist together with the piedmontite-schist in its upper horizon.

2. Green and black spotted schist.
3. Lamellar epidote-sericite-gneiss.
4. Amphibole-pyroxene schist, pyroxene-amphibole schist, pyroxene-epidote and amphibole-epidote schist, together with serpentine, gabbros and the gabbro-diorites.
5. Red, and white, platy quartzite.
6. Adinole-slate overlying the preceding.
7. The lower schalstein, intercalated with adinole-slate, and also the limestone with crinoidal stems and corals.
8. Graywacke-sandstone and slate, intercalated in their lower horizon with adinole-slate.
9. Siliceous slate or common hornstone overlaid by another series of adinole-slate.
10. Upper schalstein and siliceous radiolarian slate.
11. Diabase-sheet sometimes occurs in this horizon.
12. Fusulina limestone, etc.

Of this succession of rocks, KOTO grouped 1, 2 and 3 in one formation and treated it under the name of the Sambagawa series. At the time of his study he considered the Sambagawa series as being the oldest member among all formations developing in the Kwanto mountain region. The formations including group 5 and its overlying beds have been customarily treated as the Chichibu (Titibu) system since KOTO, and have been included in Japanese Palaeozoic. Chichibu is the type locality for these rocks.

Meanwhile KOTO's group 4 has been treated as a formation independent of either Chichibu or Sambagawa system and called under the name of the Mikabu system, because the rocks comprising this system show intermediate nature between the rocks of the highly metamorphosed Sambagawa and the non-metamorphosed ones of the Chichibu system. One school of geologists has regarded the Mikabu system as a basal member of the Chichibu system. The reason for this was that the rocks of the former, though slightly memtamorphosed, may be not originally separable from the rocks of the latter in their lithic characters.

Following KOTO, H. YABE studied the oldest formation in the Kwanto mountainarea and revised the stratigraphical summary of KOTO, concerning these rocks.

In still later years, FUJIMOTO carried out a prolonged stratigraphical study of these rocks, especially of the Chichibu system. The following is the succession of the Chichibu system, established by him (1936, a) in descending order:

4. Kamiyoshida formation
3. Mamba formation

2. Kashiwagi formation
1. Sakahara formation

Of these, the Sakahara formation, the present writer thinks, may be almost equivalent with group 5 of KOTO, which consists mainly of quartzite, white, brown, dark red and dark green in colour, occasionally intercalating with thin limestones or layers of graywacke and shale. Whole thickness is about 700 m, according to FUJIMOTO.

No megascopic fossils have been reported from this formation by anyone to date, however, the writer believed now, that a specimen of *Arachnolasma* cf. *sinense* (YABE et HAYASAKA), formerly described by himself (1947) might be derived from a limestone intercalating in the quartzite rocks, apparently equivalent to the Sakahara formation in stratigraphical position. The specimen of this coral was collected by the late Dr. S. OISHI from a small limestone lense, exposed to the west of Siroi, Ueno-mura, Tano-gun, Gumma Prefecture.

According to verbal information from Messrs S. IZIRI, H. FUJIMOTO and S. MASUBUCHI, this limestone is found at Siroi as a small patch in the reddish quartzite.

The mentioned coral has a close similarity to *Arachnolasma sinense* (YABE et HAYASAKA) as formerly (1947) discussed by the present writer, although it is an imperfect specimen; therefore it may be not unreasonable to regard the geological age of the limestone containing this coral as being upper Viséan, or almost equivalent to the Onimaru series of the Kitakami mountain region.

The Sakahara formation is covered by the Kasiwagi formation, the latter of which is again overlaid by the Mamba formation. According to FUJIMOTO, the oldest fossil horizon of the Mamba formation may correspond to the *Fusulinella* zone, hence it is probable that the Sakahara formation is correlated to the Lower Carboniferous.

The quartzite rocks intercalated with coral limestone at Siroi (Shirai or Shiroi) are much like the reddish quartzite rocks at Sakahara, the type locality of the Sakahara formation. Moreover one may see also a few layers of limestone beds in the quartzite rocks at this type locality.

Such being the case, the quartzite formation at Siroi may be safely correlated to the Sakahara formation at its type locality, and both of them may be Lower Carboniferous in age.

Kasiwagi (Kashiwagi) formation is composed chiefly of green adinole chert and green siliceous slate. It comprises also a few layers of clay slate, sandstone and schalstein. According to FUJIMOTO, this group attains about 1300 m in whole thickness. However, no megascopic fossils are obtainable.

The Kasiwagi (Kashiwagi) formation may be correlated to the lower half

of the Middle Carboniferous (Lower Pennsylvanian) from its stratigraphical position, because the underlying Sakahara formation is Lower Carboniferous in age and the overlying Mamba formation represents the *Fusulinella* zone at the lowest part.

The Mamba formation is about 1700 m in maximum thickness and is composed mainly of schalstein facies, which are occasionally intercalated with limestone. From the fusulinid remains from these limestones, FUJIMOTO distinguished five faunal zones in this formation, which are (in descending order):

V. Zone of *Yabeina globosa*
IV. Zone of *Neoschwagerina margaritae*
III. Zone of *Neoschwagerina craticulifera* or *Schwagerina* (*Pseudofusulina*) *ambigua*
II. Zone of *Schwagerina* (*Pseudofusulina*) *vulgaris*
I. Zone of *Fusulinella bocki*

Of these, the zone of *Neoschwagerina craticulifera* or that of *Schwagerina vulgaris* may be a transitional horizon from *Neoschwagerina* zone to *Parafusulina* zone, while the zone of *Schwagerina vulgaris* (FUJIMOTO's zone of *Schwagerina* (*Pseudofusulina*) *vulgaris*) may be the *Parafusulina* zone, although FUJIMOTO had correlated it to the Uralian (now in the sense of Sakmarian in age). In FUJIMOTO's *Schwagerina vulgaris* zone there are not yet to be found such genera as *Pseudoschwagerina* or *Paraschwagerina*, characterizing the Sakmarian series or its equivalent, at least so it seems from FUJIMOTO's own publications. Hence YABE (1948) held to the opinion that the zone of *Schwagerina vulgaris* of FUJIMOTO may be *Parafusulina* and not *Pseudoschwagerina* zone and accordingly that the faunal zone of *Pseudoschwagerina* is apparently lacking in the Kwanto mountain region.

Meanwhile MORIKAWA (1952) found recently a peculiar limestone conglomerate at Shimokuzu, Agano-mura, Iruma-gun, Saitama Prefecture. The matrix of this conglomerate is comsosed of schalstein, while all the pebbles are limestone. Among these limestone pebbles, MORIKAWA found the existence of two types, one contains such foraminifera as *Parafusulina* and *Nagatoella*, and the other includes *Pseudoschwagerina* and *Schwagerina*.

For the geological age of the accumulation of this limestone, there are two reasonable interpretations: firstly, the deposition of this conglomerate took place there in the *Parafusulina-Nagatoella* age. In this case one must consider that the so-called pebbles containing fusulinid foraminifera must be not truly pebbles but pieces of nodulous limestone forming a part of the matrix and furthermore that *Pseudoschwagerina* and *Schwagerina* fauna were coexistent with *Parafusulina* and *Nagatoella* in the same sea.

A second possible interpretation is that MORIKAWA's two types of pebbles are both definitely pebbles and the deposition of this conglomerate took place in time far after the *Parafusulina* and *Nagatoella* age.

At any rate, it is an open question whether the Lower Permian, almost equivalent to the Sakmarian or the *Pseudoschwagerina* zone is definitely developed in the Kwanto mountain region or not. Also it is not finally concluded whether or not there was an erosion interval preceding the pre-*Parafulina* age.

FUJIMOTO once described and figured *Fusulina girtyi* (DUNBAR and CONDRA) from a limestone at Raidenyama, Nisi-Saitama-gun, Saitama Prefecture, in association with *Schwagerina* (*Pseudofusulina*) fauna. The foraminifera is a well known good horizon marker for the Des Moines series of Mid-continental, U. S. A., accordingly the writer doubts whether this species was really obtained by FUJIMOTO in the same limestone as that yielding such Permian fossils as *Pseudofusulina*. Even though his statement be quite correct, the possiblity may be not wholly denied that this specimen may be a derived fossil brought back into the sediments of *Schwagerina* (*Pseudofusulina*) zone. Did *Fusulina girtyi* really survive so long as until the *Schwagerina* (*Pseudofusulina*) age?

This may be regarded to form another reason why it may be expectable to find the existence of an erosional interval predating the formation of *Parafusulina* zone in the Kwanto mountain region.

Furthermore, there has not been known any formations representing the definite *Fusulina* zone, *Triticites* zone nor the *Pseudoschwagerina* zone in the Kwanto mountain region, although FUJIMOTO stated that no stratigraphical hiatus was detected through the Mamba formation.

Such being the case, it must now be regarded that there are numerous problems left unsolved about the stratigraphical order of succession, concerning the faunal zones and their stratigraphical relations in the Kwanto mountain region, although the Mamba formation really comprises several faunal zones.*

* Quite recently from Jinzawa, Otaki-village, Saitama Prefecture in the Kwanto mountain region, MORIKAWA (1953) reported an occurrence of fusulinid foraminifera which includes such species as *Triticites nakatsugawensis* MORIKAWA, *T. nakatsugawensis* var. *hemmi* MORIKAWA, *T. kagaharensis* FUJIMOTO, *T.* cf. *plummeri* DUNBAR and CONDRA and *T. uemurai* MORIKAWA. Basing his opinion on this fossil fauna, he declared that it is decidedly denote the Uralian, which is Upper Carboniferous in age. However, of the fossils, two species and one variety were unknown to science before he reported them, one species was regarded by him to be doubtful as to precise identification, and the other one species had been formerly known to occur from the Permian. Accordingly the present writer is now of opinion, that it may be somewhat unwise to come to any final conclusion upon the geological age of this fauna, based upon MORIKAWA's specific identification, although it may very probably be that the fauna does represent the Uralian age, as he claims.

Kamiyoshida formation consists chiefly in graywacke and clay slate and is barren of megascopic fossils; it attains more than 2000 m in thickness. This is stratigraphically almost equivalent to the Toyoma sub-system in the Kitakami mountain region; at least this point is certain in respect to the formation developing around the type locality.

Kii mountain region

To the southwest of Ujiyamada City, Mie Prefecture, there have long been known several localities yieldling Palaeozoic fossils, viz:

1) *Lithostrotion* sp. (H. YABE) YABE (YABE and SUGIYAMA, 1939) brought back a piece of limestone which contained *Lithostrotion* sp. from the roadside at Eribara, Isobe-mura, Shimagun, Mie Prefecture. Unfortunately this was not collected in situ, so the precise locality of the origin of the specimen was left unknown, although it must rather certainly be near by. The present writer twice visited the place several years ago, in desire to discover the outcrop of this coral limestone, but without success. However he believes now, that YABE's material might have been derived from a lenticular limestone in a formation composed mainly of quartzite, which is covered by a thick schalstein complex. These quartzite rocks remind him strongly of the rocks of the Sakahara formation in the Kwanto mountainarea from its lithic characters.

2) *Fusulinella, Bradyina* and *Endothyra* probably Moscovian in age, once listed by FUJIMOTO (1942) at about 400 m south of Matue in the same district as Eribara, seemingly derived from a complex of sandstone and shale in alternation.

3) *Schwagerina vulgaris* (SCHELLWIEN) and *Schwagerina krotovi* (SCHELLWIEN) were found by Y. OTUKA in a limestone intercalated in the heavy bedded schalstein, exposed at Aosaka pass, also in the same district. This fossil horizon may be correlated with the *Parafusulina* zone in the other districts of Japan.

4) *Neoschwagerina* cf. *craticulifera* (SCHWAGER) and others were listed also by FUJIMOTO from another locality in the same district; he reported his specimens to be derived from a lenticular limestone in a shale and sandstone complex.

Thus, the writer now is inclined to assume the following succession of rocks in this district, basing his view upon the palaeontological evidences above noted.

Neoschwagerina zone .....shale and sandstone
Parafusulina zone.....schalstein
Fusulinella zone .....shale and sandstone
Lithostrotion zone .....quartzite

In comparing this order of succession with the sequence of formations established by FUJIMOTO at Mamba district in the Kwanto mountain region, one finds that the lower member of both districts containing Viséan fossils is represented by reddish quartzite group. They quite coincide with each other. But the overlying formation, equivalent to the Kasiwagi (Kashiwagi) formation in the Kwanto mountain area, is seemingly lacking in the Kii mountain area. Moreover, *Fusulina*, *Triticites* and *Pseudoschwagerina* formations also have not yet been found in this district, at least to the present writer's best knowledge.

It may be an open question whether the mentioned faunal zones are actually lacking in this district or not. Besides this, the corresponding formations for the *Yabeina* zone and its overlying Kamiyoshida formation of the Kwanto region have also not been definitely found in this district.

Very recently K. TANAKA, geologist of the Geological Survey of Japan, submitted to the writer one coralline specimen for study. It was brought back from a formation exposed at Itokawa, Ishigashi-mura, Arita-gun, Wakayama Prefecture. The mentioned locality is situated at the western end of the Kii Peninsula, quite on the opposite side from the district around Uji-yamada City. The specimen is in very excellent preservation and can be nothing but *Huangia hasimotoi* (NAGAO et MINATO). According to TANAKA, this coral was found in association with *Pseudofusulina* or *Parafusulina*. The writer thinks this may denote the Upper *Pseudoschwagerina* zone, like the case of the Kitakami region, regarding which point some discussion will be offered below in the section on Sikoku island.

Anyhow, at present two zones are definitely known yielding coralline remains in the Upper Palaeozoic of the Kii mountains, one of which is upper Viséan in age, while the other is Lower Permian.

Omi limestone district, (Echigo province), Niigata Prefecture

Limestones, about 2000 m in thickness, develop at Omi-mura, Niigata Prefecture. Since the pioneer work of I. HAYASAKA (1922, 1924) several faunal zones have been established in this limestone, although the stratigraphical relations amongst them is still left undetermined.

Yabeina zone (Y. OZAWA)
Neoschwagerina zone (I. HAYASAKA)
Verbeekina deprati YABE
Parafusulina cf. *japonica* (GÜMBEL)
Pseudodoliolina ozawai YABE et HANZAWA
Neoschwagerina craticulifera SCHWAGER
Parafusulina zone (H. FUJIMOTO)
Pseudofusulina vulagris (SCHELLWIEN)

Schwagerina rouxi (DEPRAT)
Schwagerina longissima MÖLLER
Schwagerina omiensis OZAWA
Schubertella transitoria STAFF et WEDEKIND
Pseudoschwagerina zone lacking ?
Triticites zone (H. FUJIMOTO)
Triticites cullomensis DUNBAR and CONDRA
Triticites skinneri THOMPSON
Triticites minimus (SCHELLWIEN)
Triticties montipara (EHRENBERG et MÖLLER)
Fusulina zone lacking ?
Fusulinella zone (I. HAYASAKA)
Fusulinella biconica HAYASAKA
Fistulipora minima HAYASAKA
Batostomella sp.
Gigantoproductus zone (I. HAYASAKA)
Amygdalophyllum giganteum (YABE et HAYASAKA)
Corwenia ? *omiensis* (HAYASAKA)
Axophyllum gracile HAYASAKA=*Amygdalophyllum gracile*
Lithostrotion somaense YABE et HAYASAKA
Stylidophyllum sp.
Chaetetes sp.
Gigantoproductus edelburgensis (PHILLIPS)
Avonia cf. *aculeatus* (MARTIN)
Echinoconchus punctatus var.
Productus semireticulatus MARTIN
Camarophoria globulina PHILLIPS
Martinia glabra decora PHILLIPS
Reticularia lineata MARTIN

From this limestone *Clisaxophyllum awa* MINATO was once described by the writer, the precise locality of whose origin is at present unknown to him, but it was probably derived from a limestone of *Fusulinella* zone.

The description of so-called *Syringothyris cuspidata* MARTIN by HAYASAKA was quite ambiguous concerning its stratigraphical horizon. The fossil was not collected by HAYASAKA himself, although it may probably have been brought back from a limestone of Lower Carboniferous age.

Megistocrinus sp. aff. *Actinocrinus globrus* PHILLIPS described by HAYASAKA is also uncertain in its stratigraphical position.

In the Kitakami mountain region *Syringothyris* is most prevalent in the Jumonji stage, while crinoidal remains, especially *Actinocrinus* are most richly found in the Hikoroichi series. So the writer once supposed that these two

species might be not originated from the *Gigantoproductus* zone but derived from a still lower formation, which may develop somewhere near Omi.

Hida Mountain district

Knowledge of the Palaeozoic stratigraphy in this district has been much advanced in recent years, owing to the effort of Messrs. T. KAMEI, M. KANUMA, K. KOBAYASHI and others. The writer also twice visited the region and collected many fossils. The following several zones have been established at present, in descending order.

Azusagawa formation: Develops widely along the lower course of the Azusagawa river, composed mainly of black slate, intercalated by various kinds of cherts. It may be almost equivalent to the Toyoma subsystem in rough estimation, as well as to the Kamiyoshida formation of the Kwanto mountain region. Conglomerates containing pebbles of granitic rocks are also occasionally fouud in this complex. Whole thickness of this formation is unknown at present, but it may attain far beyond 1000 m. It is quite barren in megascopic fossils.

Yabeina zone: This faunal zone is not firmily established in this district, but it will be probably found in near future.

Neoschwagerina zone: *Neoschwagerina* limestone is now regarded to be extremely rare in the Hida mountains, the only exception being a limestone which develops to the southwest of Obara, Kiyomi-mura, Ono-gun, Gifu Prefecture. From it Kanuma reported the occurrence of *Neoschwagerina* sp.

H. MATUO, Kanazawa Univ., brought back a collection of brachiopod fossils, from the upper part of Oguradani, Nojiri, Anama-mura, Ono-gun, Fukui Prefecture, in which collection HAYASAKA and the writer found *Lyttonia*, *Camarophoria*, *Productus* and *Phricodothyris*. This fauna reminds the present writer strongly of the fauna of the Lower Kanokura series in the Kitakami mountain area. Hence he now regards the formation yielding this brachiopoda fauna as possibly representing a different facies of the *Neoschwagerina* limestone.

Parafusulina zone: At Shirabune, Aki-mura, Azumi-gun, Nagano Prefecture, there is a limestone, fairly thick, which is intercalated in a greenish and reddish schalstein. From there the writer once reported the occurrence of the following three foraminifera:

Pseudodoliolina ozawai YABE et HANZAWA
Parafusulina japonica (GÜMBEL.)=*Pseudofusulina japonica* (GÜMBEL)
Parafusulina kaerimizuensis (OZAWA)

This limestone represents the *Parafusulina* zone.

Furthermore S. TAKANO reported the following fusulinid foraminifera from a limestone, a member of Nyukawa formation, developed to the east of the City of Takayama, Yoshiki-gun, Gifu Prefecture. The limestone is mainly

composed of sandstone, slate and chert.

Pseudofusulina japonica (GÜMBEL)
Pseudofusulina vulgaris (SCHW.)
Pseudofusulina huecoensis DUNBAR and CONDRA
Psoudofusulina fusiformis DUNBAR and SKINNER
Pseudodoliolina ibukiensis FUJIMOTO and YAMADA
Pseudodoliolina kotoi FUJIMOTO and YAMADA

Pseudoschwagerina zone

At Ichinotani, Fukuchi, Kamitakara-mura, Yoshiki-gun, Gifu Prefecture, there occurs a limestone yielding *Pseudoschwagerina* (*Zellia*) sp., which is closely related *Pseudoschwagerina* (*Zellia*) *schellwieni* HANZAWA. This formation directly covers the underlying schalstein and agglomeratic complex, which is intercalated occasionally by *Fusulinella* limestone.

The formation of *Pseudoschwagerina* zone comprises, lithologically, three divisions; the lower part consists mainly of conglomerate or alternations of conglomerate and sandstone, barren in fossils; the middle part chiefly of sandstone and slate, also lacking in fossils; while the upper part of the formation is made of limestone. From one horizon of the last mentioned limestone the writer found *Pseudoschwagerina* (*Zellia*) sp. Stratigraphically at a little higher horizon than this, he also collected one coral as *Cystiphora manchurica kikkawai* (YABE et HAYASAKA).

The total thickness of the lower and middle divisions of this formation attains about 100 m, and the limestone reaches almost the same total thickness.

In lithological aspect, the conglomerate of this formation is much like the basal conglomerate of the Sakamotosawa series of the Kitakami mountain area. Additionally, either in lithic character or in the sequence of the rocks, the middle and upper divisions of this formotion well coincide with the middle and upper part of the Sakamotosawa series. Thus the writer now tends to believe in the probably existence of an unconformity between the *Pseudoschwagerina* and the underlying *Fusulinella* zone in this district, surrounding Ichinotani, Gifu Prefecture, similar to the case in the Kitakami district.

Although the true nature of the stratigraphical relation between the base of the *Pseudoschwagerina* zone and its underlying formation has not yet been established clearly, it should be reported that the writer also could not find between the *Fusulinella* and *Pseudoschwagerina* zones any formations representing either the *Triticites* zone or the *Fusulina* zone.

A formation yielding *Pseudoschwagerina* fauna also develops in the neighbourhood of Takayama City, west of Ichinotani, to which KANUMA gave the name "Sakamoto formation." According to Kanuma, this formation is covered by Obara formation containing *Neoschwagerina* fauna on the one hand, while

it covers the Oppara formation with *Triticites* fauna on the other hand.

Sakamoto formation consists chiefly in clay-slate and sandstone, which is occasionally intercalated by limestone. These limestones are very fossiliferous, fossils being:

Pseudoschwagerina orientale FUJIMOTO
Pseudoschwagerina sp.
Triticites cf. *powwensis* DUNBAR and CONDRA.

Triticites zone

The Oppara formation develops near Takayama as above noted, being covered by Sakamoto formation, apparently without hiatus between them. The Oppara formation consists in sandstone and slate occasionally being intercalated with limestone and chert. In this limestone the following fossils are found:

Fusulinella sp.
Fusulina cf. *longissimoidea* BEEDE
Triticites pygmaus (DUNBAR and CONDRA)
Triticites kagaharensis FUJIMOTO
Triticites montipara (EHRENBERG et MÖLLER)
Triticites cf. *nebraskensis* THOMPSON
Triticites cullomensis DUNBAR and CONDRA
Triticites cf. *beedi* DUNBAR and CONDRA
Triticites cf. *plummeri* DUNBAR and CONDRA
Triticites sp.

Fusulina zone

At least so far as fossil evidences are concerned, there are not known any formations representing the *Fusulina* zone in this district of the Hida mountains.

Fusulinella zone

At a locality immediately south of Kanzaka, Kamitakara-mura, Yoshiki-gun, Gifu Prefecture, there develops a limestone, about 30 m in thickness, from which the writer once detected *Fusulinella* sp. and simple coral of *Neokoninckophllum*. It is his present opinion that these two forms are representatives of the faunal zone of *Fusulinella*.

Furthermore, S. TAKANO has listed the following fusulinids from a limestone, intercalated in the formation, consisting chiefly in sandstone, clay-slate and chert, which develops in Nyukawa-mura, also in Yoshiki-gun, Gifu Prefecture. The faunal aspect indicates that the whole of the mentioned limestone represents the *Fusulinella* zone.

Fusulinella compressa OZAWA
Fusulinella acuminata THOMPSON

Fusulinella pseudobocki LEE et CHEN
Fusulininella furnishi THOMPSON ?
Fusulinealla sp.

Akasaka region

Akasaka, near Gifu City, Gifu Prefecture, being situated near the middle of the Inner zone of Southwestern Japan is also one of the most well known regions for the study of Japanese Palaeozoic stratigraphy and palaeontology. Since the early days of C. SCHWAGER (1888), there have been published many contributions concerning the stratigraphy and palaeontology of the limestone found there; among them the works of H. YABE (1902), B. KOTO (1898), J. DEPRAT (1914), A. KARPINSKY (1908), T. WAKIMIZU (1902), I. HAYASAKA (1925, 1932, 1938, 1939, 1943), Y. OZAWZ (1927) and H. FUJIMOTO (1941) may be most worthy of note. Up to the present day three distinct faunal zones have been recognized in this limestone. From the reports of the various authors have enumerated, they are, in descending order:

Yabeina zone: *Yabeina, Sumatrina, Neoschwagerina* and *Waagenophyllum akasakensis* (YABE), *Pseudoromingeria kotoi* (YABE et HAYASAKA).

Neoschwagerina-Verbeekina zone: *Neoschwagerina, Verbeekina, Pseudodoliolina, Parafusulina, Pseudofusulina.*

Parafusulina zone: lacking ?

Pseudoschwagerina zone: *Pseudoschwagerina schellwieni* HANZAWA, *Pseudofusulina ambigua, Parafusulina granumavenae, Schwagerina vulgaris* (SCHELLWIEN), *Schwagerina* sp.

Additionally to the fusulinid and coralline remains, the following fossils hitherto described, which are quite important species as horizon indicators, are also known from this same formation.

From *Yabeina* zone: *Liebea sinensis* FRECH, *Myophoria japonica* HAYASAKA, *Parallelodon obsoletiformis, Solenomorpha elegantissima* HAYASAKA, *Dentalium akasakensis* HAYASAKA, *Dentalium neornatum* HAYASAKA, *Laevidentalium* cf. *priscum* MÜNSTER, *Plagioglypta herculum* (DE KONINCK), *Squamularia* cf. *inequilateralis* GEMMELLARO, *S. asiatica* CHAO, *S. waageni* FRECH, *Trachydomia magna* HAYASAKA, *Spiromphalum yabei* HAYASAKA, *Terebratuloidea* sp., *Aviculopecten minoensis* HAYASAKA, *Aviculopecten reticularis* HAYASAKA.

From *Neoschwagerina* zone: *Lyttonia richthofeni* KAYSER, *Scacchinella* cf. *gigantea* GEMMELLARO, *Squamularia asiatica* CHAO, *Enteletes akasakensis* OZAWA, *Enteletes minoensis* HAYASAKA, *Enteletes suessi* SCHELLWIEN, *Geyerella* sp. and *Stromatopora* (*Parallelopora*) *minoensis* YABE et SUGIYAMA.

Hunabuse mountain region

Many years ago the late Dr. G. IIZAKA engaged in a stratigraphical survey

of the district surrounding the Hunabuse (Funabuse) mountains; he left behind valuable collections of fusulinid and coralline remains, though the results of his study have unfortunately remained unpublished. According to the verbal information of Mr. KONISHI, now in Tokyo Univ., the specimens in Iizaka's collections seem all to have been derived from a limestone definitely representing the *Yabeina* zone.

Geyerophyllum hunabuseum MINATO, sp. nov., which appears superifically to be a type of Uralian coral, as will be described below in this paper, is believed by KONISHI also to have been derived probably from a limestone in the same stratigraphical horizon as the *Yabeina* limestone.

In this paper a few forms of *Lophophyllidium* derived from the limestone of the same horizon in this district will be described, although specifically indeterminable.

Ibuki mountain region

The Palaeozoic formation in this district has been throughly studied by T. SEKI (1939), who recognized the following four distinct faunal zones in descending order.

Neoschwagerina zone: This faunal zone is lithologically represented by the dominance of limestones, while the other consists chiefly of cherts, with subordinate slate and graywacke. The former makes up the main part of the so-called Ibuki limestones, while the latter is called the Kasukawa formation by SEKI.

Characteristic fossils are:

Parafusulina japonica (GÜMBEL)
Neoschwagerina cf. *craticulifera* (SCHWAGER)
Neoschwagerina nipponica OZAWA
Schwagerina kraffti (SCHELLWIEN)
Codonofusiella paradoxides DUNBAR and SKINNER

Parafusulina zone: This faunal zone is lithologically also represented by two types; one is characterized by dominance of calcareous facies, the other by less calcareous deposits; the former constitutes the basal part of the Ibuki limestone formation, while the latter builds the main part of the Onogi formation. The Onogi formation is mostly made from slate and chert, but occasionally is intercalated by lenticules of limestone; whole thickness of the zone about 350 m.

Fossils of the Onogi formation listed by SEKI are as follows:

Doliolina cf. *ovalis* DEPRAT
Schwagerina kraffti (SCHELLWIEN)
Schubertella omiensis SEKI (MS)

Text-fiig 3.



Wentzelella sp.
Yatsengia sp.

This coral listed as *Yatsengia* sp. is now called by the writer by the name *Yatsengia ibukiensis* MINATO; it will be described below in this paper. There are abundant *Yatsengia* individuals in the formation reprenting the *Parafusu-*

lina zone in the Kitakami mountain region, though they are specifically different from the Ibuki species; therefore this genus must be remembered as one of horizon indicators of this zone. The case is quite the same as in the Chihsia-*Parafusulina* limestone in Southern China. The coral of *Wentzelella* sp. of SEKI may also be a new species, which will be described below in this paper under the name of *W. sekii* MINATO.

Pseudoschwagerina zone: This faunal zone is represented by the Samegai formation of Seki, which is characterized by prevalence of limestone facies, with not numerous cherts, about 800 m in whole thickness. Fossils:

Paraschwagerina oblonga (OZAWA)
Pseudoschwagerina sp.
Schwagerina vulgaris (SCHELLWIEN)
Schwagerina cf. *kraffti* (SCHELLWIEN)
Schwagerina simplex LANGE
Doliolina aliciae DEPRAT

Triticites zone: lacking?

Fusulina zone: Also this faunal zone is not yet established in this district; it may probably be lacking.

Fusulinella zone: The Otaki formation treated by SEKI as the lowest member of this district, contains a limestone in a basal part, which yields fossils characteristic of the *Fusulinella* zone.

The formation mostly consists of black slate, and slate with sandstone in alternation, intercalated by a few lenticular cherts. Whole thickness attains about 800 m. It comprises also limestone, as above mentioned, which is usually hard and very white in colour; but the limestone occasionally becomes conglomeratic, containing reddish and greenish schalstein pebbles. The following fossils have been found in this limestone.

Fusulinella cf. *biconica* HAYASAKA
Staffella sp.
Bradyina sp.
Nagatophyllum satoi OZAWA
Chaetetes sp.

As above stated, there have not yet been found any formations representing the *Triticites* and *Fusulina* zones in this district of Ibuki. A problem left unsolved by SEKI still remains, whether or not the Permian formation lies conformably on the formation yielding *Fusulinella* fauna. According to SEKI, very interesting conglomerates were found at Tani, Iawate-mura, Fuwa-gun, Gifu Prefecture, also in this district; the pebbles therefrom are round, well water-worn, and composed of such various kinds of rocks as schalstein, limestone and sandstone; the matrix of the conglomerate consists mainly of

slate. Among pebbles, those of limestone may be quite worthy of note. They are exclusively composed of material derived from the Otaki formation of the *Fusulinella* zone.

It is an open question to what stratigraphical position this conglomerate occupies. It may not be unreasonable to imagine that this may form the basal member of the Samegai formation and that there is a stratigraphical break between the Otaki-*Fusulinella* and the Samegai-*Pseudoschwagerina* formation.

Taisyaku (Taishaku) limestone plateau

According to H. FUJIMOTO, the limestone of the Taisyaku plateau which has considerable thickness, forms an anticlinal folding; several faunal zones in succession were recognized by him. In descending order they are as follows:

Yabeina zone: *Sumatrina annae* VOLZ, *Yabeina globosa* (YABE), *Yabeina shiraiwensis* OZAWA, *Lepidolina multiseptata* (DEPRAT), *Neoschwagerina minoensis* DEPRAT et OZAWA, *Neoschwagerina douvillei* OZAWA, *Neoschwagerina craticulifera* (SCHWAGER), *Pseudofusulina kraffti* (SCHELLWIEN)

Neoschwagerina zone: *Neoschwagerina craticulifera* (SCHWAGER), *Neoschwagerina margaritae* DEPRAT, *Pseudofusulina japonica* var. *hayasakai* (LEE), *Verbeekina verbeeki* (GEINITZ), *Ozawainella delawarensis* DUNBAR and SKINNER.

Transitional zone between *Neoschwagerina* and *Parafusulina* zone (*Pseudodoliolina* zone of FUJIMOTO): *Pseudodoliolina ozawai* YABE et HANZAWA, *Triticites kagaharensis* FUJIMOTO, *Pseudofusulina japonica* var. *hayasakai* (LEE), *Parafusulina ambigua* (DEPRAT), *Staffella yobarensis* OZAWA, *Verbeekina verkeeki* (GEINITZ)

Schwagerina zone: *Schwagerina insisa* (SCHELLWIEN), *Schwag. krotowi* (SCHELLWIEN), *Schwagerina prisca* (EHRENBERG et MÖLLER), *Schwg. tschernyschwi* (SCHELLWIEN), *Pseudofusulina japonsca* var. *hayasakai* (LEE), *Parafusulina ambigua* (DEPRAT), *Pseudofusulina kraffti* (SCHELLWIEN), *Pseudofusulina vulgaris* (SCHELLWIEN), *Parafusulina kaerimizuensis* OZAWA, *Texturlaria eximia* D'EICHWARD.

Fusulinella zone: *Fusulinella bocki* MÖLLER, *Fusulinella rhomboides* LEE et CHEN, *Eoschubertella obscura* LEE et CHEN, *Fusulinella* aff. *typica* LEE et CHEN, *Triticites* cf. *ovoideus* CHEN, *Ozawainella angulata* (COLANI), *Nagatophyllum satoi* OZAWA, *Thysanophllum* sp., *Lithostrolionella* sp., *Clisaxophyllum awa* MINATO, *Taisyakuphyllum rostfer* MINATO.

According to S. HANZAWA (1941) the Palaeozoic formation in the Taisyaku region is divisible into main three parts. The lower part is made up of gray

or light buff coloured cherts and dark gray limestones; from the last mentioned rocks HANZAWA found *Fusulinella* fauna. The middle part is made mostly from slate, graywacke, chert, schalstein and *Schwagerina* limestone, while the upper part is composed of slates, schalsteins and *Yabeina* limestone.

The *Yabeina* limestone, according to HANZAWA, in some places lies directly on the formation of the *Schwagerina* horizon, the formation corresponding to the *Neoschwagerina* zone being lacking there. Further the *Yabeina* limestone is occasionally brecciated or conglomeratic in texture, even though it sometimes appears compact and homogeneous. It contains such fusulinids as *Yabeina*, *Sumatrina* and *Parafusulina*, in the matrix, besides *Triticites* and *Fusulinella* in fragmental state in the limestone pebbles. These two facts suggest that *Triticites* and *Fusulinella* in the limestone blocks may be secondary in origin, obviously reworked from the older rocks, at the time when the *Yabeina* limestone was formed.

Therefore HANZAWA has believed and believes now, that an erosion period occurred there which was pre-*Yabeina* in time.

It is an open question whether or not the *Schwagerina* zone of FUJIMOTO (1944) and HANZAWA is in true correspondence to the *Pseudoschwagerina* zone of the Kitakami mountain region, because *Pseudoschwagerina* has not been detected in the Taisyaku plateau. But it seems highly reasonable from the association of species, that the mentioned *Schwagerina* zone in this region may be correlated to the upper zone of *Pseudoschwagerina* of the Kitakami mountain area.

The limestone representing the *Schwagerina* zone lies always directly on the formation of *Fusulinella* zone and no one up to the present day has found between them any formations to be correlated to either the *Triticites* or the *Fusulina* zone. Moreover *Schwagerina* limestone, according to FUJIMOTO, is also conglomeratic occasionally. He found fusulinid remains in the pebbles of this conglomerate as well as in the matrix; the former specimens (in pebbles) are the older types to indicate the *Triticites* and *Fusulinella* zones.

Hence, both HANZAWA and FUJIMOTO believe now, that the formation of the *Schwagerina* zone (probably the *Pseudoschwagerina* zone) rests unconformably upon the *Fusulinella* formation and that the formation of *Triticites* and *Fusulina* zone and probably a part of *Fusulinella* zone are lacking as a result of erosion of pre-*Schwagerina* (probably *Pseudoschwagerina*) time.

Akiyoshi limestone plateau

The Palaeozoic limestone, forming a limestone plateau surrounding the districts of Akiyoshi, Ofuku and neighborhood was studied by the late Dr. OZAWA (1925) in detail. However, later studies made by T. SUGIYAMA (1939),

S. HANZAWA (1941), R. TORIYAMA (1953) and others have revealed that important corrections are necessary in OZAWA's zoning in every respect. HANZAWA revised the succession of the faunal zones there as follows, in descending order:

Upper zone:

Upper subzone: characterized by *Yabeina, Sumatrina, Neoschwagerina, Verbeekina, Misellina* and *Parafusulina,* but lacking *Paraschwagerina.*

Lower subzone: characterized by *Parafusulina* and *Paraschwagerina* but lacking *Yabeina, Sumatrina, Neoschwagerina, Verbeekina* and *Misellina.*

Middle zone: characterized by *Pseudoschwagerina, Paraschwagerina, Schwagerina* and *Triticites.*

Lower zone: characterized by *Fusulinella* and correspondent to the coral limestone of OZAWA.

The lower zone of HANZAWA is unquestionably Middle Carboniferous in age. From this horizon OZAWA described such corals as *Nagatophyllum satoi, Dibunophyllum rugosum* var. *ofukensis, Polycoelia nipponica, Lonsdaleia floriformis crassiconus* and *Lonsdaleia enormis,* which will be revised in this paper. Moreover the present writer also reported the occurrence of *Clisaxophyllum awa* and *Taisyakuphyllum rostfer.*

Ozawa now 30 years ago, reported that the lower division of the Akiyoshi limestone comprises three distinct faunal zones in descending order, which are:

Fusulinella bocki subzone
Lonsdaleia floriformis subzone
Nagatophyllum satoi subzone

However in actual fact he had also found *Fusulinella bocki* as well as *Fusulinella biconica* in the same limestone in association with the corals above enumerated. Moreover *Nagatophyllum satoi* was later also found by SEKI (1939) in the same horizon of the *Fusulinella* zone in the Ibuki district as already stated, and this species was also collected by FUJIMOTO in Taisyaku region in association with *Stafella* sp.

Now, *Clisaxophyllum awa* MINATO has come to be accepted as an important horizon indicator for the Middle Carboniferous *Fusulinella* zone throughout Southwestern Japan. Therefore it is not at all reasonable that anyone should regard these coralline species as being older elements than the *Fusulinella bocki* zone.

Specific names given by OZAWA for these corals must be revised as follows:

Dibunophyllum rugosum var. *ofukensis* OZAWA ..... =*Clisaxophyllum ofukensis* (OZAWA)
Lonsdaleia enormia OZAWA..... =*Lonsdaleoides enormis* (OZAWA)
Lonsdaleia floriformis crassiconus..... =*Stylidophyllum* sp.
Polycoelia japonica OZAWA..... =*Polycoelia japonica* OZAWA
Nagatophyllum satoi OZAWA ..... =*Natophyllum satoi* OZAWA

It can now be safely concluded that none of those coraline species above enumerated are conspecific in age with any corals of the Lower Carboniferous; in this regard the writer wishes to present some detailed comment.

First, let the presence of *Polycoelia japonica* in the *Fusulinella* limestone be taken into considertion. This genus had been rather regarded to be limited only to the Permian until the time when OZAWA first described this species from the *Fusulinella* limestone in association with *Nagatophyllum satoi* from the Akiyoshi limestone plateau.

However the coral now in question may not be considered in any respect to show such older type similar to those being derived from the Carboniferous formation. Therefore the writer is now doubtful whether or not this coral was actually collected by OZAWA from the *Fusulinella* limestone.

The Akiyoshi limestone which the late Dr. OZAWA studied, shows quite complicated structure; for example, the older formation is said to be found occasionally quite near, side by side, in fault contact with a far younger formation.

OZAWA once described *Fusulinella itoi* from the *Sumatrina* zone at Shirai, Akiyoshi plateau. According to HANZAWA (1938a), *Fusulinella itoi* is a species not likely to have come from the same horizon with *Yabeina* or *Sumatrina*.

Also TORIYAMA has recently succeeded in finding two formations in different horizons, situated close together with fault contact at Shiraiwa also on the Akiyoshi plateau. The one of them is the *Yabeina-Sumatrina* limestone, while the other is the limestone yielding *Fusulinella itoi*. It is believed now that the latter limestone includes only *Fusulinella itoi* but is wholly lacking in the other young fusulinid genera such as *Yabeina* or *Sumatrina*.

Furthermore, *Parashwagerina oblonga* (OZAWA) was reported by OZAWA to be derived from limestone immediately below his *Sumatrina* zone at Yobara, also on the Akiyoshi limestone plateau. However, according to HANZAWA, there develops a *Pseudoschwagerina* limestone separated by a fault from the *Yabeina* limestone and *Paraschwagerina oblonga* is now believed to be derived from the former formation of *Pseudoschwagerina* limestone, at Yobara.

This species is believed to continue upwards to *Parafusulina* zone in some other locality of this plateau, as HANZAWA has already stated. To be sure this species is found ranging from the *Pseudoschwagerina* to the

Parafusulina zone but it is regarded to be an element of neither the *Yabeina* nor the *Neoschwagerina* zone.

Such being the case, it is not improbable that *Polycoelia japonica* is truly a fossil derived from the Permian limestone, which may perhaps develop adjacent to the *Fusulinella-Nagatophyllum* limestone with fault contact.

In any event, in the Akiyoshi limestone plateau region there have been detected none of the formations representing the *Triticites* and *Fusulina* zones up to the present. The limestone bearing the *Pseudochwagerina* fauna is regarded to lie directly on the *Fusulinella* formation; and the former to lie, to be sure unconformably on the latter, lacking any formations of considerable thickness.

From the *Pseudoschwagerina* zone OZAWA reported no corals but from the *Parafusulina* zone he described such corals as *Lonsdaleia yokoyamai*, and *Waagenophyllum indicum* var. *akagoensis* which will be reviewed below in this paper. The former is, admittedly a kind of *Stylidophyllum*, while the latter is such a species that it is rather preferable to consider it as independent from the genotype of the genus *Waagenophyllum*.

From *Neoschwagerina* zone, no definite horizon indicators among corals have yet been detected; from the *Yabeina* zone, OZAWA described such corals as the following: *Lonsdaleia katoi* OZAWA, *Waagenophyllum akasakensis* (YABE), *Waagenophyllum gerthi* OZAWA, *Waagenophyllum timorica* GERTH, *Waagenophyllum frechi* (VOLZ) and *Chaetetes* sp., although the generic and specific names of these corals must now be revised except *Waagenophyllum akasakensis* (YABE). The nomenclature will be dealt with in the descriptive part of this paper.

Later than the time of OZAWA's work, YABE and SUGIYAMA (1942) described *Akiyosiphyllum stylophorum* YABE et SUGIYAMA from the *Yabeina* limestone at Shiraiwa, Akiyoshi plateau, and the writer found also a coral named *Lonsdaleiastraea nipponica* from the same horizon in a few localities including the mentioned Shiraiwa.

Shikoku (Sikoku) Island

The Palaeozoic formations in Shikoku Island have as yet been little investigated, although they appear to have the same habit either stratigraphically or lithologically as those of the Kii Peninsula. From the palaeontological evidence the Younger Palaeozoic of Shikoku Island is now believed to range from the Moscovian to the Permian in age. Gotlandian fossils were also found at several localities in recent years, but not investigated in detail. Devonian as well as Lower Carboniferous deposits have not been clearly established in this island.

The well-known localities yielding Younger Palaeozoic fossils are as described below.

Inomine limestone, Tosa Province.

From the limestone conglomerate, TORIYAMA (1945) detected the following foraminifera, which were, according to him, preserved partly in the limestone pebbles and partly in the calcareous matrix.

Ozawainella cf. *angulata* COLANI
Fusulinella cf. *bocki* MÖLLER
Fusulinella cf. *biconica* HAYASAKA
Fusulinella sp.
Eoschubertella magna LEE and CHEN
Eoschubertella inominensis TORIYAMA
Eoschubertella minima TORIYAMA

All of these fossils above mentioned may denote the Middle Carboniferous in age, although two of them were new to science at the time when TORIYAMA described them.

Tosayama, Tosa Province.

Formerly NAGAO and the writer (1941) described under the name of *Corwenia hasimotoi* one Tetracoral from the limestone developing near Tosayama, about 15 km north of Koti (Kochi) city. Since no other reliable fossils were found with this coral, it was necessary at that time to presume the geological age of it, mainly from the similarity between the known species and the new specimen. It was stated that it may represent the Middle Carboniferous in age, because *Corwenia hasimotoi* has much resemblance to *Corwenia chiitsingensis* CHI, one of the good horizon indicators of the Middle Carboniferous in Southern China.

Since then, same species have been found in the southern part of the Kitakami district, and in Wakayama Prefecture in association with fusulinid foraminifera. From the former locality, *Corwenia hasimotoi* was found in the same limestone yielding *Pseudoschwagerina* and *Parafusulina*, while in the latter it came from the limestone containing *Parafusulina* and *Pseudofusulina*. Therefore, it has become quite evident, this species denotes the upper part of the *Pseudoschwagerina* zone; that is to say, it denotes the Lower Permian in age, instead of the Middle Carboniferous, as was formerly imagined. Accordingly at Tosayama, this coral should be regard to indicate the Lower Permian in age.

Futhermore, *Corwenia hasimotoi* has lately been treated by YABE under the genus *Huangia*, which was newly established by him with *C. chiitsingensis* as the genotype.

Meanwhile, at Tosayama, from a different locality from that of the coral above mentioned, TORIYAMA (1947) has described a good many fusulinid foraminifera which comprise such genera as *Staffella, Neoschwagerina, Doliolina*

and *Cancellina*. It is quite probable that those fauna represent the *Neoschwagerina* and *Verbeekina* zone. Following are the species which TORIYAMA described:

Staffella sp.
Schwagerina cf. *lutugni* (SCHELLWIEN)
Pseudoschwagerina sp.
Verbeekina katoi TORIYAMA
Verbeekina sp.
Doliolina iisakai TORIYAMA
Doliolina tosaensis TORIYAMA
Doliolina sp.
Cancellina kobayashii TORIYAMA
Cancellina tosayamaensis TORIYAMA
Neoschwagerina craticulifera (SCHWAGER)
Neoschwagerina douvillei OZAWA
Neoschwagerina margaritae DEPRAT
Neoschwagerina staffeloides TORIYAMA
Neoschwagerina iisakai TORIYAMA

Among them, so-called *Pseudoschwagerina* sp. is now believed by TORIYAMA himself and the writer to be nothing but *Verbeekina*.

Yamanba limestone, near Sakawa-mati, Tosa province:

Formerly T. KOBAYASHI (1931) reported that the Yamanba limestone is Triassic in age from his study on mollucan fossils collected from this limestone. However, he also found later on such brachiopods as *Martinia, Squamularia, Schizophoria* and so forth. Then he revised his former view. Following him, NONAKA (1946) took these fossils for study and made some specific identifications. Among them:

Schizophoria indica (WAAGEN)
Orthotichia derbyi (WAAGEN)
Camarophoria mutabilis TSCHENYSCHEW
Streptorhynchus pseudopelargonatus (BROILI)
Meekella ? sp.
Aulosteges polyangensis (KAYSER)
Squamularia asiatica CHAO
Martinia orbicularis GEMMELLARO
Spiriferina multiplicatus SOWERBY
Spiriferina nasuta WAAGEN var.
Spiriferina sp.

This brachiopod fauna as a whole reminds one of the well known brachiopoda fossils described by HAYASAKA from the *Parafusulina* zone of Nabeyama,

although there is not yet found even a single species which co-existed in the two localities.

Meanwhile, YABE and SUGIYAMA (1933) reported independently the presence of the Hexacoral, *Omphalophyllia* in this limestone, which they named as *O. yamanbaensis*. According to them *Omphalophyllia* had been known as a Triassic genus, but it had also been found from the Permian of Sumatra.

On occasion of his short vist to the Yamanba limestone locality in 1948, the writer succeeded to find one other coralline fossil, besides such foraminifera as *Pseudofusulina* sp., which was named by him *Lonsdaleiastraea yamanbaensis* and has already been described in a former paper (1949).

From the fossil evidences, above mentioned, the writer is now inclined to consider that the Yamanba limestone may represent the *Parafusulina* zone of the Lower Permian and accordingly it may stratigraphically be in a position between the limestone yielding *Huangia hasimotoi* and the limestone of *Neoschwagerina* both of which develop at Tosayama.

The Yamanba limestone was observed to be enclosed in schalstein; the whole complex of the formation is encircled by fault lines, separating from the Mesozoic rocks.

Yasuba, near Sakawa, Province of Tosa.

In the Sakawa basin, limestone conglomerates develop here and there, as well as at Inomine, as above mentioned; one of them is the Yasuba conglomerate. According to KOBAYASHI (in TORIYAMA's paper, 1942), the so-called Yasuba conglomerats is a lens, containing various kinds of pebbles, including granite, porphyrite, schalstein, and limestone. Fossils are now believed to be found also in the matrix, as well as in the limestone pebbles. From the investigation of TORIYAMA, there are two kinds of fusulinid foraminifera in this conglomerate. One type comprises comparatively higher forms such, as *Yabeina* and *Neoschwagerina;* while the other includes older forms as *Triticites* and *Fusulina*. Hence he concluded that this conglomeratic limestone may be correlated to the *Yabeina* formation and the older types of foraminifera may be a kind of derived fossils brought back into the sediments from the older formation when this conglomerate was forming:

TORIYAMA (1942) identified such species as follows:

Triticites minima (SCHELLWIEN)
Triticites trunacatus CHEN
Triticites spp.
Fusulina sinkaiensis TORIYAMA
Schwagerina sp.
Neoschwagerina margaritae DEPRAT
Neoschwagerina craticulifera (SCHWAGER)

Yabeina shiraiwensis OZAWA
Yabeina yasubensis TORIYAMA

Mimikiri, near Sakawa, Province Tosa.

Formerly YABE and SUGIYAMA (1934) described a kind of fossil sponge under the name *Amblysiphonella sikokuensis* YABE et SUGIYAMA from the limestone, developing at Mimikiri, near Sakawa, as well as *Waagenophyllum indicum* and *Staffella spherica* ABICH. The present writer is now in doubt whether the mentioned *Staffella* was truly brought back from the same stratigraphical horizon, with *Waagenophyllum*, even though it was derived from the same limestone mass. Usually *Waagenophyllum indicum* denotes only the *Yabeina* zone in Japan, while *Staffella sphaerica* is believed to be one of the most important horizon indicators of the Middle Carboniferous.

Kyusyu (Kyushu) island

In Kyusyu there is a wide distribution of Upper Palaeozoic deposits which have been studied in considerable detail in the past ten years. Especially in the mountainous area of the southern part of the island, the Palaeozoic formations have been throughly investigated; they have been divided into various series and stages thanks to the efforts of H. YABE, T. SUGIYAMA, K. KANMERA, R. TORIYAMA and others.

According to KANMERA (1952), the Carboniferous deposits there developed are divisiable into the following formations in ascending order:

Kakisako formation: Composed of black shale, with some lenticular beds of sandstone, intercalated by fossiliferous limestone and accompanied also by a thin conglomerate. Whole thickness 500 to 600 m. Type locality: Tutui (Tsutsui), Kakisako-mura, Yatsusiro-gun, Kumamoto Prefecture. First (1939), H. YABE and T. SUGIYAMA described such corals as *Diphyphyllum* cf. *platiforme* YÜ, *D.* cf. *gracile* MCCOY, *Siphonodendron* aff. *hsinanense* YÜ and such foraminifera as *Endothyra* sp. from the lenticular limestone developing near Tutui. Thus the Lower Carboniferous deposits were first established in Kyusyu upon the fossil evidences.

Following this discovery, Kanmera began his study on the Palaeozoic deposits including the Kakisako formation in the area of the Yatsusiro district. He described such corals as,

Dibunophyllum cf. *kankouense* YÜ
Kueichouphyllum latifossulatum KANMERA
Diphyphyllum platiforme YÜ var. *kakisakoense* KANMERA
Siphonodendron sp.
Hexaphyllia sp.

besides many species of formanifera as:

Millerella japonica KANMERA

Millerella gigantea KANMERA
Millerella japonica KANMEAA
Millerella spp.
Endothyra sp.
Saccamminopsis carteri (BRADY)

Of them *Diphyphyllum platiforme* Yü var. *kakisakoense* is the same species as *Diphyphyllum* cf. *platiforme* described by YABE and SUGIYAMA.

Each species of these corals above enumerated shows, to be sure, strong affinity to the corals described by Yü from the *Yuanophyllum* zone in Southern China: except *Hexaphyllia* sp., but they also have close similarities to the corals of the Onimaru series, Kitakami district, N. E. Japan. First of all, *Kueichouphyllum latefossulatum* is much like *K. yabei* from the Kitakami district. Moreover the presence of *Hexaphyllia* sp. in the Kakisako formation requires much attention; the occurrence of this genus was formerly reported only from the Kitakami district by YABE and SUGIYAMA, outside of Europe. Also *Saccamminopsis cartei* (BRADY) was found by YABE and the present writer from the limestone of the Onimaru series, in both the Abukuma and the Kitakami districts. Besides this, *Millerella japonica* from the Kakisako formation is believed by KANMERA to be quite near to *Millerella* sp. described by YABE (1949) from the Onimaru series.

Fusulinella zone, unnamed formation.

Middle Carboniferous deposits are also found in the area along the Kuma river, Ohno-mura district, Kumamoto Prefecture. They mostly consist of limestone. Fossils are not yet completely investigated but *Fusulinella bocki* and *Fusulinella biconica* are the leading types among them.

The Kuriki series.

Along the Hikawa valley, Yatsusiro-gun, Kumamoto Pref., there is a typical development of younger Palaeozoic deposits which are mainly composed of limestone accompanied by thin schalstein; in these deposits KANMERA (1952) newly established two distinct faunal zones, the *Fusulina* and *Triticites* zones respectively. The Kuriki series represents the former zone.

Fossils are:

Staffella pseudosphaeroidea DOUTKEVITCH
Fusulinella sp.
Fusulina higoensis KANMERA
Wedekindellina prolifica KANMERA
Fusulina ohtanii KANMERA
Fusulinella gracilis KANMERA
Fusulina kurikiensis KANMERA

The Hikawa series

Superimposed upon the Kuriki series with slight unconformity, there develops the Hikawa-series, which is also mostly composed of limestone, intercalated occasionally with schalstein.

Fossils are:

Quasifusulina longissima (MÖLLER)
Triticites sp.
Triticites matsumotoi KANMERA (MS)
Triticites yayamadakensis KANMERA (MS)

According to KANMERA, coralline fossils are not lacking in either the Kuriki or Hikawa series, but they have not been investigated in detail from the palaeontological viewpoint. However they all belong to the Clisiophyllidae and show some similarities to the corals of the *Fusulinella* zone in Southwestern Japan, for example, in the Akiyoshi limestone plateau or in the Taishaku region.

Permian formations are more widely distributed than the Carboniferous in Kyusyu. They are very fossiliferous. Thanks to the efforts of YABE, FUJIMOTO, TORIYAMA and KANMERA, it has become evident that the following four faunal zones in ascending order are to be recognized in these deposits. This zoning is established mainly upon the results of the investigations of fusulinid fossils.

Pseudoschwagerina zone: The limestone formation yielding *Pseudoschwagerina* fauna is also developed in the same district as the two preceding series; the former (*Pseudoschwagerina* zone) rests unconfomrably on the Hikawa series (*Triticites* zone) and is very fossiliferous. Of those fossils the following are the most important horizon indicators.

Triticites parvula (SCHELLWIEN)
Triticites montipara (EHRENGERG)
Triticites pusilla (SCHELLWIEN)
Pseudoschwagerina cf. *mounthensis* (DEPRAT)
Pseudoschwagerina minatoi KANMERA (MS)
Paraschwagerina shimodakensis TORIYAMA
Pseudofusulina cf. *vulgaris* var. *fusiformis* (SCHELLWIEN)
Schwagerina krotowi (SCHELLWIEN)

FUJIMOTO has also described *Pseudoschwagerina* besides *Triticites* and *Schwagerina* from the limestone developing at Kawanobori-mura, Ono-gun, Oita Prefecture.

Parafusulina zone: Also in the Kiku Penisula, northern Kyusyu, FUJIMOTO once discovered the fossil: *Schwagerina kraffti* (SCHELLWIEN) and *S.* cf. *logissima* (MÖLLER).

Neoschwagerina zone: For many years, the formations with *Neoschwagerina* fauna have been known in the Kuma district. The fauna comprises such fusulinid genera as *Neoschwagerina, Verbeekina,* and *Cancellina.*

Yabeina zone: In central Kyusyu, also in Kumamoto Prefecture, a characteristic formation is widely traceable which comprises sandstone, shale and conglomerate and is occasionally intercalated by lenticular limestones in various horizons. Some years ago MATSUMOTO and KANMERA named this formation the Kuma formation. The conglomerate contains various kinds of pebbles, consisting mainly in plutonic and dyke rocks such as granite, quartz porphyrite, and diabase. The limestones above mentioned are mostly also conglomeratic, and gradually tend toward a true conglomerate. They are usually very fossiliferous.

The lithologic facies of this Kuma formation as a whole quite resembles the so-called Usuginu conglomerate formation of Kitakami district as well as the conglomerate formation developing in Sikoku, where it is known as the Yasuba conglomerate. The geological age of the Kuma formation, especially its lower part has been considered to correspond to that of the *Yabeina* zone in rough estimation. However KANMERA (1953) is now of the belief that the so-called *Yabeina* zone in Japan, may be separable into two distinct subzones: the lower is the *Yabeina globosa* subzone, and the upper the *Lepidolina* subzone. According to him, the *Yabeina globosa* subzone (or the Upper *Yabeina* subzone) is characterized by *Yabeina globosa* (YABE), *Yabeina katoi* OZAWA and the presence of specimens of the genus *Neoschwagerina,* while the *Lepidolina* subzone (the lower *Yabeina* subzone) is distinguishable from the former in lacking *Neoschwagerina,* besides showing presence of the genus *Lepidolina* and advanced forms of *Yabeina.*

Following are the species, which KANMERA enumerated as the most important elements of his *Lepidolina* subzone of the Kuma formation.

Yabeina yasubensis TORIYAMA
Yabeina columbiana (DAWSON)
Lepidolina kumaensis KANMERA (MS)
Lepidolina toriyamai KANMERA (MS)
Codonofusiella aff. *paradoxides* DUNBAR and SKINNER
Pseudodoliolina pseudolepida (DEPRAT)
Schwagerina pseudocrassa KANMERA (MS)
Yabeina gubleri KANMERA (MS)
Schwagerina sp.
Rauserella sp.
Dunbarula? sp.

Waagenophyllum indicum (WAAGEN et WENTZEL)
Wentzelella sp.

From amongst the above listed by KANMERA, *Waagenophyllum* indicum, is truly a species perfectly identifiable to the genotype of genus *Waagenophyllum*. The writer also once collected this species at Kasamatsu, Kawamata-mura, Kumamoto Prefecture, the type locality of the Kuma formation.

As is already well known, *Waagenophyllum indicum* has been regarded in Japan as one of the good horizon indicators of the *Yabeina* zone in a wide sense. The species has been reported from various districts in Japan from the *Yabeina globosa* subzone in KANMERA's definition, but it is also found from KANMERA's *Lepidolina* subzone as above stated. Moreover the genus *Wentzelella* is also more prevalent in the *Yabeina* zone in Japan than in any other horizon; this species is also listed by KANMERA from his *Lepidolina* subzone.

Such being the case, the *Lepidolina* subzone is not easily separable from the *Yabeina globosa* subzone, at least in respect to the coralline species, although they are not very plentiful either in species or individuals as are the fusulinid foraminifera. The present writer is now inclined to treat the *Yabeina* zone in wide sense as it has been formerly employed by various authors, until that future time when the Permian stratigraphy in Japan will have been studied more in detail.

Ryukyu islands

In the Inner zone of the Ryukyu islands, Palaeozoic deposits are developed in the islands as Isigaki-zima, Iriomote-zima, Okinawa-zima, Tokuno-sima, Amamiosima, etc. They consist mainly of slate, sandstone, phyllite, limestone and conglomerate. It must be noted that the conglomerate occasionally includes granite pebbles.

The Palaeozoic deposits of these islands are quite barren in fossils, but S. HANZAWA in 1933 first found fusulinid fossils from a limestone at Tamagusuku, Nakizin-mura, Kunigami-gun, in Okinawa-zima, viz., *Neoschwagerina* sp., *Parafusulina* sp., and *Verbeekina douvillei* (DEPRAT). Accordingly one may consider the limestone yielding these fossils to represent the *Neoschwagerina* zone.

From the above description of the Younger Palaeozoic deposits of Japan it is to be noticed that in no one place in a complete sequence of formations found; however in the Kitakami district the Lower Carboniferous deposits are almost completely developed, although there is a stratigraphical hiatus between the Onimaru series and its immediately underlying formations. In the Kitakami mountain region, however the development of the Younger Carboniferous or the equivalent of Pennsylvanian is incomplete, except the

TABLE 1. Stratigraphical and geographical distribution of some leading genera of corals in the Upper Palaeozoic of Japan. M. MINATO (1955)

Division	Distinct			Ryukyu Is.	Kyushu Is.	Shikoku Is.	Akiyoshi	Taisyaku	Kii	Kyoto	Ibuki	Hunabuse	Akasaka	Omi	Hida Mts.	Kwanto Mts.	Ashio Mts.	Toriashi Mts.	Abukuma Mts.	Kitakami Mts.	Hokkaido Is.	FUSULIND DIVISION	CORAL DIVISION	BRACHIOPODA DIVISION
PERMIAN SYSTEM			Toyoma-sub-system																					
	Yabeina zone	Kanokura series	Iwaizaki stage		*Waakenophyllum indicum* *Wentzelella* *Yabeina* *Lepidolina*	*Yabeina* *Waagenophyllum indicum*	*Yabeina* *Lonsdaleiastraea* *Akiyosiphyllum*	*Yabeina* *Lepidolina* *Neoschwagerina*		*Akiyosiphyllum*		*Yabeina* *Geyerophyllum*	*Yabeina* *Sumatrina* *Waagenophyllum akasakense* *Pseudoromingeria*	*Yabeina* *Akiyosiphyllum*		*Yabeina*	*Yabeina*		*Waagenophyllum indicum* *Wentzelloides* *Yabeina* *Lepidolina*	*Waagenophyllum indicum* *Wentzelloides* *Lepidolina*		*YABEINA* *LEPIDOLINA*	*WAAGENOPHYLLUM indicum* *AKIYOSIPHYLLUM*	
	Neoschwagerina zone		Kaltisawa-stage	*Verbeekina-Neoschwagerina*	*Neoschwagerina*	*Neoschwagerina* *Cancellina* *Verbeekina*		*Neoschwagerina* *Verbeekina*	*Neoschwagerina*	*Lyttonia*	*Neoschwagerina* *Codonofusiella*	?	*Neoschwagerina* *Verbeekina* *Lyttonia*	*Neoschwagerina* *Verbeekina* *Pseudodoliolina*	*Neoschwagerina* *Lyttonia*	*Neoschwagerina*	*Neoschwagerina*		*Lyttonia*	*Lyttonia*		*NEOSCH-WAGERINA* *VERBEEKINA*		*Uncinulus jabiensis*
	Parafusulina zone	Sakmotosawa-series	Kahoyama-stage		*Pseudofusulina* *Petraia sp.*	*Lonsdaleiastraea* *Omphalophyllia* *Parafusulina*	*Parafusullina* *Stylidophyllum yokoyamai* *Yatsengia ibukiense* *Waagenophyllum akagoense*	*Parafusulina* *Pseudodoliolina*	*Schwagerina* *Pseudofusulina*		*Pseudofusulina* *Yatsengia ibukiense* *Wentzelella sekii*	*Waagenophyllum akagoense* *Yatsengia ibukiense*	present ?	*Pseudofusulina* *Schwagerina*	*Pseudodoliolina* *Parafusulina*	*Parafusulina* *Pseudofusulina*	*Parafusulina* *Pseudoyatsengia* *Meekella*			*Parafusulina* *Yatsengia kabayamaensis* *Michelinia multitabulata*		*PARAFUSULINA* *PSEUDO-FUSULINA*	*YATSENGIA* *PSEUDOYATSENGIA*	*Meekella gigantea*
	Pseudoschwagerina zone		Kawaguti-stage		*Pseudoschwagerina*	*Huangia hasimotoi*	*Pseudoschwagerina* *Schwagerina*	*Parafusulina* *Pseudofusulina*	*Huangia hasimotoi*		*Paraschwagerina* *Pseudoschwa-gerina* *Schwagerina*		*Peudoschwagerina* *Pseudofusulina*		*Pseudoschwagerina* *Cystophora manchurica kikkawai*	?		*Pseudoschwagerina*	*Huangia hasimotoi* *Pseudoschwagerina* *Lophophyllidium suetomii*		*PSEUDO-SCHWAGERINA*	*HUANGIA hasimotoi* *LOPHOPHYLLIDIUM suetomii*	*Munella*
PENNSYLVANIAN SYSTEM	Triticites zone	Hikawa-series			*Triticites* *Quasifusulina*									*Triticites*		*Triticites* ?						*TRITICITES*		
	Fusulina zone	Kariki-series			*Fusulina* *Staffella* *Wedekindellina* *Fusnlinella*									?	?	?						*FUSULINA*		
	Profusulinella-Fusulinella zone	Nagaiwa-series			*Fusulinella*	*Ozawainella* *Fusulinella* *Eoschubertella*	*Fusulinella* *Nagatophyllum* *Lonsdaleoides* *Clisaxophyllum awa*	*Nagatophyllum* *Clisaxophyllum awa* *Lithostrotionella* *Lonsdaleoides*	*Fusulinella*		*Fusulinella* *Staffella* *Nagatophyllum*		*Fusulinella* *Clisaxophyllum awa* *Lonsdaleoides*	*Fusulinella* *Neokoninckophyllum*	*Fusulinella*		*Fusulinella* *Ozawainella*	?	*Profusulinella* *Thysanophyllum* *Lithostrotionella*		*FUSULINELLA* *PRO-FUSULLINELLA*	*NAGATOPHYLLUM* *CLISAXOPHYLLUM awa*	
MISSISSIPPIAN SYSTEM	Upper Visean	Onimaru-series			*Dibunophyllum* *Kueichouphyllum* *Hexaphyllia* *Millerella*					*Lithostrotion*				*Amygdalophyllum* *Lithostrotion somaense* *Gigantoproductus*		*Arachnolasma sinense*			*Kueichouphyllum* *Lithostrotion somaense* *Siphonodendron* *Saccamminopsis*	*Kueichouphyllum* *Dibunophyllum* *Hexaphyllia* *Gigantoproductus* *Millerella*		*MILLERELLA*	*DIBUNOPHYLLUM* *KUEICHOUPHYLLUM* *HEXAPHYLLIA*	*Gigantoproductus edelburgensis*
	Lower-Visean	Ohdaira-series	Kozubo-stage																	*Sugiyamaella*			*SUGIYAMAELLA*	
			Maide-stage																	*Amplexus nipponensis*			*AMPLEXUS nipponensis*	*Brachythyrina nagaoi*
	Eroswngtian-Tournaisian	Arisn-series	Jumonji-stage																					*Syringothyris jumonjiensis*
			Ithozuti-stage																					
		Ehkoruti-series																						*Kitakamithyris tyoanjiensis*
	Upper Devonian	Tobigamori-series																	*Sinospirifer australis*	*Sinospirifer australis*				*Sinospirifer australis*

Nagaiwa series, which is considered only to represent the *Fusulinella* zone only from its fossil evidences. There is almost lacking in that region any formations which can be correlated either to the *Fusulina* zone or the *Triticites* zone.

On the contrary, in Middle Kyusyu, the Younger Carboniferous deposits are typically developed, from the *Fusulinella*, *Fusulina* to *Triticites* zone in ascending order; all the beds yield fossils, characterizing each faunal zone and they lie on one another, though there may be regarded to be some stratigraphical breaks both between the *Fusulinella*, and *Triticites* zone and between the *Triticites* and overlying *Pseudoschwagerina* zone.

In Japan the Permian deposits are more widely distributed than the Carboniferous and show more complete records in some districts, although there have been observed some stratigraphical breaks in some places, especially in Kyusyu island, Akiyoshi limestone plateau, Taisyaku limestone plateau in S. W. Japan, Akasaka district, Central Japan and Kitakami district.

From these formations the coralline remains are extremely rare in the lower half of the Lower Carboniferous, except from the Maide stage, and are wholly lacking in the upper half of the Permian, the Toyoma subsystem. On the contrary, other formations are yielding coralline fossils in more or less abundance; especially they are found abundantly everywhere in Japan in the formations of the Onimaru series and the upper half of the Kanokura series (the *Yabeina* zone).

In summarizing the foregoing paragraphs, the writer wishes to insert here tables 1 and 2, which show the correlations of the Upper Palaeozoic deposits in Japan and also the stratigraphical and geographical distributions of coralline remains.

4) *Some remarks on the Japanese Upper Palaeozoic coralline remains.*

The stratigraphical and geographical distributions of coralline remains in the Upper Palaeozoic of Japan have been treated in the preceding section. The calcareous facies containing coralline fauna in Japanese Upper Palaeozoic are generally to be found more prevalent in the Inner zone of Honsyu and the Abukuma mountains as well as the Kitakami district than in the Outer zone including Shikoku, Kyushu, Kii peninsula and Kwanto mountain region. Especially in the Onimaru series, the coralline fauna are found mainly in the Omi, Abukuma and Kitakami districts as already described; while only a small number of fossil coral specimens may be enumerated from a few localities in Middle Kyusyu, the Kii Peninsula, and Kwanto regions, where specimens of fossil corals have been found only sparsely. Such contrast is

also recognizable in the geographical distributions of corals in the Permian period. The corals of that period flourished best in the Inner zone of S. W. Japan and in the Abukuma and Kitakami districts.

Of coralline remains of Onimaru series in the Kitakami district, the existence of certain species may be specially worthy of note in having similarities or close affinities to those of Northwestern Europe. Amongst them *Heterophyllia kitakamiensis*, *Hexaphyllia elegans, japonica*, two species of *Rhodophyllum*, such species as *sugiyamai* and *yokoyamai*, *Dibunophyllum bristolense*, *Carcinophyllum onukii*, *Stylidophyllum japonica* of *floriformis* type, *Siphonodendron martini, pauciradiale*, *Palaeosmilia kitakamiensis* and moreover *Hexaphyllia* as well as *Heterophyllia*, may be especially important in consideration of free communication of such remote provinces at that age. Those corals were known only from Scotland and Central Russia, until the occasion when YABE and SUGIYAMA found them in the Kitakami mountain region.

It shold be also noted that in other kinds of fossils the same similarity is recognizable, e. g. *Saccamminopsis carteri* was reported from the Japanese Lower Carboniferous in the Onimaru series from Kyusyu and Abukuma as well as from Kitakami district. That occurrence also reminds one of the communication between the Japanese sea and the N. W. European sea.

Further the existence of such species as *Dibunophyllum asiatica*, *Kueichouphyllum yabei*, *Yuanophyllum yabei* and *Kueichoupora setamaiensis* in the Onimaru series of Kitakami district may indicate that an intimate relation existed between the Southern China and the Japanese sea in Lower Carboniferous times, because such genera and species are not known from any other localities outside of Southern China until the present day.

Moreover, coralline fauna almost equivalent to the Onimaru fauna in age, found by YABE, SUGIYAMA and KANMERA at Tsutsui (Tutui), Kakisako-mura, Kumamoto Prefecture, also show close similarity to the corals described by Yü from Southern China. The Kakisako formation possesses *Dibunophyllum* cf. *kankouense* Yü, *Kueichouphyllum latefossulatum* KANMERA, *Diphyphyllum platiforme* Yü var. *kakisakoense* KANMERA, *Diphyphyllum* cf. *gracile* MCCOY, *Hexaphyllia* sp. besides such foraminifera as *Endothyra*, *Saccamminopsis carteri* (BRADY) and many species of *Millerella*.

Thus the writer holds now the opinion that the Onimaru sea, covering the whole Japanese islands, in the later Eo-Carboniferous age might have had a very intimate relation with the sea covering Southern China, in respect to palaeozoogeographical province. Most of all, the presence of *Kueichouphyllum* in Japanese Upper Eo-Carboniferous is quite worthy of note; there have been found rather many individuals both in Kyusyu and the Kitakami mountain area, while it is also abundantly found in the Abukuma district.

The genus *Hexaphyllia* has been formerly regarded to be one of the most characteristic elements showing the similarity of the corals of the Onimaru series to the corals of Europe, but this is known at present to be also distributed as far as southward Kyusyu.

From the considerations presented in the foregoing paragraphs, the Japanese Onimaru sea might be thought to have been an open communicating freely to the geosynclines of S. China and belonging to the same zoogeographical province, however the Onimaru sea might also have been united to the geosyncline of W. Europe, probably through the Boreal sea existing at that time which was probably influenced by a much warmer climate. The deposits containing coralline fossils in the Japanese islands may represent the neritic zone of the said Onimaru sea.

Needless to say, from the occurrence of coralline fossils as enumerated above the Japanese Onimaru series may be therefore easily correlate in stratigraphical position to the European Upper Viséan, the *Dibunophyllum* zone of Avonian as well as Dinatian, the Chinese Upper Fengninian, and to *Yuanophyllum* zone of Yü.

The Manchurian Lower Carboniferous limestons*) contain such species as *Endothyra* sp., *Siphonodendron irregulare* var. *asiatica* (YABE et HAYASAKA), *S.* sp., *Clisaxophyllum* sp., *Dibunophyllum* sp., *Lonsdaleia floriformis* MARTIN, *Carcinophyllum* sp., *Caninia* sp., *Diphyphyllum* sp., besides such brachiopod species as *Gigantoproductus latissumus* (SOWERBY) and *G. manchuriensis* (MINATO), which were found in the vicinity of Ronjazu, southward 80 km from Kirin (Chirin) and were reported in the series of the present writer's papers. It may be desirable to compare them with the species found in the Japanese Onimaru series, although the coralline fauna are specifically not common with the Japanese fauna in spite of the relatively near adjacent geographical position.

The Onimaru series overlaps transgressively the older formations in the Kitakami mountain region, and the same relation has been believed by some geologists to be recognizable in the Abuknma district.

This transgressive movement should be quite worthy of note from the

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*) M. MINATO: Unterkarbonfauna in der Manschuri. Bull. Geol. Inst. Manchoukuo, no. 106, 1942.

M. MINATO: Note on some Lower Carboniferous fossils from the Kirin-formation in Mincheing, Panshi-hsien, Province Kirin, Manchoukuo. Jour. Fac. Sci. Hokkaido Univ., ser. IV, vol. VII, no. 1., 1942.

H. YABE und M. MINATO: Eine *Aulina*-Art aus der Mandschurei. Jour. Geol. Geogr. Japan, vol. 19, 1944.

M. MINATO: New discovery of Lower Carboniferous Millerella in Manchuria. Jour. Geol. Soc. Japan, vol. 56, 1950.

viewpoint of comparative tectonics which the writer has already discussed upon several occasions. Such stratigraphical relations have also been noted in some parts of Yunan, Kweichou, Nanking hill and other districts in the Tien Shan geosynclines.

Moreover, in the Japanese islands, the occurrence of some type of diastrophism of Pre-Onimaru epoch is recognizable in the Kitakami district, which was formerly called the Sizu folding. In several districts of Europe such transgressions of Upper Viséan age are evident in many localities.

Such being the case, the transgressive movement at the dawn of the Upper Viséan time and Pre-Upper Viséan diastrophism might not ever have been local in nature but should be considered as having taken place on a quite large scale.*

In Japan the Lower Permian, Sakamotosawa stage (*Pseudoschwagerina* zone) is believed to rest unconformably on the Middle Carboniferous of the *Fusulinella* zone or older. There is an absence of uppermost Carboniferous of the *Triticites* zone as of *Fusulina* zone everywhere, especially in the Kitakami, Abukuma, Taisyaku, Akiyoshi and Middle Kyusyu districts caused by some transgressive overlapping. Such has already been quite definitely proved from either the stratigraphical or the palaeontological viewpoint.

However, thanks to the efforts of KANMERA, FUJIMOTO, KAWADA, and KANUMA, fossils characterizing the *Triticites* zone as well as *Fusulina* zone have been newly found in a few localities of the Hida mountains and middle Kyusyu as above stated. Especially in Kyusyu island each bed or formation representing the *Fusulina* and *Triticites* zone was found to lie in sequence and to show the most complete development, although there are some stratigraphical breaks in these formation.

Notwithstanding this discovery, there is still lacking any knowledge concerning the coralline fauna for these younger Carboniferous formations, although corals are occasionally found either from *Triticites* or *Fusulina* zone,

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* As already stated the coralline remains are extremely rare in formation older than the Onimaru series in Kitakami mountains. It is impossible at present to generalize on the palaeozoogeography of the Japanese geosyncline at that time from only the evidence of the coralline fauna. However from the analyses of other kinds of fossils, such as brachiopods, Echinodermata and so forth, it may be stated that the older fauna derived from the Hikoroichi, Arisu and Ohdaira series show some affinity to that of Eastern Australia, which affinity the writer has pointed out upon various occasions. Thus it may be assumed that, from the viewpoint of palaeozoogeography, profound change occurred in the sea covering the Japanese islands, after the diastrophism of Size folding of Pre-Upper Viséan age. This suggests that the Japanese geosynclinal sea was in more intimate relation with Australia than with the Chinese basin in the older Eo-Lower Carboniferous age, but it came to be in the same zoogeographical province with the sea of South China, after the dawn of the Onimaru epoch.

according to the verbal information of KANMERA.

Therefore, it is possible to mention coralline species only from the *Fusulinella* zone as the representatives of the Younger Carboniferous in Japan, which are:

From Southwestern Japan, including Kyusyu, Shikoku Island and S. W. Honsyu.

Clisaxophyllum ofukensis (OZAWA)
Lonsdaleoides enormis (OZAWA)
Lonsdaleoides toriyamai MINATO
Polycoelia japonicum OZAWA
Taisyakuphyllum rostfer MINATO
Clisaxophyllum awa MINATO
Lithostrotionella sp. cfr. *tingi* CHI
Stylidophyllum sp.
Nagatophyllum satoi OZAWA

From northeastern Japan

Thysanophyllum aseptatum DOBROLYUBOVA
Lithostrotionella kitakamiensis MINATO
Diphyphyllum equiseptatum YABE et HAYASAKA
Chaetetes nagaiwaensis MINATO

In comparing these corals above enumerated with those of the Onimaru series, it is to be noticed that there is a marked contrast between the two groups. Firstly there is no common species found in both the Onimaru-series and the Nagaiwa series of the *Fusulinella* zone. Secondly the genera such as *Nagatophyllum*, *Clisaxophyllum*, *Lonsdaleoides* and *Thysanophyllum* appeared firstly in the *Fusulinella* zone in Japan; but not all of these genera have yet been found in the underlying Onimaru series.

Meanwhile one should also not overlook the fact that there may be an important difference among corals of the *Fusulinella* zone between northeastern and southwestern Japan; there has not been reported any species common to the two districts up to the present day.

In this regard, a final conclusion cannot yet be reached because there may be still more numerous coralline species in the *Fusulinella* zone left unknown, in addition to the described known species.

However, despite the wide distribution of *Kueichouphyllum* through the sea of the Japanese geosyncline in the Onimaru epoch, it may rather safely be concluded that the sea covering Japanese islands at the Middle Carboniferous (*Fusulinella*-zone) age might be separated into two basins from the view point of palaeozoogeography especially as concerns the coralline fossils.

The writer is now of the opinion that these two basins may be somewhat

comparable to the Penchi series of North China and the Weiningian series of South China. In Japan there have been found such Northern elements as *Lithostrotionella kitakamiensis, Thysanophyllum aseptatum* and *Chaetetes nagaiwaensis* from the Middle Carboniferous of Northeastern Japan, while such corals as *Amygdalophyllum* and *Lonsdaleoides* from Southwestern Japan remind one of some Weiningian corals, although there have not been reported any species common to both the Japanese and Chinese series.

Between the Carboniferous and Permian ages a distinct faunal change should be recognizable in respect to the coralline remains in Japan.

Among Clisiophyllidae, *Waagenophyllum, Wentzelella, Lonsdaleisatraea, Wentzelloides, Yatsengia, Verbeekiella, Huangia*, appeared newly in the Permian period while such genera as *Dibunophyllum, Corwenia, Carcinophyllum, Setamainella, Nagatophyllum* and *Amygdalophyllum* had already disappeared. The existence of *Sochikineophyllum* and many species of *Lophophyllidium* belonging to Lophophyllidae in the Permian must be also noted together with such peculiar elements as *Khmerica problematica* and *Omphalophyllia yamanbaensis.*

So far as known to the present day, *Geyerophyllum* may be recorded only from the Carnic Alps in Moscovian age as well as Gshelian; however the Japanese representatives may denote the Permian judging from the associated fusulinid foraminifera.

Of Permian corals, *Verbeekiella* are known from the Urals and Timor outside of Japan; *Omphalophyllia*, Carnic Alps and Sumatra; Khmeria, Indo-China; *Lonsdaleisatraea*, the Urals, Himalaya; *Sochikneophyllum* Urals; *Yatsengia*, S. China. Thus all of them came from the geosynclines represented by the Tethys sea and moreover, both *Waagenophyllum* and *Wentzelella* may be the most characteristic Tethys Sea elements. The Japanese Permian coralline sea should be therefore regarded as a direct eastern extension of the Tethys sea.*

Most of the corals enumerated in the above paragraph appeared in the Lower Permian and flourished mainly in the later Middle Permian epoch. Among them, however, it must be remembered that *Waagenophyllum* together with *Wentzelella*, had begun already to appear in the lower part (*Pseudoschwagerina*-zone) of the Permian.

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* As exceptional case, no species belonging to the genera such as *Polythecalis* and *Tetrapora*=*Hayasakaia* has been found from Japanese Permian; both of them, however were quite flourishing in the Chinese Permian. Neverthless, the writer is now of the belief, that the Japanese Permian sea might be a direct extension of the Tethys sea, including the Chinese basin. The so-called *Polythecalis*, formerly described by YABE and the writer from the Permian of Sikoku Island should be now revised: it may be nothing but *Stylidophyllum.*

Lastly there should be mentioned here something as to the morphological nature of the corallites observed in some types of the Japanese Permian, that is, the plocoidal nature of the outer wall seen in such genera as *Wentzelloides* or *Lonsdaleiastraea*. These Japanese representatives which appear at the late Middle Permian deposits, may be terminals of the series of corals from *Stylidophyllum* or *Wentzelella* in respect to the other morphological features of the corallites, which appeared as early as Lower Permian or such still earlier time as the Lower Carboniferous, but were more flourishing at the middle Permian age and disappeared wholly before the succeeding stage, roughly in the Upper Permian.

In such basins of the Tethys sea as those of Japan and Southern China, the so-called Upper Permian may be represented by clay facies. The deposits comprises high contents of clay materials in contrast to the far less quantity of calcareous sediments. The writer presumes that the plocoidal nature of these corals may denote the character of an adaptive ability to protect themselves from the muddy sea-water although they may have been soon overwhelmed by the vast supply of clay materials in the next stage, the Upper Permian.

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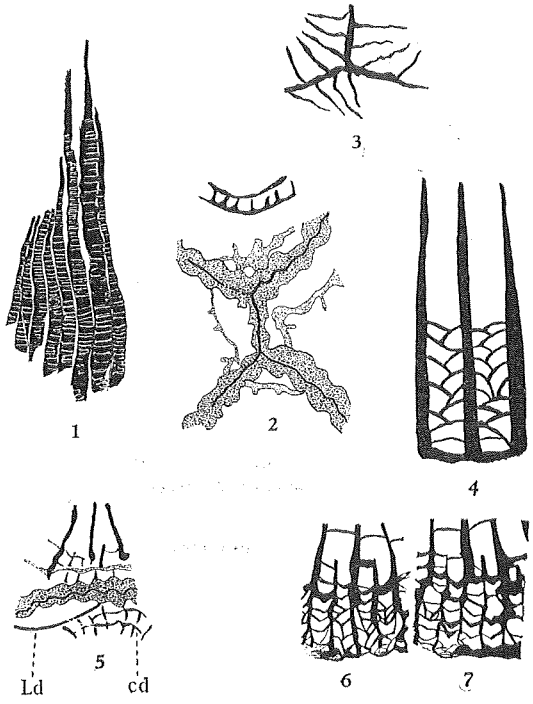
*YABE, H. & SUGIYAMA T.: *Akiyosiphyllum*, a new Type of Permian Rugose Corals from Japan. Proc. Imp. Acad. Tokyo, vol. 18, p. 574, Tokyo, 1942.

YABE, H., SUGIYAMA, T. & EGUCHI, M.: A new Haxacoral-like Carboniferous Coral (Preliminary note). Jour. Geol. Soc. Japan, vol. 50, p. 242, 1943.

6) *Description of Species*

TERMINOLOGY FOR DESCRIPTION OF CORALS

The terminology used in this paper is based on that formulated by R. WEDEKIND,[1] D. HILL,[2] W. G. SANFORD[3] and W. H. EASTON.[4] Although the writer believes now that there is nothing more to be added to their terminology, he wishes here to explain some terms to avoid any confusion, which might arise.



Text-fig. 4.

1) R. WEDEKIND: Einfürung in die Grundlagen der historischen Geologie, Bd. II, 1937.
2) D. HILL: British terminology for Rugose corals. Geol. Mag., vol. LXXII, 1935.
3) W. G. SANFORD: A review of the families of Tetracorals. American Jour. Sci., vol. 237, 1939.
4) W. H. EASTON: Corals from the Chouteau and related formations of the Mississippi valley region. Report of Investigation, no. 97, State Geol. Surv. Illinois, 1944.

TABLE 2

Carboniferous and Permian Corals from Japan 1955

	Kyusyu	Shikoku	Chugoku (Western Honsyu)	Chubu (Central Honsyu) Kii Peninsula	Kanto (Kwanto) Mountains Ashio Mountainland	Abukuma Mountains	Southern Kitakami Mountains
ANTHOZOA							
TETRACORALLA							
PETRAIDAE							
Petraia ? sp.	+						
POLYCOELIDAE							
Polycoclia joponica OZAWA			+				
STREPTELASMIDAE							
Sochikineophyllum s-hashimoton MINATO							+
HAPSIPHYLLIDAE							
Meniscophyllum longiseptata MINATO			+				
ZAPHRENTIDAE							
Amplexus nipponensis OISHI & MINATO							+
A. sp.							+
Caninia juddi (THOMSON) var. *ozawai* MINATO							+
Pseudocaninia sp.							+
LITHOSTROTIONIDAE							
Siphonodendron pseudomartini (YABE & HAYASAKA)							+
S. sp. a.							+
S. sp. b.							+
S. inugasirayamaensis MINATO							+
S. martini (EDWARDS & HAIME)							+
S. densitabulata (YABE & HAYASAKA)							+
S. pauciradiale (M'COY)							+
S. aff. hsianense YÜ	+						
Lithostrotion somaense YABE & HAYASAKA			+				+
L. hinozuchiense MINATO							+
L. sp.			+				
Diphyphyllum equiseptatum YABE & HAYASAKA							+
D. flexuosum YABE & HAYASAKA							+
D. platiforme YÜ var. *kakisakoense* KANMERA	+						
Depasophyllum cf. *gracile* (M'COY)	+						
Thysanophyllum aseptatum DOBROLYUBOVA							+
Lithostrotionella sp.							+
Lithostrotionella tingi CHI			+				
Lithostrotionella kitakamiensis MINATO							+
Pseudodorlodotia kakimii MINATO							+
Dorlodotia ? sp.							+
Orionastraea sp.				+			
Cystophora manchurica forma *kikkawai* (Y. & H)				+			
CLISIOPHYLLIDAE							
Dibunophyllum bristolense GARWOOD & GOODYEAR							+
D. asiaticum MINATO							+
D. inugasirayamaensis MINATO							+
D. cf. *kankouense* YÜ	+						
Neokoninckophyllum sp.				+			
Rhodophyllum yokoyamai MINATO							+
Rh. sugiyamai MINATO							+
Waagenophyllum indicum (WAAGEN & WENTZEL)	+	+	+	+	+		+
W. indicum var. *usuginuense* MINATO							+
Waagenophyllum akasakensis (YABE)		+	+	+			+
W. akagoensis OZAWA			+	+			
W. polyseptata MINATO				+			+
Wentzelella sekii MINATO				+			
W. ozawai MINATO			+				
W. iwaizakiensis YABE & MINATO							+
W. kitakamiensis YABE & MINATO							+
W. subtimorica HUANG			+				+
Wentzelloides maiyaensis YABE & MINATO					+	+	+
Iranophyllum permicum MINATO							+
Yatsengia kiangsuensis var. *mabutii* MINATO							+
Y. ibukiensis MINATO			+	+			
Y. kabayamaensis MINATO							+
Pseudoyatsengia kuzensis YABE					+		
Huangia hasimotoi (NAGAO & MINATO)			+	+			+
Huangia ? sp.			+				
Verbeekiella japonicum YABE & MINATO							+
Leonardophyllum ? sp.			+				
Londaleia katoi OZAWA			+				
Corwenia ? omiensis (YABE & HAYASAKA)				+			
Stylidophyllum japonicum (YABE & HAYASAKA)							+
S. sikokuense MINATO		+					
S. yokoyamai (OZAWA)			+				
Lonsdaleiasraea nipponica MINATO			+				
L. yamanbaensis MINATO	+						
Clisiaxophyllum ofukense (OZAWA)			+				
C. awa MINATO			+	+			
Nagatophyllum satoi OZAWA			+	+			
Carcinophyllum onukii MINATO							+
Setamainella hayasakai MINATO					+	+	
Arachnolasma cf. *sinense* (YABE & HAYASAKA)					+		
Yuanophyllum yabei (NAGAO & MINATO)							+
AMYGDALOPHYLLIDAE							
Taisyakuphyllum rostifer MINATO			+				
Amygdalophyllum naosoidea MINATO			+				
A. ? gracile (HAYASAKA)				+			
A. giganteum (YABE & HAYASAKA)				+			
A. setamaiensis YABE & MINATO							+
Amygdalophyllum sp. a							+
Amygdalophyllum sp. b							+
LOPHOPHYLLIDAE							
Sugiyamaella carbonarium YABE & MINATO							+
Lophophyllidium suetomii MINATO							+
L. sp. a							+
Lophophyllidium sp. b				+			
Lophophyllidium sp. c				+			
Lophophyllidium sp. d							+
GEYEROPHYLLIDAE							
Geyerophyllum hunabuseum MINATO				+			
Geyerophyllum gerthi (OZAWA)			+				
Lonsdaleoides enormis (OZAWA)			+	+			
Lonsdaleoides toriyamai MINATO			+	+			
Akiyosiphyllum stylophorum YABE & SUGIYAMA			+	+			
CYATHOPHYLLIDAE							
Cyathophyllum ? sp.							+
Palaeosmilia kitakamiensis MINATO							+
Kueichouphyllum latifossulatum KANMERA	+						
K. yabei MINATO					+	+	
K. kesenense MINATO							+
K. yahagiensis MINATO							+
Cyathophylloid coral							+
Camophyllum ? sp.				+			
HETEROPHYLLIDAE							
Hexaphyllia sp.	+						
H. sp. YABE & SUGIYAMA							+
H. elegans YABE & SUGIYAMA							+
H. japonica YABE & SUGIYAMA							+
Heterophyllia kitakamiensis YABE & SUGIYAMA							+
GENUS OF UNKNOWN SYSTEMATIC POSITION							
Khmeria problematica MANSUY			+				
HEXACORALLA							
ANABASIIDAE							
Omphalophyllia yamanbaensis YABE & SUGIYAMA	+						
PSEUDOPAVONIDAE							
Pseudopavona taisyakuana YABE, SUGIYAMA & EGUCHI			+				
ASEPTATA							
FAVOSITIDAE							
Michelinia (*Michelinopora*) *multitabuata* Y. & H.							+
Thamnopora ? chaetetoidea (HAYASAKA)							+
T. ? nipponica (HAYASAKA)							+
AULOPORIDAE							
Pseudoromingeria kotoi (YABE & HAYASAKA)			+				
SYRINGOPORIDAE							
Sgringopora cfr. *reticulata* GOLDFUSS							+
S. sp.							+
Kueichoupora setamaiensis MINATO							+
CHAETETIDAE							
Chaetetes nagaiwaensis MINATO							+
Chaetetes sp.			+				
C. ? sp.			+				?

	Carboniferous													Permian					
	Mississippian							Pennsylvanian											
	Hikoroiti (Hikoroichi) series	Arisu series		Ohdaira series		Onimaru series	*Millerella* zone	Nagaiwa series,	*Profusulinella* zone	*Fusulinella* zone	Kuriki series, *Fusulina* zone	Hikawa series, *Triticites* zone	Sakamotosawa series	*Pseudoschwagerina* zone	*Parafusulina* zone	Kanokura series	*Neoschwagerina* zone	*Yabeina* zone	Toyoma subsystem
	K	P	Sy	Br	Su	D	M	Pf	Fu	Fs	T	Ps	Pa	N	Y	Nu			
PETRAIDAE																			
Petraia ? sp.													?						
POLYCOELIDAE																			
Polycoclia joponica OZAWA								?	—										
STREPTELASMIDAE																			
Sochikineophyllum s-hashimoton MINATO																			—
HAPSIPHYLLIDAE																			
Meniscophyllum longiseptata MINATO									?	—									
ZAPHRENTIDAE																			
Amplexus nipponensis OISHI & MINATO																			
A. sp.																			
Caninia juddi (THOMSON) var. *ozawai* MINATO																			
Pseudocaninia sp.																			
LITHOSTROTIONIDAE																			
Siphonodendron pseudomartini (YABE & HAYASAKA)																			
S. sp. a.																			
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S. inugasirayamaensis MINATO																			
S. martini (EDWARDS & HAIME)																			
S. densitabulata (YABE & HAYASAKA)																			
S. pauciradiale (M'COY)																			
S. aff. hsianense YÜ																			
Lithostrotion somaense YABE & HAYASAKA																			
L. hinozuchiense MINATO																			
L. sp.																			
Diphyphyllum equiseptatum YABE & HAYASAKA																			
D. flexuosum YABE & HAYASAKA																			
D. platiforme YÜ var. *kakisakoense* KANMERA																			
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Cystophora manchurica forma *kikkawai* (Y. & H)																			
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Dibunophyllum bristolense GARWOOD & GOODYEAR																			
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Neokoninckophyllum sp.																			
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Waagenophyllum indicum (WAAGEN & WENTZEL)																		?	—
W. indicum var. *usuginuense* MINATO																			
Waagenophyllum akasakensis (YABE)																			
W. akagoensis OZAWA																			
W. polyseptata MINATO																			
Wentzelella sekii MINATO																			
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W. iwaizakiensis YABE & MINATO																			
W. kitakamiensis YABE & MINATO																			
W. subtimorica HUANG																			
Wentzelloides maiyaensis YABE & MINATO																			
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Verbeekiella japonicum YABE & MINATO																			
Leonardophyllum ? sp.																		?	?
Londaleia katoi OZAWA																			—
Corwenia ? omiensis (YABE & HAYASAKA)																			
Stylidophyllum japonicum (YABE & HAYASAKA)																			
S. sikokuense MINATO																			?
S. yokoyamai (OZAWA)																			
Lonsdaleiasraea nipponica MINATO																			
L. yamanbaensis MINATO																		?	
Clisiaxophyllum ofukense (OZAWA)																	?		
C. awa MINATO																	?		
Nagatophyllum satoi OZAWA																	?		
Carcinophyllum onukii MINATO																			
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Arachnolasma cf. *sinense* (YABE & HAYASAKA)																			
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AMYGDALOPHYLLIDAE																			
Taisyakuphyllum rostifer MINATO																	?		
Amygdalophyllum naosoidea MINATO																	?		
A. ? gracile (HAYASAKA)																	?		
A. giganteum (YABE & HAYASAKA)																			
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Lonsdaleoides enormis (OZAWA)																	?		
Lonsdaleoides toriyamai MINATO																	?		
Akiyosiphyllum stylophorum YABE & SUGIYAMA																			
CYATHOPHYLLIDAE																			
Cyathophyllum ? sp.																			
Palaeosmilia kitakamiensis MINATO																			
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HEXACORALLA																			
ANABASIIDAE																			
Omphalophyllia yamanbaensis YABE & SUGIYAMA																		?	—
PSEUDOPAVONIDAE																			
Pseudopavona taisyakuana YABE, SUGIYAMA & EGUCHI																	?	—	
ASEPTATA																			
FAVOSITIDAE																			
Michelinia (*Michelinopora*) *multitabuata* Y. & H.																		—	
Thamnopora ? chaetetoidea (HAYASAKA)																			?
T. ? nipponica (HAYASAKA)																			?
AULOPORIDAE																			
Pseudoromingeria kotoi (YABE & HAYASAKA)																			—
SYRINGOPORIDAE																			
Sgringopora cfr. *reticulata* GOLDFUSS																			
S. sp.																			
Kueichoupora setamaiensis MINATO																			
CHAETETIDAE																			
Chaetetes nagaiwaensis MINATO																	?		
Chaetetes sp.																			
C. ? sp.																	?	?	?

Note: Very recently when this manuscript is in printing, Y. ONUKI and Y. YAMADA reported that the so-called *Fusulinella* in H_0 horizon of the Nagaiwa series (see page 10) is nothing but *Prafusulinella*. And the age of this horizon is now regarded to be settled as *Profusulinella* zone. Accordingly such corals, in association with *Profusulinella*, should be regarded to indicate the *Profusulinella* zone, which are: *Diphyphyllum equiseptatum* YABE et HAYASAKA, *Thysanophyllum aseptatum* DOBROLYUBOVA, *Lithostrotionella kitakamiensis* MINATO and *Chaetetes nagaiwaensis* MINATO.

Meanwhile TORIYAMA is recently also in opinion, that some of such corals, which formerly thought to be found only from the *Fusulinella* bed are truely also observed to occur still lower horizon as *Profusulinella* zone, which are *Nagatophyllum satoi* OZAWA, *Clisaxophyllum ofukense* (OZAWA) and *Clisaxophyllum awa* MINATO.

Accordingly the geological range of those corals, above enumerated is here revised so as to denote still lower horizon than that was stated in the foregoing chapter.

Septal grating: Discontinuous septa which are made up of unfused trabeculae. Fig. 1 shows the septa with gratings in the transverse section.

Lonsdaleoid dissepimints: Large vesicles occupying the outer area of coralites, which is untraversed by any septa. (fig. 5 Ld.)

Concentric dissepiments: Uniformly distributed dissepiments, which are arranged in concentric pattern in transverse section. (fig. 5 cd)

Angulo-concentric dissepiments: Dissepiments being similar to the preceding ones but the most of their (dissepimental) intersections are more or less angular in arrangement. (fig. 7) This figure was reproduced from the paper of LEWIS, 1929.[1)]

Herringbone dissepiments: Dissepiments arranged as shown in fig. 4.

Pseudoherringbone dissepiments: Dissepiments similar to the preceding, but occurring between major and minor septa and not between major septa. (fig. 6)

Stereoplasma or *Stereoplasmatic deposits:* Calcareous secondary deposits upon any skeletal elements such as wall, columella and septa. Figs. 2 and 5 show the outer wall strengthened by stereoplasma, while fig. 3 shows the outer wall free from such deposits.

DESCRIPTIONS

PHYLUM COELENTERATA, CLASS ANTHOZOA
ORDER TETRACORALLA HAECKL

Family Petraididae L. DE KONINCK, 1872

Genus ***Petraia*** MÜNSTER, 1839

Petraia ? sp.

1931. *Petraia* sp. G. IIZAKA: On the geological age of some crinoidal remains in Northern Kyusyu. Jour. Geol. Soc. Tokyo, vol. 38, p. 607. (in Japanese)

As IIZAKA gave neither a detailed description nor figures for this coral, no accurate information on the structure of the corallite of this coral is at present available. According to him, however, the corallum of his specimen is simple, corallite is conical and septa usually very short, except the counter septum; besides this, the columella is wholy absent. Thus he considered this

1) H. P. LEWIS: On the Avonian coral *Caninophyllum* etc. Annales and Mag. Nat. Hist., ser. 10, vol. III, p. 462, 1929.

coral provisionally to belong to the genus *Petraia*.

From fusulinid remains collected by H. YABE[1] at the same locality the geological age of the bed containing this coral may be regarded to be the Lower Permian in rough estimation.

Hor.: *Parafusulina* ? zone.

Loc.: Aohama, Moji City, Kiku-gun, Fukuoka Prefecture.

Family Polycoelidae F. ROEMER, 1883

GRABAU[2] defined this family as follows:

"Simple corals, of relatively primitive character, in which the four primary septa are well marked, sometimes but not always thickened, and nearly reaching the center, but not uniting. Secondary septa equal in number in all the quadrants, or the counter quadrants accelerated. All septa more or less radial. In the most primitive species, the dissepiments or other endothecal tissue may be wholly or largely wanting, but in the more specialized forms, the dissepiments may unite into tabulae in the center. No columella. Tertiary septa may occur."

Although GRABAU mentioned that Polycoelidae are confined wholly to Permian in age, the Japanese *Polycoelia*, according to OZAWA occurs from the *Fusulinella* bed in association with *Nagatophyllum satoi*, *Lonsdaleoides enormis* etc.

Genus ***Polycoelia*** KING, 1849

Polycoelia japonica OZAWA

Text-figure 5

1925. *Polycoelia japonica*, OZAWA: Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato, Part II, Jour. Coll. Sci. Tokyo Imp. Univ., vol. 45, Art. 6, p. 80, pl. 14, figs. 10, 11, 12.

Description (OZAWA, 1925): Corallum simple, short conical. Diameter of calyx 1.2 cm. Epitheca thick, 2 mm or more. No columella and dissepiments. Septa 26. Four principal ones devide the calyx into four comparatments, of which two contain four and other two contain 7 minor septa of inequal length.

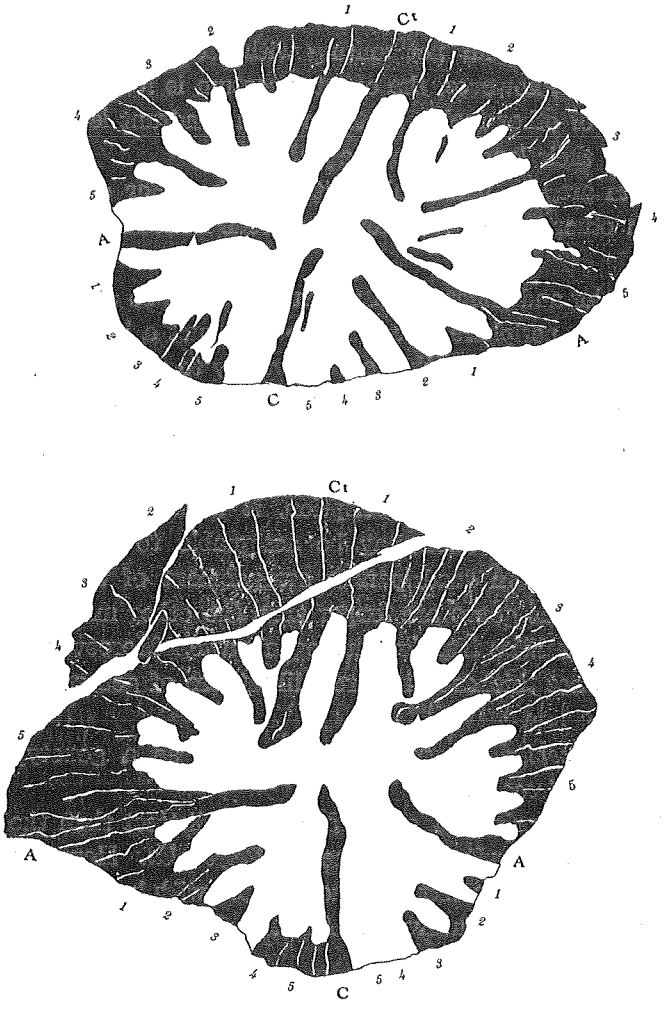
Description above given should be somewhat revised in every respect. Unfortunately figures shown by OZAWA in his plate XIV are also wanting in accuracy to give exact ideas concerning this coral. Therefore the writer wishes

1) H. YABE: So-called Mesozoic formation in the Kiku Peninsula, Prov. Buzen, North Kyusyu, Jour. Georgr., vol. 32, no. 384, 1920.

2) A. W. GRABAU: Palaeozoic corals of China. Palaeontologia Sinica, Ser. B, vol. 2, fasc. 2, p. 23, 1928.

here to offer new text-figures of thin sections of this coral, drawn by camera-lucida apparatus, based on OZAWA's original material. Revised description as follows:

Corallum simple ?, though two corallites are found in contact with each other in transverse section. Outer form unknown. Specimens are unfortunately



Text-fig. 5. *Polycoelia japonica* OZAWA (ca×5)

Holotype, OZAWA's collection from Tobinosu. These figures were made from the typical specimens, which were figured by OZAWA himself when he first described this species. However OZAWA's figures unfortuantely lacked something in accuracy. We are not determinable the orientation of septa from OZAWA's figures. In truely, however the principal four septa in this species are clearly distinguishable from other major septa, as the writer's figures show.

in bad state of preservation, lacking wall and peripheral part, especially in cardinal quadrants.

The counter and cardinal septum and two alar septa are clearly distinguishable from other major septa, which divide the corallites into four subequal parts (the cardinal parts are slightly more narrow than the counter ones) in transverse section. These four principal septa are long, reaching nearly but not quite to the center and not uniting with each other even at their distal ends. Among them, however, the counter septum is longest and strongest.

The number of other major septa in each quadrant is the same; namely four or five, but their lengths are unequal.

Minor septa are, as usual, alternating with major ones, but sometimes adjoining each other. They are more numerous in counter quadrants than in cardinal sides.

All these major and minor septa are much dilated so as to fuse completely with each other in peripheral area and to construct a kind of strerozone.

All major septa are never thickened inwardly to represent rhopaloid (club-like) form in thin section, like corals of genera *Tachylasma* and *Gerthia*.

There is no columella, no dissepiments and probably no tabulae (?), at least in (none of) the corallites observed.

Remarks: From the above description, it is far from doubtful that the coral now under consideration may be assignable to the genus *Polycoelia*, which is characteristic in quadripartite arrangement of the septa. The four principal septa of this genus are longer than the other major septa and typically divide the corallites into four sub-equal parts. Moreover all major septa of this coral are not thickened inwardly like those of genera *Tachylasma* and *Gerthia*.

Gerthia,[1] *Polycoelia angusta* ROTHPLETZ 1892 as a genotype, somewhat resembles genus *Polycoelia*.

In *Gerthia* four principal septa are more distinct than the other major septa; the feature is quite the same in *Polycoelia*. However the counter quadrants of this coral are distinctly accelerated with larger numbers of major septa than in the cardinal quadrants. Additionally the major septa of *Gerthia* present rhopaloid nature.

Genus *Plerophyllum*[2] HINDE, 1890, established by HINDE, *Plerophyllum australe* HINDE as a type, is also nearly related *Polycoelia* in having non-rhapaloid septa.

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1) A. ROTHPLETZ: Die Perm-, Trias- und Jura-Formation auf Timor und Rotti im indischen Archipel. Palaeontographica, vol. 39, p. 69, pl. 12, figs. 23, 31, 32, 1892.

2) H. A. NICHOLSON and G. J. HINDE: Notes on the palaeontology of Western Australia. Geol. Mag., New ser. vol. 27, p. 195, 1890.

However the arrangement of major septa in *Plerophyllum* is seen to be quite different from *Polycoelia*, if carefully observed. In *Plerophyllum* counter septum is short and such five septa as the first two laterals of counter quadrants, two alar septa and the cardinal septum are more prominent in length and strength than the other major septa.

Tachylasma[1] has also four long major septa, however in this case two of them are not principal septa, because the longer two septa are alar ones but the other two are first counter laterals. Accordingly the counter and cardinal septa of this genus are rather short, especially the cardinal septum is quite rudimentary. Moreover the septa of *Tachylasma* are typically rhopaloid.

Such being the case, *Polycoelia* is far more distinct from such genera as *Tachylasma*, *Pleropyllum* and *Gerthia*, than OZAWA formerly considered. He stated: "*Tachylasma* is probably, so far as the genotype *Tachylasma cha* is concerned, synonymous with *Plerophyllum* HINDE and has the nearest relation with *Polycoelia*."

Moreover OZAWA once considered his *Polycoelia japonica* to nearly resemble *Plerophyllum sulcatum* but the later is probably *Gerthia*.[2]

So far as the corallite now under consideration is concerned, the present Japanese form is no doubt distinct from *Polycoelia profunda* (GERMER), (genotype), *Polycoelia cylindrinca* GRABAU and *Polycoelia longiseptata* GRABAU.[3] They are all Permian forms.

According to OZAWA this singular coral was collected at Tobinosu in Oda-mura in association with *Nagatophyllum satoi* and *Lonsdaleoides enormis*; accordingly its geologic age may be Middle Carboniferous.

Loc.: Tobinosu, Oda-mura, (now Ohta-machi, Mine-gun), Yamaguchi Prefecture. Specimens are now stored at Inst. Geol. Tokyo Univ.
Hor.: "*Profusulinella*"? to "*Fusulinella*" zone, the Middle Carboniferous.

Family Streptelasmaidae GRABAU, 1922

Sub-family Sochikineophyllidae GRABAU, 1928

Genus ***Sochikineophyllum*** GRABAU, 1928

Sochikineophyllum s-hasimotoi MINATO, sp. nov.

Pl. 37, figs. 2a, 2b, 2c, 2d, 2e.

Corallum simple, turbinate, slightly curved in early stage. Corallite small

1) A. W. GRABAU: Palaeozoic corals of China. Palaeont. Sinica, Ser. B, vol. 2, fasc. 1. p. 34, 1922.
2) D. HILL: The Permian corals of Western Australia. Jour. Royal Soc. Western Australia, vol. 23, p. 46, 1937.
3) A. W. GRABAU: Palaeozoic corals of China. Palaeont. Sinica, Ser. B, vol. 2, fasc. 2, p. 26, 1928.

in size, its calicular diameter being 10–15 mm in the mature stage. In neanic stage, septa including major and minor ones are counted as many as 19; among them counter and two alar septa are easily distinguishable from other septa in consequence of their strength. In this stage, pinnate tendency of septal arrangement is more or less distinct. Collumella is not united with any septa including counter septum. The cardinal and two alar fossulae are very conspicuous. In some specimens of this stage, there are three or four major septa on both sides of the counter septum, besides three major septa on each side of the cardinal septum. Moreover there appear also two minor septa between some major septa. In that case, two first laterals of the counter quadrants, and two alar septa are more or less strong, therefore the septal arrangement gives the impression, as a whole, as being quite similar to genus *Tachylasma*, leaving the existence of the columella out of account.

In mature stage, the first laterals become longer than in the early stage, but gradually become thinner. All major septa in the counter quadrants almost reach the center, nevertheless they are shorter than the counter septum. In this stage two alar fossulae are also conspicuous. All the major septa also nearly reach the center in cardinal quadrants, besides which feature, they arrange more densely with each other than in the counter sides. Minor septa bocome also more numerous in this stage, either cardinal or counter sides, although they are mostly very short.

No longitudinal sections are obtainable.

Remarks: This species has corallite which is quite similar to the genotype of this genus, but differs from the latter in having septa which are more closely set in the cardinal quadrants than in counter ones. Moreover the alar fossulae are far more distinct in this species than in any other known species of this genus.

Hor.: *Yabeina* Zone.

Loc.: Nokkosi-saka, West of the town of Takada-machi, Kese-gun, Iwate Prefecture. (Reg. nos. 15879, genotype; 15880, 15881, 15882).

Coll.: S. Hashimoto.

Family Hapsiphyllidae Grabau, 1928

Genus ***Meniscophyllum*** Simpson, 1900

Meniscophyllum longiseptata Minato, sp. nov.

Pl. 37, fig. 1

Corallum simple, corallite very small, calicular diameter 4 to 4.5 mm in the transverse section, dorso-ventral direction a little longer. Wall thick. Septa in two orders, major septa including counter and two alar and minor ones;

all are rhopaloid in thin section.

In the counter quadrants there are five major septa on both sides of the counter septum and an equal number of minor ones. Minor septa slightly less long and thinner than the major septa and mostly alternating with the latter. The two alar septa only slightly longer than the other septa, situated near by. In the cardinal quadrants there are two septa on each side of the position where the cardinal septum should be found, but the latter is wanting in the thin section of this corallite; accordingly the cardinal fossula becomes quite prominent. All the septa in the counter quadrants coalesce to form a thickened phyllotheca, which shows crescentiform and is open on the cardinal side. Dissepiments unobservable. Longitudinal section unobtainable.

Remarks: Of this specimen only a single thin section was obtainable, nevertheless the material is perfect to admit of generic and specific determination. The present writer wishes to call it *Meniscophyllum longiseptata*, because the minor septa of this species are considerably long.

So fas as the present writer knows, *Meniscophyllum* occurs from the Mississippian including the genotype, while GRABAU[1] described one species from the Middle Carboniferous of China. DOBROLYUBOVA[2] also reported, the occurrence of this genus from the Russian Permian, which was considered by her to be quite near to *M. minutum*, the genotype. However, the present writer thinks the Russian species may be quite different from the genotype of this genus.

The geological age of the Japanase species is now uncertain, but it may perhaps denote the Middle Carboniferous.

Hor.: *Fusulinella* zone (?)

Loc.: Ohkubo, Ohtamachi, Mine-gun, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. and Palaeont. Tohoku Univ.

Family Zaphrentidae EDWARDS and HAIME, 1859

Genus *Amplexus* SOWERBY, 1814

Amplexus nipponensis OISHI et MINATO

Pl. 6, figs. 6 and 7

1952. *Amplexus nipponensis*, MINATO: A further note on the Lower Carboniferous fossils of the Kitakami Mountainland, Northeast Honsyu, Japan. This Journal Ser. IV, vol. 7, p. 82, pl. 2, figs. 2, 4, 5, 8, 10, 11, 13, 14; pl. 4, figs. 1, 2, 3, 5-24.

1) A. W. GRABAU: Palaeozoic corals of China. Palaeont. Sinica, Ser. B, vol. 2, fasc. 2, p. 140, pl. 4, figs. 4a to 4e, 1928.

2) T. A. DOBROLYUBOVA: Rugose corals of Middle and Upper Carboniferous and Permian of North Ural, p. 99, text figs. 25-26, 1936.

Remarks: This species was completely described by the writer based upon a number of thin sections as well as upon an almost complete corallite in a previous paper of this journal. The species has no clearly distinct cardinal fossula, at least in the full-grown stage, although it is not absent. It may be most nearly allied to *Amplexus coralloides* SOWERBY, the genotype of this genus. In the British Isles *Amplexus coralloides* SOWERBY is a characteristic horizon marker for the Upper Tournasian age.

Hor.: Maide stage.
Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15491, 15495, 15497, 15499, 15500, 15501, 15503, 15504, 15505, 15506, 15508, 15509.
Coll.: M. MINATO.

Amplexus sp. b

Pl. 6, fig. 5

Fig. 5 in Pl. 6 shows a corallite of coral which is trochoid or ceratoid in outer form. As far as the internal character this specimen is concerned, it may possibly be assignable to the genus *Amplexus*, although the material has been unsatisfactorily preserved.

The geological horizon of this species may be said to be far lower than that of the preceding species, because it comes from the Jumonji stage together with *Syringothyris jumonjiensis* and *Fussella nipponotrigonalis*.[1]

Hor.: Jumonji stage.
Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture.
Reg. no.: 15498.
Coll.: M. MINATO.

Genus ***Caninia*** MICHELIN, 1840

Caninia juddi (THOMSON) var. *ozawai* MINATO

Pl. 13, fig. 4; Pl. 14, fig. 12.

1943. *Caninia juddi* (THOMSON) var. *ozawai*, MINATO: On some Upper Viséan Coral fauna from the Coral Limestons of the Kitakami Mountainland, Northeastern Honsyu, Japan. Jour. Sigenkagaku-Kenkyusho, vol. 1. no. 2, p. 230, pl. 23, figs. 1a–d.

Remarks: As already stated by the writer, this variaty shows strong resemblance to such species as *Caninia buxtonensis* LEWIS var. concave YÜ,[2]

1) M. MINATO: On the lower Carboniferous fossils of the Kitakami Massif, Northeast Honsyu, Japan. This Journal Series IV, vol. 7, no. 4, 1951.
M. MINATO: A Further note on the Lower Carboniferous fossils of the Kitakami Mountainland, Northeast Japan, ibid, vol. 8, no. 2, 1952.

2) C. C. YÜ: Lower Carboniferous corals of China. Palaeont. Sinica, Ser. B, vol. 12, fasc., 3, p. 53, pl. 4, figs. 10a, 10b, 1933.

Caninia minor LEWIS,[1] *Caninia juddi* (THOMSON)[2] and its variety *cambrensis*;[3] all are Viséan corals.

From *C. buxtonensis* var. *concava* and *C. minor*, however, the material now under consideration is distinguishable in respect to large size and well-developed minor septa and from *C. juddi* and its variety it is also separable in the different size of the corallites.

Hor.: Onimaru series, *Dibnophyllum* zone.
Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15445, 15452.
Coll.: M. MINATO.

Genus ***Pseudocaninia*** STUCKENBERG, 1896

Pseudocaninia sp.

Pl. 8, fig. 8; Pl. 13, fig. 16.

1943. *Pseudocaninia* sp. M. MINATO: On some Upper Viséan coral fauna, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 3, p. 231, pl. 23, figs. 10a, 10b.

As the writer has formerly discussed, the present form somewhat resembles *Pseudocaninia longiseptata* LEWIS.[4]

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 15245.
Coll.: M. MINATO.

Family Lithostrotionidae GRABAU, 1927

Genus ***Siphonodendron*** M'Coy, 1849

Siphonodendron pseudomartini (YABE et HAYASAKA)

Pl. 3, fig. 1; Pl. 4, fig. 9; Pl. 31, fig. 7; Text-fig. (6), figs. A, B, C, D.

1915. *Lithostrotion pseudomartini*, YABE and HAYASAKA: Palaeozoic corals from Japan, Korea and China. Jour. Geol. Soc. Tokyo, vol. 22, p. 128.
1943. *Siphonodendron pseudomartini*, MINATO: On some Upper Viséan coral fauna from the Coral Limestone of the Kitakami Mountainland, etc., Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 234, pl. 22, fig. 5.

1) H. P. LEWIS: The Avonian succession in the South of the Isle of Man. Q. J. G. S., vol. 86, p. 267, pl. 20, figs. 1a-h, 1930.
2) H. P. LEWIS: Upper Viséan corals of the genus Caninia, ibid, vol. 80, p. 289, pl. 22, fiigs. 1-4; pl. 23, figs. 1-2; pl. 29, figs. 1-2, 1924.
3) H. P. LEWIS: ibis, p. 397, pl. 30, figs. 1, 2, 1924.
4) H. LEWIS: On the Carboniferous Coral *Pseudocaninia* (STUCKENBERG) and *Pseudocaninia longiseptata* sp. nov. Ann. Mag. Nat. Hist., 7, ser. 10, 1931.

This species is quite chatacteristic in having smaller corallites and possessing relatively less numerous septa. *Siphonodendron pauciradiale* (M'Coy) also has small corallites, and in this point they are very similar to each other, but the species now under consideration is easily separable from M'Coy's species in having dissepiments arranged in two rows, in contrast to the single row of *pauciradialae.*

Hor.: Onimaru series, *Dibunophyllum* zone.

Loc.: Kitakami mountains. Iwate prefecture.

Tashiro, and Nagaiwa, Hikoroichi-mura, Onimaru, Hikoroichi-mura; Yukisawa, and Fukurosawa, Yokota-mura; Takanosu, Iwanosawa, Ohgaisawa, Hinozuchi, Torigasaki, Shimoarisu-mura; Inugashirayama, Akabatake, Kawamukai, Shizu, Usagisawa, Setamai-machi.

Coll.: M. Minato.

Also this species has been known from the Abukuma mountains: Miyatagawa, near Hitachi, Taga-gun, Ibaragi Prefecture. Coll.: M. Watanabe.

Siphonodendron densitabulata (Yabe et Hayasaka)

Pl. 3, fig. 2; Pl. 4, fig. 1; Text-figs. (6), H, I, J.

1915. *Lithostrotion densitabulata*, Yabe and Hayasaka: Palaeozoic corals from Japan, Korea and China, Jour. Geol. Soc. Tokyo, vol. 22, p. 130.

Original description runs as follows: Corallum composite, fasciculate. Corallites long, cylindrical, slightly flexuous and attaining 9 mm in diameter; usually free laterally except at the point of gemmation, though sometimes in contact with the adjacent ones; never distant from each other by a space of more than their own diameter. There are numerous longitudinal costal striae on the external surface on the corallites. Wall thin, surrounded by extremely thin epitheca. Septa very thin, almost straight, numerous, numbering 28+28 in a full grown corallite; longer and shorter ones in alternation. Longer ones about 1/3 of the diameter of the corallites in length, the shorter ones being shorter than 1/3 of the longer ones. Interseptal space filled up with abundant fine, vesicular dissepiments in two layers, within which the shorter septa are always confined. Columella characteristically thin, more or less lamellar, apparently in connection with two of the septa in opposition; discontinuous? Tabulae thin, slightly elevated at the central portion, otherwise almost horizontal; more or less strongly flexuous and often coalescing with each other; very crowded, 8-10 in a space of 5 mm.

Remarks: This species has almost the same sized corallites as *Siphonodendron martini*, but differs from the latter in the following three points: firstly the former has more numerous septa in the full grown stage, secondly it pos-

sesses more densely arranged tabulae and thirdly it has flexuous corallites different to the relatively straight corallites of the latter.

Hor.: Onimaru-series, *Dibunophyllum* zone.

Loc.: Takase, Shimoarisu-mura; Shizu and Inugashirayama, Setamai-machi, Iwate prefecture. Reg. nos.: 15364, 15365.

Coll.: M. MINATO.

Siphonodendron martini (EDWARDS et HAIME)

Pl. 8, fig. 2; Pl. 13, figs. 5, 12; Text-figs. (6), k, 1.

1850. *Lithostrotion martini*, EDWARDS et HAIME: A monograph of the British fossil corals. Palaeont. Soc., p. 197, pl. XL, figs. 2a-g.

1876. *Lithostrotion martini*, THOMSON et NICHOLSON: Contributions to the study of the chief general type of the Palaeozoic corals. Ann. and Mag. Nat., Ser. 4, p. 17, pl. 15, fig. 2.

1923. *Lithostrotion martini*, BENSON and SMITH: On some rugose corals from Brindi series of New South Wales. Q. J. G. S., vol. 79, p. 167, pl. 4, fig. 5.

1930. *Lithostrotion* cf. *martini*, LEWIS: The Avonian succession in the South of the Isle of Man. Q. J. G. S., vol. 86, pl. 22, figs. 11a-b.

1935. *Lithostrotion martini*, MECHIKOFF et TE YU HSU: Les Polupirs Carb. Sahara occidental. Bull. Soc. Géol. France, vol. 5, ser. 5, p. 250.

1943. *Siphonodendron* cf. *martini*, MINATO: On some Upper Viséan corals, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 3, p. 233, pl. 22, figs. 2-4, 6, 8; pl. 23, fig. 11.

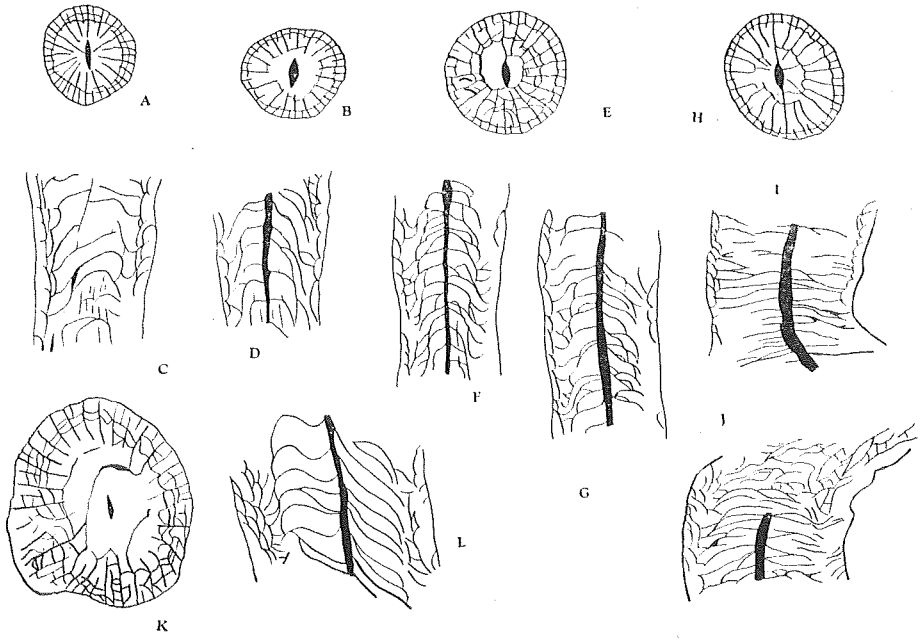
The writer was of the opinion for a long time, that some specimens of *Siphonodendron* collected from the Onimaru series of the Kitakami Mountain-land may be quite near to *Siphonodendron martini*, nevertheless he hesitated to regard them to be fully conspecific with the latter.

Since that time, however, a number of specimens have been collected from various localities and the writer is now inclined to believe them to be specifically unseparable from the European specimens. In the Japanese specimens dissepimental vesicles are arranged steeply in the longitudinal section, while in the holotype of this species, according to EDWARDS and HAIME, they are less inclined in thin section. The writer doubts now, whether such a feature may be a perfect criterion to separate those two types as different species.

Siphonodendron martini also resembles *S. densitabulata*, but in the latter species diphymorphic individuals are rather numerous. Besides this, the tabulae of the latter are more densely arranged than those of the former.

Hor.: Onimaru-series, *Dibunophyllum* zone.

Loc.: Nagaiwa and Tashiroyashiki, Hikoroichi-mura; Ishibash, Hikoroichi-mura; Yubanosawa, Hikoroichi-mura; Komatagawa, Kawamukai and Inugashira-yama, Setamai-machi; Hinozuchi, Ohgaisawa, Iwanosawa, Takanosu,



Text-figure 6. (All figures magnified 8/3)

A. B. C. D.: *Siphonodendron pseudomartini* (YABE et HAYASAKA)
E. F. G.: *Siphonodendron pauciradiale* (M'COY)
H. I. J.: *Siphonodendron densitabulata* (YABE et HAYASAKA)
K. L.: *Siphonodendron martini* (EDWARDS et HAIME)

A: 15447, B: 15447, C: 15359, D: 15693, E: 16842, G: 16835, H: 15364, I: 15364, J: 15365, K: 15335, L: 15337

Shiritakasawa, Tochibora, Matsubi, Shimoarisumura; Yahagigawa, Yahagimura; Kozubo, Yokota-mura. Coll.: M. MINATO.

Siphonodendron pauciradiale (M'COY)

Pl. 3, figs. 3, 4; Text-figs. (6), E, F, G.

1843. *Lithostrotion irregulare*, PHILLIPS: Geology of Yorkshire. vol. 1, p. 202, pl. 2, figs. 14, 15.
1852. *Lithostrotion irregulare*, EDWARDS et HAIME: British fossil corals, p. 198, pl. 41, fig. 1.
1869. *Lithostrotion irregulare*, KUNTH: Zt. d. d. Geol. Gesell., p. 206, pl. 2, fig. 9.
1933. *Lithostrotion* (*Siphonodendron*) *irregulare*, YÜ: Lower Carboniferous Corals of China. Pal. Sinica, ser. B, vol. 12, fasc. 3, p. 93, pl. 19, figs. 2a–b; pl. 20, figs. 3a–b.
1933. *Lithostrotion* (*Siphonodendron*) *irregulare* var *jungtungense*, YÜ: ibid, p. 96, pl. 19, figs. 5a–b, none 6a–b.

1940. *Lithostrotion pauciradiale* (M'Coy), Hill: A monograph of the Carboniferous rugose corals of Scotland, Palaeontogr. Soc., vol. XCIV, p. 169, pl. 9, figs. 1-2, text fig. c.

Coralum composite, phaceloid. Each corallite round in the transverse section, small in size, the diameter of it usually 5 mm, never exceeding 5.5 mm. Major sepata usually 18-21, rarely 22; most of them not directly uniting with columella, except cardinal and counter septum. Minor septa alternating with the major ones, which are short, reaching 1/4 to 1/5 the length of the latter. All of them thickened at the wall, gradually diminishing in thickness distally. Columella spindle form in cross section, sometimes compressed. At the interseptal space of the medial area, cut-edges of tabulae seen usually in transverse section. Dissepiments in one row, occupying the extrathecal area, concentrically arranged, being parallel to the outer wall. The outer wall not quite thick, completely free from any stereoplasmic deposits.

In the longitudinal section, 7 to 8 tabulae are contained in a space of 5 mm, sub-horizontal or occasionally convex in the central portion and slightly ascending toward the columella, bending downwards at the margin. The dissepimental vescicles arranged in one row, their convex sides facing inwards.

Remark: These specimens, now under consideration are quite indistinguishable from *Lithostrotion pauciradiale*, described and illustrated by Hill as well as Chinese representatives described by Yü under the name of *Lithostrotion* (*Siphonodendron*) *irregulare* and its var. *jungtungense*, in septal number, size of columella, size of corallite and mode of aggregation. All of them, including the Japanese specimens posses one row of dissepiments.

According to Hill, original description of so-called *Lithostrotion irregulare* was incorrectly made by Phillips on figured specimen, which does not coincide in morphological characters with his own description. The original specimen is now misplaced, thus the re-examination of Phillip's specimen is impossible. Hill further pointed out that specimens identified by Edwards and Haime and following authors, with Phillip's so-called *irregulare*, were nothing but *Lithostrotion pauciradiale* (M'Coy) and therefore Phillip's specific name should be held in abeyance until syntype may be found.

Siphonodendron asiatica (Yabe et Hayasaka) var. *minor* Minato[1] is nearly allied to *S. pauciradiale* as formerly stated by the writer, but the former is far smaller in corallites than the latter.

A specimen from Hitati (Hitachi) in the Abukuma Mountainland, which is now stored at Inst. Geol. and Palaeont., Tohoku Univ., may be also refer-

1) M. Minato: Note on some Lower Carboniferous fossils from the Kirin Formation in Mincheng, Panshin-hsien, Prov. Kirin, Manchoukuo. Jour. Fac. Sci. Hokkaido Imp. Univ., Ser. 4, vol. 7, p. 63, pl. 7, figs. 3-6, 1943.

able to this species, although it is much deformed and in poor state of preservation.

Hor.: Onimaru series, *Dibunophyllum* zone.

Loc.: Ishibashi, Tashiroyashiki, and Onimaru, Hikoroichi-mura; Yubanosawa, Hikoroichi-mura; Sakamotosawa, Hikoroichi-mura; Hotoke-saka, Yahagi-mura; Yukisawa and Kozubo, Yokota-mura; Ohgaisawa, Hinozuchi (Hinozuti), Torigasaki, and Kingindo, Shimoarisu-mura; Inugasira-yama, Setamai-machi. Iwate prefecture, Kitakami district. Coll.: M. MINATO.
Miyatagawa, near Hitachimine, Ibaragi Prefecture. Coll.: T. KAKIMI.

Siphonodendron inugasirayamaensis MINATO

Pl. 8, fig. 5; Pl. 14, figs. 6, 8, 19.

1943. *Siphonodendron inugasirayamaensis*,, MINATO: On some Upper Viséan coral fauna, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 235, pl. 22, figs. 1, 7; pl. 23, figs. 4a-b, 7a-b.

Remarks: As formerly mentioned, this species shows some similarties to *Siphonodendron hsinanense* YÜ[1] as well as to *Lithostrotion affine*[2] MATIN in size of the corallites and in the same septal number. Moreover it is more nearly allied to *S. hsinanense* YÜ than to *Lithostrotion affine* in having quite rudimentary minor septa. Nevertheless the present species is distinct from *S. hsinanense* YÜ, because the latter has (1) spindle-like columella in cross section, swollen at the middle and pointed at the ends, (2) the tubulae are more vesiculated in form, and (3) there is a broad dissepimental zone.

Lithostrotion affine is nothing but *Siphonodendron* and has similar aspect with this species now under consideration, but the former has longer minor septa as above stated.

Hor.: Onimaru series, *Dibunophyllum* zone.

Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. nos.: 15330, 15331, holotype. Coll.: M. MINATO. Takinosawa, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16902. Coll.: H. TAKEDA.

Siphonodendron sp. aff. *hsinanense* YÜ

1939. *Siphonodendron* sp., YABE et SUGIYAMA: Discovery of Lower Carboniferous Corals from the Yatsusiro district in Kyushu. Proc. Imp. Acad. Tokyo, vol. 15, p. 303, figs. 7, 8.

This specimen is very similar to *Siphonodendron hsinanense* YÜ but differs

1) C. C. YÜ: Lower Carboniferous corals etc. Palaeont. Sinica, ser. B, vol. 12, fasc. 3, p. 97, pl. 20, figs. 5a, b, 1933.

2) M. EDWARDS and J. HAIME: British fossil corals, p. 200, pl. 39, figs. 2a, 2b and 2e, 1852.

from it by possessing septa somewhat greater in number.

Hor.: Kakisako Formation, *Dibunophyllum* zone.
Loc.: Tutui, Kaikisako-mura, Yatusiro-gun, Kumamoto Prefecture.
Coll.. YABE and SUGIYAMA, specimens now stored at Inst. Geol. and Palaeont., Tohoku Univ.

Siphonodendron sp. *a.*

Pl. 8, fig. 4; Pl. 14, fig. 9.

1943. *Siphonodendron* sp. *a*, MINATO (par.): On some upper Viséan coaral fauna from the coral limestone of the Kitakami mountainland, Northeastern-Honsyu, Japan. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 236, pl. XXIII, fig. 2 and 12.

The present specimens are quite similar to *Siphonodendron inugasirayamaensis*, but the septa of the former are less numerous than those of the latter. Moreover the minor septa of the former are fairly long.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Takase, Shimoaraisu-mura, Iwate Prefecture. Reg. no.: 15292; Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15411.
Coll.: M. MINATO.

Siphonodendron sp. *b.*

Pl. 8, fig. 6; Pl. 14, fig. 7.

1943. *Siphonodendron* sp. *b.* MINATO: ibid, p. 237, pl. XXIII, figs. 3a, á.

This species is also quite similar to *Siphonodendron inugasirayamaensis* in the size of the corallite and septal number, but the former is easily separable from the latter in having very thick dissepimentarium.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Matsubi, Shimoarisu-mura, Iwate Prefecture.
Reg. nos.: 15291, 15292.
Coll.: M. MINATO.

Genus ***Lithostrotion*** LHWYD, 1699 (FLEMING, 1828)

Lithostrotion somaense YABE et HAYASAKA

Pl. 35, figs. 1, 4, 6.

1915. *Lithostrotion somaense*, YABE and HAYASAKA: Palaeozoic corals from Japan, etc. p. 49.
1924. *Lithostrotion somaense*, HAYASAKA: On the fauna of the Anthracolithic limeston, etc. p. 21, pl. IV, figs. 3, 4.

As HAYASAKA formerly mentioned, S. SMITH, with whom HAYASAKA had

been in communication, held the opinion that this species may be identical with the British species, *Lithostrotion m'coyanum* EDWARDS et HAIME[1].

Meanwhile, according to HILL[2], so-called *Lithostrotion m'coyanum* EDWARDS and HAIME has come to be considered synonymous with *Lithostrotion decipiens* (M'COY).

Comparing the Japanese specimens now under consideration to *Lithostrotion decipiens* (M'COY), described and figured by her, nobody doubts but that there exists a close affinity between them. It should be not overlooked, however, that the dissepiments are more sporadically arranged in the Japanese specimens than in the British species and that point may be considered to be a criterion sufficient to separate the Japanese specimens specifically from tne latter.

Hor.: Onimaru series, *Dibunophyllum* zone.

Loc.: Omi, along the Omi-river, Omi-mura, Nisikubiki-gun, Niigata Prifecture. Specimens now stored at Inst. Geol. and Palaeont., Tohoku Univ., Coll.: I. HAYASAKA.

.: Limestone exposed between Okura and Kamitochikubo in Kamimano-mura, some 16 km west of Kasima, near the town of Nakamura, Soma-gun, Fukusima Prefecture. Specimens now stored also at Inst. Geol. and Palaeont., Tohoku Univ.

Lithostrotion hinozuchiense MINATO, sp. nov.

Pl. 36, figs. 1, 2.

Corallum composite, massive compound numerous corallites, which are unequal in size and form. Of the corallites irregular quadrilateral or pentagonal forms occur not seldom in the tangential section, but hexagonal form is more common. When they are in the mature stage, the corallites attain more than 7 mm in the greatest diagonals. Walls show complete cerioid type, which are not very thick. In the thin sections, there is a thin translucent layer in the middle of the wall, which is covered by black thin layers from both sides. Septa are also thin. Major septa commonly number 17 to 19 in the full grown stage, which are alternated by the same number of minor septa. Minor septa are short, being usually 1/3 the length of the major ones, and they stop their growing always far before reaching the sclerotheca. Major septa are rarely prolonged to the columella.

The columella is fairly thick, fusiform in cross section. The dissepiments

1) M. EDWARDS and J. HAIME: British fossil corals. p. 195, pl. 42, figs. 2a, 2b. 1852.
2) D. HILL: Carboniferous rugose corals of Scotland. Palaeontographical Socienty, vol. XCIV, p. 173, pl. 10, figs. 2-4, 1940.

are sub-concentrically arranged in several rows, being more crowded towards the theca.

In longitudinal sections, dissepimental vesicles are obliquely arranged with their convex sides facing upwards as well as inwards. Tabulae are almost complete, flat in the middle portion but inclined at theca, their convex sides faced toward the dissepimentarium. Tabulae are counted about 7 in the distance of 5 mm.

Remarks: This species differs from *Lithostrotion somaense* YABE et HAYASAKA in respect to size of the corallites and septal number. *Lithostrotion decipiense* (M'COY) described and figured by HILL[1] from the Lower Carboniferous of Scotland may be comparable with this species from the general appearance of the corallum, especially in the irregular form and size of the corallites. But the minor septa of the British species are far longer than those of the Japanese species now under consideration, and the nature of the tabulae is somewhat different from that of the Japanese species. The tabulae of the British species are usually in two series as HILL mentioned, an inner series of globose tabulae reinforcing the axial structure, and an outer series of flat or concave plates. Such feature is almost lacking in the Japanese species.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: A small tributary stream at Hinozuchi, Shimoarisu-mura, Kese-gun, Iwate Prefecture. Reg. nos.: 16754, holotype, 16753, 16755, 16758, Paratypes.
Coll.: M. MINATO.

Lithostrotion sp.

1939. *Lithostrotion* sp., YABE and SUGIYAMA: Discovery of Lower Carboniferous corals from the Yatsusiro district in Kyusyu. Proc. Imp. Acad. Tokyo, vol. 15, p. 300, listed.

YABE wrote formerly on the occurrence of *Lithostrotion* sp. at Eribara, Isobe-mura, Shima-gun, Kii Penisula, Mie Prefecture, about which he commented in the paper reporting the discovery of the Lower Carboniferous corals from Kyusyu in collaboration with SUGIYAMA. This specimen (reg. no. 32540) is now stored in the Inst. Geol. and Palaeont., Tohoku Univ. Sendai.

Unhappily the writer has not examined this coral and cannot comment upon it. According to YABE, this coral was collected by him from the side of road at Eribara, Isobe-mura, Shima-gun, Mie Prefecture but the preciese locality is left unknown, until the present day.

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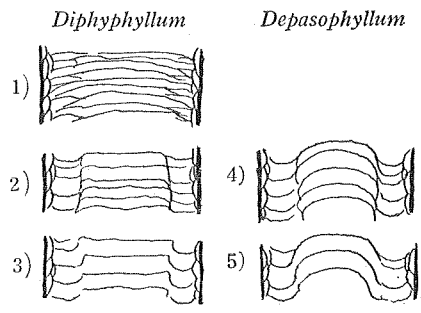
1) D. HILL: A monograph of the Carboniferous Rugose Corals of Scotland. p. 178, pl. 10, fiigs. 2, 3, 4, 5? 6?, 1940.

Here the writer wishes merely to mention the occurrence of such coral from Eribara.

Genus *Diphyphyllum* Lonsdale, 1845

On account of the structure of the tabulae, genus *Diphyphyllum* may be subdivisible into subgenera *Depasophyllum* Grabau and *Diphyphyllum* s. str.; the former having inner tabulae being strongly arched, whilst the latter shows the inner tabulae usually horizontal.

Meanwhile each of these groups is also subdivisible into two or three subgroups basing on the structure at the thecal area.



Text figs. 7
Diphyphyllum and *Depasophyllum*
(longitudinal section)

Diphyphyllum (s. str.)

1) Inner tabulae are almost horizontal and inosculating with the small outer tabulae. Representatives: *Diphyphyllum* sp. *a* of S. Smith, *D. fulcatum* Thomson. etc. Geological range: *Syringothyris* zone to the *Dibunophyllum* zone.

2) Inner tabulae are almost horizontal, the outer tabulae slightly concave; both outer and inner tabulae are horizontally uniting at the theca, and each arched tabula rests upon the one below, which is also adhering closely to the theca from top to bottom. Representatives: *D. platiforme, D. multicystatum, D. fasciculatum, D. flexuosum*, etc. Geological range: *Dibunophyllum* zone~(Permian?)

3) Inner tabulae are horizontal, the outer tabulae slightly concave; all these tabulae are uniting horizontally at the theca; other tabulae apart from each other. Representatives: *D. equiseptatum, D. simplex, D. ingens*, etc. Geological age: *Dibunophyllum* zone to the Middle Carboniferous, and Permian (?)

Depasophyllum

4) Inner tabulae are highly arched, while the outer tabulae are concave; both of them horizontally uniting with each other at the theca; each tabula rests upon the one below, uniting also vertically with each other. Representatives: *D. gracile, D.* sp. *b* of S. Smith,[1) 2)] *D. hochangpingense,*

1) S. Smith: The Carboniferous coral *Nemistium edmondsi*. Gen. et Sp. nov. Ann. Magazine Nat. Hist. vol. 1, 10 ser. p. 112, 1928.

2) Y. S. Chi: Additional fossil corals from Weiningian limestone. Pal. Sinica. ser. B, vol. 12, fasc. 6, p. 20, 1935.

D. lateseptatum, etc. Geological range: *Dibunophyllum* zone.

5) Inner tabulae are strongly arched, while the outer tabulae are concave; both these sorts of tabulae are separated from top to the bottom, except uniting horizontally at the theca. Representative: *D. convexum*, etc. Geological range: *Dibunophyllum* zone.

Diphyphyllum equiseptatum YABE et HAYASAKA

Pl. 4, figs, 3, 5, 6.

1915. *Diphyphyllum equiseptatum*, YABE and HAYASAKA: Palaeozoic coarals from Japan, Korea and China, Jour. Geol. Soc. Japan, vol. 22, p. 137 (59).

Corallum composite, fasciculate. Corallites large, about 10 mm in diameter. Outer wall thin, marked by annulations of growth line and faint longitudinal striae. Calyx shallow.

In cross section, corallites, sub-circular in outline. Major septa numbered as many as 23 in the full grown stage, thickened slightly near the wall by stereoplasmic deposits; minor ones same in number as major ones, very thin and short. Central area of the corallites well spaced; axial structure wholy lacking. Tabulae unequally spaced, 9 or 10 in a distance of 10 mm. In the inner tabularium, tabulae almost horizontal or only slightly convex upwards, occupying the central area of corallite, while the outer tabulae inclined towards the dissepimentarium. All these successive tabulae in the outer tabularium as well as inner tabularium, however are separated from each other from top to bottom and not directly uniting, although each outer- and inner-tabula is horizontally uniting at the theca.

Peripheral area occupied by dissepiments which are concentric in arrangement and mostly in two rows.

In the longitudinal section, dissepiments are irregular in size, with their convex sides faced upwards and inwards. Most large vesicles are arranged in two rows, while smaller vesicles imbricating occasionally in three rows.

Remarks: Original description of *Diphyphyllum equiseptatum* was made based on ill-preserved material. Description was as follows:

> Corallum probably composite; corallites long, cylindrical, 12 mm in diameter; with sharp, prominent, annular ridges. Wall thin; epitheca very thin. Septa likewise thin, 26 in number; all septa of equal length, being as long as 1/3 of the diameter of corallites, thus leaving a side central area quite free from them. Tabulae numerous, irregularly distant, some 6 tabulae being found in a space of 5 mm; almost horizontal, but slightly deflected downwards near the periphery (except a number of them which are incomplete and inosculating); they are crossed by

distal half of the septa. Peripheral zone, 1.5 mm broad, including the proximal half of the septa and having well-developed vesicular dissepiments in the interseptal loculi; vesicular dissepiments very variable in size, some being large enough alone to fill up the peripheral zone, and the others so small that two or even three, imbricating to one another, are needed to occupy the same space; they are all convex, facing inwards and simulatenously slightly upwards.

Newly found material could be identified with certainty with *Diphyphyllum equiseptatum*, except for the presence of definite minor septa. YABE and HAYASAKA mentioned formerly, "Most characteristic of the species (*D. equiseptatum*) are its septa which are rather few in number and of equal length; a single transverse section of the coral at hand shows absolutely no trace of the shorter septa." However they stated also as follows: "but it seems highly probable that they (minor septa) exist, in so much reduced a size as hardly to be recognizable in a specimen which is not specifically favourably preserved."

Thus, the writer is now inclined to consider the specimens at hand to be probably identical to YABE and HAYASAKA's species.

In the Kitakami mountaimarea, one additional other species of *Diphyphyllum* has been known for a long time, which is *D. flexuosum*. That species is smaller than *D. equiseptatum* and denotes doubtlessly the Onimaru-series, Lower Carboniferous in age, while *D. equiseptatum* may indicate the Nagaiwa series, Middle Carboniferous.*

Diphyphyllum simplex[1] described and figured by YABE and HAYASAKA from Southern China is also somewhat allied to the specimens now at hand, however the Chinese species has thinner septa and only a single row of dissepiments.

Hor.: Nagaiwa series, "*Profusulinella*" to *Fusulinella* (?) zone.
Loc.: Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. nos. 17300, 17309, 17310, 17311.
Coll.: M. MINATO and T. KAKIMI.

1) H. YABE and I. HAYASAKA: Geographical research in China. Atlas of fossils. pl. 10, figs. 1a, 1b, 1911-1916.

* To the first, this specie was originally reported to be derived from the Permian limestone at Nagaiwa, Kitakami mountainland, and since then this view has been long accepted in Japan. Grabau was also in the belief that this species belong to the Permian, when he described *Diphyphyllum ultimum* from the Mapping limeston, South China. (A. W. GRABAU: Early Permian fossils of China. Pal. Sinica, Ser. B, vol. 8, fasc. 4, p. 44, 1936). However it becomes sure that this species denotes the Middle Carboniferous from the writer's stratigraphical study at the type locality of this species.

Diphyphyllum platiforme Yü var. *kakisakoense* KANMERA

Pl. 40, figs. 9, 10, 11, 12, 13.

1939. *Diphyphyllum* cf. *platiforme*, YABE and SUGIYAMA: Discovery of Lower Carboniferous Corals from the Yatusiro district in Kyusyu. Proc. Imp. Acad. Tokyo, vol. 15, p. 301, figs. 2–5.

1952. *Diphyphyllum platiforme* YÜ, var. *kakisakoense*, KANMERA: The Lower Carboniferous Kakisako formation of Southern Kyusyu, with a description of some corals and fusulinids. Men. Fac. Sci. Kyusyu, Univ., Ser. D. vol. 3, no. 4. p. 168, pl. 9, figs. 1–15.

Description (YABE and SUGIYAMA, 1939): Corallum fasciculate, forming a colony over 10 cm. broad. Corallites cylindrical, 4–5 mm broad, intervals variable, surface annulated; calices not preserved. Septa moderately thick, 32–34 in number, alternately long and short, major ones as long as one-third diameter of corallites and minor ones as long as one-third to one-half of majors. Central area free from septa, and surrounded by pseudo-inner wall at their distal ends and formed by vertical marginal portion of tabulae. Two narrow layers of small cells along periphery, outer layer composed of small subequal dissepiments in a single row which are convex inwards as well as somewhat upwards, and inner layer of peripheral tabulae likewise in a single row, which are similar in size to dissepiments and rather concave upwards instead of beiug convex. Axial tabulae broad, regularly spaced, usually not much close, 6 counted in 5 mm, flat, but abruptly descending downwards at margin and connected with the preceding one.

Hor.: *Dibunophyllum* zone.
Loc.: Tutui, Kakisako-mura, Yatsushiro-gun, Kumamoto Prefecture. Specimens now stored at Inst. Geol. and Palaeont., Tohoku Univ.
Coll.: T. SUGIYAMA.

Diphyphyllum flexuosum YABE et HAYASAKA

Pl. 42, figs. 3, 4.

1915. *Diphyphyllum flexuosum*, YABE and HAYASAKA: Palaeozoic corals from Japan, Korea and China, p. 135.

Description (YABE and HAYASAKA 1915): Corallum composed of an aggregation of numerous long, more or less flexuous, subparallel, cylindrical corallites, very variably distant from each other. Corallites always slender, 5–7 mm in diameter, with the external surface more or less corrugated annually. Epitheca and external wall thin. Septa likewise thin, very little flexuous, almost always 24+24 in number; the longer septa being about one-third as long as the diameter of the corallites, and the shorter about 1/2–2/3 as long as the former. Central part of the corallites quite free from septa and provided with flat tabulae occupying a little less than half of the diameter of the corallites. Tabulae numerous, in regular intervals, about 8 in a space of

5 mm, abruptly deflected downward along their margin; thus coming into contact with the preceeding one and then again recovering their original horizontal position, the vertical portion of tabulae thus forming a kind of inner wall. Peripheral zone of corallite, occupying about 1/6 of its diameter in breadth, provided with vesicular dissepiments in the septal loculi, vesicles in three or sometimes four rows, very variable in size, some being twice as large as the others, being vertically elongated; the innermost of the dissepiments again mark also a kind of thin wall, beyond which the shorter septa are hardly protruded inward. A narrow zone bounded by these two inner walls is divided vertically by the longer septa only and horizontally by flat tabulae which sometimes are set a slightly oblique and rarely inosculating.

Remarks: The specimens now at hand quite coincide with the description above given. This species is characteristic in the inner tabulae being almost horizontal and very numerous dissepiments arranged in three or four rows.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Nagaiwa, Hikoroiti-mura, Kesen-gun, Iwate Prefecture. Reg. nos.: 17395, 17383. Coll.: M. MINATO.
: Behind the Nojiri mines, Setamai-mati, Kesen-gun, Iwate Prefecture. Specimens now stored at Inst. Geol. and Palaeont., Tohoku Univ. Coll.: YABE and HAYASAKA.

Subgenus *Depasophyllum* GRABAU, 1922

Depasophyllum aff. *gracile* M'COY

1939. *Diphyphyllum* sp, YABE and SUGIYAMA: Discovery of Lower Carboniferous corals from the Yatsusiro district in Kyusyu. Proc. Imp. Acad. Tokyo, vol. 15, p. 303, fig. 6.

YABE and SUGIYAMA once compared their specimens from Tsutsui, provisionally to *Diphyphyllum gracile* (M'COY). The YABE and SUGIYAMA's specimens were unfortunately in poor state of preservation. According to them such specimens referarable to *D. gracile* are also believed to be common in the Lower Carboniferous Onimaru-series in the Kitakami region.

Hor.: Kakisako Formation, *Dibunophyllum* zone.
Loc.: Tutui, Kakisaka-mura, Kumamoto Prefecture. Specimens now stored at Inst. Geol. Palaeont., Tohoku Univ.
Coll.: T. SUGIYAMA.

Genus *Thysanophyllum* NICHOLSON and THOMSON, 1917

emend MINATO, 1939

Diagnosis given by the writer on a former occasion runs as follows:

Corallum compound, massive, cerioid, with lonsdaleoid dissepiments, with

septa withdrawn from the axial part. No distinct columella, except one of the septa slightly prolonged into the central part of the corallites in the position of counter septum. Tabulae complete, usually forming flat-topped dome, but sometimes being quite flat or even sagging.

Genolectotype: *Thysanophyllum orientale* NICHOLSON and THOMSON.

Remarks: The writer feels the necessity for repeating the discussion of this genus given previously by him.

Thysanophyllum orientale NICHOLSON and THOMSON, a cerioid form, is the genolectotype of the genus *Thysanophyllum* chosen by GREGORY in 1917. *Thysanophyllum minus* THOMSON and *T. argylli* (THOMSON) from the Lower Carboniferous of Scotland as well as such forms as *T. aseptatuma*, and *T. cystosum* and its variety described by T. A. DOBROLYUBOVA from the Higher Lower Carboniferous of the Urals seem to be perfectly congeneric with the genotype, especially in their cerioid corallites.

There are, however, many fasciculate forms assigned to the same genus as *Thysanophyllum pseudovermiculare* (M'COY), *T. kendalense* (SMITH and LANG) and *T. longiseptata* YABE et HAYASAKA. Such fasciculate thysanophyllya are more akin to the genus *Dorlodotia* SALÉE than to massive *Thysanophyllum*, in the fundamental structure of corallites and especially in their fasciculate corals. *Dorlodotia* is fasciculate *Thysanophyllum* with stouter columella. In this regard, *T. circulosysticum* CHU, *T. asiaticum* YÜ and *T. grabaui* YÜ from the Lower Carboniferous of Southern China should be better classified to *Dorlodotia* than to *Thysanophyllum*.

The genus *Dorlodotia* 1919 is regarded by some palaeontologists to be synonymous with *Lithostrotionella* YABE and HAYASAKA 1915, both having distinct columella, and hence the name should be abandoned, according to the rule of priority. However, the genotype of the *Lithostrotionella* and its allied species are all cerioid corals in distinction from fasciculate forms of *Dorlodotia*. In the writer's opinion, the generic name *Lintostrotinella* should be reserved for cerioid forms with distinct columella and *Dorlodotia* for fasciculate forms with distinct columella and in the same manner, a new generic name should be given to the fasciculate forms of *Thysanophyllum*, as enumerated before, confining the name *Thysanophyllum* to tis cerioid forms.

The following is the proposed schema for classification of genus *Thysanophyllum* and its allied genera.

a) Cerioid form

With discontinuous, indistinct columella.....genus *Thysanophyllum*.

Thysanophyllum minus THOMSON

Thysanophyllum orientale NICHOLSON and THOMSON, genolectotype

Thysanophyllum argylei THOMSON

Thysanophyllum aseptatum DOBROLYUBOVA
Thysanophyllum cystosum DOBROLYUBOVA
Thysanophyllum cystosum var. *major* DOBROLYUBOVA
Thysanophyllum perpastum DOBROLYUBOVA
Lithostrotionella simplex HAYASAKA
Lithostrotionella kueichouensis YÜ

With distinct columella.....genus *Lithostrotionella.*
Lithostrotionella spiniformis YÜ
Lithostrotion (*Lithostrotionella*) *unicum* YABE et HAYASAKA. gen. type
Lithostrotionella pennsylvanica (SCHIMER)
Lithostrotionella asteraeiformis (WARREN)
Lithostrotionella jasperensis KELLY
Lithostrotionella micra KELLY
Lithostrotionella sp. KELLY
Lithostrorionella sp. PARKS
Lithostrotionella castelnaui HAYASAKA
Lithostrotionella hemisphaerica HAYASAKA
Lithostrotionella girtyi HAYASAKA
Lithostrotionella americana HAYASAKA
Lithostrotionella vesicularis HAYASAKA
Lithostrotionella multiradiata HAYASAKA
Lithostrotionella tubifera HAYASAKA
Lithostrotionella floriformis HAYASAKA
Lithostrotionella tubulata HAYASAKA
Lithostrotionella tingi CHI
Lithostrotionella kitakamiensis MINATO, sp. nov.

b) Fasciculate form

With discontinuous, indistinct columella.....*Pseudodorlodotia,* n. gen.
Thysanophyllum longiseptatum YABE and HAYASAKA, genolectotype
Thysanophyllum pseudovermiculare (M'COY)
Pseudodorlodotia kakimii MINATO sp. nov.

With distinct columella.....*Dorlodotia* SALÉE
Thysanophyllum circulocysticum CHU emend YÜ
Thysanophyllum asiaticum YÜ
Dorlodotia briarti SALÉE, genotype

Geological range of these corals is as follows:

	C	S	D	Moscovian
Pseudodorlodotia	×	——	×	
Dorlodotia	×	——	?	
Thysanophyllum	×	——	×	—— ×
Lithostrotionella	×	——	×	—— ×

Thysanophyllum aseptatum DOBROLYUBOVA

Pl. 35, fig. 2

1936. *Thysanophyllum aseptatum*, DOBROLYUNOVA: The corals of the Carboniferous deposits of the Western slope of the Middle Ural, and their stratigraphical importance, p. 31, pl. XIV, figs. 40, 41; pl. 15, figs. 42, 43.
1949. *Thysanophyllum aseptatum*, MINATO: On the genus *Thysanophyllum* (Tetracoral). Proc. Japan Acrd. vol. 25, p. 31, fig. 1.

The presence of such species as typical Moscovian representative in Northern Honsyu in Japan may be specially important, because the coralline fauna of S. W. Japan in the same age shows a quite different aspect as a whole, from that of the Moscovian as well as Penchian formations.

Former description of this species (MINATO, 1949) is follows:

Corallum compound, massive, cerioid. Wall not much thickend. Non-septated dissepimentarium occupied by a few, very large lonsdaleoid dissepiments, septa more than 17: all short and never thickened by any organic deposits. Minor septa lacking. One septum (probably counter septum), thin as the others, elongated in some, especially young corallites. Tabulae complete, usually flat, 5, or 7 counted in 1 mm.

Hor.: *Profusulineila-* ? *Fusulinella* zone.
Loc.: Nagaiwa, Hikoroich-mura, Kesen-gun, Iwate Prefecture. The type locality of the Nagaiwa-series. From there *Chaetetes nagaiwaensis* Minato was once collected by the writer in association with this species.
Reg. no.: 16433. Coll.: M. MINATO.

Genus ***Lithostrotionella*** YABE and HAYASAKA, 1916

Lithostrotionella sp. indet.

Pl. 1, fig. 3; Pl. 34, fig. 11; Pl. 37, fig. 9

Corallum massive, consisting of polygonal corallites of unequal size. Large corallite 12 mm in greatest diagonal, corallites in irregular form, 3 to 6 sides, and all of them cerioid.

Septa in two orders, major and minor respectively, all of them thin. Minor ones very short, and never extending beyond the theca.

Most of septa, including major and minor ones are starting to grow immediately from the outer wall in the early stage but become disunited from the wall in the mature stage and thus there appears a peripheral area with lonsdaleoid dissepiments untraversed by any septa.

Pseudocolumella unobservable in some corallites in cross section, but in some other corallites it is distinctly developed. This columella is a direct prolongation of the counter septum and presents a fusi-form in transverse

section. Cut edges of tabulae are more crowded near the theca, forming a cyathotheca.

In the longitudinal section, dissepimental vesicles occupy wide peripheral area, arranging in oblique row, facing their convex sides both inwardly and upwardly. Tabulae in inner tabularium are almost horizontal and irregularly distant. Outer tabulae steeply inclined towards the peripheral area.

Remarks: Although the outer form of this specimen is unknown, the present form is somewhat allied to the American species, *Lithostrotionella hemisphaerica*, described and figured by HAYASAKA,[1] in having cyathotheca. However the present form has less numerous septa and smaller corallites than the latter.

From associated fossils the present form may be judged perhaps to be one of the oldest representative of this genus; at least it denotes a far lower horizon than the *Dibunophyllum* zone.

Hor.: Unknown, but it may be a far lower horizon than the *Dibunophyllum* zone.

Loc.: Unabata, Setamai-machi, Kesen-gun, Iwate Prefecture.

Reg. nos.: 17315, 17316. Coll.: H. SUETOMI.

Lithostrotionella kitakamiensis MINATO, sp. nov.

Pl. 4, figs. 2, 7, 8, 10; Pl. 34, figs. 2, 3.

Forms of the entire corallum unknown; fragments only being available for study. Corallum compound, massive, cerioid, composed of prismatic corallites. Corallite irregularly polygonal and varying in size. An average diameter of tabularium is about 3 mm. Outer walls are not wholly straight, but somewhat zig-zag in transverse section; they are rather thin, but composed of three distinct layers.

Septal number	short diameter of corallite	longest diameter of corallite	tabularium
15	5.0 mm	8.0 mm	3.6 mm
17	4.5	7.0	3.0
16	4.5	6.1	3.0
15	4.3	5.2	3.3
15	5.0	7.0	3.2

Septa in two orders, the major and minor; the former number as many as 15 to 17 mature stage, while the latter are only quite rudimentary or

1) I. HAYASAKA: On some North American species of *Lithostrotionella*. Mem. Fac. Sci. and Agriculture, Taihoku Imp. Univ., vol. 13, no. 5, p. 61, pl. 12, fig. 1; pl. 13, figs. 1 and 2, 1936.

occasionally absent. All septa, thin, start to grow at the inner wall of the peripheral zone, and do not grow from the outer wall. Major septa rather uniform in length, except the counter septum, which is usually prolonged into the central area and directly uniting with the palicolumella.

Concentric dissepiments between interspace of major as well as minor septa are wholly lacking. Cut-edges of tabulae are unobservable. Fossulae absent. The peripheral zone is occupied by large unequal lonsdaleoid dissepiments; which are usually arranged in two rows, but rarely arranged in more numerous rows.

In the longitudinal section, tabulae are horizontal or slightly concave and rather widely spaced, being counted as many as six in a distance of 5 mm. Lonsdaleoid dissepiments are unequal in size, arranged in two or more numerous rows, facing their convex sides upwards and inwards.

Remarks: The present species is characteristic in having rather thin outer wall, rudimentary minor septa, the continuous palicolumella with counter septum, and rather distinct tabulae.

In respect to the number of major septa, rather thin outer wall and very rudimentary minor septa, the present species is somewhat resemblant to a Chinese Middle Carboniferous species described by CHI from Weiningian under the name *Lithostrotionella tingi*.[1] However the Chinese species has columella usually disunited from any septum and has larger corallites.

For the time being the present species should be considered as more nearly related to *Lithostrotinella stylaxis* (TRD.)[2] described and figured by DOBROLYUBOVA from the Middle Carboniferous of the Moscow basin; the latter has corallites of the same size as the former, similar continuous palicolumella and very rudimentary minor septa. However the present from is specifically different from the latter in having far thinner outer-wall and relatively more numerous septa than the latter.

Hor.: Nagaiwa-series, *Profusulinella- ? Fusulinella* zone.
Loc.: Sakamotosawa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture.
Reg. nos.: 17608, 17609, 17611, 17612, 17613, 17224.
Coll.: M. MINATO.

Lithostrotionella cfr. *tingi* CHI

Compare with:

1931. *Lithostrotionella tingi*, CHI: Weiningian (Middle Carboniferous) corals of China. Palaeont. Sinica, Ser, B, vol. XII, fasc. 5, p. 28, pl. IV, figs. 6a-b.

1) Y. S. CHI: Weiningian corals of China. Palaeont. Sinica, Ser. B, vol. XII, fasc. 5, p. 28, pl. IV, figs. 6a-b. 1931.
2) T. A. DOBROLYUBOVA: The rugose colonial corals in the Middle Carboniferous of the Moscow basin. Trans. All-Union Sci. Res. Inst. Economic Mineralogy, Fasc. 81, p. 14, pl. 1, figs. 1 and 2, 1935.

The Japanese specimens now in consideration are unfortunately in bad state of preservation, however they are somewhat like *Lithostrotionella tingi* described by CHI from the Middle Carboniferous of Southern China.

According to FUJIMOTO, the specimens were collected at Dangyokei, Taisyaku plateau in association with *Nagatophyllum*, *Thysanophyllum* and a formaminifera, *Stafella* sp.: therefore the age of this coral may be Middle Carboniferous.

Hor.: *Fusulinella* zone.

Loc.: Dangyokei, Taisyakudai, Taisyaku-mura, Kameishi-gun, Hiroshima Prefecture, loc. no. 52 of FUJIMOTO.[1] Specimens now stored at Univ. Education, Tokyo.

Genus ***Pseudodorlodotia*** MINATO, gen. nov.

Corallum fasciculate like the genus *Dorlodotia* SALÉE[2]. The genotype of the genus *Dorlodotia* has quite strong columella. However the newly proposed genus provides always quite indistinct columella in the corallites. The columella of this coral is nothing but a direct prolongation of the counter septum, which is usually quite thin and indistinct.

Pseudodorlodotia kakimii MINATO, sp. nov.

Pl. 1, figs. 1, 2; Pl. 4, figs. 4, 11, 12; Pl. 22, fig. 7.

Outer characters unknown. Corallum composite, fasciculate. Corallites sub-circular in outline in the transverse section. Corallites unequal in size, inter space also variable. Outer wall thin. Major septa 20 in the corallite, of which the diameter is about 9mm, but usually 17 in still smaller corallites.

diameter of the corallites	septal number
5.5 mm	17
5.5 mm	17
5.5 mm	17
6.5 mm	17
7.0 mm	17
8.0 mm	19
9.0 mm	20

1) H. FUJIMOTO: Palaeontological study on the Titibu system of Taisyaku region, Hiroshima Prefecture. (in Japanese). Sci. Rep. Geol. Min. Inst. Tokyo Bunrika Daigaku, no. 1, p. 1, 1944.

2) A. SALÉE: Sur un Genre nouveau de Tétracoralliaires (*Dorlodotia*) et la valeur stratigraphique des *Lithostrotion*. Ann. Soc. Sci. Bruxelles. t. XXXIX, second fasc. p. 3, 1919-1920.

Minor septa quite rudimentary or almost lacking in many corallites. Peripheral area rather broad, consisting of large lonsdaleoid dissepiments. Columella indistinct in most corallites but its existance is undoubted in some other corallites; it is directly united with counter septum. This thin columella is encircled by cut-edges of tabulae in thin section.

In the longitudinal section large vesicles are arranged in one row, facing their convex sides both upwards and inwards. The tabulae almost complete and horizontal.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate prefecture. Reg. nos.: 17317, 17318, 17319, 17315, 17389, 17845.
Coll.: T. KAKIMI.
: Upper course of Higuchisawa, Hikoroichi-mura. Reg. nos.: 17845.
Coll.: T. HASHIMOTO

Genus ***Dorlodotia*** SALÉE, 1920

Dorlodotia? sp. indet.

Pl. 9, fig. 7; Pl. 13, figs. 6, 13.

1943. *Dorlodotia* sp. MINATO: On some upper Viséan coral fauna from the Coral limestone of the Kitakami mountainland, Northeastern Honsyu, Japan. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2. p. 237, pl. XXII, figs. 5a, b, 6a, b.

Description (MINATO, 1943) was as follows: Only two transverse sections are referable to the genus *Dorlodotia*. The corallum is simple. The wall of the corallum is not thin. The size of the corallite is somewhat variable, as the diameter of large one is more than 15 mm. The major septa range from 27 to 30 in number and are alternating with the minor ones, which may be quite rudimentary. The major septa are not developed from the outer wall, but appear at the inner margin of the vesiclose zone.

The vesicles in the outer zone are quite large and scarce in number, appearing well spaced. The septa are not thickened by any organic deposits. No longitudinal section was obtained.

Remarks: Although SALÉE[1] defined this genus as follows: "Polypier composé, constitué par des polypiérites cylindriques, allongés." the specimens here treated are simple in form. In this regard, the writer doubts whether the Kitakami specimens are assignable to the genus *Dorlodotia* or not, although the foundamental structure of the corallite is quite the same as *Dorlodotia*. The columella is also definitly developed in these specimens. (See Pl. 13, fig. 13)

1) A. SALÉE: Sur un Genre nouveau de Tétracoralliaires (*Dorlodotia*) et la valeur stratigraphique des *Lithostrotion*. Annales Soc. Sci. Bruxelles. t. XXXIX, p. 1, 1920.

Hor.: Onimaru series, *Dibunopeyllum* zone.
Loc.: Sizu, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15204, 15205. Coll.: M. MINATO

Genus ***Orionastraea*** M'COY (fide SMITH, 1917)

Orionastraea sp.

Pl. 34, figs. 10, 12.

1932. *Orionasteaea* sp. HAYASAKA: An astraeiform coral from Central Japan. Geol. Mag. vol. 69, p. 273, figs. 1, 2.

Description (HAYASAKA, 1932): The corallum is composite and massive, flat and possibly encrusting. The corallites have no epitheca and are united by their dissepimental tissue and perfectly confluent septa. The tabula areas, which are rather widely separated, are about 2 mm in diameter. There are about 26-30 septa of which the major and minor ones are not very clearly distinguished, all the septa extend into the tabular areas and a few actually reach or almost reach the stout columella. The "theca" is 2mm in diameter, and the columella about 1mm in diameter. Some of the septa appear from the transverse section to take part in the formation of the columella. The tabulae are rather irregularly spaced and are nearly horizontal or only slightly convex. The dissepiments are arranged in irregular series which descend inwards; they are small and arch distally inwards.

Remarks: From above description and annexed text-figure reproduced from HAYASAKA's paper, this specimen appears to be possibly *Orionastraea*, although it is not in good preservation and accordingly it cannot be specifically determinable with certainty. Notwithstanding, it is far from doubtful that this specimen, now in consideration is quite like *Orionastraea phillipsi*[1] as HAYASAKA formerly suggested.

Hor.: Onimaru series, *Dibunophyllum* zone
Loc.: Omi-mura, Nishikubiki-gun, Niigata Prefecture.
Coll: I. HAYASAKA

Genus ***Cystophora*** YABE and HAYASAKA, 1916

Cystophora manchurica forma *kikkawai* (YABE et HAYASAKA)

Pl. 34, figs. 1, 4, 9; Pl. 36, fig. 6

1916. *Cystophora kikkawai*, YABE and HAYASAKA: Palaeozoic corals from Japan, Korea and China. Jour. Geol. Soc. Tokyo, vol. 23, p. 72.

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1) S. SMITH: *Aulina, Phillipsastraea* and *Orionastraea*, gen. nov. Q. J. G. S. vol. 62, p. 298, pl. 23, figs. 1, 3, 4; Pl. 24, fig. 2, 1916.

1944. *Cystophora manchurica* forma *kikkawai*, YABE and EGUCHI: On some corals from the Penchi coal-field of Manchuria. Jour. Geol. Soc. Japan, vol. 51, p. 75.

Corallum compound, corallites form a large mass, the diameter of which reaches usually more than 20 cm. The outer form is unobservable, the corallum being too firmly embedded in the matrix. Weathered surface shows shallow calix and lonsdaleoid dissepiments.

Transverse section: Corallum compound, massive. External wall of the corallites almost completely lacking anywhere. Each corallite confluent by the lonsdaleoid dissepiments. The distance of the center of the adjacent corallites measures from 7mm to 11mm. The columella simply constructed, showing styliform or pali-columella type. Septa in two orders; major and minor respectively; the latter is much shorter and less numerous than the former. One of the major septa is directly united with the columella, which may be counter septum. Each septum becomes thin and disappears in the lonsdaleoid dissepiments. There are also a few rows of dissepiments near the bass of each septum, which surround the inner side of the dissepiments of the lonsdaleoid dissepiments. Thus the inner side of the concentric dissepiments shows a marked inner wall.

Longitudinal section: Tabulated area very narrow, where the subhorizontal tabulae are sporadically arranged. Lonsdaleoid dissepiments are arranged obliquely with their convex sides facing upwards and inwards.

Number of major septa	Number of minor septa	diameter of corallite	diameter of intrathecal region
11	3	7.5 mm	3.8 mm
13	3	9.0 mm	4.0 mm
13	7	11.0 mm	4.2 mm
10	4	10.0 mm	4.2 mm

Remarks: In consequence of the careful re-examination of YABE in cooperation with EGUCHI, it seems that several types of corals, though formerly considered to be different species under the genus *Cystophora*, should be, in fact, regarded as belonging to one and the same species. Thus they grouped four types of *Cystophora* under the same specific name of *manchurica* and besides this, they distinguished three sub-species among them.

1. *Cystophora manchurica*, YABE et HAYASAKA
2. *Cystophora manchurica* forma *podolskensis* (DOBROLYUBOVA)
3. *Cystophora manchurica* forma *humboldti* (STUCKENBERG)
4. *Cystophora manchurica* forma *kikkawai* (YABE et HAYASAKA)

The specimens now at hand, the writer thinks, show evidence in every respect, making them fully referable to *Cystophora manchurica*, especially to

forma *kikkawai*. This sub-species is distinguishable from other sub-species in the following points namely (1) from forma *podolskensis* by the entire lack of external wall of the latter, (2) from forma *humnoldti* by the simply constructed columella and less numerous septa of the latter, and (3) from the species s.s by the relatively thin septa and columella of the former.

The forma *kikkawai* is also easily separable from the Weiningian species, *Cysotophora typica*, described by CHI.[1)]

Cystophora manchurica forma *kikkawai* was first described by YABE and HAYASAKA from the *Pseudoschwagerina* limestone, developing in the Heijo-coal field (now Pyong-yong), North Korea, but this species now is known to occur also, by the subsequent study of YABE and EGUCHI, from the Middle Carboniferous, in Wuhtui coal-field of South Manchuria.

In Japan, this species was found in the limestone yielding *Pseudoschwagerina* fauna, including *Pseudoschwagerina* (*Zellia*) sp.

Hor.: *Pseudoschwagerina* zone
Loc.: Ichinotani, Fukuchi, Kamitakara-mura, Yosiki-gun, Gifu Prefecture.
Reg. nos.: 16704, 16705, 16706. Coll.: M. MINATO

Family Clisiophyllidae NICHOLSON and THOMSON, 1886

Under the name of Clisiophyllidae, the writer grouped numerous genera which may be perhaps polypyletic in origin. The writer believes now, the former classification proposed to classify the groups of corals belonging to the so-called families Lithostrotionidae, Lonsdaleidae, Clisiophyllidae, Lophophyllidae and also Amygdalophyllidae, to be quite artificial.

Although in this paper, the writer followed provisionally the previous foreign palaeontologists, it is quite evident, that there are at least four phyllogeneitic groups in the family Clisiophyllidae.

One of those groups comprises such genera as *Waagenophyllum*, *Wentzella*, *Wentzelloides*, and so forth, all which corals possess corallites with complicated axial structure and broad dissepimentarium occupied by concentric dissepiments; but the corallites have characteristics of *Siphonodendron* or *Lithostrotion* in early stages of ontogeny, and in still earlier stages they lack columella while the septa arrange in pinnate pattern.

The second group comprises such genera as *Lonsdaleia*, *Stylidophyllum*, *Polythecalis* and so forth. All of them have quite complicated axial structure in the mature stage and wide dissepimentrium composed of concentric dissepiments, besides large lonsdaleoid dissepiments in the peripheral area.

1) Y. S. CHI: Weiningian corals of China. Palaeont. Sinica. ser. B, vol. 12, fasc. 5, p. 31, pl. 3, fig. 9, 1931.

Also this group of corals possesses corallites being indistinguishable from *Dorlodotia*, or *Thysanophyllum* in their early stages and thus corals of this second group must be regarded to be direct decendants of some genera above enumerated, belonging to so-called "Lithostrotionidae."

If that consideration holds, it may be quite unnatural to classify those corals *Waagenophyllum*, *Wentzella*, *Wentzelloides*, *Lonsdaleia*, *Stylidophyllum* and *Polythecalis* into one family and *Dorlodotia*, *Thysanophyllum*, *Siphonodendron* and *Lithostrotion* into another family, Lithostrotionidae for an example.

It may be far preferable to classify those genera above enumerated into the following two sub-families from the viewpoint of phylogeny: one sub-family would include such genera as *Wentzelloides*, *Wentzellella*, *Waagenophyllum* as advanced forms, and *Lithostrotion*, *Siphonodendron* as primitive forms, while the second of them would comprise such genera as *Polythecalis*, *Stylidophyllum*, and *Lonsdaleia* as progressive forms and *Pseudodorlodotia*, *Dorlodotia*, *Thysanophyllum* and *Lithostrotionella* as primitive forms. (see Text-fig. 20.)

The third group belonging to so-called "Clisiophyllidae" comprises such genera as *Dibunophyllum*, *Corwenia*, *Huangia*, and so forth on the one hand, and *Koninchophyllum*, *Lophophyllum*, *Arachnolasma*, and *Yuanophyllum* and so forth on the other. All of them posses a quite complex axial structure and wide dissepimentarium with dissepiments arranging in angulo-concentric, or pseudo-herring-bone, or herring-bone pattern.

Of them, such genera as *Koninckophyllum*, *Lophoyllum*, *Aracholasma*, and *Yuanophyllum* have been treated by some palaeontologists under the family Lophoyhyllidae for the reason that the median plate of the columella in these corals is always united with counter septum. However the corallites of such advanced forms, *Dibunophyllum* for example, show Koninckophylloid nature in the early stages of ontogeny. Thus those genera, above mentioned, at least so far as the ontogeny is concerned, might be derived from a common ancestor.

Beside this, all the corals above enumerated have a thick dissepimentarium, with rather complicate dissepiments, as above stated; the feature is quite characteristic and in this respect the writer regards now that it may be correct to classify not only *Dibunophyllum* and its closely allied genera but also those koninckphylloid genera under the Clisiophyllidae rather than under the Lophophyllidae.

The fourth group of the Clisiophyllide includes such genera as *Caruthersella* for example, which have compact columella in the maturer stage, although they might be perhaps evolved from the same common ancestor as the koninckophylloid corals.

Under such considerrations the writer is opinion that the former classification of these groups of corals, presented by various palaeontologists, SANFORD[1] for example, shoud be revised in many respects from the phylogenetic points of view.

The schema which the writer pictures now to himself, in revising the previous classification, is shown in fig. 20 in which an attempt is made to classify the phylogenetic relations of each genus.

Thus, it comes already to be quite evident that there are many confusions in former classifications respecting the boundaries between Clisiophyllidae and Lithostrotionidae, or between Clisiophyllidae and Lophophyllidae, and so forth.

However, to the writer's great regret, the new schema for classification of these corals above enumerated is not finally settled at the present moment, therefore, it is proposed to follow provisionally in this paper the former classification in general.

Neverthelese, such genera as *Lophophyllum* and *Koninckophyllum* and so forth will be treated under the Family Clisiophyllidae but not Lophophyllidae. Also such genera as *Lonsdaleoides, Geyerophyllum* and others will be considered as under the new one family, although formerly HERITSCH considered them to be belonging to Clisiophyllidae. On this point the writer will present a detailed discussion later.

Genus ***Dibunphyllum*** NICHOLSON and THOMSON, 1876.

Dibunophyllum cf. *kankouense* YÜ

Pl. 40, figs. 1, 2, 3, 4, 5, 6.

1933. *Dibunophyllum bristolense* GARWOOD and GOODYEAR var. *kankouense* YÜ: Palaeontologia Sinica, Ser. B, vol. 12, fasc. 3, p. 124, pl. 23, figs. 8a-c; pl. 24, figs. 5a-c.

1952. *Dibunophyllum* cf. *kankouense*, KANMERA: The Lower Carboniferous Kakisako formation of Southern Kyusyu, with a description of some corals and fusulinids. Mem. Fac. Sci. Kyusyu Univ., ser. D, vol. 3, no. 4, p. 165, pl. 9, figs. 1-10, 1a, 2a, 4a.

A few years ago KANMERA sent his specimens now at hand accompanied by a letter stating his view that they may be quite nearly allied to *Dibunophyllum bristolense* GARWOOD et GOODYEAR var. *kankouense* YÜ. The writer was and is now of opinion that his view may be quite correct. The corallites of the specimens sent to the writer showed quite close resemblance in character to the Chinese specimens, described and figured by YÜ under the referred

1) W. G. SANFORD: A review of the families of Teteracorals. Amer. Jour. Sci. vol. 237, no. 5, no. 6, 1939.

name, except that the axial tabelae of the Japanese specimens are more densely arranged and more steeply inclined than the Chinese one, and the tabulae of the Japanese specimens are more conical.

On the other hand the Chinese species described by Yü is clearly distinguishable from *bristolense*, because the former always has quite thick median plate and provides more conical tabulae.

Accordingly the writer advised KANMERA that it may be reasonable to treat Yü's variety as being specifically different from *bristolense*, and to refer KANMERA's specimens to Yü's species.

Hor.: Kakisako formation, *Dibunophyllum* zone.
Loc.: Tsutsui, Kakisako-mura, Yatsusiro-gun, Kumamoto Prefecture.
Reg. no.: 50014-10018, GKD Kyusyu Univ. Coll: K. KANMERA

Dibunophyllum bristolense GARWOOD et GOOKYEAR

Pl. 9, fig. 4; Pl. 13, fig. 3; Pl. 14, figs. 1, 2, 13, 15.

1905. *Dibunophyllum* ψ VAUGHAN: The palaeontological sequence in the Carboniferous limestone of the Bristol area. Q. J. G. S. vol. 61, p. 284, pl. 24, figs. 2, 2a.
1924. *Dibunophyllum bristolense*, GARWWOD et GOODYEAR: The Lower Carboniferous succession in the Settle district etc. Q. J. G. S. vol. 80, p. 259, pl. 16, figs. 6a, 6b.
1930. *Dibunophyllum bristolense*, LEWIS: The Avonian succession in the Isle of Man. Q. J. G. S. vol. 86, p. 271, pl. 22, figs. 4, 5a, 5b.
1943. *Dibunophyllum bristolense*, MINATO: On some Upper Viséan Coral fauna etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2 p. 222, pl. 20, figs. 15a-d; pl. 21, figs. 3, 7a-c, 8a-b.
1943. *Dibunophyllum* cf. *bristolense*, MINATO: Ibid. p. 224, pl. 20, figs. 5, 6; pl. 21, fig. 2.

Corallum simple, corallites rather small. Outer wall thin. Major septa numerous, usually 43 to 46 in the full grown stage, alternating with minor ones, which are short, being rarely beyond 1/3 the length of the former. Major septa thin, both near the wall and in axial area, while they are slightly thickened near the theca. Central area occupied by columella of spider-web structure, in which median plate is prominent and slightly strengthend by stereoplasma. Dissepiments numerous being arranged in pseudo-herring bone pattern; more densely crowded near the theca, giving an appearance of the existence of sclerotheca.

In longitudinal section, triareal arrangement is well defined. Numerous vesicles occupy the area of the outer zone, with their convex sides faced upwards as well as inwards. Tabulae incomplete, horizontal or slightly inclined outwards, counting 12 or 13 in a distance of 10 mm, while axial tabullae more densely arranged and more steeply inclined from the median plate.

Remarks: Since the writer described this coral from Japan, new material has been added to his collection from a few localities of the Kitakami moun-

tain region; reexaminations have made of all these specimens. They are quite characteristic in having less long minor septa, in comparison with the typical specimen of VAUGHAN as well as GARWOOD'S and GOODYEAR'S material, therefore in this respect they may be regarded to be rather near to *Dibunophyllum vaughani*; moreover the longitudinal sections of the Japanese specimens show that the tabulae are rather distant from each other; the feature quite conicides with the case of *Dibunophyllum vaughani*. Such being the case the specimens, now under consideration, are doubtlessly near to *D. vaughani* on the one hand. However the Japanese specimens are preferably to be dealt with as *D. bristolense* rather than as *D. vaughani* in having sclerotheca and slightly thickened major septa near the theca. Besides this, the minor septa are never so rudimentary as in the typical specimens of *Dibunophyllum vaughani*.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugahsirayama, Setamai-machi, Kesen-gun, Iwate Prefecture Reg. nos.: 15196, 15198, 15200, 15203, 16053.
: North of Hotoke-zaka, Yahagi-mura, Kesen-gun, Iwate Prefecture. Reg. nos.: 16825, 16826, 16827. Coll. M. MINATO

Dibunophyllum inugasirayamaensis MINATO

Pl. 14, fig. 5.

1943. *Dibunophyllum inugasirayamaensis*, MINATO: On some Upper Viséan Coral fauna etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 225, pl. 21, fig. 1.

Remarks: As has been already discussed by the writer, this species with relatively smaller corallites is quite different from other species of this genus in possessing major septa probably in the counter quadrants which join each other with their axial ends. The feature reminds one somewhat of a pinnate arrangement of septa. In spite of this, the axial structure of this coral represents common features of genus *Dibunophyllum* in which median plate is well developed; besides, axial tabulae and septal lamellae correspond to *Dibunophyllum*.

Hor.: Onimaru-Series, *Dibunophyllum* zone.
Loc.: Inugasirayama Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 15425. Coll.: M. MINATO

Dibunophyllum asiaticum MINATO, nom. nov.

Pl. 8, fig. 1; Pl. 10.

1933. *Dibunophyllum vaughani*, YÜ, non GARWOOD et GOODYEAR; Palaeontologia Sinica, Ser. B, vol. 12, fasc. 3, p. 128, pl. 24, figs. 3a, 3b.

1943. *Dibunophyllum yüi*, MINATO, non CHI.: Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 224, pl. 20, figs. 3, 9-11.

Discription (MINATO, 1943): Corallum simple, considerably large in size, a little curved. The external characters are not clearly observed, but the epitheca may be not thick in the transverse section. The septa are numerous, numbering 48 in the mature stage of 30 mm. in diameter: all of them extend from the outer wall and almost reach the outer margin of the central area. They are slightly flexuous in the peripheral area and become thicker between the medial and external area because of stereoplasmic deposits: therefore the septa in this part often appear bifurcated. The central area is occupied by a stout medial plate and numerous concentric axial tabellae which are crossed by the discontinuous septal lamellae. The mesial plate also seems to be bifurcated in consequence of thickening by organic deposits. The fossula is remarkable and the medial plate slightly projects into it as a cusp. The dissepiments exist in the peripheral and external area and are arranged in pseudoherring bone pattern, although the minor septa are quite rudimentary.

The medial area is occupied only by the margin of the septa and a few dissepiments. In the longitudinal section triareal arrangement is very clear. The dissepimental zone is composed of about 6 or 7 vertical rows of vesicles of unequal size, with their convex sides faced upwards. There are about 5 or 6 in a space of 5 mm. while the dissepiments in the central column are very dense and face more steeply upwards along the medial plate.

Remarks: As formerly discussed by the writer, Yü's specimen is neither conspecific with *Dibunophyllum vaughani*, described and figured by GARWOOD et GOODYEAR, nor with specimens figured by VAUGHAN under the name of *Dibunophyllum* ψ. *Dibunophyllum* coming from the Lower Carbniferous of England, was later named by GARWOOD and GOODYEAR as *D. bristolense*, which is specifically distinguishable from *D. θ*, which was later named also by them as *D. vaughni* with which Yü identified his specimens. Although Yü recognized *D.* ψ as synonymous with *D. vaughani*, they are actually quite different species.

It is far from doubtful that the Japanese specimens now in consideration are identical with Yü's specimens (Yü's so-called *D. vaughani*) and at the same time they are safely separable from the typical specimens of *D. vaughani* designated by GARWOOD and GOODYEAR.

Under such circumstances, the writer believed it to be best to give a new name to the Japanese specimens, which are quite identical with Yü's material and named it as D. *yüi* in memory of that eminent Chinese palaeontologist. However this name was preocupied by some other coral derived from the

Middle Carboniferous of China.[1] Therefore the writer wishes here to revise the former name to *Dibunophyllum asiaticum*.

Hor.: Onimaru series, *Dibunophyllum* zone.
Lod.: Inugasirayama, Setamai-machi, Kesen-gun. Iwate Prefecture.
Reg. no.: 15120, holotype.
: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. nos.: 15113, 15117.
: A tributary of Kattisawa, Kofugane, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15252.
Coll.: M. MINATO.

Dibunophyllum sp. indet.

Pl. 13, fig. 14.

1943. *Dibunophyllum* sp. a, MINATO: On some upper Viséan coral fauna from the coral limestone of the Kitakami mountainland, Northeastern Honsyu, Japan. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p, 226, pl. XX, fig. 13.

The specimens here treated are found in numerous localities of Southern Kitakami district, although they are all unfortunately bad in state of preservation.

Corallum is simple, fairly large in size, the diameter of the corallite ranges 30 to 35 mm in mature stage. Major septa long, numbering many as 40 in full grown stage, while the minor septa are almost rudimentary, columella composed of loosely arranged septal lamellae and axial tabellae, in which the median plate is rather thin.

Remarks: This species is characteristic in the loosely constructed axial structure and in slight development of the minor septa.

Hor.: *Dibunophyllum* zone. Loc.: Komata, Setamai-machi; Ishibashi, Hikoroichi-mura; Sakamotosawa, Hikoroichi-mura; Hotoke-zaka, Yahagi-mura; Kozubo, Yokota-mura; Shiritakazawa, Shimoarisu-mura; Inugasirayama, Setamai-machi; all in Kesen-gun, Iwate Prefecture. Coll.: M. MINATO.

Genus ***Neokoninckophyllum*** FOMITCHEV, 1939

Neokoninckophyllum sp. indet.

Corallum simple, fairly large. The calicular diameter range as large as 15 mm. There are about 70 septa including major and minor ones alternating with each other. All the septa are fairly thickened at the thecal region and

1) Y. S. CHI: Weiningian (Middle Carboniferous) Coral of China. Palaeontologia Sinica, ser. B, vol. 12, fasc. 5, p. 39, pl. IV, figs. 7a-b, 1931.

become gradually thin both proximally and distally. Dissepiments are numerous, arranged in pseudoherring-bone patterns. Columella is imperfectly preserved; no distinct median plate is recognizable, except a sinuous plate at the middle portion connecting the axial ends of cardinal and counter septa. Fossula lacking. Wall unobservable. No longitudinal thin sections obtained.

Hor.: Middle Carboniferous, *Fusulinella* zone.
Loc.: North of Kamitakara-mura (Hitoegane), Yosiki-gun, Gifu Prefecture.
Reg. nos.: 16708. Coll.: M. MINATO

Genus ***Rhodophyllum*** THOMSON, 1876

Rhodophyllum yokoyamai MINATO

Pl. 9, fig. 5; Pl. 13, figs. 10, 15; Pl. 14, fig. 10.

1943. *Rhodophyllum yokoyamai*, MINATO: On some Upper Viséan Coral fauna from the Coral limestone, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 228, pl. 20, figs. 7a-b; pl. 21, figs. 4a-b, 6a-b.

That this species is most nearly allied to the two European species *Rhodophyllum slimonianum* THOMSON and *Rhodophyllum distans* GARWOOD et GOODYEAR is indubitable, but the Japanese species now in consideration is distinguishable from the "*slimonianum*" in having more narrow central area, and from the "*distans*" in having quite different aspect of corallite in the trasverse section, although it shows much resemblance to the latter in longitudinal section.

Hor.: Onimaru-series, *Dibunophyllum* zone.
Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15076, 15078. Coll. M. MINATO.

Rhodophyllum sugiyamai MINATO

Pl. 9, figs. 2, 3; Pl. 13, fig. 1; Pl. 14, fig. 18.

1943. *Rhodophyllum sugiyamai*, MINATO: On some Upper Viséan Coral fauna from the Coral limestone etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 227, pl. 20, fig. 12; pl. 21, figs. 9a-b.

This species is easlly separable from the preceding species in having major septa much dilated in the intrathecal area.

Hor.: Onimaru-series, *Dibunophyllum* zone.
Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15074, 15075. Coll.: M. MINATO.

Genus *Waagenophyllum* HAYAYAKA, 1924

Waagenophyllum indicum (WAAGEN et WENTZEL)

Pl. 21, figs. 1 and 2; Pl. 26, figs. 2, 4, 5, 6 and 8.

1886. *Lonsdaleia indica*, WAAGEN et WENTZEL: Salt Range fossils. Pal. Indica ser. 13, p. 987, pl. CI, figs. 1-3; CXV, figs. 3, 4.

1915. *Lonsdaleia* (*Waagenella*) *indica*, YABE and HAYASAKA: Palaeozoic corals from Japan, Korea and China, Jour. Geol. Soc. Tokyo, vol. 22, p. 96.

1935. *Waagenophyllum indicum*, SMITH: Anthracolithic corals from British Columbia and related species from the Tethys. Jour. Palaeont. Vol. 9, p. 32, pl. 8, fisg. 1-6.

1943. *Waagenophyllum indicum*, MINATO: Notes on some Permian fossils from the Toman formation in Southeastern Manchoukuo. Jour. Fac. Sci. Hokkaido Imp. Univ., ser. 4, vol. 8, no. 1, p. 52, pl. 1, figs. 1-4.

Corallum composite, fasciculate, consisting of fairly long cylindrical corallites which are more or less irregularly arranged and separated from one another at variable distances, the greater distances being more than the diameter of the corallites; but occasionally connecting corallites are also found with uniting process. Corallites are usually very small in size; their calicular diameter ranging from 4 mm to 5.5 mm. Septa are in two orders, major and minor respectively; they number from 19 and 22 in each order, never beyond 26, and of these 22 is the most common case. The major septa very thcik at the proximal ends becoming thin distally. They are straight or more or less sinuous and mostly reaching the columella. Major septa are more or less variable in length but longer than one-third and usually shorter than one-half of the major septa. The columella is rather loosely constructed by septal lamellae and axial tabellae, in which no distinct median plate is recognizable. Near the outer wall, sometimes stereozone develops.

In the longitudinal section, triareal arrangement rather indistinct. The inner tabularium is occupied by columella. Tabulae are almost lacking or quite sporadically developed at the quite narrow outer tabularium. The dissepimental vesicles are elongate in form, their convex sides facing inward. While there are also relatively smaller vesicles in one part of the dissepimentarium.

Remarks: It must be remembered that *Waagenophyllum indicum* is represented mostly by corallites which are of quite regular round form in contrast to such species as *W. akasakensis*, *polyseptata* or *indicum* var. *usuginuensis*; the latter forms show always very irregular form in thin section. Of course the observed irregular shape must be regarded to be not wholly due to secondary deformation, and accordingly the regular round shape of the corallites in cross section may be concluded as one of the most characteristic features to distinguish this species from allied ones.

However it may become difficult to distinguish this species from *Waagenophyllum virgalensis*, when the stereozone at the peripheral part is much developed. S. SMITH[1] considered *virgalensis* to be entirely synonymous with *indicum*.

Hor.: *Yabeina* zone.
Loc.: Iwaizaki, Hajikami-mura, Motoyosi-gun, Miyagi Prefecture.
Reg. nos.: 15522, 15523. Coll.: M. Minato.
: Ohsawa, Maiya-mati, Tome-gun, Miyagi Prefecture.
: Takamori-yama, Kamimano-mura, Higasiiwai-gun, Iwate Prefecture.
: Hisahawara, Soma-gun, Fukusima Prefecture.
: Kinsyo-zan, Akasak-mati, Fuwa-gun, Gifu Prefecture.
: Siroiwa, Akiyosi-dai, Omine-mura, Mine-gun, Yamaguti Prefecture.
: Kanoide, Kyowa-mura, Mine-gun, Yamaguti Prefecture.
: Kurotaki, Sakawa-mati, Takaoka-gun, Koti (Kochi) Prefecture.
: Mimikiri, Simoyama, Sakawa-mati, Takaoka-gun, Koti (Kochi) Prefecture.
: Kasamatsu, Kawamata-mura, Yatsusiro-gun, Kumamoto Prefecture.

Examined specimens are now stored at Inst. Geol. and Palaeont., Tohoku Univ.

Waagenophyllum indicum (WAAGEN et WENTZEL) var.

usuginuensis, MINATO, var. nov.

Pl. 19, fig. 3; Pl. 31, fig. 1.

Corallum fasiculate. Corallites are very irregular in form in the transverse section. There are about 20 major septa in the largest corallite, alternating with same number of minor ones; the latter septa are more or less thinner and relatively shorter than the former. The columella shows no typical spiderweb structure, in which no distinct median plate is recognizable, and occupies usually very small area in the transverse section. Dissepiments are arranged in concentric pattern. There is no peripheral area free from septa.

In the logitudinal section, the dissepiments are rather elongate in form and show no typical conical vesicles, which face their convex sides upwards and inwards. There are no distinct horizontal tabulae.

Remarks: In respet to having sporadic horizontal tabulae and subelongate dissepiments in the longitudinal section, the present form may be regarded as almost identical with the genotype of this genus.

Although the materials at hand are unfortunately in bad state of preservation, they may be considered to be easily separable from *indicum* in having relatively large sized corallites and characteristically less numerous septa;

1) S. SMITH: Anthracolithic corals from British Columbia etc., p. 34, 1935.

the criteria seem to be sufficient to distinguish the specimens from the genotype in the rank of variety.

At present, specimens which should be regarded as belonging to this variety, have been collected from at least two localities in the Kitakami mountainarea.

Hor.: *Yabeina* zone
Loc.: Sanmaiyashiki, Maikawa-mura, Higashiiwai-gun, Iwate Prefecture.
Reg. nos.: 15552
: Kattisawa, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 15556. Coll.: M. MINATO.

Waagenophyllum akasakensis (YABE)

Pl. 37, fig. 6a-e, 7.

1909. *Lonsdaleia akasakensis*, YABE: Materials for a knowledge of the Anthracolitic fauna of Japan. Jour. Geol. Soc. Japan, vol. 9, p. 4.
1915. *Lonsdaleia* (*Waagenella*) *akasakensis*, YABE and HAYASAKA: Palaeozoic corals from Japan, Korea and China. Jour. Geol. Soc. Japan, vol. 22, p. 100.
1925. *Waagenophyllum akasakensis*, OZAWA: Palaeontological and stratigraphical studies on the Permo-Carboniferous limstone of Nagato. Jour. Coll. Sci. Tokyo, Imp. Univ., vol. 45, Art 6, p. 75, pl. 14, fig. 5, 6.
1930. *Waagenophyllum akasakensis*, SMITH: Two Anthracolithic corals from British Columbia and related species from the Tethys. Jour. Palaeont. vol. 9. p. 36.

Corallum fasciculate, composed of long cylindrical corallites, which are sometimes flexuous. Corallites usually are perfectly separated from each other but sometimes the neighbouring corallites fused together with uniting process. Corallites are usually 7 or 8 mm in diameter in the cross section but sometimes attain as large as 12 mm, but never beyond this. Major septa 20 to 22 in the mature stage but they come to be more than 30 in the extraodinary large individuals. Minor septa alternating with the former, which are relatively thinner and less long, ranging usually 2/3 to 3/4 the length of the former. Tertiary septa quite absent.

Columella, large, occupying a space from 2/5 to slightly less than 1/3 the diameter of the corallites, being composed of abundant tabellae and less numerous lamellae. Median plate is not usually distinct.

In the longitudinal section triareal arrangement rather distinct. Tabulae sporadically develop, which are almost horizontal. Dissepiments elongate, their convex sides facing inwards; outer wall free from any organic deposits.

Ontogenetic observation: The writer examined minutely one specimen which was figured by the Late Dr. Y. OZAWA in his plate 14, fig. 5. The thin section was said to be made from specimens which had been collected by OZAWA from Shiraiwa, Omine-mura Akiyoshi plateau. In this section, there

are observable many corallites representing various ontogenetic stages.

In the earlier stage, corallites are very small and have quite less numerous septa than in mature stage, including major and minor ones and do not possess either axial structure or dissepiments. The counter septum in this stage is only slightly longer, while the cardinal one is decidedly shorter than the other major septa. Fossula is not prominent even in this stage, but near the cardinal as well as two alar septa there is more large space than the other part of the corallites.

Then, simple columella appears in the corallite; the form of it reminds one of *Siphonodendron*, and in this stage disspiments also become visible.

In succeeding stage, the counter septum is uniting with columella, the feature representing an appearance of Koninckhphylloid or Lophephylloid corals. Also the dissepimentarium becomes wider in this stage.

Next the columella begins to be consructed of septal lamellae and axial tabellae and the coralite shows the mature stage.

Remarks: YABE first mentioned the existence of the tertiary septa in this species in the original description: they were clearly recognizable in his text figure, but he found later that his statement was in error. Thus this species may be regarded to be more nearly akin to *Waagenophyllum indicum*, than formely considered. However these two corals are never conspecific, because the former has slightly large corallites, and secondly it possesses longer minor septa and relatively large columella.

Hor.: *Yabeina*-zone

Loc.: Siraiwa, Omine-mura, Akiyosi-dai, Mine-gun, Yamaguti Prefecture.
Specimen now stored at the Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.
: Kinsyozan, Akasaka-mati, Fuwa-gun, Gifu Prefecture.
: Ohsawa, Tome-gun, Maiya-mati, Miyagi Prefecture.
: Sogao, Oharano-mura, Otokuni-gun, Kyoto Prefecture.

All these specimens now stored at Inst. Geol. Tokyo Univ. and Inst. Geol. and Palaeont. Tohoku Univ.

Waagenophyllum polyseptata MINATO, sp. nov.

Pl. 21, fig. 3.

Corallum fasciculate, corallites large, their calicular diameter sometimes attaning more than 14 mm. Septa numerous, major septa number more than 30, alternating with same number of minor septa. Besides the minor and major ones, there are distinct tertiary septa which are about 2/3 to 1/3 the length of the minor ones. All those septa reach the outer wall and there is no peripheral area free from septa.

The major septa slightly thickened at the medial zone, and becoming thinner towards both ends, except the very base at the outer wall, where they again become thick.

Columella, round or elliptical in outline in the transverse section, not loosely constructed; composed of numerous septal lamellae, tabellae and rather distinct median plate in cross section.

In the longitudinal section, dissepimentarium is composed of more than seven rows of small sub-elongate vesicles, which face their convex sides upwards as well as inwards. Tabularium occupies about 2/3 the space of the corallites and the columella about 1/2 or 2/3 the width of the tabularium. Outer tabularium is very narrow. Tabulae sub-horizontal and counted as many as 9 or 10 in a distance of 5 mm.

Remarks: From large size of corallites, numerous septa and relatively thick dissepimentarium, this species may be rather remote from the genotype of this genus. Besides this, columella of this species presents typical spider-web structure in cross section. However, the median plate of columella is somewhat sinuous in the longitudinal section and does not connect with any septa. Further, the dissepiments are arranged in typical concentric pattern which is one of the most chracteristic features of the genus *Waagenophyllum*. Moreover the outer tabularium is very narrow, although the tabulae develop decidedly. Thus the generic position of this species is firmly ascertained.

More than thirty years ago, YABE described *Lonsdaleia akasakensis*, which is *Waagenophyllum* as has been revised by YABE himself. According to his figure and description, the described specimens have definite tertiary septa, besides the major and minor septa; that feature reminds the writer strongly of this species now under discussion.

Meanwhile YABE and his collaborator denied later the existence of such tertiary septa in the original specimens of *akasakensis*. On this point YABE and HAYASAKA wrote as follows : what the senior author thought as such on the former occasion is in reality totally deceptive and is nothing but the boundary lines between each pair of the first (major) septa and second order (minor), disguised under a special state of preservation." Also the present writer had the opportunity to examine the holotype of *akasakensis*, now stored at Inst. Geol. and Palaeont., Tohoku Univ. and he (MINATO) ascertained for himself that there are no tertiary septa in *akasakensis*.

Such being the case the so-called *akasakensis* which was supposed by YABE to have teriary septa is not at all conspecific with the specimens now in consideration.

In the Kitakami mountainarea, this species comes from the *Neoschwagerina* zone in association with *Lyttonia* fauna.

Some specimens collected by the late Dr. NAGAO from a limestone quarry (Kahan), Kinsyosan, Akasaka and called to the writer's attention are quite the same species as the one, now described, which denotes a definitely higher horizon. Because from Kahan limestone, *Yabeina globosa* (YABE), was reported by OZAWA, in association with *Waagenophyllum akasakensis* (YABE), this species may have geological range from the *Neoschwagerina*-zone to the *Yabeina* stage.

Hor.: *Neoschwagerina-Yabeina* Zone.

Loc.: Tsukitate, Motoyoshi-gun, Miyagi Prefecture. Reg. nos.: 15526, 15513, 15512. Coll.: M. MINATO.

: Kahan, Kinsyozan, Akasaka-mati, Fuwa-gun, Gifu Prefecture. Reg. nos.: 9959, 9958, 9735. Coll.: T. NAGAO.

Waagenophyllum akagoensis OZAWA

Pl. 30, fig. 4; Pl. 33, fig. 1.

1923. *Lonsdaleia kotoana*, OZAWA (MS): Stratigraphical studies of the Upper Palaeozoic system of the Akiyosi limestone plateau. (in Japanese) Jour. Geol. Soc. Tokyo, vol. 30, p. 243, listed.

1925. *Lonsdaleia* (*Waagenophyllum*) *indica* var. *akagoensis*, OZAWA: Palaeont. study, etc. Jour. Coll. Sci. Tokyo Imp. Univ. vol. 45, Art. 6, p. 76, pl. 14, figs. 7, 8, 9.

Corallum fasciculate, corallites cylindrical and sub-parallel. Calicular diameter of the corallites larger than 6 mm in the mature stage, sometimes attaining more than 12 mm. There are about 20–28 major septa, alternating with an equal number of minor septa; the latter are half the length of the former. Septa become sometimes much thinner near the outer wall and to be disunited from the outer wall; in such a case more or less large vesicles develop at the peripheral area. In the columella, median plate is occasionally distinct.

In the longitudinal section, the dissepimentarium is composed of small conical vesicles in irregular size which are arranged in oblique row, with their convex sides facing upwards as well as inwards. Tabulae count as many as 6–8 in a distance of 5 mm.

Remarks: This species is near to the genotype of *Waagenophyllum*, however the corallites of this species are larger than the latter and take rather irregular form in the cross section. From possessing relatively short minor septa and rather distinct horizontal tabulae, it is also easily separable from the latter.

From above mentioned fact, it is also distinguishable from *Waagenophyllum akasakensis* (YABE).

As OZAWA has mentioned, in the corallites of this species there is some-

times a non-septated peripheral area, therefore this species is seemingly more akin to the genus *Lonsdaleia* than to typical *Waagenophyllum*. However in this peripheral area there is no typical lonsdaleoid dissepiments in the thin section; besides this, the dissepiments mostly are arranged in a typical concentric pattern.

OZAWA considered this as a mere variety of the genotype of genus *Waagenophyllum*, but from the above mentioned point, the writer considered that it should be treated as a species independent from any other known species of *Waagenophyllum*.

Hor.: Uppermost *Pseudoschwagerina* zone (?) or *Parafusulina* zone.
Loc.: Kaerimizu, Akago-mura, Mine-gun, Akiyoshidai, Yamaguchi Prefecture. Holotype specimen now stored at Inst. Geol. Tokyo Univ.
: Funabuse (Hunabuse), Yamagata-gun, Gifu Prefecture
: Siramizu, Shinsaka-mura, Kameishi-gun, Hirosima Prefecture.

Genus ***Wentzelella*** GRABAU, 1927

Wentzelella sekii MINATO, sp. nov.

Pl. 26, fig. 9; Text-fiigs. 8. D, 1, 2, 3, 4.

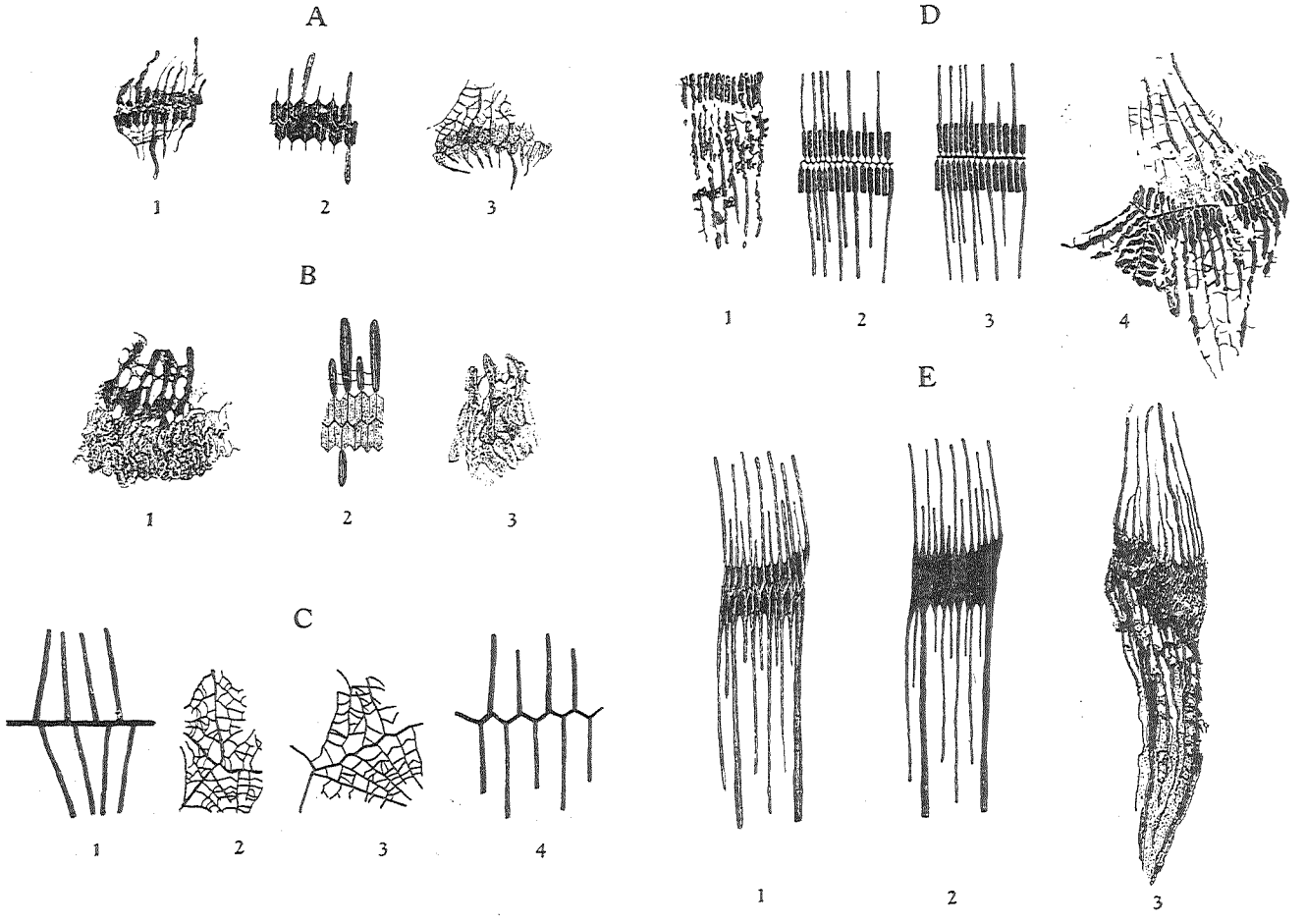
Corallum compound, composed of corallites of sub-tetragonal shape in the transverse section. Outer wall originally thin, however slightly strengthened by organic deposits. Major septa count up to 21 in the corallite which is 7–10 mm in diameter. Minor septa alternate with the major ones. Tertiary speta shorter than the former two, which are quite thick throughout their length. Major and minor septa thin in the medial area, while they are subequal in thickness compared with the tertiary septa near the outer wall.

Columella small, loosely constructed, in which no median plate is observable. Dissepiments are arranged concentrically and the dissepimental zone is rather thick.

Remarks: This form may be comparable to *Wentzelella kitakamiensis* YABE et MINATO,[1] but the former has less numerous septa and no quaternary septa. For the same reasons, this species now under consideration is also specifically separable from *Wentzelella szechuanensis* HUANG.[2] The columella of the Chinese species is also more densely costructed than this Japanese form.

Hor.: *Parafusulina* zone
Loc.: Oishizawa, Iwate-mura, Fuwa-gun, Gifu Prefecture. Specimens now

1) H. YABE und M. MINATO: Eine neue Art von *Wentzelella* aus dem japanischen Perm. Japanese Jour. Geol. Geogr. vol. 19, p. 139. pl. 11. 1944.
2) T.K. HUANG: Permian Corals of Southern China. Pal. Sinica, ser. B, vol. 8, fasc. 2, p. 62, pl. 5, fig. 4, 1932.



Text fig. 8. Schema of walls and septa of some species of *Wentzelella* and *Wentzelloides*.

A: *Wentzelloides maiyaensis* YABE et MINATO
B: *Wentzelella ozawai* MINATO, sp. nov.
C: *Wentzelella subtimorica* HUANG
D: *Wenizelella sekii* MINATO, sp. nov.
E: *Wentzelella kitakamiensis* YABE et MINATO

stored at Inst. Geol. and Palaeont., Tohoku Univ.
Coll.: T. SEKI

Wentzelella ozawai MINATO, nom. nov.

Pl. 25, figs. 5, 7; Pl. 30, fig. 8; Text-fig. 8, B, 1, 2, 3.

1925. *Lonsdaleia* (*Waagenophyllum*) *frechi*, OZAWA (non VOLZ): Palaeontological and stratigraphical studies of the Permo-Carboniferous limestone of Nagato. Jour. Coll. Sci. Tokyo Imp. Univ., vol. 45, Art. 6, p. 72, pl. 12, fig. 8.

Corallum compound, composed of corallites of polygonal form. Walls are strongly thickened by stereoplasmic deposits as well as septal ridges and sometimes partly plocoid. There are two orders of septa, major and minor; the latter are more numerous than the former. The average numer of major septa may be 10 in the mature stage. The calicular diameter is about 4 mm. Columella is rather simply constructed but is occasionally strenghthend by stereoplasmic deposits in some corallites. No perfect longitudinal sections were obtained but the tabulae are almost horizontal being counted as many as 9 in a distance of 3 mm.

Remarks: The above description was based on the original specimens, which were dealt with by OZAWA and were compared by him to VOLZ's species.

So-called *Lonsdaleia frechi* VOLZ[1] may be a representative of the genus *Polythecalis*, while OZAWA's specimens may be nothing but *Wentzelella*. Accordingly it is rather likely that there may by neither generic nor specific identify between them.

Of species of *Wentzelella*, OZAWA's specimens may without much doubt be allied to *Wentzelella iwaizakiensis* YABE et MINATO, described from the Permian Iwaizaki limestone of the Kitakami district. Still, they may be, specifically different from the Kitakami species, in having more strong outer wall ornamented by spine-like septal ridges.

Hor.: *Yabeina* zone.

Loc.: Sibukura, Omine-mura, Akiyosi-dai, Yamaguchi Prefecture. Specimens now stored at Inst. Geol. Tokyo Univ.

Wentzelella iwaizakiensis YABE et MINATO

Pl. 20, figs. 1, 2.

1945. *Wentzelella iwaizakiensis*, YABE and MINATO: A new species of *Wentzelella* from the Permian limestone near Iwaizaki, Kitakami district, Northeast Japan. Proc. Japan Acad. vol. 21, p. 469, figs. 1-5.

1) VOLZ: Zur Geologie von Sumatra. Geol. und Palaeont. Abhand. Neue Folge, Bd. 6, p. 100, figs. 32-34, 1904.

Description (YABE and MINATO, 1945): Corallum massive, composed of small corallites measuring never more than 5 mm in diameter and about 4.5 mm in average. Wall moderately thick, usually zig-zag of flexuous in transverse section. Septa not numerous, major ones 9-11 in number, alternating with minor ones of same number. Major septa extend from outer wall, never connected dircetly with columella; the minor ones slightly thinner and much shorter than majors. Columella round or rather elliptical in transverse section, composed of septal lamellae, axial tabellae, and rarely also of a median plate which is usually flexuous. Dissepiments arranged in two concentric rows in dissepimental zone.

In the logitudinal section, dissepiments arranged with convex sides inwards. Tablarium occupied by columella and tabulae; the latter more or less flat, usually 11 in 0.27 mm. Median plate and axial tabellae recognizable in inner tabularium; axial tabellae a ascending steeply towards median plate, numbering 16 in 0.16 mm.

Remarks: As formerly discussed by YABE and the writer, presence of so-called gaps or conals in this species observed in the outer wall in some corallites, is the most characteristic feature of this species.

Of *Wentzelella*, such species as *W. canalifera* (*Lonsdaleia canalifera* of SEN),[1] *Wentzelella paracanalifera* HUANG[2], *Wentzelella socialis* (*Lonsdaleia solialis* of MANSUY)[3] have also such canals in the outer wall; to these species the present form shows much affinity in this respect.

However from the thickness of dissepimental zone, septal number and size of corallites, the present form is specifically distinct from all those known species.

Hor.: *Yabeina* zone.

Loc.: Iwaizaki, Hajikami-mura, Motoycshi-gun, Miyagi Prefecture. Specimens now stored at Inst. Geol. and Palaeont., Tohoku Univ.

Wentzelella kitakamiensis YABE et MINATO

Pl. 25, fig. 6; Text-fig. 8 E, 1, 2, 3.

1944. *Wentzelella kitakamiensis*, YABE und MINATO: Eine neur Art fon *Wentzelella* aus dem japanischen Perm. Japanese Jour. Geol. Geogr. Vol. 19, p. 139, pl. 11.

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1) A. SEN: On the development of the genus *Waagenophyllum* YABE and HAYASAKA from the Productus limestone beds of the Salt Range. Q.J.G.S. and Mining and Metallogical Soc. India, Vol. 3, p. 126, pl. 9, figs. 1-6: pl. 10, figs. 1-2, 1931.

2) T. K. HUANG: Permian corals of Southern China. Pal. Sinica, ser. B. vol. 7, fasc. 2, p. 64, pl. 5, fig. 2, 1932.

3) H. MANSUY: Faunes des calcaires à Productus du Camnodge. Mém. Serv. Géol, de Indochine, vol. 2, fasc. 4, 1913.

Description (YABE und MINATO, 1944): Aus einem grossen Stock war es möglich sieben Querschnitte und einen Längschnitt zu becommon. Die Koralliten schliessen sich eng aneinander an. In der grossen Kelchen (12–13 mm. Durchmesser) ist die Zahl der langen Saptan 1. Ordnung 26, in den meisten Kelchen (Durchmesser 7–10 mm) aber 22–25. Die Septen 1. Ordnung reichen nicht an das Saulchen heran; es ist immer ein schmaler Raum zwischen beiden vorhanden. Die Septen II. Ordnung dunner und etwas kurzer als jene der 1. Ordnung. Kurze Septen III Ordnung sind auch deutlich entwicklt. Sie liegt regelmässig zwischen den lange Septen I und II. Ordnung. Bei allen Koralliten sind die äusseren Mauern sehr stark durch Stereoplasma verdickt. Das Säulchen besteht aus Medianplatte, Tabellae und Lamellae. Gelegentlich ist die Medianplatte von anderen Lamellen nicht unterscheiden. Die externe Zone zeigt eine breite Entwicklung von Dissepimenten. Es ist ursprünglich kein randliches Blasengewebe aber die Septen I. und II ordnung sind gegen dem Rand sehr dunn geworden, deshalb sieht man, ob eine Blasenzone vorhandet ist. Der Längsschliff mit drei Zonen ist etwas schief getroffen. Die Tabulazone ist sehr schmal.

Remarks: This species may be comparable to *Wentzelella szechuanensis* HUANG[1] in general form but is distinguishable in possessing larger columella in the cross section.

Until the present day the writer has learned of three other localites additional to the type locality yielding this species which are 1) the eastern slope of Abutoge (pass), 2) Miyagisawa and 3) Yamamoto, all are in the area of the Kitakami Mountain district. From the last mentioned locality Mr. T. YOSHIDA collected this species from the tuff formation, on account of which fact he holds the opinion that it should be correlated to the Lower Sakamotosawa series. Thus this species may be ranging from the Early Permian to the *Yabeina* stage.

Hor.: *Pseudoschwagerina* zone to *Yabeina* stage. The upper limit is now not settled.

Loc.: Kattisawa, Setamai-mati, Kesen-gun, Iwate Prefecture. Reg. nos.: 15156, 15157, 15158, 15159, 15235. Coll.: M. MINATO

: East of Abu-toge (pass), Matsukawa-mura, Higasiiwai-gun, Iwate Prefecture. Coll.: M. MINATO

: Miyagasawa, north of the Rodai, Tome-mati, Tome-gun, Miyagi Prefecture. Coll.: M. MINATO

: About 1 kilometer from Yamamoto, Yonesato-mura, Esasi-gun, Iwate Prefecture. Coll.: T. YOSHIDA.

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1) T. K. HUANG: op. cit., p. 62, pl. V, fig. 4, 1932.

Wentzelella subtimorica HUAEG

Pl. 22, fig. 8; Pl. 23, fig. 7; Pl. 25, fig. 2; Pl. 26, fig. 3; Pl. 30, fig. 6; Text-fig. 8, C. 1, 2, 3, 4.

1925. *Lonsdaleia (Waagenophyllum) timorica*, OZAWA: Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato, Jour. Coll. Sci. Imp. Univ. Tokyo, vol. 45, art. 6, p. 74, pl. 13, figs. 7-9.

1932. *Wentzelella subtimorica*, HUANG: Permian corals of Southern China. Palaeont. Sinica, ser. B, vol. 12, fasc. 2, p. 59, pl. 4, fig. 1.

1944. *Wentzelella subtimorica*, MINATO: An occurrence of *Wentzelella subtimorica* in Northern Tai. Proc. Imp. Acad. Tokyo, vol. 20, p. 105, figs. 1-3.

Remarks: The present form is indistinguishable from *Wentzelella subtimorica* HUANG, but is easily separable from *Wentzelella timorica* GERTH described and figured by GERTH from the Permian of Timor, although the late Dr. OZAWA once considered this to be assignable to GERTH's[1] species. In *Wentzelella timorica*, tabulated area is almost absent or only poorly developed.

Hor.: *Yabeina* zone

Loc.: Shigeyasu, Omine-mura, Mine-gun, Yamaguchi Prefecture.

: Serida, Kyowa-mura, Mine-gun, Yamaguchi Prefecture. Specimens now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA

Genus ***Wentzelloides*** YABE and MINATO, 1944

This genus is somewhat similar to *Protlonsdaleia* GORSKY[2], both have corallites, occasionally plocoid; however, the outer wall of *Wentzelloides*, if it is retained, is very thick, while the reverse is the condition in the genus *Protolonsdaleia*.

However, the most characteristic feature of this genus, now under consideration may be decidedly in the mode of arrangement of corallites; they are occasionaly arranged in linear or rather meandroid; such arrangement is not known in Tetracoral, although it is a quite common feature in the case of Hexacoral.

The diagnosis for this genus formerly given (YABE and MINATO, 1944) was as follows: In der allgeminen Characteristik erinneren die vorliegenden Exemplare an das Genus *Wentzelella* GRABAU, aber die ausseren Mauern sind teilweise verschwunden, und die Kelch reihen mehr oder weniger lineal.

1) H. GERTH: Anthozoen der Dyas von Timor. Palaeontologie von Timor. Lief. 9, pl. 145, figs. 1, 2, 1921.

2) T. A. DOBROLYUBOVA: The corals of the Upper Carboniferous of the Western slope of the Middle Urals and their stratigraphic importance. Trans. All-Union Sci. Res. Inst. Eco. Min. fasc. 103, p. 54, 1936.

Wentzelelloides maiyaeensis YABE et MINATO

Pl. 24; Text-fig. 8, A, 1, 2, 3.

1944. *Wentzelloides maiyaensis*, YABE und MINATO: *Wentzelloides maiyaensis* YABE et MINATO, gen. et sp. nov. aus dem Perm des Süd-Kitakami-Gebirges. Japanese Jour. Geol. and Geogr. vol. 19, nos. 1-4, p. 141, pl. 12.

Description (YABE und MINATO, 1944): Die Koralle steckt ganz in Gesteinen, deshalb ist die Aussenseite unbekannt. Es sind fünf Dünnschliffe möglich. Die Koralliten schliessen sich eng aneinder an. Die Durchmesser der Kelche betragen meistens 5 mm. Es gibt drei Arten Septen: I. Ordnung, II. Ordnung und III. Ordung. Die Zahl der Septen I. Ordnung beträgt 8-10.

Die Septen I. Ordnung sind gewöhlnlich durch Stereoplasma verdickt. Man sieht dabei in ihrer Mitte eine schwarze Linie, an welcher die Verdickung aüsetzt. Sie erreichen nicht das Zentrum. Die Septen II. Ordnung sind kürzer und schwäher als jede der I. Ordnung und erreichen 1/4 bis 2/3 die Länge jener der I. Ordnung. Die Anzahl der Septen II. Ordnung ist etwas grösser als die der I. Ordnung. Die Septen III. Ordnung sind etwas kürzer als jene der II. Ordnung, aber ihre Länge ist öfters gleich. Alle Septen sind in der Nähe der äusseren Mauern stark verdickt.

Das Säulchen ist klein und relative einfach gebaut. Es besteht aus einigen Blättchen. In den meisten Kelchen sieht man im Querschliff keine deutliche Medianplatte, aber im Lägschliff gibt es im Form einer weissen Linie in der Mitte des Säulchens eine Andeutung davon. Die Tabellae sind im Langschliff etwas dicht, dagegen sind die Lamellae im Querschliff sehr spählich. In allgemeinen ist die Struktur der Säulchen ganz dicht mit Stereoplasma bedeckt und besonders ist die Verdickung in den äusseresten Tabellae deutlich.

Die Dissepimentzone ist ziemlich breit. Ein randliches Blasengewebe ist nicht vorhanden. Um das Säulchen schlingt sich eine Zone ohne Septen. Das ist die Region der Tabulae der Längsschliffe. Es sind zahlreiche flache Tabulae vorhanden (Entfernung durchschnittlich 17-20.5 mm). Die äusseren Mauern sind durch Stereoplasma stark verdickt. Schon anfangs ist darauf hingewiessen worden, dass sie öfters teils verschwunden und dann die Septen der benachbarten Koralliten mit aneinader vereingt sind, wobei die Verdickung der Septen etwas schwacher wird. Die Verschwinden der äusseren Mauern findet teils in der Mitte statt, teils an beiden bzw. am einem Ende der Kante und öfters tritt auch der Fall ein, dass eine Kante vollkommen fehlt.

Remarks: *Wentzelella* has usually cerioid corallites, but ssme types are partly plocoid; *Wentzelella canalifera*, *W. paracanalifera*, *W. socialis*, *W. iwaizakiensis*, for example, have canals on walls or partly lose their walls; these types must be considered as first step in the plocoidal trend of corallites

in *Wentzelella*, while *Protolonsdaleia*[1] as well as *Wentzelloides* are more progressive forms in this trend than this type of *Wentzelella*.

As formerly mentioned, however, the genus *Wentzelloides* is quite distinct from genus *Protolonsdaleia* not only in the difference of the outer wall but also in the mode of arrangement of corallites; the former has corallites grouped in linear series, althogh the neighbouring corallites are not perfectly plocoid and thus genus *Wentzelloides* is quite peculiar in giving such an appearance of maeandroid coralla as has not been hitherto known in the Tetracorals.

Meanwhile the writer has learned very recently that this species was collected by T. SATO (1953) from a limestone developing at Yumiorezawa, west of Hisahara, Soma-gun Fukushima Prefecture, Abukuma mountain region, when he examined SATO's collection from this district, upon the occasion of a short visit at Geol. Inst. Tokyo Education University. The specimens collected by Sato were in excellent preservation and are completely identifiable to the holotype.

According to T. SATO the mentioned limestone yielding this coral was found in the conglomeratic formation of the Usuginu type of the Upper Permian, and this coral was collected in association with such fusulinid genera as *Yabeina*, *Lepidolina*, *Sumatrina* and *Verbeekina*.

In this regard, a similar case had already been ascertained also in the Kitakami district, where the writer found this species at Yamazaki, in a small lenticular limestone, intercalating in the conglomerate of the Usuginu formation.

Hor.: *Yabeina* zone, associate fossils are: *Yabeina* sp., *Waagenophyllum indicum* (WAAGEN et WENTZEL).
Loc.: Yamazaki, Maiya-machi, Tome-gun, Miyagi Prefecture.
Reg. nos.: 15232, 15233, 15234, 15242, 15682. Coll.: M. MINATO.
Hor.: *Yabeina* zone, associate fossils: *Yabeina*, *Lepidolina*, *Sumatrina* and *Verbeekina*.
Loc.: Yumiorizawa, wesl of Hisahara, Kamimano-mura, Soma-gun, Fukushima Prefecture.
Coll.: TOSHIHIKO SATO.

Genus *Iranophyllum* DOUGLAS, 1936

Iranophyllum permicum MINATO, sp. nov.

Pl. 31, fig. 4; Pl. 37, fig. 3.

1944. *Sakamotosawanella permicum*, MINATO (MS): Stratigraphische Gliederung des Perm des Süd-Kitakami-Gebirges, Japan. Jour. Geol. Soc. Japan. vol. 51, p. 84, listed.

1) T. A. DOBROLYUBOVA: The corals of the Upper Carboniferous of the Western slope of the Middle Urals etc. Trans All Union Sci. Res. Inst. Economic Mineralogy, Fasc. 103, p. 54, 1936.

Corallum simple, small in size. Corallites is too firmly embedded in the matrix to extract and accordingly it was observable only in thin section. There are 33 major septa, alternating with same number of minor ones. Calicular diameter ranges from 9 to 12 mm. Major septa are fairly thicker and longer than the latter; the former reach always almost to the central part, but never directly unite with the septal lamellae of the columella. Minor septa are always slightly extruded beyond the theca. There is no peripheral area free from septa. Columella is constructed rather densely of numerous lamellae and tabellae. Median plate is also recognizable, which is thick but slightly uniting with some major septa. The cardinal septum is slightly shorter than the other major septa and this septal shortening gives an appearance of the existence of a fossula.

Dissepimental area is broad, almost 1/3 the diameter of corallites, where several rows of dissepiments are found. Dissepiments are arranged in angulo-concentric-pattern. In the medial area there are observable also many cut edges of tabulae.

Remarks: From size of the corallites, septal number and general appearance, this species reminds one of a species of *Schwagerina* limestone of Carnic Alps, described and figured by HERITSCH under the name of *Clisiophyllum carnicum*.[1] Under careful examination, however, it may be different from the Japanese species, because in HERITSCH's species no definite median plate is observable in the columella. His species, the writer thinks, should be considered to belong to the genus *Clisaxophyllum* and not *Clisiophyllum* as he supposed and therefore it has no intimate relation to the Kitakami specimens.

Dibunophyllum[2] sp. described and figured also by HERITSCH came from the *Schwagerina* limestone of the Carnic Alps, which denotes the Lower Permian in age. This species may not be *Dibunophyllum* at all, but it should be rather considered as belonging to the genus *Iranophyllum*. This species, however, also has dissepiments arranging in concentrie pattern and possesses median plate of columella which is far thinner than that of the Japanese form.

Hor.: Lower Sakamotosawa series, *Pseudoschwagerina* zone.
Loc.: Sasizawa, Maiyamachi, Tome-gun, Miyagi Prefecture.
Reg. no.: 15519 Coll.: M. MINATO.

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1) E. HERITSCH: Korallen der Moskauer-, Gsher- und Schwagerinen-Stufe der Karnischen Alpen. Palaeontogr. 83 A, p. 122, pl. 17, figs. 24-28, text figs. 25-26 in pl. III. 1936.
2) F. HERITSCH: ibid. p. 121, text fig. 24 in text fig. pl. III.

Genus *Yatsengia* HUANG, 1932

Yatsengia kiangsuensis var. *mabutii* MINATO var. nov.

Pl. 18, figs. 7, 8, 9 & 10; Pl. 29, figs. 1-4; Text-fig. 9 L-M.

1944. *Yatsengia kiangsuensis* ? YOH et HUANG, MINATO: Ueber die mittelpermischen Korallen aus dem Kitakami-Gebirge, etc. Jour. Geol. Soc. Japan, vol. 51, p. 157, pl. 1, figs. 1-6.

This variety was formerly described by the present writer under the name of *Yatsengia kiangsuensis* ? YOH et HUANG from the Permian limestone of Iwaizaki, Kitakami Mountainland. He concluded lately that it would be better to treat this form as a variety of YOH' and HUANG's species; for this form, the name *Y. kiangsuensis* var. *mabutii* is here proposed. The occurrence of *Yatsengia* at Iwaizaki was first reported by MABUTI and the name of the variety is proposed in honor of him.

The former description of this form was as follows:

Es handelt sich um eine strauchartig wachesende Koralle. Die Koralliten sind zylindrisch, erreichen gewöhnlich eine Länge wie mehr als 50 mm und einen Kelchdnrchmesser von 4 mm. Die Kelchgrube ist nicht klar beobachtet. Man zahlt 13 lange Septen, aber die kurzeren Septen sind spärlich und in den meisten Korallieten kann man sie nicht sehen. Im Jugendstandium entwickelten sich schwach bzw. fehlen sie auscheinend ganz. Die längeren Septen reichen meistens bis zum Zentrum. Die Columella ist sehr einfach in der Jugend (*Lithostrotion* Typ) und zeigt Lonsdaleia Typ (Spinnengewebeartige-Columella) im späteren Stadium ist aber eine Medianlamelle im allgemeinen undeutlich. Die Zahl der Septen ist aber eine Medianlamelle im allgemeinen undeutlich. Die Zahl der Septen ist weniger und die Koralliten sind auch kleiner in der Jugend. Die längeren Septen sind gelegentlich keilförmig im Jugendstadium. Die oben erwähnte Charakteristik zeigt die beigefügte Tabelle.

Die Mauer ist ursprünglich dunn. aber immer mit einer schmalen Stereozone bekleidet. Die Stereoplasmatische Verdickung findet sich auch in allen Septen, an der Basis der Septen in der Nähe der Mauer ist sie etwas stärker. Die Dissepimentenzone ist zwischen den Septen nur ganz schwach entwickelt und es sind immer nur wenig Dissepimenten vorhanden.

Längschnitte zeigen regelmässige flache Böden. Die Entfernung der benachbarten Böden beträgt durchschnittlich 0-4 mm, und nur selten sieht man eine Vereinigung von zwei Böden. Columella besteht aus schwach etnwickelten Vertikallamellen (undeutliche Medianlamelle?) und zahlreichen Kuppeln, die nach oben steil gewölbt sind. Im Jugendstadium aber ist nur eine schwache Vertikallamelle in Zentrum der Korallite vorhanden und die Kuppelen der Columella fehlen, wobei die Böden durchgehen. Die äussere

Zon besteht aus einer Reihe von sehr regelmässigen Dissepimenten. Die Konvexfläche der Dissepimenten wendet sich immer nach der Columella.

Remarks: This form closely resembles *Yatsengia kiangsuensis* YOH[1] but the latter has major septa which are slightly thickened at the middle part and besides this, in the Japanese form the minor septa are very poorly developed.

Although the writer did not report it, the tabulae of this form are almost horizontal but sometimes they are slightly ascending towards the columella. This feature is quite common in all known species of this genus.

Hor.: *Yabeina* zone.

Loc.: Iwaizaki, Hajikami-mura, Motoyoshi-gun, Miyagi Prefecture. Reg. nos.: 15466, 15179, 15461, 15465, 16974.

: Kattisawa, Setamai-mati, Kesen-gun, Iwate Prefecture. Reg. nos.: 15181, 15177, 15468, 15178.

Coll.: M. MINATO.

Yatsengia ibukiensis MINATO, sp. nov.

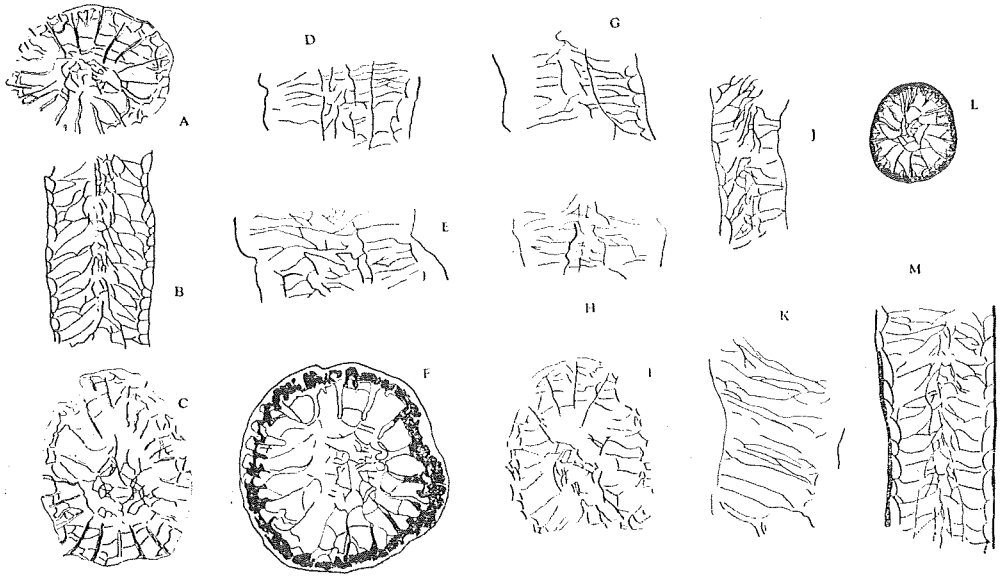
Pl. 28, figs. 1-2; Text-fig. 9, A-C.

Corallum fasciculate, corallites usually loosely aggregated. Corallites relatively large, the calicular diameter ranging from 6 to 7 mm in the mature stage. Wall characteristically thin. Septa in two orders. Major septa reaching the central area, but never directly uniting with any septal lamellae of the columella in the mature stage, while in the young stage they often penetrate into the columella. Columella, loosely constructed of axial tabellae and septal lamellae, in which no definite median plate is discerniable. Minor septa short, but extruded slightly beyond the dissepimental area.

Calicular diameter and corresponding major septal number of each corallite are as follows:

3.5 mm	13
4.0 mm	16
4.7 mm	14
5.0 mm	18
6.0 mm	18
6.3 mm	19
6.4 mm	21
6.5 mm	21
7.0 mm	20

1) S. S. YOH and T. K. HUANG: The coral fauna of the Chinsia limestone of the Lower Yangtze valley. Pal. Sinica, ser. B, vol. 8, fasc. 1, p. 33, pl. 9, figs. 1-2. 1932.



Text-fig. 9.

A-C: *Yatsengia ibukiensis* MINATO, *sp. nov.* ×3
D-K: *Yatsengia kabayamaensis* MINATO, *sp. nov.* ×3
L-M: *Yatsengia kiangsuensis var. mabutii* MINATO, *var. nov.* ×3
A-C (17780, 17331), D-K (17220-17223), L-M (15187, 15177)

In the longitudinal section, dissepimental vesicles are arranged only in one order, facing their convex sides inwardly. Tabulae almost horizontal or slightly ascending towards the columella, counting 9–10 in a distance of 5mm., central column composed of axial tabellae which are steeply ascending towards the imaginary median plate; the latter is very sinuous and presents no distinct plate.

Remarks: This form is most nearly related to *Yatsengia hangschowensis* HUANG[1] but, in the latter, minor septa are rudimentary or almost absent. *Yatsengia hangchowensis* HUANG is a good horizon marker for the Chihsia limestone in Southern China, while the new form is associated with such fusulinid foraminifera at Ibuki[2] as *Doliolina* cf. *ovalis* DEPART, *Schubertella omiensis* SEKI (MS) and *Schwagerina kraffti* (SCHELLWIEN) and thus it denotes probably the *Parafusulina* zone, which is almost equivalent with the Chihsia limestone in age.

1) S. S. YOH and T. K. HUANG: The coral fauna of the Chihsia limeston, etc. Paleont, Sinica, ser. B, vol. 8, fasc. 1, p. 32, pl. 9, figs. 3a-c, 1932.

2) T. SEKI: The Upper Palaeozoic stratigraphy of Mt. Ibuki and its neighbourhood. Jubilee publication in commemoration of Prof. H. Yabe's 60th Birthday, vol. 1, p. 521, 1939.

Hor.: *Parafusulina* zone.

Loc.: North of Yataka, Suisyo-mura, Ibuki district Sakata-gun, Gifu Prefecture. Specimens now stored at Inst. Geol. Tohoku Univ. Coll.: T. SEKI.

: Funabase, Yamagata-gun, Gifu Prefecture.

: Serida, Akiyosi-dai, Yamaguchi Prefecture. Specimens now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA

Yatsengia kabayamensis MINATO, sp. nov.

Pl. 37, fig. 10; Pl. 41, fig. 3; Pl. 43, fig. 3; Text-fig. 9 D-K.

Corallum compound, fasciculate and phaceloid, corallites usually in close contact. Major septa 16 in number when the corallites reach full-grown stage. They are very thick near the outer wall, then they become thin towards the central area and a little flexuous at their ends. Major septa are also reaching the columella and directly uniting with the septal lamellae of the columella. Minor septa short. Columella irregularly cystose, composed of axial tabellae and septal lamellae, while median plate is almost lacking or not typically developed. Dissepimentarium is very narrow, where concentric dissepiments are arranged in a single row.

In a longitudinal section, tabulae rather horizontal or only slightly inclined toward the columella, counting 8 to 9 in a distance of 5 mm. Axial tabellae also horizontal or slightly uparching toward the center and a little more denesely arranged than the tabulae. Peripheral vesicles one layered, with their convex sides facing inwards.

Septal number (major septa)	Calicular diameter
12	4.5 mm
14	6.0 mm
15	4.5 mm
15	7.5 mm
16	6.5 mm
16	8.0 mm
16	8.5 mm
17	8.7 mm

Remarks: Specimens treated here which were collected at Kabayama-sawa, near Setamai, Kitakami mountain district, are in different states of preservation in comparison to the preceding species, and apparently show no intimate relation to the latter. Careful observation, however, reveals that the closeness of the present species to the latter is rather great and the writer cannot but help hesitating to separate it specifically from the latter. Nevertheless the specimens, now under consideration have always relatively small number or septa for their size and besides this, provide horizontal

tabulae. Upon these two points, the writer is led to believe them to be not conspecific with each other.

Further, the writer once collected specimens of a fasciculate coral from the *Michelinia multitabulata* limestone, developed near Maiya, Southern Kitakami mountain region, which may be assignable to the genus *Yatsengia*. At that time, however the specimens were not specifically determinable owing to their scantiness and poor preservation. But the writer now believes their closeness to the species, now under consideration, to be great. If this supposition may be true, this species denotes always the *Parafusulina* zone in both localities of the Kitakami district, judging from its associated fossils.

Meanwhile same species was found in the collections of T. KAKIMI brought back from Shiratori-zawa, Hikoroichi-mura; the horizon of the coral should be doubtlessly regarded to be the *Parafusulina* zone from the associated forminiferas.

Hor.: *Parafusulina* zone.

Loc.: Kabayamasawa, Setamai-machi, Ksesn-gun, Iwate Prefecture. Reg. nos.: 17220, 17221, 17222, 17392. Coll.: M. MINATO.

: Maiya, Tome-gun, Miyagi Prefecture. Coll.: M. MINATO.

: Shiratori-zawa, Sakamoto-zawa, Hikoroichi-mura, Iwate Prefecture. Reg. no. 17392. Coll.: T. KAKIMI.

Genus ***Pseudoyatsengia*** YABE, 1951

Genotype: *Pseudoyatsengia kuzuensis* YABE, 1951

Corals in fasciculate form, quite nearly related to the genus *Yatsengia*, but distinguishable from the latter in having septa which are thinning or sometimes disappearing in the dissepimentarium, while the genus *Pseudoyatsengia* greatly resembles *Huangia* YABE, but the construction of columella is somewhat different in those two genera.

Pseudoyatsengia kuzuensis YABE

Pl. 42, figs. 1, 2.

1951. *Pseudiyatsengia kuzuensis*, YABE: A new type of Lower Permian Tetracorals *Pseudoyatsengia*. Proc. Japan Acad. vol. 27, p. 201, figs. 1-2.

Description: YABE, (1951) Corallum compound, phaceloid, large, with corallites in general loosely aggregated, but occasionally in close contact, being more or less flexuous. Corallites cylindrical, circular, in cross-section, 5-6 mm broad, externally rugose, lacking prominent longitudinal striae. Wall thin. Dissepimentarium narrow, usually single-, sometimes locally two-layered. Dissepiments unequal in size, in general more or less elongate vertically,

steeply superimposed one above the other.

Axial column 1.5-1 mm broad, not well circumscribed, built rather loosely of a few radial elements and conically elevated tabellae; median lamella lacking. Major septa usually 14 in number, thin, flexuous, seldom extending to the wall and most of them disappearing in the dissepimentarium; shorter ones in alternation very feeble, never extruding from the dissepimentarium. Interseptal loculi between the dissepimentarium and the axial column traversed by numerous rather distant tabulae, which are mostly horizontal, sometimes slightly convex and then not seldom some disposed oblique and anastomosing with rach other, or rarely somewhat concave upwards.

Remarks: YABE discussed throughly, genus *Pseudoyatsengia* is quite allied to the genera *Yatsengia*, *Huangia*[1] and *Waagenophyllum*, but differs from all of them in having major septa which are thin and disappearing in the dissepimentarium.

Hor.: *Parafusulina* zone.
Loc.: Aisawa, 3km north of Kuzu-machi, Aso-gun, Tochigi Prefecture.
Coll.: K. SHIRAI.

Specimens are now registered at Geol. Inst. Tokyo Univ. of Education and Tokyo Science Museum, and also at Tohoku Univ.

Genus ***Huangia*** YABE* 1950

Genotype: *Corweina chiitsingensis* CHI

According to YABE, the Chinese corals described and figured by CHI,[2] YOH and HUANG[3] under the generic name of *Corwenia*, diverge from the typical species of *Corwenia* in the construction of columella and the inclination of tabulae. Thus he proposed a new generic name for those corals, *Corweina chiitsingensis* CHI as the genotype. This genus includes the following species.

C. chiitsingensis CHI. Moscovian of Yunnan and Kueichou.
C. chihsianense YOH. Chihsia limestone of the Nanking Hills.
C. chiuyaoshanensis YUANG. Feilaifeng (Lower Permian) limestone of Hangchow, Chekiang.
C. sp. cf. *Lonsdaleia indica* of REED, 1925=*Waagenophyllum chitralicum*

1) and *) H. YABE: Permian corals resembling *Waagenophyllum* and *Corwenia*. Proc. Japan Acad. vol. 26, p. 74, 1950.
2) Y. S. CHI: Weiningian (Middle Carboniferous) corals of China Pal. Sinica, ser. B, vol. 12, fasc. 5, p. 44. 1931.
Y. S. CHI: Additional fossil corals from the Weiningian limestones of Hunan, Yunnan and Kwangsi previnces, in SW. China. ibid. vol. 12, fasc. 6. p. 25, 1935.
3) S. S. YOH and T. K. HUANG: The coral fauna of the Shihsia limestone of the Lower Yangtze valley. ibid. vol. 7, fasc. 1, p. 27, 1932.

SMITH, 1935. Chihsia limestone of Howchow, Anhui.

C. parachihsiaensis HUANG. Chihsia limestone of Kueichou and Feilaifeng limestone of Chekiang.

C. lipoensis HUANG. Chihsia limestone of Kueichou.

C. diphyphylloides HUANG. Chihsia limestone of Anhui and Szechuan.

The so-called *Corwenia hasimotoi*, described by NAGAO and the writer, should be regarded decidedly to be congeneric with the species of Chinese *Corwenia*. YABE accepted the writer's former view; however YABE regards now, that the Japanese species (*Corwenia hasimotoi*) may be also different from the typical species of *Corwenia*, described from the Lower Carboniferous in Europe and must be grouped under his newly established genus *Huangia*. Many authors, as DOUGLAS,[1] SMITH,[2] HILL,[3] MOORE and JEFFORDS[4] held the opinion, that the corals being assignable to YABE's genus may be closer to *Waagenophyllum* in certain features of corallites, but the arrangements of dissepiments of those two genera in the transverse section, are quite different from each other.

Huangia hasimotoi (NAGAO et MINATO)

Pl. 2, figs. 1, 2, 3; Pl. 22, figs. 3, 4, 6.

1941. *Corwenia hasimotoi*, NAGAO and MINATO: *Corwenia hasimotoi*, a new Tetracoral from the Upper Palaeozoic of Sikoku. Jour. Fac. Sci. Hokkaido Imp. Univ., ser. 4, vol. 6, no. 2, p. 102, pl. 27.

Corallum fasciculate, with corallites in general loosely aggreated, being more or less flexuous, corallites cylindrical, semicircular in cross section, less than 20 mm broad, provided with prominent longitudinal striae. Wall rather thin. Major septa less than 30 in number, thin flexuous in extrathecal region, slightly thickened at the theca and then becoming gradually thin toward the axial area, not directly uniting with the axial structure.

Minor septa short, sinuous at the extrathecal area. Dissepimentarium very narrow in the early stage, where the dissepiments are arranged in subconcentric pattern, while it becomes broader at the mature stage and the dissepiments are arranged in pseudo-herring bone pattern. Dissepiments

1) J. A. DOUGLAS: A Permo-Carboniferous fauna from South-west Persia (Iran). Pal. Indica. N. S. Mem. no. 6, p. 12, 1936.

2) S. SMITH: Two Anthracolithic corals from British Columbia and related species from the Tethys. Jour. Palaeontlogy. vol. IX, p. 34, 1935.

3) D. HILL: A monograph on the Carboniferous Rugose Corals of Scottland. Palaeont. Soc. London, p. 100, 1939.

4) R. C. MOORE and R. M. JEFFORDS: New Permian Corals from Kansas, Oklahoma and Texas. State Geol. Surv. Kansas, Bull. 38, p. 96, 1941.

packed more densely near the theca and construct rather definite sclerotheca. No prominent fossula.

Axial structure built loosely, composed of septal lamellae and concentric axial tabellae, lacking median plate.

In early stage, this axial structure wholly lacking, and then only thin columella-like plate appearing at the central area, the direction of this plate pointing in the direction of elongation of cardinal and counter septum. In the mature stage pseudocolumella is accompanied by a number of septal lamellae and axial tabellae, where as above mentioned, definite median plate is no longer recognizable.

In the longitudinal section triareal arrangement is distinct, central column broad, columnal tabellae crowded, apparently low inclined, outward, without median plate. Dissepiments, unequal in size, arranged in six rows in the mature stage, their convex sides facing inwards. Tabulae incomplete, usually horizontal, but rarely down turned, counted as many as 10 in a distance of 5 mm.

Remarks: YABE[1] separated the Chinese species of so-called *Corwenia* from the genus *Corwenia* SMITH and RYDER[2] as stated before. He emphasized that this group of corals in very charcteristic in having tabulae almost horizontal or slightly descending towards the axial column, and he established a a new genus *Huangia*, with *Corwenia chiitsingensis* CHI as a genotype.

The Japanese species now under consideration was firstly reported by the late Dr. NAGAO and the writer basing on specimens coming from Tosayama, Shikoku.

After the publication of the description for this coral, a new coralline collection being wholly conspecific with the former material was unexpectedly brought back from the *Pseudoschwagerina* limestone of the Kitakami mountain region.

Further, excellent specimens of this species were also recently brought to the writer from Wakayama Prefecture. They were collected by K. TANAKA, geologist, Geological Survey in Tokyo, from a limestone developing at Itokawa, Ishigashi-mura, Arita-gun in association with *Parafusulina* and *Pseudofusulina*. This limestone may with high probability represent the *Pseudoschwagerina* zone.

The description given in the foregoing paragraph was made on these new materials, which have tabulae usually horizontal like the specimens described

1) H. YABE: Permian corals resembling *Waagenophyllum* and *Corwenia*. Proc. Japan Acad. vol. 26, p. 77, 1950.

2) S. SMITH and T. A. RYDER: The genus Corwenia, gen. nov. Ann. Mag. Nat. Hist. ser. 9, vol. XVII, p. 149, 1926.

and figured by NAGAO and the writer, but rarely have also tabulae being down-turned towards the columella. Except this, the new material is quite indistinguishable from the former specimens in every respect.

Thus the geological age of this coral, is now settled as the Lower Permian, although it was formerly supposed to be the Middle Carboniferous in age, from only the similarity between the specimens from Shikoku and the genotype of the genus *Huangia*, which shows the Middle Carboniferous in age in South China.

However in China, most other species of *Huangia*,* except the genotype denote the Lower Permian in age and accordingly the case of this species, now under consideration, is not too strange.

Hor.: *Pseudoschwagerina* zone.

Loc.: Limestone quarry near Tosayama, about 14 km north of Kochi City, Koti Prefecture. Reg. nos.: 15237, 15238, 15239, 15240, 15241. Coll.: K. HASIMOTO.

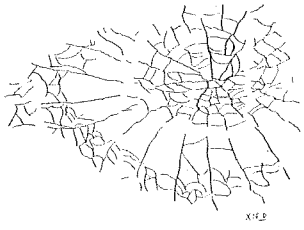
: Sakamotosawa, Hikoroichi-mura, Iwate Prefecture. Reg. nos.: 17654, 17655, 17656, 17657, 17658. Coll.: T. KAKIMI.

: Itokawa, Ishigashi-mura, Arita-gun, Wakayama Prefecture. Coll.: K. TANAKA.

Huangia ? sp.

Pl. 22, fig. 9; Text-fig. 10.

Corallum simple? probably fasciculate, corallite rather small, calicular diameter about 10 mm. There are about 20 major septa, which stop always before the central area. There is a wide space between central area and theca, no tabulae in the medial area. The axial structure composed of axial tabellae and septal lamellae, the latter of which are less numerous than the major septa. There is no distinct median plate.



Text-fig. 10.
Huangia ? sp. (drawing through Camera lucida apparatus), Terano, Doi-mura (or Tsutii-mura), Higashiuwa-gun, Ehime Prefecture. ×2.5. *Pseudoschwagerina-* (*Parafusulina* ?) zone.

Dissepimental arrangement is pseudo-herring bone pattern, although the minor septa are sometimes absent in some part of the corallites.

Remarks: The specimen is unfortunately only fragementary and bad in preservation, from which no available longitudinal section was obtained,

* *H. parachishiaensis* (HUANG), *H. lipoensis* (HUANG), *H. diphyphylloides* (HUANG), *H.* sp. of HUANG, *H. chihsiaensis* (YOH), *H. chiuyaoshaensis* (HUANG), *H.* sp. of YOH and HUANG, all these species are coming from the Permian.

therefore it is quite difficult to determine its generic position. However the thin section of this coral gives the impression that it may be quite identical with specimen described and figured by HERITSCH[1] from the *Schwagerina* limestone of the Carnic Alps under the name of *Corwenia* sp. His so-called *Corwenia* lacks any kind of definite median plate, at least in regard to the figured specimen, although he mentioned its presence in his specimen.

Besides this, the septal lamellae of the Carnic species are less numerous than the major septa, like the Japanese specimen now at hand. Moreover, the Carnic species has the same septal number and same size of corallite, and in this species the minor septa are occasionally absent in some part of corallite; in respect to this feature it quite resembles the Japanese specimen.

Hor.: *Pseudoschwagerina-* (*Parafusulina ?*) zone.
Loc.: Terano, Doi-mura, Higasiuwa-gun, Ehima Prefecture.
Reg. no.: 17817. Coll.: K. ICHIKAWA.

Genus *Verbeekiella* PENECKE, 1876

Verbeekiella japonicum YABE et MINATO

Pl. 18, figs. 1-6.

1944. *Verbeekiella japonicum*, YABE et MINATO: Eine *Verbeekiella* Art aus dem Kitakami-Gebirges, nordöstlichen Honsyu, Japan. Proc. Imp. Acad. Tokyo, vol. 20, p. 159, figs. 1-11.

Description (YABE und MINATO, 1944): Hornförming, leich gebogene Einzelkorallen mit dicker, mit Querwülsten und Einschnurngen vershener Mauer, deren Stücke gewöhlich eine Lange von 30 mm und einen Kelchdurchmesser von 12 mm erreichen.

Die Zahl der Speten beträgt 22 bei 13 mm Kdm und 19 bei 11 Kdm. Die kürzeren Septen fehlen vollkommen. Haupt-und Gegensepten sind nicht mit Sicherheit zu erkennen. Alle Seten stecken in einer breiten, steroplasmatischen Masse, welche sie umhüllt. Fossula ist nicht vorhanden. Auch die Dissepimenten fehlen und dabei ist die äussere Zone durch Steroplasma ausgefüllt. In der zentralen Zone findet sich die Säule mit vollkommen dichter Struktur. Die Säule besteht aus ursprünglich zellig-röhrigen Gewebe, in dem keine Medianlamelle zu erkennen ist. Diese Gewebe ist aber so dicht mit Steroplasma bedeckt, dass es meistens auch in polarisiertem Lichte nicht auszulösen ist.

Im Längsschnitt sehen wir, dass die breite Säule den Hauptteil der Koralle ausmacht. In der von den Septen eingenommenen äusseron Zone sind spär-

1) F. HERITSCH: Korallen der Moskauer-, Gscher- und Schwagerinen- Stufe der Karnischen Alpen. Palaeontographica, 83, A, p. 128, text-fig. 32, in pl. III, 1936.

lich, nach oben gebogene Böden und in der Mitte eine sanft nach oben gewölbte Kuppel und mehrere Lamellen. Eine deutlich Medianlamelle im Längschnitt ist auch nicht nachweissbar. Eine bedeutend Verdickung ist in diesem Schnitt gut zubeobachten. Die Böden sind gelegentlich etwas blassig.

Remarks: *Verbeekiella japonicum* was established by YABE and the present writer on the basis of specimens collected at Kohama, Miyagi Prefecture. It is very near to *Verbeekiella austale* and *V. tubulosum* from Timor, both described by GERTH.[1] However the former is distinct from the latter two, because the Japanese form is wholly lacking in minor septa and has cardinal and counter septum indistinguishable from other major septa, in contrast to the Timor specimens.

Very excellent specimens are also stored in the Inst. Geol. and Palaeont., Tohoku Univ. being conspecific with the form now under consideration, specimens of which were also collected from the same locality.

Hor.: *Yabeina* Zone.
Loc.: Kohama, Ogachi-machi, Momou-gun, Miyagi Prefecture.
Reg. nos.: 15440, 15467, 15498, 15469, 15471 (holotype), 15458, 15438.
Coll.: M. MINATO.

Genus *Leonardophyllum* MOORE and JEFFORDS, 1941

Leonardophyllum ? sp.

Pl. 16, figs. 4, 5; Pl. 22, figs. 1, 2.

Corallum simple, small in size. Outer form unobservable. Wall is not preserved. Septa in two orders, major and minor; the former ones strong and equal in length with each other, except slightly shorter cardinal septum, while the latter ones short, one-half the length of the former. No septa directly uniting with the columella, except in the early stage when the counter septum shows an intimate connection to the columella. Columella composed of median plate ? axial tabellae and septal lamellae. Dissepiments absent. No longitudinal sections were available.

Remarks: The material was sent to the writer by Prof. E. TAKAHASI, Yamaguti (Yamaguchi) Univ., accompanying label of Loc. Chichiiwa, Prov. Nagato. Specimen was unfortunately in ill-preservation, lacking the outer wall. From it the writer was unable to obtain any longitudinal section.

Thus the material although quite imperfect, agrees strikingly with genera *Verbeekiella* and *Leonardophyllum*,[2] from the fundamental structure of the corallites observed.

1) H. GERTH: Die Anthozoen der Dyas von Timor, Pal. Timor., 9, p. 84, 1921.
2) R. C. MOORE and R. M. JEFFORDS: New Permian corals from Kansas, Oklahoma and Texas. Bull. Geol. Surv. Kansas, 38, p. 85, 1941.

At present the writer thinks that the application of the generic name *Leonardophyllum* to the specimens, now under consideration is preferable to *Verbeekiella*, because it has counter septum uniting with the columella.

Hor.: *Yabeina ? Neoschwagerina ?* zone.
Loc.: Chichiiwa, Miyanoshita, Yamaguti (Yamaguchi) City, Yamaguti Prefecture.
Reg. no.: 15695. Coll.: E. TAKAHASHI.

Genus ***Lonsdaleia*** EDWARDS and HAIME, 1851

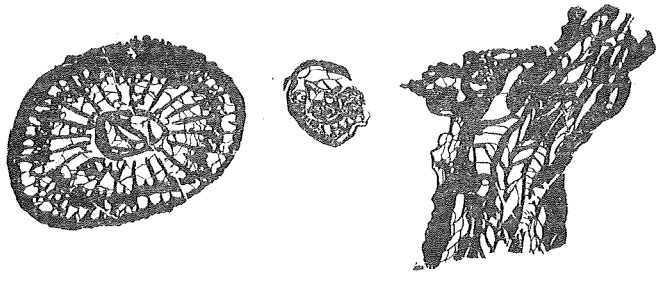
"Lonsdaleia" katoi OZAWA

Pl. 25, fig. 1; Text-fig. 11; Pl. 36, fig. 9.

1925. *Lonsdaleia katoi,* OZAWA: Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato. Jour. Coll. Sci. Tokyo Imp. Univ., vol. 45, Art. 6, p. 70, pl. 13, figs. 2, 3, 4, 11.

Description (OZAWA, 1925): Corallum fasciulate. Corallites cylindircal sinuous and free laterally, provided with a distinct wall. The interseptal ridges prominent and rugosity somewhat accentuated. Diamter of corallite 1–1.5 cm.

Central column loosely and irregularly constructed, composed of a wall developed median plate, a few incomplete septal tabellae and axial lamellae. In the longitudinal section it exhibits a loose irregular cone-in-cone type and has a well defined boundary. Horizontally tabulated zone narrow and loose. In the adult specimen, endotheca is well developed. Septa, of two orders, the major extend from the endothecal region to almost near the central collumn, but rarely reach the axial structure. The minor septa usually short, only half the length of the longer ones. (It must be kept in mind that even in the well grown form a certain proportion or all of the septa, especially the major septa reach the epitheca; and when a new corallite appears, the peripheral dissepimental zone becomes very broad as illustrated in fig. 4, pl. 13).



Text-fig. 11. *"Lonsdaleia" katoi* OZAWA ×2.5
Shiraiwa, Omine-mura, Akiyosi-limestone plateau, Yamaguti Prefecture.
Coll: Y. OZAWA.

The number of the major septa in the typical case is about 28 and as many minor ones are intercalated between each pair of the former.

The characteristic of the present form is its mode of gemmation; new corallite makes its appearance where the vesicular dissepiments are well developed, thus in the peripheral zone of an older corallites as in the case of *Lonsdaleia* (*Waagenophyllum*) *frechi* VOLZ and *Polythecalis confluens* YABE and HAYASAKA.

Remarks: This species, especially the corallite figured by OZAWA as the transverse section of the middle portion of corallite in fig. 3 in his plate shows the features suggesting it to be more nearly allied to some species of *Waagenophyllum*, *Waagenophyllum akagoensis* for example, than the usual type of "*Lonsdaleia*."

Furthermore, the peripheral increase of new corallites in this species seem to the writer also quite characteristic as OZAWA stated.

In this regard, the writer could not help hesitating to assign this species to the genus *Lonsdaleia*.

The transverse section of the upper part of the corallite shows the feature somewhat like the genus *Polythecalis*. However all the corallites (hystero-corallites) branching from the peripheral area of the parent corallite (proto corallite) are covered by a single outer wall and the gemmation seems to be quite different from the case of *Polythecalis*.

Hor.: *Yabeina* zone.

Loc.: Shiraiwa, Omine-mura, Mine-gun, Yamaguchi Prefecture. Specimens now stored at Inst. Geol. Tokyo Univ.

Coll.: Y. OZAWA.

Genus *Corwenia* SMITH and RYDER, 1926

Corwenia ? *omiensis* (YABE et HAYASAKA)

Pl. 19, figs. 4, 5; Pl. 23, fig. 6; Text-fig. 12.

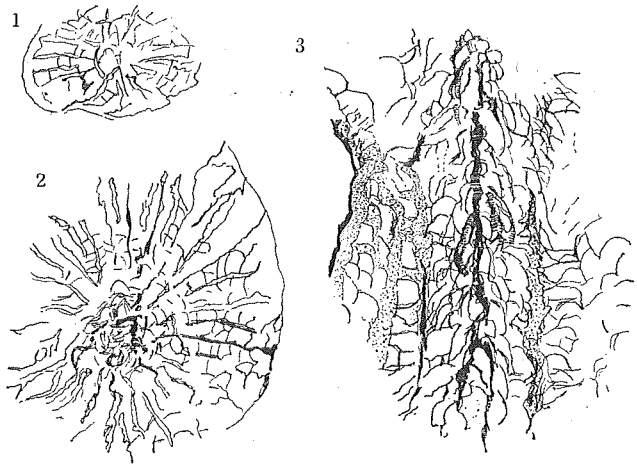
1915. *Lonsdaleia* (*Waagenella*) *omiensis* YABE and HAYASAKA: Palaeozoic Corals from Japan, Korea and China. Jour. Geol. Soc. Tokyo, vol. 22, p. 104.

1924. *Lonsdaleia* (*Waagenophyllum*) *omiensis*, HAYASAKA: on the fauna of the Anthracolithic limestone of Omi-mura in the western part of Echigo. Sci. Rep. Imp. Univ., Sendai, 2nd ser. (Geol.) vol. 8, no. 1, p. 23, pl. 4, figs. 8, 9.

Corallum fasciculate, corallites variable in size, being variably distant from each other. Columella composed of highly vesiculated tabellae, distinct median plate and numerous septal lamellae. Septa in two orders, all of them very thick at the thecal region, becoming thinner towards both ends. The minor septa are almost the same thickness or slightly thinner than the former but ditinctly shorter than the former. Dissepiments arranged not in con-

centric but angulo-concentric pattern in the transverse section.

In the longitudinal section, the dissepimentarium consists of highly vesiculated and rather regular conical vesicles, with their convex sides facing upwards as well as inwards. Columella constructed also of strongly convex tabellae, with their convex sides facing outward near the median plate becoming slightly upwards as well as outwards facing near the theca. Tabulae short, subhorizontal.



Text-fig. 12. *Corwenia* ? *omiensis* (YABE et HAYASAKA)
1 and 2: Transverse section (×5)
3: Longitudinal section (×5)

Remarks: The columella of this species, now at hand, does not present the typical spider-web structure, the tabellae of it being highly conical. Accordingly there is some slight doubt to be retained as to the assignment of this species to the genus *Corwenia*. However the present writer cannot agree with the opinion that this species should be regarded to belong to the genus *Waagenophyllum*. Firstly septa of this species are much thickened at the thecal region, secondly dissepiments are not arranged in the typical concentric pattern and thirdly the median plate of columella is rather distinct. D. HILL[1] was also of the opinion that this species is not *Waagenophyllum* and she doubtfully assigned it to the genus *Corwenia*. H. YABE[2] suggested quite recently the same view concerning the generic position of this coral.

1) D. HILL: The distribution and sequence of Carboniferous coral fauna. Geol. Mag. vol. 85, no. 3, p. 140, 1948.
2) H. YABE: Permian corals resembling *Waagenophyllum* and *Corwenia*. Proc. Japan Acad. Vol. 26, p. 76, 1950.

Hor.: Onimaru series.

Loc.: Locality no. 2 of I. HAYASAKA, Omi, Nishikubiki-gun, Niigata Prefecture.
Specimens now deposited at the Inst. Geol. and Pal., Tohoku Univ., Sendai.

Coll.: I. HAYASAKA

Genus *Stylidophyllum* FROMENTAL, 1861

Stylidophyllum japonica (YABE et HAYASAKA)

Pl. 6, fig. 8; Pl. 7, figs. 1, 2, 3.

1915. *Lonsdaleia japonica*, YABE et HAYASAKA: Palaeozoic Corals from Japan, Korea and China. Jour. Geol. Soc. Tokyo, vol. 22, p. 106.

This species is quite close ally to *Lonsdaleia floriformis floriformis* MARTIN.[1] The distinguishing point of these two corals lies only in the feature of the external wall. The present form has a thick one with numerous short septal ridges, while the latter possesses a relatively thin simple wall.

Nor.: Onimaru series, *Dibunophyllum* zone.

Loc.: Hiishi, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15515, 15516, 15417, 15423, 15421, 15415.
: Takase, Shimoarisu-mura, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15180, 15184, 15187, 15148, 15149, 15420, 15440
: Deguti, Yahagi-mura, Kesen-gun, Iwate Prefecture.
Coll.: M. MINATO
: North of Shiraishi-toge (pass), Hikoroichi-mura, Iwate Prefecture.
Reg. nos.: 17320, 17321
Coll: T. KAKIMI

Note: So far as the writer is aware, this species is coming always from the upper part of the Onimaru series.

Stylidophyllum? sp. indet.

Pl. 22, figs. 5, 10; Pl. 32, fig. 2; Pl. 36, fig. 5; Pl. 41, fig. 8.

1924. *Lonsdaleia floriformis crassiconus*, HAYASAKA (non SMITH): On fauna of the Anthracolithic limestone of Moi-mura etc. p. 22, pl. 4, figs. 1, 2.

1925. *Lonsdaleia floriformis crassiconus*, OZAWA (non SMITH): Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato, etc. p. 69, pl. 13, fig. 1.

Specimens described and figured by HAYASAKA under the name of *Lonsdaleia floriformis crassiconus* from Omi as well as specimens reported under

1) S. SMITH: The genus *Lonsdaleia* etc. Q. J. G. S. vol. 71, p. 247, pl. 19, figs. 1-5, 1915.
M. MINATO: Unterkarbonfauna in der Mandschurei, Bull. geol. Inst. Manchoukuo, No. 106, p. 38, pl. 2, figs. 5: pl. 4, fig. 3, 1942.

the same name by OZAWA with description and figures are doubtlessly conspecific with each other, and morever they are certainly quite near to *Lonsdaleia floriformis crassiconus*. However the writer cannot but hesitate to regard the Japanese specimens as wholly identical to SMITH's species, because the dissepiments of the Japanese form in the peripheral area are smaller in size and more desnely arranged than in the European form.

From the result of observations of specimens of Nagato, including OZAWA's collection, the writer had the impression that the axial structure of the Japanese specimens and other skeletal elements strongly resemble *Lonsdaleoides enormis* (OZAWA), which will be dealt with in this paper. The mentioned axial structure is always much strengthened by organic deposits.

However the present form, now under discussion is massive, while *Lonsdaleoides enormis* (OZAWA) is fasciculate in form, and accordingly they are neither congeneric nor conspecific.

According to OZAWA, this form came from the *Fusulinella* zone at Nagato, while *Lonsdaleia floriformis crassiconus*, the European species, is the leading form of the Upper *Dibunophyllum* zone in England.

Although HAYASAKA supposed his specimens named as *L. crassiconus* to be collected from the Lower Carboniferous at Omi, the precise locality for it was, in fact, unknown: therefore it is not warranted to believe that his specimens could not have been derived from the Middle Carboniferous.

Hor.: *Fusulinella* zone?

Loc.: Maruyama, Isamura, Akiyoshi, plateau, Mine-gun, Yamaguchi Prefecture. Specimens collected by the late Dr. OZAWA are now deposited at Inst. Geol. Tokyo Univ,

: Omi, Nishikubiki-gun, Niigata Prefecture. Specimens collected by the late Dr. IIZAKA are now deposited at Inst. Geol. Tokyo Univ. Specimens (Reg. no. 15681 and 15685) are also stored at Inst. Geol. Hokkaido Univ., which were collected by some members of the Institute, from a limestone quarry at Omi.

Stylidophyllum sikokuense MINATO, nom. nov.

Pl. 32, fig. 1.

1945. *Polythecalis japonica*, YABE and MINATO: On the occurrence of *Polythecalis* from the Permian of Japan. Proc. Japan Acad. vol. 20, p. 466, figs. 1-3.

Description (YABE and MINATO, 1945): Corallum compound, massive, composed of numerous corallites of very irregular shape and size. Outer wall always thick, very often vanishing partially. Septa of twe orders, major and minor; the former usually 13 in number, the latter generally 4 or 5. Minor

septa of variable length, usually only half as long as major ones. Septa never continuous with septal lamellae of columella; nor connected with outer wall gradually disappearing into meshes of vesicles. Columella composed of septal lamellae and axial tabellae, at places closely but usually loosely grouped together owing to rudimental development of septal lamellae; definite median plate not recognized. Numerous inward arching cysts of irregular size in peripheral zone. Inner wall defining peripheral and septal zone indistinct. Triareal arrangement distinct in longitudinal section. Tabulae numerous, usually ascending towards columellar wall.

The dimensions of corallites and columella are given below.

Corallite: 8×8, 6×6, 7×6, 6×6, 6×7, 7×7, in mm.

Columella 3.0×1.7, 1.5×1.7, 1.8×1.6, 1.3×1.5, 1.4×1.4, 1.2×1.2, in mm.

The breadths of dissepimentarium, tabularium and columella measured in one of the corallites are:

Left dissepimentarium: 1.8 mm, left tabularium: 0.85 mm, columella: 1.2 mm, right tabularium: 0.9 mm, and right disspimentarium: 1.6 mm.

Remarks: This species was formerly described under the name of *Polythecalis* and was believed to show most resemblance to *Polythecalis yangtzensis* var. *hochowensis* HUANG.[1] The writer learned recently that TSENG[2] held the opinion that genus *Polythecalis* must be distinguished from *Stylidophyllum* in having not only aphroid corallites but also possessing relatively narrow tabularium in mature stage. The writer now believes that to be the correct view.

The Japanese specimens now at hand have relatively narrow tabularium, therefore the generic name *Polythecalis* for this species should be revised to *Stylidophyllum*, although its outer walls are partially suppressed.

When YABE and the writer originally described the coral now under consideration, they gave it the specific name of *japonica*. However, the revised name *Stylidophyllum japonica* is unfortunately preoccupied by the other species.

Accordingly the writer wishes here to call this coral under the name *Stylidophyllum sikokuensis*.

Hor.: Middle Permian? *Yabeina*? zone

Loc.: Koike, near Sakawa-machi, Takoka-gun, Kochi Prefecture.

Specimens now deposited at the Inst Geol. and Palaeont., Tohoku Univ., Sendai.

1) T. K. HUANG: Permian corals of Southern China. Pal. Sinica, Ser. B, vol. 7, Fasc. 2, p. 85, pl. 8, fig. 4, (not fig. 5), 1932.

2) T. C. TSENG: On the genera *Stylidophyllum* and *Polythecalis*. Bull. Geol. Soc. China, vol. 30, nos. 1-4, p. 29, 1950.

Stylidophyllum yokoyamai (OZAWA)

Pl. 41, fig. 2; Pl. 43, fig. 5.

1925. *Lonsdaleia* (*? Waagenophyllum*) *yokoyamai*, OZAWA: Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato. p. 72, pl. 13, figs. 5, 6.

1936. *Lonsdaleia* (*Stylidophyllum*) cf. *yokohamai*, DOBROLYUBOVA: The corals of the Upper Carboniferous of the Western slope of the Middle Urals a d their stratigraphic importance. p. 53, pl. 31, figs. 91, 92.

Description (OZAWA, 1925): Corallum massive, corallites polygonal in cross section, their diameter attaining 1 cm. Epitheca moderate in thickness but often much thickened by septal ridges. The central column in the transverse sections shows typical cobweb structure with a perfect medial plate; in the longitudinal sections it presents a cone-in-cone type, and it is strongly marked off from the horizontally tabulated area which is exceedingly narrow and followed by obliquely arranged small vesicles. Pure dissepimental area narrow and usually traversed by both kinds of septa. Major septa 20–24, often radiating axially from the epitheca but not extending to the columella. Minor septa variable in length, often as long as the major ones but usually only half as long.

Remarks: The present form somewhat resembles the preceding species, however the former has far less numerous septa, and is cerioid, against the partly plocoid nature of the latter.

Hor.: *Parafusulina* zone.

Loc.: Kaerimizu, Akago-mura, Mine-gun, Yamaguchi Prefecture.

Specimens now stored at Inst. Geol, Tokyo Univ.

Coll.: Y. OZAWA

Genus ***Lonsdaleiastraea*** GERTH, 1921

Lonsdaleiastraea nipponica MINATO, sp. nov.

Pl. 30, fig. 5; Pl. 34, fig. 6; Pl. 43, fig. 2.

Corallum compound, being composed of sub-regular corallites, plocoid: septa of each neighbouring corallite confluent. Major septa 20 in number. Minor septa less numerous and far shorter than the former. Columella very simply constructed. Dissepiments concentrically arranged. Sometimes columella and septa are much strengthened by organic deposits.

In the longitudinal section, axial tabellae ascending steeply towards the median plate, tabularium very narrow, where the tabulae are almost horizontal.

Remarks: This species shows an intermediate nature between genera *Wentzelella* (or *Protolonsdaleia*) and *Lonsdaleiastraea*, because the septa of this species do not show a true thamnoastraeoid trend.

Such species as *Lonsdaleiastraea vinassi*, *complexa* and *longiseptata* described and figured by DOBROLYUBOVA from the Ural Mountains,[1] are plocoid but the walls of these species do not completely disappear. They may be regarded to belong to the plocoidal *Wentzelella* or *Protolonsdaleia*. The criterion whether the central zone is primitive in nature or not, employed by DOBROLYUBOVA to distinguish the genus *Protolosdaleia* from *Lonsdaleiastraea* may be untrustworthy. It should be remembered that *Wentzelella* or allied genera possess in general rather simply constructed axial structure.

This species is quite unlike *L. yamanbaensis*, which shows distinctly thamnoastraeoid trend in septa.

Hor.: *Yabeina* zone. Associated fossils are: *Yabeina shiraiwensis* OZAWA, *Neoschwagerina margaritae* DEPRAT, *N. craticulifera* SCHWAG., *Waagenophyllum akasakensis* (YABE), *Wentzelella subimorica* HUANG, *"Lonsdaleia" katoi* OZAWA.

Loc.: Shiraiwa, (Loc. III, 62, cf the late Dr. OZAWA), Omine-mura, Mine-gun. Yamaguchi Prefecture. Specimen is now stored at the Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

: Kanoide, Kyowa-mura, Mine-gun, Yamaguchi Prefecture. Reg. no. G.K.D.PT. 276, the holotype. Coll.: R. TORIYAMA

Lonsdaleiastraea yamanbaensis MINATO

Pl. 3, fig. 5.

1949. *Lonsdaleiastraea yamanbaensis*, MINATO: Eine Tetrakoralle aus Yamanba Kalkschicht, Sakawa Gegend, Sikoku, Japan. Proc. Japan Academy, vol. 25, p. 58, fig. 1.

Description (MINATO, 1949): Die Koralle steckt ganz im Gestein, und ihre Aussenseiten sind schwer zu beobachten. Die Beschreibung deshalb ist nur an Dünnschliffen möglich. Die Koralliten schliessen sich eng aneinander, und die Aussenwände sind beinähe vollkommen verschwunden. Die Septen bei benachbarten Koralliten sind vollkommen verbunden und zeigen eine Thamnastraea-ähnliche Anordnung. Es gibt drei Arten Septen: I. Ordnung, lang und durch Stereoplasma verdickt: II. Ordnung, etwas kürzer und dünner: III. Ordnung noch kürzer, dabei zeigen sie sich einen etwas unvollständigen Zyklus. Das Säulchen ist klein, einfach gebaut, steht teilweise in Verbindung

1) T. A. DOBROLYUBOVA: The corals of the Upper Carboniferous of the Western slope of the Middle Urals and their stratigraphical importance. Trans. All Union Sci. Res. Inst. Economic Mineralogy, Fasc. 103, p. 56, 1936.

mit eineme Septum der I. Ordnung und meistens ist durch Stereoplasma sehr verdickt; niemals kann man deutliche Medianplatten in Querschnitten erkennen, aber Andeutung davon sind im Längsschliffe sichtbar. Der Raum zwischen den Septen ist mit zahlreichen konzentrischen Dissepimenten ausgefüllt.

Remarks: This species shows quite different aspect to the preceding species but has strong resemblance to *Lonsdaleiastraea typica* described and figured by GERTH from Karakorum.[1)]

Of the geological age of this coral, the writer once suggested it probably to be the *Yabeina* stage, only from resemblance between this coral and *L. typica*, the latter of which was reported to occur in association with *Waagenophyllum indicum*, *Wentzelella caracorumensis* and *Stylidophyllum variable*.

However from the fossils associated with this coral, now under consideration, especially from the Brachiopods fauna, the writer is now inclined to consider this coral denoting a still lower horizon than formerly supposed; it probably belonge to the *Neoschwagerina* or *Parafusulina* Zone.

Hor.: *Parafusulina* Zone?

Associate fossils: *Omphalophylla yamanbaensis* YABE et SUGIYAMA, *Parafusulina* sp., *Schizophoria indica* (WAAGEN) *Schizophoria* sp., *Orthotichia derbyi* (WAAGEN), *Camarophoria mutabilis* TSCHENYSCHEW, *Streptorhynchus pseudopelargonatus* (BROILI), *Meekella*? sp., *Aulosteges polyangensis* (KAYSER), *Squamularia asiastica* CHAO, *Martinia orbicularis* GEMMELARO, *Spiriferina* sp.

Loc.: Yamanba, near Sakawa-mati, Takaoka-gun, Kochi Prefecture. Reg. nos.: 16459, 16428, 16529.

Coll.: M. MINATO.

Genus ***Clisaxophyllum*** GRABAU and YÜ, 1933

This genus is easily separable from the genus *Clisiophyllum* on the basis of the axial structure, in which the median plate is very short and the central column is free from any septa. Thus the medial area of this coral gives the appearance of being well spaced. Columella is composed of septal lamellae and numerous axial tabellae besides the median plate.

Clisaxophyllum ofukensis (OZAWA)

Pl. 33, figs. 5, 6, 7 and 8.

1925. *Dibunophyllum rugosum* var. *ofukensis*, OZAWA: Paiaeontological and stratigraphical studies on the Permo-Carboniferous limestone, etc. Jour. Coll. Sci. Tokyo Imp. Univ., vol. 45, Art. 6, p. 77, pl. 12, figs. 6, 7.

1) H. GERTH: Permokorallen aus dem Oestlichen Karakorum und Trias Korallen aus dem Nordwestlichen Himalaya. Palaeontographica 88 A, p. 232, pl. 15, fig. 7, 1937.

This species may be not at all related to *Dibunophyllum rugosum* SMITH in any respect, either specific or generic. The latter has come to be recognized as the genotype of the genus *Corwenia*.[1)]

Also, OZAWA's specimen is a simple coral and is never *Corwenia*, quite aside from the construction of the corallites. Accordingly the varietal name of OZAWA for this specimen must be taken as the specific name.

Description: Corallum is simple. Moderate in size. There are two orders of septa, major and minor respectively. The former reach almost to the axial area of the corallite, while the latter are far less long than the former. All septa are considerably thick near the theca and become thin towards both ends. All septa are uniting with the outer wall. The columella is composed of septal lamellae, axial tabellae and short but slightly thick median plate. The dissepiments are arranged in pseudoherring bone pattern.

In the longitudinal section triareal arrangement is rather distinct. The outer zone consists of the outer wall and the vesiculate dissepiments, with their convex sides facing both inwards and upwards. These vesiculate dissepiments are almost uniform in size. The outer tabularium consists of more or less vesiculate or conical tabulae which are rather sporadically arranged, while the inner tabularium is made up of steeply ascending and rather densely arranged vesiculate tabullae. The median plate of the columella is also slightly thickened in the longitudinal section.

Remarks: This species is somewhat allied to *Iranophyllum permicum* MINATO, but is distinguishable from the latter in the different kind of dissepimental arrangement. It is far from doubtful that this species is quite different from the genotype of the genus *Corwenia*, not only from its simple form but also from the different construction of the columella.

Hor.: Middle Carboniferous, *Fusulinella* Zone. Associated fossils: *Fusulinella bockii* MÖLLER, *Fusulinella biconica* (HAYASAKA).

Loc.: Ofukudai, Ofuku-mura, Mine-gun, Yamaguchi Prefecture. (Specimens now deposited at Inst. Geol. Tokyo Univ. with label inscribed III 32, 33, 34, 35.)

Coll.: Y. OZAWA

Clisaxophyllum awa MINATO

Pl. 5, fig. 1, Pl. 17, fig. 7; pl. 33, fig. 9; pl. 36, fig. 8; pl. 37, fig. 4; Text-fig. 5, figs. c1, c2, d1, d2, d3.

1951. *Closaxophyllum awa*, MINATO: Some Carboniferous corals from Southwestern Japan. Trans. Proc. Palaeont. Soc. Japan, n.s. no. 1, p. 5, figs. c/1-d/3.

1) S. SMITH and T. A. RYDER: The genus *Corwania*, gen. nov., Ann. and Mag., Nat. Hist. 9th ser., vol. 18, p. 140, 1926.

Diagnosis (MINATO, 1951): Almost identical with *Amygdalophyllum giganteum* YABE et HAYASAKA, except for the construction of the columella, which is composed of a median plate and numerous vesiculate tabellae. The septa and dissepimental tissues are identical with *Amygdalophyllum giganteum* (YABE et HHYASAKA).

Remarks: As is shown in the text figures, the columella of this species is quite characteristic, because the axial tabellae are vesicular in transverse section while the medial plate is short but distinct.

So far as the present writer is aware, this species is widely distributed in Southwestern Japan and denotes always the early Middle Carboniferous in age.

Hor.: Middle Carboniferous, *Fusulinella* zone, especially its lower zone.
Loc.: Omi, Nishikubiki-gun, Niigata Prefecture. Reg. no.: 15683, holotype.
: Kuwabara, Ofuku-mura, Mine-gun, Yamaguchi Prefecture. Reg. no. 16418. Coll.: R. TORIYAMA.
: Hakuundo, (loc. 30 of H. FUJIMOTO) Taisyaku-mura, Hiba-gun, Hiroshima Prefecture. Reg. no.: 19195, Tokyo Kyoiku Daigaku.
Coll.: H. FUJIMOTO.
: Serida, Kyowa-mura, Akiyoshidai, Yamaguchi Prefecture. Coll.: T. OZAWA.
Specimens now deposited at Inst. Geol. Tokyo Univ.

Genus *Nagatophyllum* OZAWA, 1925

Nagatophyllum satoi OZAWA

Pl. 22, fig. 11; Text-figs. 18, figs. b_1, b_2, b_3.

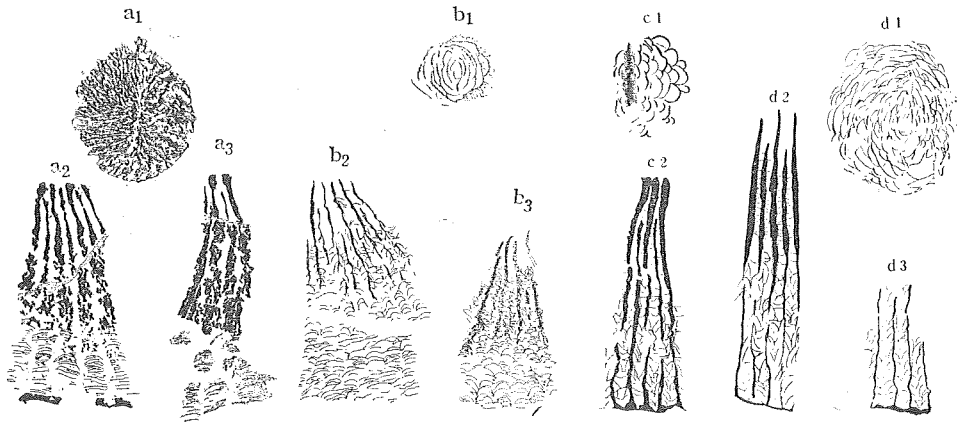
1925. *Nagatophyllum satoi*, OZAWA: Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato, p. 79, pl. 12, figs. 1, 2, 3, 4, 5.
1951. *Nagatophyllum satoi*, MINATO: Some Carboniferous corals from Southwestern Japan. Trans. Proc. Palaeont. Soc. Japan, n.s. no. 1, p. 2, figs. b/1-3.

Remarks: This coral has septa showing strong naos trend in the peripheral area and columella of simple structure, being formed of axial tabellae and indistinct median plate.

As formerly discussed by the writer, after observing the holotype of OZAWA's specimens, the so-called dissepiments described by OZAWA in his original description are not true dissepiments but mere septal modification ; the septa including major and minor show in this part strong naos trend, and this feature perhaps led OZAWA erroneously to regard them as dissepiments.

This species shows some resemblance to *Symplectophyllum*[1] *mutatum*

1) D. HILL: The Lower Carboniferous corals of Australia. Proc. Royal Soc. Queensland. vol. 45, no. 12, 1934.



Text-fig. 13. Figs. a_1, a_2, a_3.: *Amygdalophyllum naosoidea* MINATO
Figs. b_1, b_2, b_3: *Nagatophyllum satoi* OZAWA
Figs. c_1, c_2, d_1, d_2, d_3. *Clisaxophyllum awa* MINATO

HILL, except for the structure of the columella: in *Nagatophyllum* septal lamellae are wholly lacking, while they are present in *Symplectophyllum*. However, the columella of the Australian species seems to be considerably variable, therefore the writer doubts whether these two corals should be held distinct as in generic rank.

Hor.: Middle Carboniferous, *Profusulinella-Fusulinella* zone, especially its lower horizon.

Loc.: Tobinosu, Oda-mura, Yamaguti Prefecture. Specimens now deposited at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA

Note: *Nagatophyllum* is known at present from two or three other localities in Southwestern Japan: from Ibuki district it was reported by T. SEKI[1] in association with Moscovian fusulinid fossils: from Taisyaku plateau this species was found by Prof. FUJIMOTO[2] in association with *Lophocarinophyllum* sp. and *Chaetetes* sp. in one locality, and also collected in another locality with such fossils as *Stafella* sp., *Lithostrotionella* sp., and *Thysanophyllum* sp. From the result of his examination, the present writer believes the mentioned *Lithostrotionella* of FUJIMOTO may be near to *Lithostrotionella tingi*, one of the most characteristic Middle Carboniferous species in Southwestern China, although FUJIMOTO believed the stratigraphical horizon of *Nagatophyllum* at Taisyaku to be Lower Carboniferous in age.

1) T. SEKI: The Upper Palaeozoic stratigraphy and structure of Mt. Ibuki and its neighbourhood. Jubilee publ. in commemoration of Prof. H. Yabe's 60th Birthday, vol. 1, p. 521, 1939.

2) H. FUJIMOTO: (Huzimoto): Palaeontological study of Titibu system of the Taisyakukyo-region, Hiroshima-Prefecture. Studies from the Dept. Geol. and Min. Tokyo Bunrika Daigako, No. 1, p. 1, 1944.

Genus *Carcinophyllum* THOMSON and NICHOLSON, 1868

Carcinophyllum onukii MINATO, sp. nov.

Pl. 17, figs. 4, 5, 6.

Corallum simple, trochoid in form. Calicular diameter more than 25 mm; probably 30 mm is the maximum. Outer wall not preserved in many specimens. Septa in two orders, the major and the minor; the former more thick, reaching almost to the columella, without direct confluence with any septal lamellae of the columella; the latter less than 1/2 the length of the former and occasionally quite rudimentary. Major septa are counted from 26 to 34 in the mature stage. Columella composed of rather indistinct median plate, and dilated septal lamellae. The former is occasionally found uniting with cardinal and counter septum, although the two septa are not distinguishable from other major septa either in thickness or length, only by their positions in the corallites. Fossula not noticeable. Dissepimentarium is wide, where many dissepiments are arranged in pseudo-herring bone or angulo-concentric pattern.

In the longitudinal section triareal arrangement is quite distinct, columella composed of steeply ascending tabellae and much dilated median plate; tabulated zone at both sides of columella is almost same width as the columella where are found rather thin and almost horizontal tabulae. In the dissepimentarium there are many almost horizontal tabulae, also much elongated dissepiments which are arranged in oblique row, with their convex sides facing upwards as well as inwards.

Remarks: Specimens described here were collected by Y. ONUKI near Sizu, Setamai district, so that the specific name was propsed to commoemorate. The specimens are quite distinct from any known species in the ratio of septal number and calicular diameter. It is somewhat comparable to *Carciophyllum kirsopinatum* THOMSON, described and figured by D. HILL[1] from the Lower Carboniferous of Scotland, however it is different in having no naos trend in septa and sub-irregular development of minor septa.

Hor.: Onimaru-series, *Dibunophyllum* zone.
Loc.: Sizu, Setamai-machi, Kesen-gun Iwate Prefecture. Specimens now deposited at Inst. Geol. Palaeont., Tohoku Univ.
Coll.: Y. ONUKI.

Genus *Setamainella* MINATO, 1943

The fundamental structure of this genus is quite similar to that of genus *Carcinophyllum*, but in respect to the central column it is quite distinct from

1) D. HILL: A monograph of the Carboniferous Rugose corals of Scotland. Pal. Soc. vol. XCIV, p. 159, pl. 8, figs. 19-24, 1940.

the latter as well as from all known genera of Clisiophyllidae.

Columella of this genus gives the appearance of fine reticulation tn cross section, composed of septal lamellae and axial tabellae, in which no median plate is discernible.

Setamainella hayasakai MINATO

Pl. 9, fig. 1.

1943. *Setamainella hayasakai*, MINATO: On some Upper Viséan coral fauna from the coral limestone of the Kitakami Mountainland, Northeastern Honsyu, Japan. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 229, pl. 20, figs. 4a, b.

Until the present day, only one fragmental specimen was obtainable, from the Kitakami Mountains. The former description of it is here revised as follows.

Corallum simple in form, corallite moderate in size, diameter of intrathecal area 30 mm. Septa in two orders, major and minor respectively. Each of these numbered as many as 50 or a little more. Major septa much thickened in the intrathecal area, while the minor ones thin through their whole length. Central area occupied by columella which gives an appearance, in thin section, of fine reticulation composed of numerous lamellae and tabellae. Dissepimentarium is decidedly present, but only partly preserved, where few dissepiments are observable.

One coralline fossil obtained by KAKIMI from the Carboniferous limestone exposed near Hitachi mine, Ibaragi Prefecture, with *Kueichouphyllum* sp., *Siphonodendron pauciradiale* etc. was called to the writer's attention. It shows quite similar aspect to *Setamainella hayasakai*. However, unfortunately, from it no thin sections were made for the specific identification. Yet it is quite certain that the coral now in hand is *Setamainella*.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugasirasama, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 15451. Coll.: M. MINATO.

Genus ***Lophophyllum*** EDWARDS et HAIME, 1850

Subgenus ***Arachnolasma*** GRABU, 1922

Arachnolasma cfr. *sinense* (YABE et HAYASAKA)

Pl. 17, fig. 8; Text-fig. 14.

Compare with:

1920. *Lophophyllum sinense*, YABE and HAYASAKA: Geographical research in China, Atlas of fossils, pl. 6, figs. 2a–2d.

1922. *Arachnolasma sinenses*, GRABAU: Palaeozoic corals of China, pt 1, p. 59, text-fig. 66.

1927. *Arachnolasma* cf. *sinense*, REED: Palaeozoic and Mesozoic fossils from Yun-nan. Pal. Indica. n.s. vol. 10, p. 79, pl. 5, fig. 7.

1933. *Arachnolasma sinense*, YÜ: Lower Carboniferous Corals of China. Pal. Sinica, ser. B, vol. 12, fasc. 3, p. 34, pl. 1, figs. 6a-c; figs. 4a-c.

1947. *Arachnolasma* sp., MINATO: A coral of the Lower Carboniferous type from the Kwanto Mountainland, with short note on the Lower Carboniferous deposits of Outer Zone of S. W. Japan. Proc. Japan Acad. vol. 23, p. 120, text-fig. 1.

Although this specimen is quite imperfect, as before mentioned, its similarity to the genotype of this genus *Arachnolasma* may be beyond doubt.



Text-fig. 14. Columella of *Arachnolasma cf. sinense* (YABE et HAYASAKA) in thin section.

This specimen was believed to be collected by the late Dr. OISHI from west of Shirai (Shiroi ?), Ueno-mura, Taga-gun, Gunma Prefecture according to its label. More than twenty years ago the late Prof. OISHI made a geological survey in the area surrounding Ueno-mura and noted the occurrence of the coralline remains from a limestone near by. According to verbal information of Prof. FUJIMOTO, there exists a limestone lense in the Quarzite group, from which the material now under discussion might have been brought back.

Hor.: Onimaru series ? *Dibunophyllum* zone ?

Loc.: West of Shiroi (Shirai ?), Ueno-mura, Tano-gun, Gunma Prefecture. Specimens now deposited at Inst. Geol. and Palaeont., Tohoku Univ.

Coll.: S. OISHI.

Genus *Yuanophyllum* YÜ, 1931

Yuanophyllum yabei (NAGAO et MINATO)

Pl. 14, fig. 11; Pl. 15, figs. 1a-1f.

1941. *Yuanophyllum* (*Kesenella*) *yabei*, NAGAO and MINATO: An interesting coral from the Lower Carboniferous of the Kitakami district Japan. Jour. Fac. Sci. Hokkaido Imp. Univ., ser. 4, vol. 6, no. 2, p. 107, pl. 28.

Corallum simple, slightly curved, conical in the proximal half and almost cylindrical in the mature stage. It probably a little exceeds 70 mm in total length, although both extremities are lost, and is more than 25 mm in maximum diameter.

Major septa numerous, counted as many as 63, alternating with the same number of minor septa. Cardinal and counter septum and also alar septa are distinguishable from other kind of septa, from their position and difference of length. Axial structure composed of septal lamellae and axial tabellae, in which the median plate is united with counter septum, while it is widely

separated from the axial structure and cardinal fossula. Cardinal fossula very wide and deep.

In the longitudinal section, axial structure composed of steeply ascending tabulae and vertical median plate; while tabularium formed by incomplete tabulae, which are rather loosely arranged but ascend also steeply. Dissepimental vesicles are very crowded and arranged vertically with convex surface facing inwards, the arrangement of which in the transverse section is concentric in the early stage, but angulo-concentric in the mature stage.

Remarks: This species, when it was first described by NAGAO and the writer, was thought to have long minor septa which are far beyond the theca in the cardinal quadrants. However from the result of recent reexamination of the original material, it was revealed that a different view is allowable. Namely the so-called prolonged part of minor septa, in the former observation, in the intrathecal area of the cardinal quadrant may be more interstices between each pair of major septa, which are so much dilated as to be almost completely fused together, accordingly the interstices become very narrow and mislead one to consider them as if a prolongation of minor septa.

Therefore, this species has come to be considered to be more close to the genotype of this genus than formerly believed, and the subgeneric name of *Kesenella* may better be abandoned.

Yuanophyllum occurs only from the *Yuanophyllum* zone of the Fengnian system of Southern China; the Japanese representative was also found in a horizon nearly equivalent to it.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugashirayama, Setadai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 15442–15450.
Coll.: M. MINATO.

Family Amygdalophyilidae GRABAU

Genus ***Taisyakuphyllum*** MINATO, gen. nov.

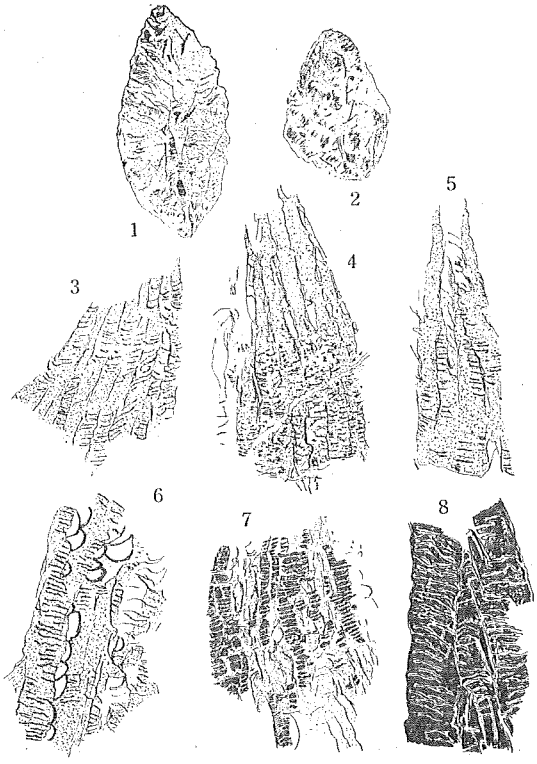
Fundamental structure of this coral is quite similar to the genus *Amygdalophyllum*, however the present new form provides charactistic septal grating in septa. Genotype: *Taisyakuphyllum rostfer* MINATO. Grate is Rost in German, which come to the specific name of the genotype.

Taisyakuphyllum rostfer, sp. nov.

Pl. 22, fig. 12; Pl. 25, fig. 4; Pl. 34, fig. 8; Text-fig. 15.

Corallum simple. The calicular diameter of this coral reaches as much as 26 mm. Septa are counted more than 45, including major, minor and tertiary. Fos-

sula is narrow, but distinct, where the cardinal septum is present, being slightly thinner and more short than the other major septa. In each septum conspicuous grating is clearly observable both in the transverse and longitudinal section. In the transverse section gratings are seen to be perpendicular to the middle line of the septa, while they are observable to tend both upwards and inwards in the longitudinal section. Columella almost compact, elliptical and cuspidate in the transverse section, in which very fine fibrous tissues which are radial and concentric in arrangement are observable. Septa are rarely uniting with this columella.



Text-fig. 15. *Taisyakuphyllum rostifer* MINATO, *sp. nov.*
Figs. 1, 2. Columella in transverse section.
Figs. 3, 4, 5. Septa in transverse section, showing the septal gratings.
Figs. 6, 7. Septa in longitudinal section, showing also the septal gratings.
Fig. 8. Columella in longitudinal section.

In longitudinal section columella seems to consist of numerous superoposed cones, which are much strengthened by stereoplasmic deposits. Tabularium is rather narrow, where conical tabulae are arranged in oblique row with con-

vex sides facing inwards. Dissepiments of variable sizes are arranged also in oblique row, having their convex sides faced inwards.

Remarks: This species is quite unique in having septal gratings and tertiary septa. The holotype should be designated as being in the old collections of the late Prof. OZAWA, labelled as IV, 4, 5, 6 which came from Ofukudai, Yamaguchi Prefecure. One specimen, coming from Tarosako, Taisyaku plateau which is now stored at the Inst. Geol. and Palaeont., Tohoku Univ. may be also wholly conspecific with the Akiyoshi specimens. In the latter the same septal gratings and solid columella are observable, although the tertiary septa are unfortunately unobservable from lack of peripheral part of the corallite. Lastly, one specimen collected by Prof. FUJIMOTO at Dangyokei, same Taisyaku plateau, Hiroshima Prefecture, labelled as 1642 may also belong to the same species, now under consideration.

Hor.: Middle Carboniferous, *Fusulinella* Zone, especially its lower horizon.
Loc.: Ofukudai, Ofuku-mura, Mine-gun, Yamaguchi Prefecture. Specimens now deposited at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.
Loc.: Tarosako, Taisyaku-mura, Kameiishi-gun, Hiroshima Prefecture. Specimens now deposited at Inst. Geol. and Palaeont., Tohoku Univ.
: Dangyokei Taisyaku-mura, Hiba-gun, Hiroshima Prefecture. Specimens now deposited at Inst. Geol. Tokyo Kyoiku Daigaku, Coll.: H. FUJIMOTO.

Gnus *Amygdalophyllum* DUN and BENSON, 1920

Amygdalophyllum naosoidea MINATO

Pl. 30, figs. 1, 2; Pl. 34, fig. 7; Text-figs. 13, a_1, a_2, a_3.

1951. *Amygdalophyllum naosoidea*, MINATO: Carboniferous corals from Southwestern Japan. Trans. Proc. Palaeont. Soc. Japan, n.s. no. 1, p. 3, figs. a_1-a_3.

Description (MINATO, 1951): Corallum simple. Corallites large, ca 30 mm calicular diameter. Major septal number 33, alternating with same number of minor ones; major septa fairly thick, reaching almost to columella, but never penetrating into it. Axial ends of most major septa club shaped in transverse section; minor ones always gradually thinning distally. All septa uniting with outer wall. Major and minor septa of continuous type in distal part but they become cavernous in medial area and lastly tend to represent strong naos trend in peripheral area, where they become modified into horizontal tissue which consists of numerous plates as wide as a septum. Columella solid, in which median plate-like structure is observable in thin section.

Triareal arrangement readily observed in logitudinal section, middle part of which is occupied by columella. Columella composed of median plate (black

line in section), and many fibrous horizontal tissues. Medial area with septa and many tabulae steeply ascending toward wall. Small vesicles arranged in outer area with their convex sides facing upwards and inwards. Many lines ascending both upwards and outwards recognized in this area; they may be due to the lamellar structure of septa.

Remarks: That the present species belongs to the genus *Amygdalophyllum* is far from doubtful. As already mentioned by the writer, the present form is somewhat allied to *A. conicum* HILL[1], the Lower Carboniferous species of Australia, but the former has larger and more compact columella. *Nagatophyllum satoi*, the genotype of the genus *Nagatophyllum*, shows resembla ce to this species, now under consideration, but the former has different kinds of columella and lacks cavernous structure in septa.

Hor.: Middle Carboniferous, *Fusulinella* zone, especially its lower horizon.
Loc.: Ohkubo, Ohta-machi, Mine-gun, Yamaguchi Prefecture. Specimens now stored at Inst. Geol. Tokyo Univ.
Coll.: Y. OZAWA.

Amygdalophyllum ? gracile (HAYASAKA)

1924. *Axophyllum gracile*, HAYASAKA: On the fauna of the Anthracolithic limestone of Omi-mura in the western Part of Echigo. Sci. Rep. Tohoku Imp. Univ., 2nd ser. (Geol.) vol. 8, no. 1. p. 23, pl., 4, figs. 10, 11, 12, 13.

Description (HAYASAKA, 1924): Corallum simple, more or less cylindrical measuring 15–18 mm in diameter. Septa in two orders, counting 30–30–32+32; those of the first order reaching to the columella and the others about half in extension; they are very thick in the outer margin, forming pseudotheca that are surrounded by a thin epitheca, and gradually attenuate toward the inner. Columella thick and massive, often attaining to about 1/5 of the corallum; no structural details are retained, except a longitudinal slit in about the middle. Interseptal vesicles rather large and nearly vertically arranged. Horizontally tabulated zone which occupies a narrow space between columella and vesiculated area is quite narrow, being only about 1/2 of the diameter of the columella.

Remarks: This species was described under the generic name of *Axophyllum*. According to S. SMITH[2], however, the syntypes of genus *Axophyllum* may be nothing but isolated corallites of *Lonsdaleia crassiconus* McCOY, and according to D. HILL, *Axophyllum* is a synonym of *Carcinophyllum* from the result of

1) D. HILL: The Lower Carboniferous corals of Australia, Proc. Royal Soc. Queenland. vol. 45, no. 12, p. 71, pl. 2, figs. 49-50, 1934.
2) W. D. LANG, S. SMITH and H. D. THOMAS: Index of Palaeozoic coral genera. p. 25, 1940.

her examination of syntypes. Such being the case, gnus *Axophyllum* has no compact columella in any way, and the Japanese coral under consideration is accordingly not congeneric with *Axophyllum* EDWARDS and HAIME, disregarding for a while the generic validity of *Axophyllum*.

The writer wished provisionally to treat HAYASAKA's specimens under the name of *Amygdalophyllum*, but he now considers on the other hand that the specimens probably are young corallites of such a coral as *Lonsdaleoides enormis* (OZAWA), which will be treated later on.

Hor.: Lower Carboniferous? Onimaru series?
Associated fossils: *Amygdalophyllum giganteum* (YABE et HAYASAKA), *Corwenia* ? *ominensis* (HAYASAKA), *Fistulipora minima* HAYASAKA etc.
Loc.: II of HAYASAKA, Omi limestone, Niigata Prefecture. Specimens now deposited at Inst. Geol. and Palaeont., Tohoku Univ.
Coll.: I. HAYASAKA.

Amygdalophyllum setamaiensis YABE et MINATO

Pl. 35, figs. 3, 7.

1946. *Amygdalophyllum setamaiensis*, YABE and MINATO: *Amygdalophyllum* from the Lower Carboniferous of the Kitakami Mountainland, Northeast Honsyu, Japan. Proc. Japan Acad. vol. 22, p. 210.

This species is most nearly allied to *A. inopinatum* (ETHERIDGE)[1] described and figured by D. HILL from the Lower Carboniferous Rockhampton series[1] of Southeastern Queensland, but in the Japanese species septa lack naos-trend. Until the present day several localites have been found yielding this species in the Setamai district besides the formerly reported locality.

Hor.: Onimaru-series, *Dibunophyllum* zone.
Loc.: Takenohara, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15851–15858.
Coll.: M. MINATO.

Amygdalophyllum sp. *a*

Pl. 5, figs. 2, 3, 5 and 6; Pl. 34, fig. 5; Pl. 35, fig. 5; Pl. 36, figs. 3, 7.

1938. *Lophophyllum* sp., Y. ONUKI: On the Titubu system of Kesen-gun district, Iwate Prefecture, Kitakami Mountainland. Jour. Geol. Soc. Japan, vol. 45, p. 52, table 3, listed.

Corallum simple. Fairly large in size. Calicular diameter reaches more than 26 mm in the largest corallite. Septa in two orders, major and minor which are alternating with each other. The major septa in the intrathecal

1) D. HILL: The Lower Carboniferous corals of Australia. Proc. Roy. Soc., Queensland. vol. 45, no. 12, p. 68, pl 8, figs. 1–8, 1934.

area but slightly thickened in the medial area. Septa of each order numerous, numbering more than 40. The outer wall unobservable. Columella large, the outline of which is irregular in form. Most of septa directly uniting with the columella. The columella is not compact but composed of fibrous structure. There are sometime observable a short median plate in thin section and lamellae-like tissue prolonged perpendicularly to this plate. Cardinal fossula is not conspicuous but its presence is indubitable.

The dissepiments are arranged in concentric pattern at least near the theca. Nature of the corallites near the peripheral area is unknown. The longitudinal section was not obtainable.

Remarks: Specimens were so imperfect that they could not be refered to the known species without much difficulty. It may probably be a new species. From the distinct feature of the columella, the generic identification to the genus *Amygdalophyllum* is far from doubtful. It may be safely separable from *Sugiyamaella*. The specimens, now deposited at the Inst. Geol. and Palaeont., Tohoku Univ., with label by Y. ONUKI as "*Lophophyllum* sp. 29 East of 9 b" may be perfectly conspecific with ours, which were found at the upper course of Higuchisawa river, near Ohmori.

From the verbal information of late Dr. T. SUGIYAMA, he collected some cralline remains as *Diphyphyllum* in association with *Lophophyllum* sp. of ONUKI at the same locality of Higuchisawa. The mentioned species of *Diphyphyllum* may probably denote, according to SUGIYAMA, the Pre-Viséan in age.

Hor.: Unknown, probably Pre-Onimaru-epoch.
Loc.: Ohmori Hikoroichi-mura, Kesen-gun, Iwate Prefecture.
Reg. nos.: 16757, 16412, 16760, 16761, 16498, 16763, 16436, 16759, 16429, 16756, 16760.
Coll.: M. MINATO.

Amygdalophyllum sp. *b.*

Pl. 13, fig. 8; Pl. 14, fig. 4.

1943. *Dibunophyllum*, sp. *b*, MINATO: On some Upper Viséan Coral fauna from the Coral limestone of the Kitakami Mountainland, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 226, pl. 20, fig. 8; pl. 21, figs. 5a-b.

Fomerly the writer described this coral under t e generic name *Dibunophyllum*, however the axial structure of this form is rather simple as in some Australian species of *Amygdalophyllum* and the writer is now inclined to believe it belongs to the genus *Amygdalophyllum*. Yet the resemblance between this and some species of *Koninckophyllum* seem to be not negligible, though

the columella of this form is firmly united with both cardinal and counter septa.

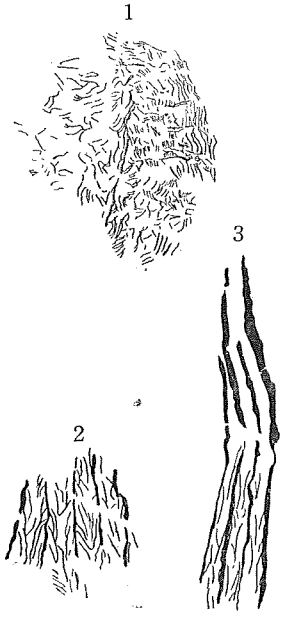
Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugashira-yama, Setamai-machi, Iwate Prefecture.
Reg. nos.: 15199, 15202.
Coll.: M. MINATO.

Amygdalophyllum giganteum (YABE et HAYASAKA)

Pl. 17, fig. 9; Text-fig, 16.

1924. *Echigophyllum giganteum* YABE and HAYASAKA, HAYASAKA: On the Anthracolithic limestone, etc. p. 20, pl. 4, figs. 5, 6, 7. (On the plate these were misnumbered 9, 10 and 11, respectively.)

1939. *Amygdalophyllum giganteum*, HAYASAKA: On the identity of *Echigophyllum* YABE and HAYASAKA (1924) and *Amygdalophyllum* DUN and BEONSON (1920) etc. Jour. Geol. Soc. Japan, vol. 46, p. 539.



Text-fig. 16. *Amygdalophyllum giganteum* (YABE et HAYASAKA)
1: Columella, tangential section, showing the fibrous tissuse.
2 and 3: Septa and interseptal dissepiments, transverse section.

Description (HAYASAKA, 1939): No complete corallum is at hand, but judging from the sha e of the fragmentary individual examined, it has the ordinary horn-shaped form. The corallum is enclosed with an epitheca which is made of dense lamella, concentric layers. The largest specimen measures about 4 cm in diameter, in which the thick columella is about 1 cm across. The longer septa are appreciably thicker than the alternating shorter ones that are about 3/4 the length of the longer ones: they tend to be dilated in the tabulate zone occupying the area between the coulmella and the peripheral dissepimental zone; septa are slightly flexuous in general.

Inter-septal spaces are filled with minute, vesicular dissepiments, of which characteristic features are observed in longitudinal section. They are more or less rounded, with the convexity faced upwards and inwards, 7–8 being counted in a longitudinal distance of 5 mm.

Tabulae are represented by small, arched plates piled up irregularly: the tabulate zone is far narrower than the dissepimental zone which occupies nearly one-half the radius of the corallum.

Columella is composed of very minute, dense,

somewhat arched cells closely piled up as is observed in longitudinal section: the cells are arranged more or less radially and concentrically in cross section. There is, in the center of the columella, a medial plate seen in cross section; it seems to lie in the direction of the cardinal and counter septa as is suggested by one of the cross sections (see fig. 5 of HAYASAKA's paper). Other thin radial elements, possibly rudimentary septal ends, seem to take part in the formation of the characteristic columella.

Remarks: The excellent description of HAYASAKA may well represent the nature of this species and there may be no need to add to it.

The writer believes, however, this species somewhat deviates from common species of this genus, in the structure of columella and dissepiments.

Firstly in the columella of this species, there are observable many encircling lamellar tissues (see text fig. 16, 1) in the transverse section, besides the septal lamellae-like structure and median plate-like structure. The mentioned encircling lamellar tissues are never usual axial tabellae.

Furthermore the dissepiments are also characteristic in this species, especially in the pattern of their arrangement. It is neither the usual concentric pattern nor angulo-concentric one, but in reality rather elongate dissepiments are arranging along the septa with convex sides faced inwardly in the transverse section, thus forming narrow infundibuli-like openings between the septa.

Hor.: Onimaru-series ?, *Dibunophyllum* zone ?.

Loc.: Omi-limestone, Omi-mura, Nishikubiki-gun, Niigata Prefecture.

Family Lophophyllidae GRABAU, 1928

Genus *Sugiyamaella* YABE et MINATO, 1944

Sugiyamaella carbonarium YABE et MINATO

Pl. 5, fig. 4; Pl. 6, fig. 4; Pl. 13, figs. 7, 11; Pl. 14, figs. 3, 14, 16, 17; Pl. 15, figs. 2, 3, 4, 5.

1941. *Lophophyllidium* ? sp. MINATO: On the Lower Carboniferous deposits at Setamai, Kesen-gori, Iwate Prefecture. Jour. Geol. Soc. Japan, vol. 48, p. 477, listed.

1944. *Sugiyamaella carbonarium*, YABE und MINATO: Sugiyamaella carbonarium Yabe et Minato, Gen. et Sp. nov., usw. Japanese Jour. Geol. Geogr. vol. 19, p. 143, pl. 13, figs. 1-9, Text-figs. 1-4.

1947. *Sugiyamaella carbonarium*, MINATO (par.) New locality of *Sugiyamaella carbonarium*. Jour. Geol. Soc. Japan, vol. 53, p. 22. listed.

1951. *Sugiyamaella carbonarium*, MINATO: On the Lower Carboniferous fossils of the Kitakami massif, Northeast Honsyu, Japan. Jour. Fac. Sci., Hokkaido Univ., ser. 4, (Geol. and Min.) vol. 7, no. 4, p. 381, pl. 1, fig. 13; pl. 3, fig. 4.

1952. *Sugiyamaella carbonarium*, MINATO: A further note on the Lower Carboniferous fossils of the Kitakami Mountainland, etc. ibid. vol. 8, no. 2, p. 149, pl. 2, fig. 9.

Remarks: After the publication of the descriptions for this coral by YABE and the writer, additional materials were colleted from the type and other one locality, rendering the structure of this coral clearly known. This coral is characteristic in having simple and ceratoid form of corallite, with much thickened septa in the cardinal side, which show marked pinnate arrangement, and with very short and thin cardinal septum, together with alar and cardinal marked fossulae and very compact columella, while lacking in tabulae. The writer considers this genus should be placed in the family Lophophyllidae.

Hor. Kozubo stage.

Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. nos.: 15126, 15127, 15128, 15129, 15130, 15131, 15132, 15133, 15134, 15135, 17839.
: Usagisawa, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. nos. 15883, 16003

Coll.: M. MINATO

Genus *Lophophyllidium* GRABAU, 1928

Lophophyllidium suetomii MINATO, sp, nov.

Pl. 26, fig. 7; Text-fig. 17.

Corallum simple and small. Outer form unobservable. Calicular diameter usually about 12 mm in maximum; diameter along the counter cardinal line longer than at a right angle to it. Wall thick? Columella compact, fusiform in thin cross section, uniting with counter septum. Major septa numbered 27 including counter and cardinal septa, the latter of which are slightly shorter than the other septa. All these septa radially arranged and rhopaloid, some of which reach the columella and unite directly to it; most of them, however, stop their growing before the columella and unite with each other at their axial ends to form a stereotheca, surrounding the columella. Minor septa quite rudimentary, except a few of them in the conter quadrants. Both major and minor septa also thickened near the wall. Fossula not prominent but its presence is suggested at the cardinal septum.

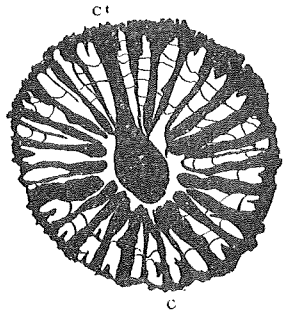
Remarks: Corals assignable to the genus *Lophophyllidium* are abundantly found in Japan, especially in the Lower part of the Sakamotosawa series in the Kitakami mountain region. Among them, this type of coral, now being considered, is especially worthy of note in respect to construction of stereotheca by usual dilation of major septa at their axial end. This feature was said to be one of the characteristic points in genus *Sinophyllum*, according to GRABAU, to separate the former from the genus *Lophophyllidium*. GRABAU[1]

1) A. W. GRABAU: Palaeozoic corals of China, part 1. Pal. Sinica. ser. B, vol. 2, fasc. 2, p. 99, 1928.

recognized the generic distinction between his genus *Sinophyllum* and *Lophophyllidium* lying in the presence of a large pendulum-like columella of the former and in the development of stereotheca surrounding it.

Careful examination by T. K. HUANG,[1] however, of the genotype of genus *Lophophyllidium*, *Cyathaxonia prolifera* MCCHESNEY from the Pennsylvanian of North America, reveals the American species also to have large pendulum-like columella and moreover to possess definite stereotheca.

Accordingly *Sinophyllum* seemed to hin to be possibly synonymons with genus *Lophophyllidium* on the one side. HUANG recognized, however, a slight difference in the construction of stereotheca between *Sinophyllum pendulum* and the genotype of *Lophophyllidium*.



Text-fig. 17. *Lophophyllidium suetomii* MINATO, sp. nov. (ca × 2.5)

In the genotype of genus *Lophophyllidium*, the stereotheca is constructed, according to HUANG, only by the dilation of the septa at their axial ends while in *Sinophyllum pendulum*, this structure is accomplished by the bending over of the major septa in addition is the mere thickening of them. Thus he treated *Sinophyllum* as a subgenus of *Lophophyllidium*.

However the writer was doubtful whether to regard the distinguishing point mentioned by HUANG as being quite sufficient to separate the genus *Sinophyllum* from *Lophophyllidium* in subgeneric rank.

R. M. JEFFORDS[2] who described a number of Pennsylvanian Lophophylloid corals is also of the opinion that the validity of genus *Sinophyllum* is doubtful. JEFFORDS wrote as follows "*Sinophyllum* was stated to differ also in having an inner wall formed by flexed ends of major septa. In as much as observations on Pennsylvaian and Permian lophophylloid corals have indicated that the inner wall seen in illustrations of the genotype species of *Sinophyllum* does not differ from that of other lophophylloid corals, and as the diameter and shape of the axial column alone were judged not sufficently diagnostic to

1) T. K. HUANG: Permian corals of Southern China. Pal. Sinica. ser. B, vol. 8, fasc. 2, p. 22, 1932.

2) R. M. JEFFORDS: Pennsylvanian lophophylloid corals. Univ. Kansas, Pal. contrib. 1, 1947.

Some lophodhylloid corals described by JEFFORDS as *L. hadrum*, *L. coniforme*, *L. lanosum* and *L. plummeri* have rhopoloid major septa in early stage, which, however, become thin in mature stage. Such being the case, the rhopoloid nature of septa must not be regarded as a definite character for specific distinction; but it is problematical, it seem, to the writer, in what stage of the ontogeny of corallites the septa are rhopoloid.

warrant generic separation, *Sinophyllum* was considered a junior synonym of *Lophophyllidium*."

The Japanese specimen, now under consideration is nearly related to *Lophophyllidium* (*Sinophyllum*) *zaphrantoidea* HUANG[1] from size of corallite, septal number and rhopaloid major septa, which were described and figured by Huang from the Permian of Southern China, but the Chinese species is different from the Japanese specimens having quite rudimentary cardinal septum and marked fossula.

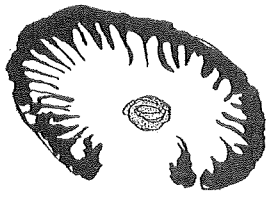
The writer thinks this Japanese species is quite characteristic in having relatively longer cardinal septum, the feature being sufficient to distinguish it from hitherto known species of Pennsylvanian as well as Permian.

Hor.: Basal Part of Sakamotosawa series, Lowermost Permian: *Pseudoschwagerina* zone.
Loc.: Kawaguchi, Setamai,-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 17399
Coll.: H. SUETOMI

Lophophyllidium sp. *a*

Pl. 37, fig. 11; Text-fig. 18.

The corallite is quite small. Wall is rather thick; major septa are numerous, counted as many as over 40, which are short, and mostly thinning distally. Minor septa irregularly develop here and there, but most of them are quite rudimentary. Columella round in cross section, and relatively small. No dissepiments, and distinct fossulae.



Text-fig. 18. *Lophophyllidium* sp. *a* (×5.0)
Kawaguchi, Setamai-machi, Iwate Prefecture. Lower Sakamotosawa-series. (Lower *Pseudoschwagerina* zone)

Remarks: A number of specimens of this coral were collected at a few localities near Setamai, from the Lower Sakamotosawa series; it may belong to the genus *Lophophyllidium* but is specifically different from the preceding species.

Hor.: *Pseudoschwagerina* zone.
Loc.: Kasiwari, Setamai-machi, Kesen-gun, Iwate Prefecture.
: Kattisawa, Setamai-machi.
: Kawaguchi, Setamai-machi.
Coll.: M. MINATO

1) T. K. HUANG: Permian Corals of Southern China. Pal. Sinica. ser. B, vol. 8, fasc. 2. p. 28, pl. 2, figs. 7, 8, 1932.

Lophophyllidium sp. *b*

Pl. 16, fig. 8.

Corallum simple, small in size, calcicular diameter 5.0 mm. Columella large, the diameter of which attains about 2/7 the length of the calcicular diameter. The outline of the columella is almost circular in transverse section; it is firmly united with counter septum.

Septa in two orders, all of them quite thick in thin section. Pinnate arrangement rather definite.

Major septa counted as much as 15 including the counter septum, while there are the same number of minor septa, in which two alar septa and cardinal septum are recognizable. Most of major septa reach the columella, while the length of the minor septa are about 2/3 the length of the formers.

No dissepiments.

Remarks: Although the specimen is excellently preserved, the writer is available for this species only single thin transverse section, which shows probably the corallite of the early stage belonging to any species of genus *Lophophyllidium*.

Such being the case it is specificaly indeterminable, however the species now in concern is quite different from the preceding two species in having quite longer minor septa.

Hor.: *Yabeina* zone?

Loc.: Funabuse (Hunabuse), Yamagata-gun, Gifu Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ.

Coll.: G. IIZAKA.

Lophophyllidium sp. *c*.

Pl. 37, fig. 8.

The specimen now in concern was also found in the collection of the late Dr. G. IIZAKA, like the preceding species. It was derived from the limestone developing at Funabuse (Hunabuse), Gifu Prefecture.

Although it is not specifically determinable from the scantiness of the material, the writer believes now, that the specimen in concern may belong to the species being different from which were described in the foregoing pages.

To the writer there is available only one transverse thin section. Description follows: corallite circular in cross section. Calcicular diameter about 6.5 mm. Wall rather thin. Major septa long, almost reach the columella, counted as much as 20, in which very short cardinal septum and counter septum uniting firmly with the columella are clearly distinguishable from the others.

Minor septa rudimentary. Columella large and compact. In the interspace between each septum cut edges of tabulae recognizable.

Hor.: *Yabeina* zone?
Loc.: Hunabuse (Funabuse), Yamagata-gun, Gifu Prefecture. Specimen is now stored at the Inst. Geol. Tokyo Univ.
Coll.: G. IIZAKA.

Lophophyllidium sp. *d.*

Pl. 16, fig. 2; Pl. 22, fig. 13.

Only one fragmental specimen is available for study. The specimen seems rather to resemble *Lophophyllidium suetomii* MINATO, than the other species in foregoing desccription. However, the former may be distinguishable from the latter in having septa which come to be gradually thinning towards the axial edges, and longer minor septa.

Hor.: Lower Sakamotosawa series, *Pseudoschwagerina* zone.
Loc.: Komata, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 17847.
Coll.: M. MINATO

Family Geyerophyllidae, n. Fam.

Corals assignable to this new family are forms belonging to such genera as *Lonsdaleoides* HERITSCH, *Geyerophyllum* HERITSCH, *Carinthiaphyllum* HERITSCH, *Carniaphyllvm* HERITSCH, *Akiyosiphyllum* YABE et SUGIYAMA and *Cionodendron* BENSON & SMITH, all appearing from the Late Lower Carboniferous in age and ranging to the Upper Carboniferous and also some of them to the Permian.

They are fasciculate in form rarely of simple form; generally possess corallites giving an appearance like corals of Clisiophyllidae in the mature stage; they have usually perfect or imperfect peripheral area occupied by lonsdaleoid dissepiments, which area is untravarsed by any septa. They have much complicated axial structure, built of solid columella, composed of axial tabellae and septal lamellae; all are much thickened by stereoplasmic deposits. Thus the columella of these corals shows apparently features quite similar to that of Amygdalophyllidae on the one side, but also it represents the type of Clisiophyllidae in mature stage as above stated.

Still in the earlier stage, septa of these corals show somewhat pinnate arrangement and the columella is compact, uniting directly with counter septum; besides this the dissepiments are wholy lacking. Thus the corallites present an appearance of lophophylloid corals.

No genera are known in the Family Clisiophyllidae which show lophophylloid nature in the early stage, and accordingly this group of corals now under consideration, should be separated from Clisiophyllidae, although the corallites of this group show strong resemblance in mature stage to some genera of Clisiophyllidae.

Discussion: In some corals of Clisiophyllidae, possessing complicate axial structure and wide dissepimentarium, genera *Lonsdaleia* as well as *Waagenophyllum* for example, have corallites with narrow dissepimentarium and simple plate-like columella in their early stages. As has been clearly shown genera *Lonsdaleia* is the descendant form of *Dorlodotia* or *Pseudodorlodotia*,[1] while genus *Waagenophyllum*[2] may be regarded to be the descendant form of genus *Siphonodendron*; this shows that the Clisiophyllidae, at least with respect to some genera, was derived from a common ancestor with Lithostrotionidae.

Meanwhile there is a coral called under the name of genus *Cionodendron*, which is also quite worthy of note in consideration of the phylogenetic development of the corals belonging to Geyerophyllidae.

Genus *Cionodendron* shows a similarity with *Siphonodendron* or *Amygdalophyllum* in mature stage, but this coral, according to BEONSON and SMITH lophophylloid nature in the early stage; dissepiments wanting, fossulae prominent, counter septum long and united with solid columella, and septa in pinnate arrangement.

Thus it is now firmly ascertained that *Cionodendron* was derived from a common ancestor with Lophophylloid coral, *Lophophyllidium* for example.

Now, the ontogenetic development of some species of such genera as *Lonsdaleoides*, *Carithiaphyllum* and *Geyerophyllum* has become clear in certain point, through the efforts of HERITSCH as well as the writer's own investigation, and all of them evidently are derived from lophophylloid corals, as above stated.

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1) The onotgenetic development of some species of *Lonsdaleia* has already been minutely observed by SMITH and LEWIS: *Lonsdaleia duplicate alstonensis* SMITH, (S. SMITH: The genus *Lonsdaleia* and *Dibunophyllum rugosum* MCCOY, Q. J. G. S. vol. 71, p. 241, pl. XVII, figs. 5-24), *Lonsdaleia pictoense* (BILLINGS) (H. P. LEWIS: The Carboniferous corals of Nova Scotia, Annales Mag. Nat. Hist. ser. 10, vol. 16, p. 139, text.fig.)

2) The ontogenetic development of *Waagenophyllum akasakense* (YABE) was already described in the paper. (see p. 104, pl. 37, figs. 6A-E.)

3) W. N. BENSON and S. SMITH: Rugose corals from the Burindi series. Q. J. G. S. vol. 79, p. 165, Pl. VII, figs. 4, 5; Pl. IX, figs. 4, 7, 1923.

Beside this, corals beloging to *Lonsdaleoides* as well as *Carinthiaphyllum* are quite interesting in possessing corallites which do show the *Cionodendron* stage.

To be sure, these two genera may be evolved at first from lophophylloid coral, because they show lophophylloid nature, in early stages of ontogeny, but after those stages, their corallites are quite indistinguishable from the mature stage of *Cionodendron* or *Akiyosiphyllum*.

As will be later stated, genus *Akiyosiphyllum* is a slightly more advanced form than *Cionodendron*.

Thus both *Lonsdaleoides* and *Carinthiaphyllum* are ascertained to be derived from a *Cionodendron*-like coral through a lophophylloid coral, *Lophophyllidium* as an example.

At any rate, it is far from doubtful, that the new family Geyerophyllidae was branched directly from lophophylloid corals, in spite of their corallites being apparently quite similar to some corals of Clisiophyllidae in mature stage; thus the phylogeny of those corals above enumerated is induced as shown schematically in fig. 20.

The writer wishes to put genera *Akiyoshiphyllum* and also *Cionodendron* into this new family, although these two genera are primitive in form in comparison with the other four genera.

Accordingly the new family is thus defined: corallum fasciculate or simple; with solid and compact columella in the early stage, septa originally in pinnate arrangement, provided with concentric dissepiments, while peripheral area occupied by lonsdaleoid dissepiments is perfect, or imperfect, or almost lacking. Geological range, Lower Carboniferous (Viséan) to Permian.

Genus *Geyerophyllum* Heritsch, 1936.

According to Heritsch,[1] the corallites of this genus are pentareal, that is, in cross section, built up of (a) columella, (b) the intermediate zone traversed by the major septa alone, (c) the dissepimental zone with dissepiments, (d) the vesiculated zone with considerably reduced or almost disappearing septa, and (e) the outermost zone with lonsdaleoid dissepiments; zones c and d are separated by a inner wall and zones d and e by another inner wall. Genotype is *Geyerophyllum carnicum* Heritsch.

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1) F. Heritsch: Korallen der Moskauer-, Gshel- und Schwagerinen-Stufe der Karnischen Alpen. Palaeontographica, 83 A, p. 131, 1936.

Geyerophyllum hunabuseum MINATO, sp. nov.

Pl. 16, figs. 1, 6, 9; Pl. 25, fig. 3; Pl. 30, fig. 7.

Corallum simple, corallites small, less than 9 mm in calicular diameter. In cross section pentareal arrangement is well recognizable. Central area occupied by columella which gives the appearance as if it were a so-called solid columella but is truly constructed of highly thickened stereoplamic deposits at a few tabellae and septal lamellae converging to meet the median plate of columella. In the early stage, columella directly unites with the counter septum, while in the mature stage it is free from the latter.

The intermediate zone is occupied by the major septa alone, which are faily thick, especially near the theca, and counted as many as 20. The third zone is relatively narrow, occupied by major and minor septa and less numerous dissepiments. The former two are thin in this area, and the dissepiments are arranged in angulo-concentric pattern and two or three layered.

The fourth zone is composed of vesicles in irregular arrangement and very thin or partly disappearing septa. The outermost zone is occupied by only lonsdaleoid dissepiments.

In the longitudinal section, columella is constructed of steeply arched tabellae, which are much strengthend by stereoplasmic deposits, in which no definite median plate is discernible.

Tabulae mostly horizontal, but occasionally slightly arching upwards, their convex sides facing upwards as well as outwards.

Dissepimentarium separated into two parts; the inner part occupied by equal-sized vesicles in two or three rows, arranged vertically their convex sides facing inwards; while in the outer part unequal-sized vesciles are arranged in an oblique row, with their convex sides facing upwards as well as inwards.

Remarks: Of two forms described and figured by HERITSCH, the genotype is more nearly like the present form. The writer was in doubt for a long time, whether he should specifically distinguish these two forms, but he is sure about the fact the Japanese form is distinct from the former in having dissepiments arranged in different manner. The Carnic species has dissepiments arranged in concentric pattern, while in the Japanese species they are arranged in angulo-concentric pattern.

Hor.: *Yabeina* zone (?)
Loc.: Mt. Funabuse (Hunabuse), Yamagata-gun, Gifu Prefecture.
Coll.: G. IIZAKA.

Geyerophyllum gerthi (OZAWA)

Pl. 41, fig. 5; Pl. 42, figs. 8a, 8b and 10.

1925. *Lonsdaleia gerthi*, OZAWA: Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato, Jour. Coll. Sci. Tokyo, Imp. Univ, vol. 45, Art. 6, p. 73, pl. 12, fig. 10; pl. 12, figs. 9-12.

1936. *Geyerophyllum gerthi*, HERITSCH: Korallen der Moskauer-, Gsher- und Schwagerinen-Stufe der Karnischen Alpen. Palaeontogr. 83 (A), p. 133.

Description (OZAWA, 1925): Central column strong and bisymmetrical in cross section, composed of merely septal tabellae. The arrangement of tabellae resembles that of *Carruthersella* GARWOOD or that of *Carcinophyllum wichmanni* GERTH. Columella of full grown specimen well defined and separated from major septa excepting counter septum which is continuous with the central plate. Septa of two orders, major and minor. Major septa strong and generally reach the epitheca, but when the outer area of dissepiments is developed, the bases of the septa thickened and fused together to form the pseudowall. Minor septa either confined to this pseudowall or represented by mere septal ridges.

Outer area when present, formed of narrow zone of very coarse dissepiments.

In longitudinal section, central column strong, composed of closely packed axial tabellae. Tabulated zone narrow and very irregular. Dissepiments large and loosely arranged.

Mode of Gemmation. The young corallite rests on the horizontal tabulae, which are curved and form the external wall of the new corallite. Two cases are observed.

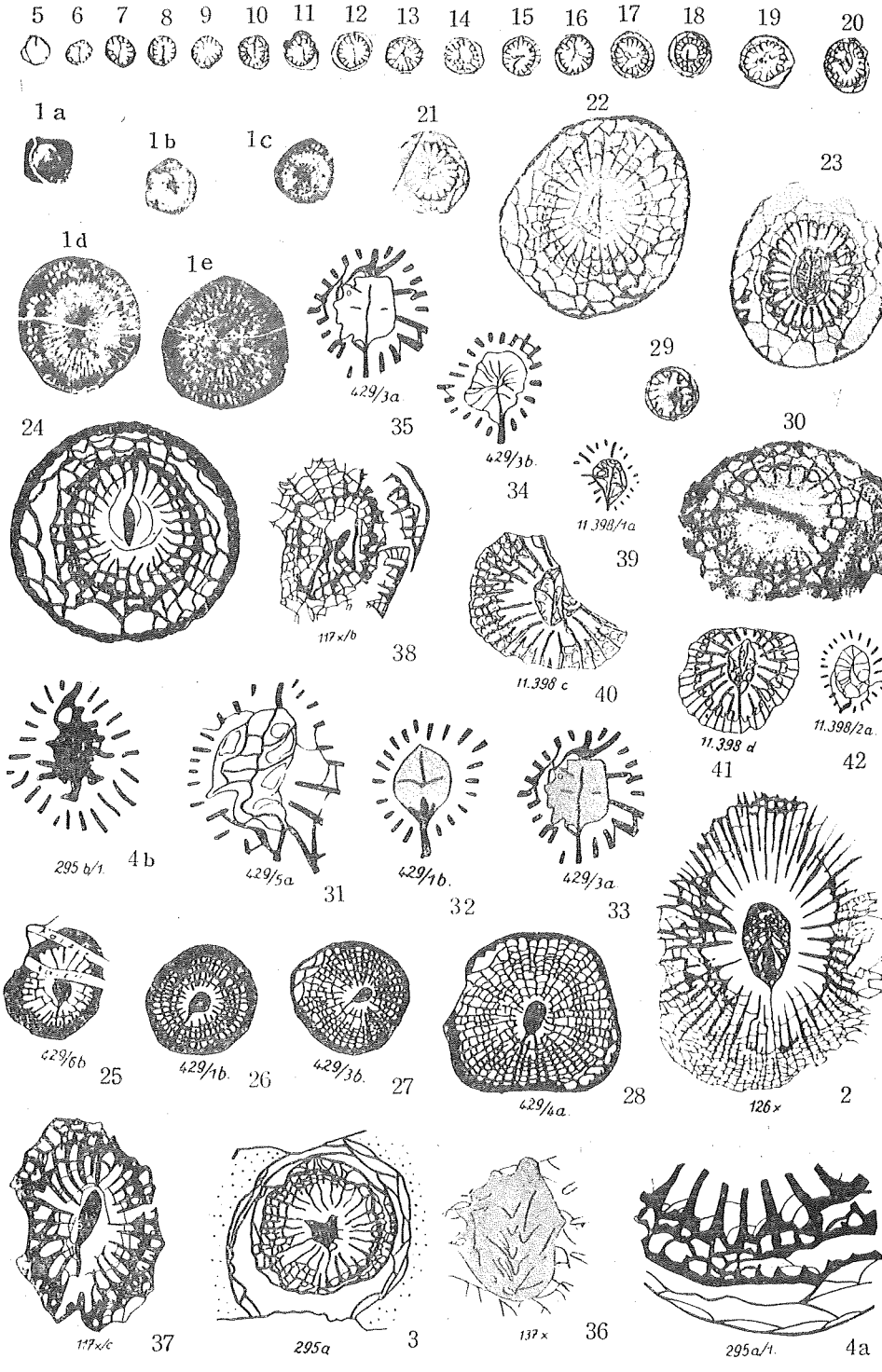
Remarks: The writer tried to find the original specimens described and figured by OZAWA, which might be expected to be now stored at the Inst. Geol. Tokyo Univ., but in vain. The following paragraphs are, accordingly the writer's veiw on the corallites of this peculiar coral, being based mainly on the figures given by OZAWA.

The writer believes the columella of this species apparently to resemble that of the genotype of genus *Caruthersella*, as OZAWA was convinced, especially in regard to the transverse section. The columella of former seems to be almost identical with that the latter, however in the longitudinal section of it shows quite different aspect.

Caruthersella compacta GARWOOD[1] has solid columella in transverse sec-

1) E. J. GARWOOD: The Lower Carboniferous suecession in the Northwest of England. Q. J. G. S. vol. 68, p. 555, pl. 48, figs. 1a-d, 1912.

Text-fig. 19


5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
1a
1b
1c
21
22
23
1d
1e
429/3a
35
429/3b.
34
29
24
30
11.398/1a
39
117x/b
38
11.398 c
40
11.398 d
41
11.398/2a.
42
295 b/1.
4b
429/5a
31
429/1b.
32
429/3a.
33
429/6b
25
429/1b.
26
429/3b.
27
429/4a.
28
126x
2
117x/c
37
295a
3
137x
36
295a/1.
4a

tion, which may be composed of thickened and somewhat undulating, closely set, vertical lamellae in the longitudinal section, while in OZAWA's species columella seems to be compact even in the longitudinal thin section.

Also it is quite different from the columella of *Carcinophyllum wichmanni* GERTH, which is *Verbeekiella*.

Such being the case, even only from the nature of the columella, this species must be regarded to be not congeneric with *Caruthersella* nor with *Verbeekiella*.

Meanwhile the fundamental structure of this coral, now under consideration, is quite the same with genus *Geyerophyllum*; the pentareal arrangement

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Text-figs. 19. In this plate showing the ontogenitic developments of the corallites of some species, in worthy of note.

Cionodendron columen BENSON et SMITH.

Figs. 1a-1e. Figures are reproduced from: W. N. BENSON and S. S. SMITH: Rugose corals from the Burindi series. *Q.* J. G. S. vol. 79, p. 156, pl. VIII, fig. 5.

Carniaphyllum gortanii HERITSCH.

Figs. 2. which is reproduced from: F. HERITSCH: Korallen der Moskauer-, Gshel- und Schwagerinen-Stufe der karnischen Alpen. Palaeontegraphica 83 (A), p. 131, pl. IV, fig. 35.

Geyerophyllum carnicum HERITSCH.

Figs. 3, 4a, 4b. Figures are reproduced from: ibid. p. 132, Pl. IV, figs. 36, 37. Fig. 4a showing the peripheral part of the corallite and fig. 4b showing the columella in the transverse section.

Geyerophyllum broilii HERITSCH.

Figs. 36, 37, 38. Reproduced also: ibid. p. 133, Pl. IV, fig. 38. Fig. 36 showing the columella in the cross section.

Lonsdaleia duplicata alstonensis SMITH.

Figs. 5-23. Figures are reproduced: S. SMITH: The genus *Lonsdaleia* and *Dibunophyllum rugosum* (MCCOY). Q. J. G. S. vol. 71, p. 241, Pl. XVII, figs. 5-23.

Dorlodotia briarti SALÉE.

Fig. 24. which is reproduced from: A. SALÉE: Sur un genera noveau de *Téteracoraliaires* (*Dorlodotia*) er la valeur stratigraphique des *Lithostrotion*. Annales Soc. Sci. Bruxelles vol. XXXIX, p. 8, text-fig. 5.

Thysanophyllum pseudovermiculare MCCOY: *Pseudodorlodotia pseudovermiculare* (MCCOY).

Figs. 29, 30. These figures are reproduced from: S. SMITH: ibid. Pl. VII, figs. 29, 30.

Carinthiaphyllum kahleri HERITSCH.

Figs. 25-28, 31-35. These figures are reproduced from: HERITSCH: ibid. p. 135, Pl. IV, fig. 39. Figs. 31-35 showing the columella in the cross section.

Carinthiaphyllum carnicum HERITSCH.

Figs. 39-42. Figures reproduced from: HERITSCH, ibid. p. 137, Pl. V, fig. 41. Figs. 39 and 42 showing the columella in the transverse section.

of corallite in cross section, one of the most characteristic features of *Geyerophyllum*, is clearly discernible in OZAWA's species. Moreover the columella of this coral is solid, as above mentioned. Therefore it may be preferable to treat the species under the name of genus *Geyerophyllum*, as HERITSCH stated.

Hor.: *Yabeina* zone.
Loc.: Shiraiwa, Omine-mura, Mine-gun, Yamaguchi Prefecture.
Coll.: Y. OZAWA.

Genus ***Lonsdaleoides*** HERITSCH, 1936.

HERITSCH regarded this genus to be quite closely allied with *Lonsdaleia*, because the fundamental structure of the corallite seemed to him to be wholy analogous with the latter.

The difference regarded by him to distinguish these two genera, consist in the relatively imperfect development of lonsdaleoid dissepiments in the outer layer and the much strengthened stereoplasmic deposits. The columella is uniting, according to him, with counter septum even in the mature stage, and the median plate, septal lamellae and axial tabellae are all much strengthened by organic deposits.

HERITSCH defined this coral as follows:

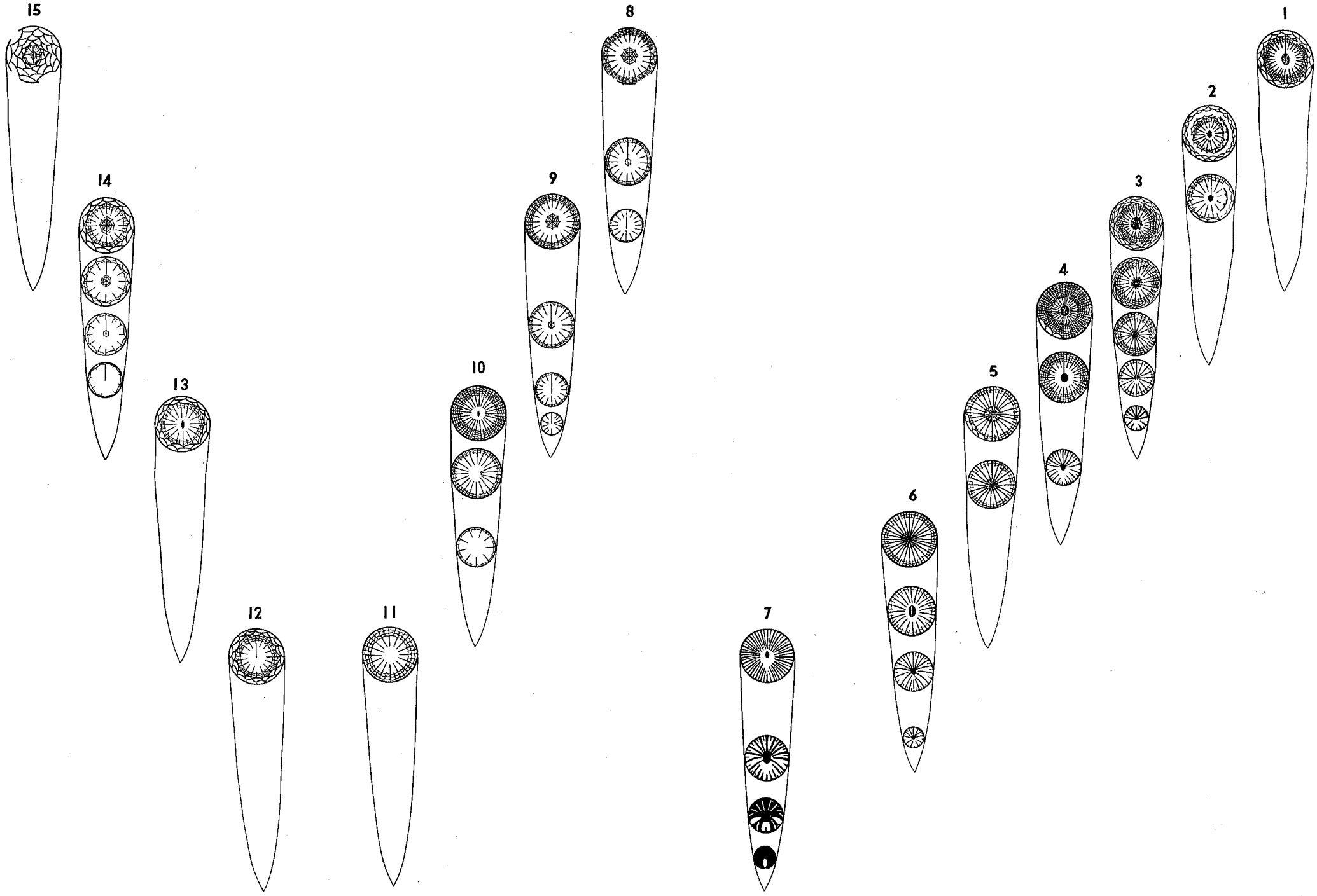
1. Die Columella hängt mit dem Gegenseptem zusammen und zeigt einen Bau wie bei *Waagenophyllum*. Es ist zwar die Medianplatte zu erkennen, sie verläuft aber gebogen; um sie herum liegt ein einfaches Netzwerk von Tabellae und Radiallamellen. Alle Elemente des Bauplanes sind stark stereoplasmiatisch verdickt.

2. Um die Columella schlingt sich eine Zone ohne Septen. Das ist die Region der Tabulae des Längsschnittes. Vereinzelt laufen aus dem Bau der Septenzone feine Linien durch die freie Zone, wobei es sich vielleicht um Schnitte von Tabulae handelt.

3. Die Zone der Septen wird nur von den Septen 1. Ordnung eingenommen. Zwischen ihnen liegt sehr wenig Dissepiment.

4. Dann folgt die Zone des Dissepiments. Sie wird nach aussen durch eine verdickte Balssenzone, die innere Mauer, abgeschlossen. Die Septen I und II ordnung haben in der Dissepimentzone ihr äusseres Ende.

5. Die Randzone ist von der inneren Mauer und der Epithek begrenzt; sie kann auch fehlen, in welchem Fall die Septen in eine sehr breite stereoplasmatische Randzone übergehen. Die Randzone wird von Blasen



Text-fig. 20. Phylogeny of some corals belonging to Clisiophyllidae, Lithostrotionidae, Lophophyllidae, and Geyerophyllidae, in showing the ontogeny of some genera.

Pseudodorlodotia-Polythecalis series.

15: *Polythedalis* (massive, plocoid form).

14: *Stylidophyllum* (massive, cerioid form), *Lonsdaleia* (solitary or fassiculate form). The neanic stage: *Pseudodorlodotia* or *Dorlodotia.*

13: *Ltthostrotionella* (massive, cerioid form), *Dorlodotia* (fassiculate form). The neanic stage: *Pseudodorlodotia.*

12: *Thysanophyllum* (massive, ceroid form), *Pseudodorlodotia* (fassiculate form).

Diphyphyllum-Wentzelloides series.

11: *Diphyphyllum.*

10: *Lithostrotion* (massive, cerioid form), *Siphonodendron* (fassiculate form). The neanic stage: *Diphyphyllum.*

9: *Wentzelella* (massive, cerioid or partly plocoid form), *Waagenophyllum* (fassiculate form), and *Iranaphyllum* (solitary form). The neanic stage: *Lithostrotion* or *Siphonodendron* stage, though *Diphyphyllum* stage.

8: *Wentzelloides, Protolonsdaleia, Lonsdaleiastraëa* (massive, plocoid forms).

Lophyllidium-Lonsdaleoides series.

7: *Lophophyllidium.* The brephic stage shows the so-called Füllmasse stage of WEDEKIND.

6: *Cionodendron.* The neanic stage: *Lophophyllidium.*

5: *Akiyosiphyllum.* The neanic stage: *Cionodendron* stage, through *Lophophyllidium* stage.

4: *Carinthiaphyllum.* The nanic stage: *Akiyosiphyllum* and *Cionodendron* stage, through *Lophophyllidium* stage.

3: *Lonsdaleoides.* The neanic stage: *Akiyosiphyllum* and *Cionodendron* stage, though *Lophyphyllidium* stage.

2: *Geyerophyllum.*

1: *Carniaphyllum.*

Of them, 15, 14, 9, and 8 are now classified into Clisiophyllidae, while 13, 12, 11 and 10 into Lithostrotionidae, however this classification may be quite artificial from the phylogenical point of view. Corals belonging to Geyerophyllidae nov. (figs. 6–1) were formerly grouped into the family Clisiophyllidae by HERITSCH and otheres, and corallites of corals belonging to Geyerophyllidae give and appearance to be quite similar with some corals of Clisiophyllidae in their mature stage, however their ontogenical developments show to be decidedly different from such corals as *Stylidophyllum, Lonsdaleia, Waagenophyllum, Wentzelella* and *Iranophyllum.*

eingenommen, deren tangentiale Längserstreckung meist deutlich ist; diese Blasen sind aber meist viel kleiner, als es bei den Lonsdaleien üblich ist.

However, the writer does not agree with HERITSCH's view; it is indubitable that the genus *Lonsdaleoides* is phylogenetically quite different in origin from *Lonsdaleia*. The former possesses the corallites, being derived from lophophylloid coral in the early stage, *Lophophyllidium* as an examples; while the latter is decidedly the descendant of a thysanophylloid coral.

Accordingly the apparent similarity observed in the corallites of the mature stage of both genera is only superficial.

The columella of the genus *Lonsdaleoides* is solid in the early stage, which become split into the septal lamellae and axial tabellae, while the columella of the genus is only simple plate in the early stage, which becomes increasingly complicated by the addition of tabellae and lamellae.

Beside this, the pinnate arrangement of septa is quite prominent in the early stage of the genus *Lonsdaleoides*.

Such being the case, the writer is of opinion that the narrowness of the peripheral area occupied by the lonsdaleoid dissepiments or their imperfect development is not of prime importance in distinguishing the genus *Lonsdaleoides* from *Lonsdaleia*, although HERITSCH mentioned this to be especially important.

In Japan, two species belonging to this genus, now in consideration, have been found up to the present day, both coming from the Middle Carboniferous deposits, although the genotype was described by HERITSCH from the Lower Permian in the Carnic Alps.

Genotype: *Lonsdaleoides boswelli* HERITCH.

Remarks: This genus is not fundamentally different from such genera as *Carniaphyllum*, *Carinthiaphyllum* and *Geyerophyllum*. Yet it is distinguishable from *Carniaphyllum* in the structure of the columella. The columella of the latter is composed of the follwing elements in the mature stage: (1) the median plate uniting with counter septum, which is much thickened by stereoplasmic deposits but is short, attaining the half the length of the longer diameter of the columella, (2) the septal lamellae are not radial in arrangement, (3) and axial tabellae filling the inter space of the lamellae. It is worthy of note that all these structural elements are thickly constructed. From the genus *Geyerophyllum* this genus is easily separable form the pentareal arrangement of the corallites.

Also the genus now in consideration is distinguishable from the genus *Carinthiaphyllum*, because the lonsdaleoid dissepiments are poorly developed in the latter.

Lonsdaleoides enormis (OZAWA)

Pl. 23, figs. 4, and 5; Pl. 36, fig. 4.

1924. *Lonsdaelia irregularis* (M. S.) OZAWA: Stratigraphical study of the Palaeozoic in the Akiyoshi limestone plateau. Jour. Coll. Soc. Japan, vol. 30, p. 357, listed.

1925. *Lonsdaleia enormis*, OZAWA: Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato. Jour. Coll. Sic. Tokyo, Imp. Univ., vol. 45, Art. 6, p. 69, pl. 14. figs. 1-4.

Description (OZAWA: 1925): Corallum fasciculate, corallites straight and parallel, often attaining a consdierable length. External surface covered by straight striae, or inter-septal ridges. Calyx deep, its diameter measuring about 2 cm or 3 cm. Central column stout and prominent.

In the transverse section the central column, is composed of irregularly twisted septal lamellae and sparse axial tabellae. Tabular region broad, its width attaining about two-fifths of the cross diameter. Tabulae moderately spaced and almost horizontal, but towards the central column they are somewhat curved and form saucer-shape.

Dissepimental area narrow, invaded, but not completely, by the septa. Septa of two orders. The major septa extend from the extra-thecal region almost to the central column, but they rarely reach the axial structure on the one hand or the epitheca on the other. Minor septa one-half of the major in length. Number of major septa 32–36.

Remarks: From the result of examination of a number of specimens, including the holotype of this species, the wrirer concluded that this species, now under consideration, may be preferablly removed from genus *Lonsdaleia* and assigned to the genus *Lonsdaleoides* Heritsch for many reasons. As previously stated, genus *Lonsdaleoides* has no intimate relation to *Lonsdaleia*, although they have apparent similarity with each other in the construction of corallites in the mature stage.

The corallites of this species are widely variable in many respects even in the mature stage, especially in the development of peripheral area occupied by lonsdaleoid dissepiments and structure of columella, so that one may be apt to think them as belonging to several distinct species.

Hor.: Middle Carboniferous, *Fusulinella* zone.
Loc.: Tobinosu, Ohta-machi, Mine-gun, Yamaguchi Prefecture.
Coll.: Y. OZAWA, specimens deposited at Inst. Geol. Tokyo, Univ.

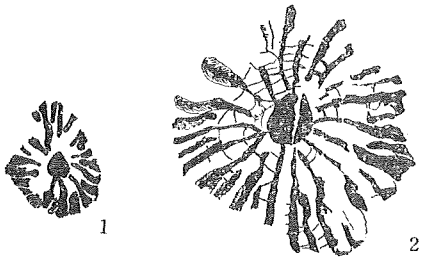
: Taisyaku, Hiroshima Prefecture. Coll.: H. MOCHIZUKI, specimens now deposited at Inst. Geol. Tokyo Univ.

Lonsdaleoides toriyamai MINATO, sp. nov.

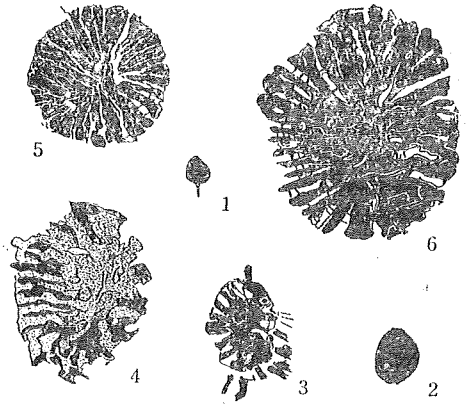
Pl. 3, fig. 6; Pl. 16, fig. 7; Pl. 23, figs. 1, 2, and 3; Text-figs. 21, 22.

The coral now in concern is specifically different from the preceding species in having considerably wider peripheral area occupied by lonsdaleoid dissepiments and columella constructed of septal lamellae and axial tabellae arranged in more regular manner in the mature stage than is found in the preceding species.

However the corallites of the two species are quite similar with each other in the ontogenetic developments, especially in the earlier stages.



Text-fig. 21. *Lonsdaleoides toriyamai* MINATO, sp. nov., showing the corallites in early stages. (×5)



Text-fig. 22. Showing the ontogenitic development of columella of *Lonsdaleoides toriyamai* MINATO. All figures are drwan basing on corallites belonging to one corallum. (×5)

Notwithstanding the writer regards the species, now in consideration, to be perhaps a more advanced form than the preceding species, in having much broader peripheral area with lonsdaleoid dissepiments. In comparing these two species, especially in the same sized corallites, the mentioned area is far wider in the species now in concern than in the preceding species.

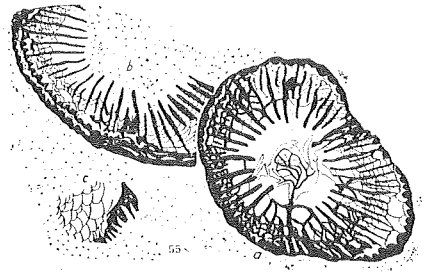
Remarks: One of the specimens collected by TORIYAMA from Kyowa-mura, Yamaguchi Prefecture is composed of numerous corallites, basing upon which the writer made observation on the ontogeny of this coral in thin sections. In the early neanic stage, septa of this species are not numerous; they are arranged somewhat in pinnate pattern, while dissepiments are wholly lacking.

Even in this stage, columella of this coral is not thin in cross section but solid and compact, round in outline, uniting firmly with the counter

septum; thus the corallite of this stage is quite indistinguishable from that of the genus *Lophophyllidium* as a whole.

As a corallite grows larger, the dissepimentarium appears, and in this stage columella, though still solid and compact, begins to be free from the counter septum. Thus the feature of this coral strongly resemble genus *Cionodendron* in this stage.

Also early stage of *Cionodendron*, according to BENSON and SMITH shows lophophylloid nature.[1] Accordingly it is quite evident that this coral, now under consderation, might be evolved from the corals which resemble genus *Cionodendron*, through the stage of *Lophophyllidium*.



Text-fig. 23. *Lonsdaleoides boswelli* HERITSCH.
This is reproduced from Heritsch's paper for comparison with the two Japanese species of *Lonsdaleoides*.

Next, septal lamellae become discerniable in the columella, besides the median plate, and the dissepimentarium becomes thick when the corallite grows larger. Lastly the columella of this coral comes to present the typical spider-web structure, composed of median plate, septal lamellae and axial tabellae, although they are much strengthened by organic deposits; thus the corallites show a form being

1) W. N. BENSON and SMITH: Rugose corals from the Burindi series. Q. J. G. S. vol. 79, p. 165, pl. VIII, figs. 4, 5: Pl. IX, figs. 4, 7, 1923.
BENSON and SMITH described the ontogenetic development of the genotype of *Cionodendron* as below, however, the writer is doubtful, whether this coral may be truly evolved from the course through the *Siphonodendron* (or *Lithostrotion*) stage, after the lophophylloid stage or not. This coral may be directly derived from lophophylloid coral without passing through the *Siphondendron* (or *Lithostrotion*) stage midway. (see text-figs. 19, 20.)
In the figure of *Cinonodeodron*, BENSON and SMITH gave illustrations showing several stages of development of corallites: These were lettered, a, b, c and d. (Pl. 8, fig. 5, p. 166)
a: (1 mm. in diameter) represents a very early neanic stage. There are about twelve major septa present, and one of these—the cardinal or counter-septum—is dilated to form a conspicuous columella: the other septa join the columella, as in later stages.
The minor septa are very short, and the dissepimental tissue is undeveloped. The pinnate symmetry is distinct.
b: (2 mm. in diameter) show the corallite at a later neanic stage. The septa have increased in number, the minor septa are well developed, and an extrathecal area is added. The columella is not conspicuously large or well formed, and at this stage *Cionodendron* is not markedly differentiated from *Lithostrotion*. A pinnate symmetry is still discernible.
c: (3 mm. in diameter). The corallite has practically attained its ephebic characters, although it has only reached half (or little more than half) of its mature dimensions. The inner ends of the major septa have gradually been enclosed by an expanding columela.
d: Ephebis stage.

quite similar the those of *Lonsdaleia.*

Meanwhile *Lonsdaleia, Lonsdaleia duplicata* for example, was minutely studied by SMITH[1], especially the ontogeny.

According to him, genus *Lonsdalia* may be derived from a *Thysanophyllum*- like coral and it has been regarded to have not experienced lophophylloid stage in its ontogenetic development.

Such being the case, so far as the construction of columella is concerned, there is not recognizable any intimate relation, between *Lonsdaleia* and *Lonsdaleoides,* in spite of the apparent similarity of the corallites in the mature stage.

Hor.: Middle Carboniferous, *Fusulinella* zone

Loc.: Kyowa-mura, Mine-gun, Yamaguchi Prefecture. Coll.: R. TORIYAMA. Reg. nos.: 17809, 17810.

Loc.: Omi, Niigata Prefecture. Coll.: G. IIZAKA, specimens deposited at Inst. Geol. Tokyo Univ.

Genus *Akiyosiphyllum* YABE and SUGIYAMA, 1942

As before mentioned, the genus *Akiyosiphyllum* is a progressive form of *Cionodendron.* The former provides peripheral area occupide by conical dissepiments only and untraversed by any septa, although the development of this area is still imperfect.

So called *Lithostrotion stanvellense* may be assignable to this genus now in concern; accordingly *Akiyosiphyllum* must be regarded to be ranging from Lower Carboniferous (Viséan) to the Permian.

Genotype: *Akiyosiphyllum stylophorum* YABE et SUGIYAMA.

Akiyosiphyllum stylophorum YABE et SUGIYAMA

Pl. 16, fig. 3; Pl. 19, fig. 2; Pl. 26, fig. 1; Pl. 30, fig. 3; Pl. 37, figs. 5a-c.

1942. *Akiyoshiphyllum stylophorum,* YABE and SUGIYAMA: *Akiyosiphyllum,* a new type of Permian Rugose corals from Japan. Proc. Imp. Acad. Tokyo. vol. 18, p. 574, figs. 1, 2.

Description (YABE and SUGIYAMA, 1942): Corallum compound, fasciculate. Corallites cylindrical, slender, round in cross-section, less than 8 mm broad. Columella broad, 7 mm in diameter, being about one third of that of corallites, solid, showing no minor structure other than the obscure trace of median lamella or primordial columella, which is elongated toward two opposite (presumably cardinal and counter) septa and fusiform in cross-section; primordial columella and coarsely vesiculated structure around it distinctly

1) S. SMITH: The genus *Lonsdaleia* and *Dibunophyllum rugosum* (M'COY) Q. J. G. S. vol. 71, pl. 17, figs. 5-23, 1915.

discernible only at the distal part of columella where stereom is not yet developed. Major septa less than 30, usually 24–28 in number, alternating with very short minor septum; stout, rapidly attenuating distally, and extending to solid columella or, where this is not yet fully developed, to vesiculated zone around its median lamella; dilated proximally, and joined laterally to each other, forming there an inner wall near the outer wall. Inner wall almost as thick as the outer; often incomplete. Tabulae abundant, vesiculated, or to express it differently, replaced by numerous vesicules arranged in conical layers; in cross-section of corallites, represented by several, more or less regularly concentrical lines; vesicules variable in size, similar in their average dimentions to those of dissepimental zone. Dissepiments vesicular, vesicules arranged in 2–3 layers.

Remarks: The columella of this species is quite variable in form in the cross section (Pl. 37, figs. 5a–c), but the general feature of it is closely similar to that of the genus *Cinonodendron*. Anyhow, the resemblance between the genera *Cinonodendron* and *Akiyosiphyllum* is indubitable.

Meanwhile, it is not negligible, the writer thinks, that this species has the septa tending to be thin near the wall, and often disappearing in this region, where coarsely arranged dissepiments develop as substitute. In this point, the writer regards this genus as a progressive form of the genus *Cionodoendron*.

In Japan, *Akiyosiphyllum* is known from three localities including two localies which YABE and SUGIYAMA mentioned; all of them come from the Permian limestone.

So-called *Lithostrotion stanvellense*, described and figured by BENSON and SMITH[1] is not *Siphonodendron* but may perhaps be congeneric with *Akiyosiphyllum*, in having large solid columella, highly vesiculated tabulae and rather distinct areolate dissepimental zone partly free from the septa. This species, according to them comes from the Lower Carboniferous formation.

Accordingly the genus *Akiyosiphyllum* may be regarded to begin to appear at the Lower Carboniferous in age in Australia.

Hor.: *Yabeina* Zone.

Loc.: Ohkubo, Ohta-mura, Mine-gun, Yamaguchi Prefecture. Reg. no.: 65033, holotype, Inst. Geol. and Paleont. Tohoku Univ. Coll.: M. KAWANO.

: Nugata, Shimoyakuno-mura, Amata-gun, Kyoto Prefecture. Reg. no.: 65034, Inst. Geol. Palaeont. Tokoku Univ.

Specimens in association with *Lyttonia*.

1) W. BENSON and S. SMITH: Rugose corals from the Burindi series. Q. J. G. S. vol. LXXXIX, pl. 9, figs. 3 and 6, 1923.

: Omi limestone, Omi-mura, Nishikubiki-gun, Niigata Prefecture. Specimens now deposited at Inst Geol. Tokyo Univ.

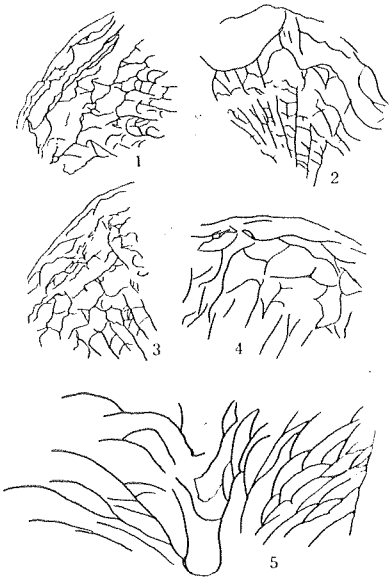
Family Cyathophyllidae EDWARDS and HAIME

Genus *Palaeosmilia* EDWARDS and HAIME, 1848

Palaeosmilia kitakamiensis MINATO

Pl. 17, figs. 1 and 2; Text-fig. 24.

1952. *Palaeosmilia kitakamiensis*, MINATO: A further note on the Lower Carboniferous fossils of the Kitakami Mountainland, Northeast Japan. Jour. Fac. Sci. Hokkaido Univ., ser. 4, vol. 8, p. 148, pl. 3, figs. 1-4.



Text-fig. 24. *Palaeosmilia kitakamiensis* MINATO
1-4, showing the peripheral part of the corallite.
5, showing the tabularium and dissepimentarium in the longitudinal section.

As formerly discussed by the writer this species differs somewhat from usual species of *Palaeosmilia* in having peripheral area free from septa. *Palaeosmilia regia* provides also peripheral area of the same type, but it is a massive coral.

To establish the new subgenus, if not a genus, on the basis of having characteristic peripheral area, using this species as a genotype, seems not to be unreasonable. However D. HILL[1] was taking the definition of genus rather broadly when she united "Cyathophyllum regia" into the genus *Palaeosmilia* in spite of its having massive form and possessing characteristic peripheral area. The writer wishes here, following D. HILL's authority, to place this coral into the genus *Palaeosmilia*.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Usagisawa, Setamai-machi, Kesen-gun, Iwate Prefecture.

Reg. nos.: 15511, 15518, 15258, 15261, 15254, 15257, 15253, 15239, 15225, 15256, 15260.

Coll.: M. MINATO.

1) D. HILL: A monograph of the Carboniferous rugose corals of Scotland. p. 121, pl. 6, figs. 14-18, 1940.

Genus *Kueichouphyllum* Yü, 1931

This genus may be distinguished from either *Cyathophyllum* Goldfuss or *Streophodes* M'Coy in having more prominent fossula, incomplete tabulae and more numerous septa, which are much thickened by organic deposits in the intrathecal area.

It may be comparable to *Heterocaninia* Yabe et Hayasaka, especially in much dilated septa in the cardinal quadrants, but the former have dissepiments arranged in concentric pattern, against the angulo-concentric arrangement of the latter. Besides this, *Kueichouphyllum* provides much longer minor septa than the genus *Heterocaninia*.

Paleosmilia may be most nearly allied to this genus, from which, however, *Kueichouphyllum*, is still distinguishable in strongly thickened septa in the cardinal quadrants, and a more prominent fossula. The writer wishes here to treat this coral as a genus independant from *Palaeosmilia*.

Meanwhile a genus *Faberophyllum* established by Parks[1] from Utah, U. S. A., also resembles *Kueichouphyllum* but the latter has the septa arranged somewhat in pinnate pattern in the cardinal quadrants. Moreover all septa in *Faberophyllum* are thin in the intrathecal area, except in one species, *Faberophyllum languidum*, and dissepiments of *Faberophyllum* are not arranged in concentric pattern. Genotype: *Palaeosmilia* (*Kueichouphyllum*) *sinense* Yü.

Kueichouphyllum latifossulatum Kanmera

Pl. 40, figs. 7, 8.

1952. *Kueichouphyllum latiforssulatum*, Kanmera: The Lower Carboniferous Kakisako formation of Southern Kyusyu, with a description of some corals and fusulinids. Mem. Fac. Sci. Kyusyu, Univ., ser. D, vol. 3, no. 4, p. 164, pl. 8, figs. 1-8, 1a, 4a.

Description (Kanmera, 1952): Corallum simple, very large, attaining more than 150 mm in length, cylindrical in mature stage, but slightly curved ceratoid in young stage. External characters unobservable, the specimens being entirely embedded in the matrix. Epitheca very thin. Septa very numerous, as many as 210 in number, including major and minor ones in the corallite about 50 mm in diameter. Of them about 1/4 to 1/5 of the number of major septa reach central area and join with one another, while the rest of the major septa extend inwardly only about 1/2 the radius of the corallite. Minor septa alternating with major ones, the length of the former attaining

1) J. M. Parks: Corals from the Brazer formation (Mississippian) of Northern Utah. Jour. Palaeont. vol. 25, no. 2, 1951.

or only slightly over the width of dissepimentarium. All septa including minor and major ones are almost straight and thin in extrathecal area, but thickened in intrathecal area, especially so in the cardinal quadrants where the major septa are so dilated that they are almost completely fused with each other. Major septa in the counter quadrants also dilated, especially near the alar septum, but far thinner than those in the cardinal area. Dissepimentarium broad, nearly 1/3 width of the diameter of the corallite in the broadest case, where more than 15 rows of dissepiments exist. All these dissepiments concentrically arranged.

Cardinal fossula prominent, rather broad, encircled by septa which show incomplete pinnate arrangement. Cardinal septum very short, situated in the central portion of the fossula. A number of cut-edges of the tabulae are crowded in the middle portion of the fossula.

In longitudinal section, dissepimental vesicles occupying broad peripheral zone, their convex sides faced upwards and simultaneously inwards. At the same time, vesicles near the outer wall are smaller and obliquely arranged, while vesicles near the theca, rather larger and steeply arranged.

Tabulae numerous, incomplete, nearly horizontal or only slightly convex upwards in the central area, but more arched near the theca.

Remarks: Some corallites belonging to this species were collected by the writer himself at Tsutsui on the occasion of a short visit with Mr. KANMERA. He was once of the opinion that these specimens from Tsutsui may be quite conspscific with *Kueichouphyllum yabei* MINATO described formerly from Kitakami district, because the corals, now under consideration, seemed to be so nearly related with the latter in all skeletal elements. It was certain, that the corals at Tsutusui, at least, may be more nearly allied to *Keichouuphyllum yabei* than any Chinese species of this genus. However KANMERA later came to the opinion from his careful observation, that the coral at Tsutsui may belong to another species from *Kueichouphyllum yabei*, in having more broad septal break, besides more dilated septa in the cardinal quadrants even at the early stage of ontogeny.

Thus the writer wishes here to follow KANMERA'S view and to regard KANMERA'S species as valid.

Hor.: *Dibunophyllum* zone. Associated fossils are many species of *Millerella, Dibunophyllum, Diphyphyllum, Siphonodendron* and *Hexaphyllia.*

Loc.: Tsutsui, Kakisako-mura, Yatsushiro-gun, Kumamoto Prefecture. Specimens are now registered at Inst. Geol. Kyusyu Univ. Reg. nos.: GKD, 5001, 5002.

Coll.: M. MINATO.

Kueichouphyllum yabei MINATO

Pl. 6, fig. 1; Pl. 8, fig. 3; Pl. 9, fig. 8; Pl. 11, fig. 2; Pl. 12, figs. 1, 2; Pl. 15, figs. 6a-f, i-k, 7a-b.

1943. *Kueichouphyllum yabei*, MINATO: New forms of *Kueichouphyllum* from Lower Carboniferous Coral limestone, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 1, p. 103, pl. 2, figs. 1-3; pl. 3, figs. 1-3; pl. 4, figs. 1, 3, 4, 5; pl. 5; pl. 6, figs. 5c, 5d, 5f.

This species quite resembles the Chinese species of *Kueichouphyllum sinense*[1] and *heishihkuanense* and their varieties but is easily separable from all of them in the dialtion of major septa. The Chinese forms possess major septa which are less thick in both counter and cardinal quadrants than in the Japanese form.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. nos.: 15283, 15140, 15143, 15150, 15153, 15136, 15144, 15288, 15289, 15150.
Coll.: M. MINATO.

Kueichouphyllum kesenense MINATO, sp, nov.

Pl. 11, fig. 1; Pl. 15. fig. 7c.

1943. *Kueichouphyllum yabei*, var. *a*, MINATO: New forms of *Kueichouphyllum* from the Lower Carboniferous Coral limestone, etc. Jour. Sigenkagaku Kenkyusyo vol. 1, no. 1, p. 105, pl. 3, figs. 2a, 2b.

In this form the axial ends of the major septa are always twisted as if to form an axial vortex. Such feature may warrant considering the present form as an independent species of this genus.

The fundamental structure of other skeletal elements of this form is quite similar to that of the preceding species.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 15137.
Coll.: M. MINATO.

Kueichouphyllum yahagiense MINATO, sp. nov.

Pl. 9, fig. 6; Pl. 41, fig. 4; Pl. 42, fig. 5.

1943. *Kueichouphyllum yabei*, MINATO, var. *b*. MINATO: New forms of *Kueichouphyllum* from the Lower Carboniferous Coral limestone of the Kitakami

1) C. C. YÜ: Lower Carboniferous corals of China, Palaeont. Sinica, ser. B, vol. 12, fasc. 3, p. 69, 1933.

Mountailnand, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 1, p. 105, pl. II, fig. 4; Pl. III, figs. 4a, 4b; Pl. IV, figs. 2a, 2b.

Corallum simple, large; epitheca thin. Septa numerous, in two orders, the major and minor. Cardinal septum very short, but longer than the minor septa. Major septa stop their growth before the central area but some of them reach the centrum. Major septa are always thicker in the intrathecal area, especially in the cardinal quadrants, but they are not often widely variable in thickness, and there can be seen sometimes rather thin septa; nevertheless they are thicker than the ones in the counter quadrants.

Cardinal fossula marked, cuts the dissepimentarium more deeply than in any other species of this genus.

Longitudinal sections showing numerous imperfect tabulae and very numerous vesicles of unequal size, which are arranged with their convex sides facing inwards and upwards at the outer rows and nearly inwards at the inner.

Septal number (major septa)

Specimens	Left Ca. Q.	Ca. sp.	Right Ca. Q.	Left Co. Q.	Co. sp.	Right Co. Q.
1	15	1	15	39	1	39
2	18	1	18	34	1	34
3	23	1	24	31	1	31

Remarks: As the writer has already mentioned, this species is characteristic in the shape of fossula in the transverse section, which cuts the dissepimentarium more abruptly and more deeply than in any other species. Moreover in this form less numerous major septa reach the central area than in any other species, giving an apperance of being well spaced. At the time when the writer first described this form, such type of coral was known only from one locality, so that he treated the specimens as only of varietal rank under *Kueichouphyllum yabei*, but more numerous specimens of such type of coral have since that time been collected at other localities in very remote places from the type locality. The distinguishing characters above mentioned are constantly recognizable and this form should be regarded as a species independant from *Kueichouphyllum yabei*.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugisirayama, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15146, 15151. Coll.: M. MINATO.
: Akabtake, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15873, 15874. Coll.: M. MINATO.
: North Hotoke-saka. Reg. nos.: 16850–16853. Coll.: M. MINATO.

Genus *Cyathophyllum* Goldfuss, 1826

Cysthophyllum sp. indet.

Pl. 13, figs. 2, 9.

1943. *Cyathophyllum* sp., Minato: On some Upper Viséan coral fauna from the Coral limestone of the Kitakami Mountainland, etc. Jour. Sigenkagaku Kenkyusyo, vol. 1, no. 2, p. 238, Pl. XX, figs. 1 and 2.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 15424.
Coll.: M. Minato.

Cyathophylloid coral

Gen. et sp. indet.

Pl. 6, fig. 3.

Pl. 6, fig. 3 shows a quite imperfect specimen which was neither generic- nor specific-determinable, although it may belong to Cyathophyllidae. The formation, from which the specimen was derived is extremely scanty in coral-line remains, so the writer wishes here only to record its occurrence.

Hor.: *Brachythyrina nagaoi* zone.
Loc.: Maide, Yokota-mura, Kesen-gun, Iwate Prefecture.
Reg. no.: 17305.
Coll.: M. Minato.

Genus *Campophyllum* Edwards and Haime, 1850

Campophyllum ? sp. indet.

Corallum compound, fasciculate. The diameter of each corallite is more than 11 mm. There are about 50 septa, half of which are major and the others minor. They are always very thin. Dissepiments are arranged in pseudo-herring bone pattern. No axial structure. No longitudinal sections were obtainable.

Remarks: The fundamental structure of this coral coincides with genus *Campophyllum*, which has relatively shorter septa than genus *Cyathophyllum*. However most species of the genus *Campophyllum* are solitary in form, at least so far as the present writer is aware; accordingly he is now heitant to assign this form to *Campophyllum*.

Hor.: *Fusulinella* zone.
Loc.: Ichinotani, Fukuchi, Kamitakara-mura, Yosiki-gun, Gifu Prefecture.
Reg. nos.: 16701, 16702.

: Kansaka, Hitoegane, Kamitakara-mura, Yoshiki-gun, Gifu Prefecture.
Reg. nos.: 16698, 16709, 16710.
Coll.: M. MINATO.

Family Heteropoyllidae McCOY

Genus ***Hexaphyllia*** STUCKENBERG, 1904

Hexaphyllia elegans YABE et SUGIYAMA

Pl. 39, figs. 8, 9, 10a, 10b.

1939. *Hexaphyllia elegans*, YABE and SUGIYAMA: Discovery of *Hexaphyllia* in the Lower Carboniferous of Japan. Trans. Palaeont. Soc. Japan, no. 16, Art. 91, p. 500, pl. 26, figs. 1-3: Text-figs. 1a, 1b.

YABE and SUGIYAMA described this species as follows: Corallum long, cylindrical, nearly straight, slightly attenuated posteriorly, over 35 mm long, up to 3.5 mm broad, calix not preserved; surface apparently smooth, faintly furrowed longitudinally in position corresponding to the outer borders of septa; where primordial wall is lacking, transversely or somewhat obliquely corrugated, and impressed by six longitudinal furrows which are wider and deeper than those exposed on the outer surface of wall; wall consists of two parts, thin primordinal wall and thick stereozone lining the inner surface of the former, both together measuring up to 0-4 mm in thickness; stereozone of wall under high magnification composed of numerous thin concentric layers which appear in transverse section of corallum to bend abruptly along the septa toward the primordial wall. Septa six, all of equal thickness; two opposite septa meeting at the center of corallum and lying on the median plane; these and four others grranged at subequal intervals, each of the latter forming a "Y" in each semicircle, when seen in transverse section, and coalescing into one lamella shortly before reaching the center. Tabulae distinct, eight counted in 4 mm, arranged opposite or subopposite on either side of the axial line in median longitudinal section, concave upward and always rather abruptly ascending along the wall.

Remarks: *Hexaphyllia elegans* according to YABE and SUGIYAMA, is nearest to *H. prismatica* STUCKENBERG[1] and *H. mirabilis* DUNCAN[2] in point of form of corallites. *H. elegens* differs from *H. prismatica* in the arrangement of septa, although the costal grooves are similar; it is also distinguishable from *mirabilis* in having no rootlet or spine-like processes.

1) A. STUCKENBERG: Das Unteren Kohlenkalkes von Central-Russland. Mem. Com. Geol., nov. ser., LIV, 14, p. 72, 1904.

2) P. M. DUNCAN: On the genera *Heterophyllia*, *Battersbya*, *Palaeocyclus*, and *Asterosmilia*: The Anatomy of their species and their position in the classification of the Sclerodermic Zoantharia. Phil. Trans. R. Soc. London, vol. 157, pp. 643-651, 1867.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Pass between Higuti-zawa in Kawaguti and Onimaru in Ohmori, both in Hikoroiti (Hikoroichi)-mura, Kesen-gun, Iwate Prefecture. Reg. no. 63279 of Inst. Geol. and Palaeont., Tohoku Univ., Sendai.
Coll.: A. SUZUKI.

Hexaphyllia japonica YABE et SUGIYAMA

Pl. 39, figs. 11, 12.

1939. *Hexaphyllum japonica*, YABE and SUGIYAMA: Discovery of *Hexaphyllia* in the Lower Carboniferous of Japan. Trans. Palaeont. Soc. Japan, no. 16, Art. 91, p. 501, pl. 26, figs. 1b, c, 4, 5.

YABE and SUGIYAMA defined this species as follows: closely resembles the preceding species, but differs from it by: 1) more or less arcuate corallum which is more rapidly attenuate posteriorly: 2) the stereozone of wall somewhat thicker, and most markedly 3) less numerous and distant tabulae, arranged alternately on either side of the axial line in median longitudinal section and disposed more or less horizontally rather than being concave in the main part and making very sharp upward bend close to the inner surface of wall. Corallum over 20 mm long and up to 3.5 mm broad.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Pass between Higuchi-zawa in Kawauti and Onimaru in Ohomori, both in Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. nos. 63271, 63272 of Inst. Geol. and Palaeont., Tohoku Univ.
: Yuba-zawa in Sakamoto-sawa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no. 63280 of Inst. Geol. and Palaeont., Tohoku Univ.
Coll.: A. SUZUKI.

Hexaphyllia sp. indet.

Pl. 39, figs. 13, 14.

1952. *Hexaphyllia* sp., KANMERA: The Lower Carboniferous Kakisako formation of Southern Kyusyu, with a description of some corals and fusulinids. Mem. Fac. Sci. Kyusyu Univ., Ser. D, vol. III, no. 4, p. 169, Pl. VII, figs. 9-11.

Figs. 13 and 14 in plate 39 show the corallites in the thin transverse section which were described and figured by KANMERA from the Tsutsui formation in Kyusyu island. According to KANMERA the specimen in fig. 13 (KANMERA's fig. 11 in pl. 8) may be specifically different from the specimen in fig. 14 (KANMERA's fig. 10 in pl. 8), the former of which is smaller than the latter and provides more prominent longitudinal ridges in position corresponding to the outer margin of septa.

However it may be not definitely stated at present that these two corallites are to be regarded as belonging to different species with each other, because they seem to be not subject to any accurate determination, from the poor preservation of material.

Nevertheless it should be considered a quite important fact, that this genus was also found in Kyusyu in association with other corals denoting the Upper Viséan in age.

Hor.: *Dibunophyllum* zone.
Loc.: Tsutsui, Kakisako-mura, Yatsurio-gun, Kumamoto Prefecture. Specimens now stored at Inst. Geol. Kyusyu Univ.
Coll.: K. KANMERA.

Genus *Hetrophyllia* McCOY, 1849

Hetrophyllia kitakamiensis YABE et SUGIYAMA

Pl. 39, figs. 1, 2, 3, 4, 5, 6, 6a, 6b, 6a′, 6b′, 7.

1940. *Heterophyllia kitakamiensis*, YABE and SUGIYAMA: Notes on *Heterophyllia* and *Hexaphyllia*. Trans. Palaeon . Soc. Japan. no. 99, p. 82, pl. 4, figs. 1-7.

YABE and SUGIYAMA described this species as follows: corallum (or corallites) cylindrical, somewhat attenuated posteriorly calical and basal parts not preserved, oblong in cross section, slightly arcuate, over 30 mm long, up to 2.5 mm broad; wall 0.15 mm thick, consists of thin primordial wall and rather thick stereozone, the latter seen, under high magnification, to be composed of numerous concentric layers arranged as in *Hexaphyllia elegans* YABE and SUGIYAMA and *Hex. japonica* YABE and SUGIYAMA. Septa 13; two opposite seta, presumably cardinal and counter septa, meeting at the center of corallum, lying on a medial plane and dividing it symmetrically into two bilateral parts, alar septa (a) as large as cardinal and counter septa, strongly convexed towards cardinal side, united by their inner margins to cardinal septa at or near the center of corallum; other septa strictly confined in counter quadrants, 9 in number in the type specimen, comprising 5 on right side and 4 on left side. Tabulae few, distant, either ascending close to wall or nearly horizontal. Outer surface more or less costulated along the inner margin of septa; otherwise smooth.

Remarks: According to YABE and SUGIYAMA, *Heterophyllia kitakamiensis* is similar to both *Het. angulata* and *Het. sedwicki*, but the latter two species are larger and have a great number of septa compared with the Japanese form. There is one other form of *Heterophyllia* in the Kitakami Mountains, for which YABE and SUGIYAMA provisionaly used the name *Het.* cf. *kitakamiensis*. This form is distinguishable form the holotype in subquadrate outline,

prominent costa-like ridges, and more slender septa; it may perhaps be a new species.

Hor.: Onimaru series, *Dibunophyllum* zone.

Loc.: Pass between Higuchi-sawa in Kawauti, and Onimaru in Ohmori Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no. 63272, 63279, of the Inst. Geol. and Palaeont., Tohoku Univ.

: Yuba-zawa in Sakamoto-zawa, Kesen-gun, Iwate Prefecture. Reg. no.: 65280 of the Inst. Geol. and Palaeont., Tohoku Univ.

Coll.: A. SUZUKI.

Genus systematic position unsolved

Genus ***Khmeria*** MANSUY, 1914

Khmeria problematica MANSUY

Pl. 33, figs. 2, 3, 4a, 4b; Pl. 40, fig. 15.

1914. *Khmeria problematica*, MANSUY: Faunas des Calcaires a Productus de l'Indochine, 2 me Sér., p. 53, pl. 1, figs. 11a-g; pl. 2, figs. 1a-p., 2 a-c; pl. 5, figs. 5a-i; pl. 6, figs. 1a-h.

1932. *Khmeria problematica*, YABE and MA: *Khmeria problematica* MANSUY from Japan. Japanese Jour. Geol. Geogr. vol. 10, p. 62, pl. 5, figs. 1-13; text-fig. 1.

Description (YABE and MA, 1932): All the specimens now at hand are simple, turbinate-conico-cylindrical, always more or less curbed as solitary cornuate tetracoralla usually are; operculate.

The operculum is a single plate in small individuals and composed of several plates in larger ones. Operculum is a single plate cap-shaped, circurar in outline, hollow inside and with an apex almost at the center: concentrically rugose on the outer surface; inside smooth and marked with no particular impressions; margin entire, with a flattened border. Compound operculum consists of 2–3 plates, often of unequal size: when composed of two plates, each of them is semicircular and when composed of more plates, each is somewhat trigonal, being always arcuate on one side, which is a part of the border of the operculum, and almost straight on the other two sides. The plates of the compound operculum are similar to the single operculum in all other features; they are separate and do not fuse together, though in close contact with one another along their straight sides. There are cases in which the component plates of the compound operculum are free.

Corallum always attenuated below and constantly broken at the very tip, suggesting lateral budding from a mother corallum. Wall 1.5 mm thick in the largest specimen, under the microscope crystallized and exhibiting no more of its proper structure. Marginal border entire, flattened and almost smooth. Inside hollow or sometimes traversed by a few rather straight tabulae, either

complete or incomplete, disposed more or less horizontally or sometimes quite obliquely and then often coalescing into one another; septa absent, but marginal border of corallum often exhibiting faint vertical crenulation or undulation, suggesting trace of almost completely reduced septa. Outside rugose annulaly, and often bearing the scars of attachment of root-like appendages; also sometimes impressed by a narrow, rather irregular, longitudinal groove, which is bordered by a linear elevation due to an excessive growth of walls on both sides, and is possibly the trace of lateral attachment of the corallum to a foreign body during life.

Remarks: MANSUY refered this species provisonally to a new form of operculate Coelenterata, but probably not coral; however YABE and MA considered this as an operculate coral. According to them this form shows some resemblance to the Silurian coral *Rhizophyllum*. There is no indication that this form belongs to brachiopods or molluscs, accordingly YABE and MA supposed that it may be perhaps an atavistic form as a coral, because septa as well as other skeletal elements of this species are so much reduced.

Hor.: *Yabeina* zone.

Loc.: Yoshinaga (Yoshinori?), Omine-mura, Mine-gun, Province of Nagato, Yamaguchi Prefecture. Reg. no.: 41966 of Inst. Geol. and Palaeont., Tohoku Univ.

Coll.: Y. OZAWA.

Order Hexacoralla HAECKEL

Family Anabaciidae DUNCAN

Genus ***Omphalophyllia*** LAUBE, 1865

Omphalophyllia yamanbaensis YABE et SUGIYAMA

Pl. 38, figs. 1, 3.

1933. *Omphalophyllia yamanbaensis*, YABE and SUGIYAMA: A new form of the genus *Omphalophyllia* collected from Yamanba, near Sakawa-machi, Province of Tosa (Shikoku). Japanese Jour. Geol. and Geogr. vol. 10, p. 114, pl. 8, figs. 1-3.

Description (YABE and SUGIYAMA, 1933): Corallum small, apparently simple and cyrindrical, attaining to 6 mm in major diameter and more than 20 mm in length. Septa rather thin, numerous, close, alternately long and short, arranged in four cycles of the six system, of which the fourth cycle is incomplete; counted 33 in the figured specimen, of which 20 are longer and 13 shorter; longer septa reaching the columella and the shorter ones united to the former with their inner margin at a short distance from the columella. Lateral surface of septa studded with rather prominent granules, normal to the surface and arranged more or less regularly in a longitudinal row;

traverses rather numerous. Septa much thickened by stereoplasmic deposits in the peripheral area of the corallum, giving rise to a pseudotheca about 1 mm broad, which is about 1/5 of the corallum diameter in thickness; septal pores rather few. Columella styloform, compact and large, about 1 mm broad.

In longitudinal section, septal granules are visible as round dark dots. Here and there lamellar traverses also seen.

Remarks: Genus *Omphalophyllia* has been known not only from Japanese Permian but also from the Permian of Sumatra, although it may be considered as a definite Hexacoral. The present form may probably belong also to the Hexacoral as YABE and SUGIYAMA supposed. However this coral has to wait further investigation, because its relation to certain lophophylloid corals, especially to a species of *Lophocarinophyllum*, is not finally settled. The Yamanba limestone, from which the present form was collected is definitely a Permian formation from other associated fossils such as *Parafusulina* sp., *Lonsdaleiastraea yamanbaensis* MINATO, and many brachiopods belonging to Orthoteteinae.

Hor.: *Neoschwagerina*? *Parafusulina* ? zone.
Loc.: Yamanba near Sakawa-mabhi, Takaoka-gun, Province of Tosa, Kochi Prefecture.
Reg. no.: 43473, Inst. Geol. and Palaeont., Tohoku Univ.
Coll.: YABE and SUGIYAMA.

Pseudopavoniidae YABE, SUGIYAMA et EGUCHI, 1943.

Genus ***Pseudopavona*** YABE, SUGIYAMA and EGUCHI, 1943.

Pseudopavona taisyakuana YABE, SUGIYAMA and EGUCHI

Pl. 41, figs. 1a, 1b.

1943. *Pseudopavona taisyakuana*, YABE, SUGIYAMA and EGUCHI: A new Hexacoral-like Carboniferous coral (Preliminary note). Jour. Geol. Soc. Japan, vol. 50. p. 242, figs. 1, 2.

YABE, SUGIYAMA and EGUCHI defined this coral as follows: A new massive coral found in a Carboniferous limestone, together with a *Stylidophullym*, several other rugose corals and a chaetoid, of the Taisyaku limestone plateau in Chugoku, suggests hexacorals in being characterized by its maeandroid corallum—a growth habit never seen among rugose corals—with narrow corallies lacking proper wall, connected by confluent, distinctly trabecular septa which are apparently disposed radially, and provided with variably broad papillar-columella surrounded by an incomplete cycle of pali or pali-like elements. Superficially it resembles such Palaeozoic corals as *Aulina*, *Phillipsastraea* and *Orionastraea*, and among recent Hexacorals, certain forms of Agaricidae, espe-

cially of the genus *Pavona*, though quite distinct from all of them in the details of its inner structure.

Remarks: YABE, SUGIYAMA and EGUCHI proposed the establishment of a new genus *Pseudopavona* with that interesting coral as the type. They considered this form to be a hexacoral.

Hor.: *Fusulinella* zone.

Loc.: Taisyaku, at a point about about one kliometer below the dam, at the end of Taisyaku gorge, Hiroshima Prefecture. Specimens now stored at Inst. Geol. and Palaeont., Tohoku Univ.

Coll.: K. HARADA.

Order Aseptata GRABAU

Family Favositidae EDWARDS and HAIME

Genus *Michelinia* de KONINCK, 1842.

This genus has been considered by some palaeontologists to be synonymous with *Pleurodictyum* GOLDFUSS 1829.[1) 2)]

According to MOORE and JEFFORDS[3)] however, the genotype of *Pleurodictyum* has very numerous large pores that extend through the thick walls perpendicularly and the tabulae are not closely spaced. Furthermore, they mentioned that the low discoidal outer form of *Pleurodictyum* seems to differentiate it from *Michelinia* rather clearly.

Also the writer is of opinion that the discoidal form of the corallum together with thick wall are quite sufficient criteria to distinguish *Pleurodictyum* from *Michelina*.

YABE and HAYASAKA'S[4)] *Eumichelinia* proposed by them as a subgenus of *Michelinia* includes typical species from Mountain limestone, including the genotype of *Michelinia*, *Michelinia tenuisepta* (PHILLIPS)[5)] as well as *M. favosa* and *M. megastoma*, and accordingly *Eumichelinia* is absolutely synonymous with *Michelina*. Thus the generic name *Eumichelinia* shoud be abandoned.

The subgenera *Protomichelinia* and *Michelinopora*, however are distinct

1) W. D. LANG, S. SMITH and H. D. THOMAS: Index of Palaeozoic coral genera, 1940.
2) H. W. SHIMER and R. R. SHROCK: Index fossils of Northern America, 1944.
3) R. C. MOORE and R. M. JEFFORDS: Description of Lower Pennsylvanian corals from Texas and adjacent states. Univ. Texas Publication 4401, p. 167, 1945.
4) H. YABE and I. HAYASAKA: Palaeozoic corals from Japan, Korea and China. Jour. Geol. Soc. Tokyo (Japan), vol. 22, p 55, 1915.
5) M. EDWARDS and J. HAIME: A monograph of the British fossils corals. p. 154–156, 1850.

from the genotype of *Michelinia*, as YABE and HAYASAKA formerly considered, in having quite camplete, rather horizontal tabulae, in contrast to the incomplete and more vesiculated tabulae of the genotype, and it is rather reasonable manner to distinguish these corals from *Michelinia* (s.s.) in subgeneric rank, although it may be still an open question, whether both these two sub-genera should be regarded to be valid or not.

Subgenus ***Protomichelinia*** YABE and HAYASAKA, 1915.

According to YABE and HAYASAKA, their *Michelinopora* much resembles *Protomichelinia*, the latter of which comprises such species as *Michelinia cylindrica*, *M. favositoidea* and *M. insignis* and Chinese Permian species of *microstoma*; all these species including the genotype of so-called *Michelinopora*, provide rather long, cylindrical corallites together with many complete tabulae as above stated. The distinction between the two genera was believed by them to consist in only the nature of the septal ridges, which are numerous, and very low in *Michelinopora* against the spinulose septal ridges of *Protomichelinia*. The difference, concerning the septal ridges between *Protomichelinia* and *Michelinopora* may however, the writer believes, be less important, than YABE and HAYASAKA considered.

Thus the writer is now of opinion that *Michelinopora* should be included into *Protomichelinia*.*)

The genolectotype of *Protomichelinia*, (*Michelinia* (*Protomichelinia*[1])) *microstoma* YABE and HAYASAKA is here chosen) has straight wall providing with short septal ridges.

Michelinia (*Protomichelinia*) *multitabulata* (YABE et HAYASAKA)

Pl. 27, fig. 1 and 2; Pl. 31, fig. 2.

1915. *Michelinia* (*Michelinopora*) *multitabulata*, YABE and HAYASAKA: Palaeozoic corals from Japan, Korea and China, Jour. Geol. Soc. Tokyo (Japan) vol. 22, p. 59.

Corallum massive, quite large; corallites which are quite long, straight and prismatic, in close contact, with one another, usually 5 to 7-sided, but generally six-sided. Corallites arranged radially in the early stage but become completely parallel with each other in the mature stage. The diameter of the

*) From the rules of nomenclature, the generic name of *Protomichelinia* is valid, against *Michelinopora*. Because the former name was described in this paper prior to the latter.

1) H. YABE and I. HAYASAKA: op. cit. p. 61, 1915.

corallite is usually 3.5 to 4.0 mm. Walls which are covered by thick layers of stereoplama, rather thick, have a dark line in the middle. The walls show sometimes straight in the transverse section, but usually represented by zig-zag lines provided with very low septal ridges.

Tabulae numerous, counted as much as 16 to 20 in the space of 10 mm, but 18 is the general number. These tabulae mostly complete, and almost horizontal or only slightly convex upwards. There are observable, however, more gently vaulted tabulae which are generally incomplete, overlapping successively with each other.

Mural pores not numerous, fairly large, sub-rounded, and irregularly scattered.

Remarks: The present species is quite characteristic in having zig-zag walls of the corallites in the transverse section. Among the Permian species of *Michelinia*, *Michelina siyangensis* REED described and figured by REED[1] from Yunan, and also by HUANG[2] from Southern China, is most nearly related to the Japanese form, so far as the present writer is aware, however the former is different from the latter in having less numerous tabulae and in being provided with straight wall.

Now, the geological horizon of this coral has been long in open question, although it was quite certain, that it denotes doublessly Permian in age, but not Carboniferous.

Recent stratigraphical work in the Kitakami district by Japanese geologists including the writer, however, have thrown much light upon this problem, and it is now established that this species denotes doubtlessly the Upper *Parafusulina* zone.

Hor.: *Parafusulina* zone.

Loc.: At the middle course of Kanokura-sawa, Setamai-machi, Iwate Prefecture. Reg. no.: 17759.

Loc.: East of Maiya-machi, Tome-gun, Miyagi Prefecture. Reg. nos.: 15700, 15701.

Loc.: Tsukitate, Niitsuki-mura, Motoyoshi-gun, Miyagi Prefecture.
Reg. nos: 15433, 16478, 16479, 16480, 16481, 16487, 16488, 17846.

Coll.: M. MINATO

1) C. REED: Palaeozoic and Mesozoic fossils from Yunnan. Pal. Indica, New ser. vol. X, no. 1, p. 83, pl. VII, figs. 4-5, 1927.

2) T. K. HUANG: Permian corals of Southern China. Palaeontologia Sinica, ser. B, vol. 8, fasc. 2, p. 94, Pl. XII, figs. 1-6, 1932.

Genus *Thamnopora* STEININGER, 1831

According to LANG, SMITH and THOMAS,[1] *Pachypora lamellicornis* LINDSTRÖM is congeneric with *Thamnopora madreporacea* STEININGER, the genotype of *Thamnopora*. Therefore the genera *Pachypora* and *Thamnopora* are synonymous.

The two Permian Japanese *Pachypora*, formerly described by HAYASAKA, apparently lack any mural pores, at least so far as the specimens treated are concerned. The writer now doubts, whether or not, this is the consequence of the bad state of preservation, although the mural pores may have originally existed. Accordingly some doubts should be retained for a while as to the final assignment of these species to the genus *Thamnopora*.

Thamnopora? nipponica (HAYASAKA)

Pl. 41, fig. 6; Pl. 42, fig. 7.

1932. *Pachypora nipponica*, HAYASAKA: Two new species of Permian *Pachypora* from the Kitakami mountains, etc. Transactions of the Natural History Soc. Formosa, vol. 22, p. 2, pl. 1, figs. 1-3; Pl. II, fig. 1.

HAYASAKA's description for the specimens collected by him was as follows (HAYASAKA, 1932): Corallum long, dendritic, rarely branching, about 2-3 cm. across, varying rather markedly in one and the same individual. Calyces irregularly polygonal, more or less variable in size and form, the walls often being somewhat flexous, thus giving rise to a network appearance. The calyces vary from about 1 to 1.2 mm sometimes up to 1.5 mm or a little more, the wall being about 0.3-0.5 mm thick. Corallites grow almost vertically at the axial part of the corallum, but they rather abruptly turn outward, and become nearly horizontal, or perpendicular to the axis of the corallum. The walls are thickened even at the axial part of the corallites, but thicker when the latter bend exteriorly, where they are usually about 1 mm. thick. Tabulae rare, straight, as thin as, or a little thinner than wall. Whether the corallites are connected by mural pores or not is uncertain, owing to the very poor state of preservation.

Remarks: There are few specimens in the writer's own collection wholly referable to HAYASAKA's species, *nipponica*, which were collected by the writer from the same locality as Yakejima, from where HAYASAKA formerly described this species. The corallites of the specimens in the writer's collection show close identity to the HAYASAKA species in any respects.

This species is quite characteristic in having rather complete and hori-

1) W. D. LANG, S. SMITH and H. D. THOMAS: Index of Palaeozoic coral genera, 1940

zontal tabulae which are very thin. Furthermore the walls of this species are by no means so thick as other typical species of genus *Thamnopora* and the mural pores are apparently lacking.

Hor.: *Yabeina* zone?

Loc.: Yakezima, one of the small islets, Ogachi-machi, Momou-gun, Miyagi Prefecture. Reg. no.: 16483.

Coll.: M. MINATO.

Thamnopora? chaetoidea (HAYASAKA)

Pl. 40, fig. 14; Pl. 41, figs. 7; pl. 42, figs. 6, 9.

1932. *Pachypora chaetoidea*, HAYASAKA: p. 3, pl. 1, figs. 4-7; pl. II, fig. 2.

HAYASAKA defined this species as follows: Corallum dendritic, in growth, frequently branching, often attaining a conspicuous length, the longest specimen in the field, exposed on the weathered surface of the rock being about 30 cm without either end. Diameter of corallum variable, some branches measuring not quite 5 mm while the largest one in my collection is more than 20 mm. across. The surface of the corallum is rather smooth, without showing the rugged appearance as is characteristic of the preceding species (*P. nipponica*). Corallites grow vertically, or nearly so, in the axial part of the corallum, where they are irregularly polygonal, with the average inner diameter of about 0.1 mm; and the walls are about half as thick. The walls get hardly thicker outward, where corallites are almost perpendicular to the length of the corallum. But the inner diameter of corallites is much larger, measuring about 0.2-0.3 mm, and are markedly rounped in outline. Tabulae are not rare, very thin, complete, very slightly concave, or nearly straight. The last or the external chambers of the corallites are filled up with muddy calcareous substance. Connecting mural pores are not evident, though in a few of the thin sections their development may be suggested.

Hor. and Loc.: same as the preceding species.

Family Auloporidae NICHOLSON

Genus ***Pseudoromingeria*** YABE et SUGIYAMA, 1941

According to YABE and SUGIYAMA, the genotype of this genus is now believed to be quite different from the genus *Romingeria* in lacking mural-pores in the walls and having rather crowded tabulae which show the funnel shaped type.

Furthermore this genus is somewhat like *Syringopora*, but is distinct from the latter in having corallites, which are much shorter than those of *Syringopora* and are never arranged regularly parallel to one another. Also this

specimen is distinguishable from genus *Aulopora* in having corallites provided by funnel shaped tabulae.

Here the writer wishes to refer to the description of this coral made by YABE and SUGIYAMA and to include the figures in plate reproduced from their papers.

Pseudoromingeria kotoi (YABE et HAYASAKA)

Pl. 17, fig. 3; pl. 43, figs. 1, 4.

1915. *Romingeria ? kotoi*, YABE et HAYASAKA: Palaeozoic corals from Japan, Korea and China. Jour. Geol. Soc. Tokyo, vol. 23, p. 85 (23).

1941. *Pseudoromingeria kotoi*, YABE et SUGIYAMA: *Pseudoromingeria*, a new genus of Auloporids from Japan, Proc. Imp. Acad. Tokyo, vol. I7, p. 379.

Description (YABE and SUGIYAMA, 1941): Corallum forming subramose colonies assembling into a lax mass more than 10 cm in diameter and consisting of a number of cylindrical corallites in clusters: probably creeping in the earliest stage of growth. Corallites 2 mm in diameter, 10–15 mm long, subcylindrical, narrowed proximally multiplying by lateral gemmation, erect, not quite straight being more or less curved to one side: usually free laterally, though several adjacent ones not seldom come into lateral contact for a short distance after gemmation; external surface apparently smooth, probably provided with faint annular swellings. Septal spines (or rather warts) more or less arranged in longitudinal rows, irregularly disposed and counted 1–5 in transverse sections of corallites, and at most 0.5 mm long. Wall thick, 0.3–0.5 mm, apparently composed of numerous concentric lamellae, and externally lined with an extremely thin epitheca. Tabulae very thin, sometimes concave upwards, or more commonly funnel-shaped and also forming cysts, very irregular in disposition, sometimes being closely set, but usually lacking for a considerable distance; almost absent in many corallites.

Hor.: *Yabeina* zone.

Loc.: Kinsyozan, Akasaka, Fuwa-gun, Gifu Prefecture.

According to YABE and SUGIYAMA, specimen which much resembled the genotype was also collected by them from the limestone developed at Hirabara, about 1 km. NW of Ota-machi, Mine-gun, Yamaguchi, Prefecture. For specific identification, however, more material seems to be needed.

Family Syringoporidae EDWARDS and HAIME

Genus ***Syringopora*** GOLDFUSS, 1826

Syringopora cf. *reticulata* GOLDFUSS

Compare with:

1852. *Syringopora reticulata*, EDWARDS and HAIME: British fossil Corals. p. 162, pl. XLVI, figs. 1, 1a.

1915. *Syringopora reticulata*, YABE and HAYASAKA: Palaeozoic corals from Japan, Korea and China. Jour. Geol. Soc. Japan, vol. 22, p. 81.

1933. *Syringopora* cf. *reticulata*, CHI: Lower Carboniferous Syringoporas of China. Pal. Sinica, ser. B, vol. XII, fasc. 4, p. 8, Pl. 1, figs. 1 & 2, a, b.

Numerous specimens brought back from the various localities in the Kitakami mountain area are now available for study. They are quite excellently preserved in appearance on the weathered surface of limestones. Notwithstannding this, however, the internal structure of the corallites is observed to be badly damaged in thin sections, by the recrystallization of the material forming the corallites. Each tube of the corallites is found to be filled only by numerous crystals of calcite.

Thus the writer wishes here to describe briefly the corallum as observed by the naked eyes.

Each corallum is quite large, measuring 120×80×70 mm, and shows somewhat bowl shape as a whole, which is massive, fasciculate, consisting of numerous, nearly equal, subparallel or slightly radiating corallites. Corallites are 2 mm or less in diameter, generally 30 mm long. The surface of the corallites is smooth, excepting numerous concentric striations, which count as many as 16 in a distance of 5 mm. Connecting tube rather thick, 1/2 the width of the diameter of the corallites, being vertical to their outer wall. There are definite septal ridges. In one part of the corallites, faint traces of infundibuli are detected on the weathered surface.

Remarks: The present specimens now in concern bear quite similar aspects to *Syringopora reticulata*, but they are all too imperfect for precise specific determination.

YABE and HAYASAKA, however, once described *Syringopora reticulata* from the Kitakami mountain region. The specimens treated by them were said to be in better preservation. They were collected at Nagaiwa, in association with *Stylidophyllum japonica*, *Siphonodendron pseudomartini* and *Diphyphyllum flexuosum*.

Now, the preeent specimens treated here, were all collected from the Onimaru limestone, like the specimen described by YABE and HAYASAKA. Accordingly it is highly probable that the writer's materials are also conspecific with *Syringopora renticulata*, although they are poorly preserved.

Hor: Onimaru series, *Dibunophyllum* zone.

Loc.: Ishibashi, Hikoriichi-mura; Inugasira-yama, Setamai-machi; Shizu, Setamai-machi, Takase, Shimo-arisumura in Kesen-gun, Iwate Prefecture,

Coll.: M. MINATO.

Syringopora sp. indet.

Pl. 6, fig. 2.

1952. *Syringopora* sp. MINATO: A further note on the Lower Carboniferous fossils of the Kitakami mountainland, Northeast Japan. Jour. Fac. Sci. Hokkaido Univ., ser. IV, Geol. and Min. vol. VIII, no. 2, p. 150, pl. 2, figs. 3, 6, 12.

This species was found in the same limestone slab containing *Amplexus nipponensis* OISHI and MINATO, at Kozubo, Yokota-mura, Iwate Prefecture.

The specimens are unfortunately in bed state of preservation and are specifically indeteminable, however relatively less numerous fossils have been known in this horizon of this coral until present day, so it is needful to record here, the occurrence of it.

Hor.: Maide stage, *Amplexus nipponensis* OISHI et MINATO zone.
Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture.
Reg. no.: 15496.
Coll.: M, MINATO.

Genus ***Kueichowpora*** CHI, 1933

This genus bears a considerable resemblance to the genus *Syringopora*. The essensial difference consists in the presence of a hollow tube in *Kueichowpora*, which my be sufficient basis to distinguish this from *Syringopora* in generic rank.

Genotype: *Kueichowpora tushanensis* CHI.

Kueichowpora setamaiensis MINATO, sp. nov.

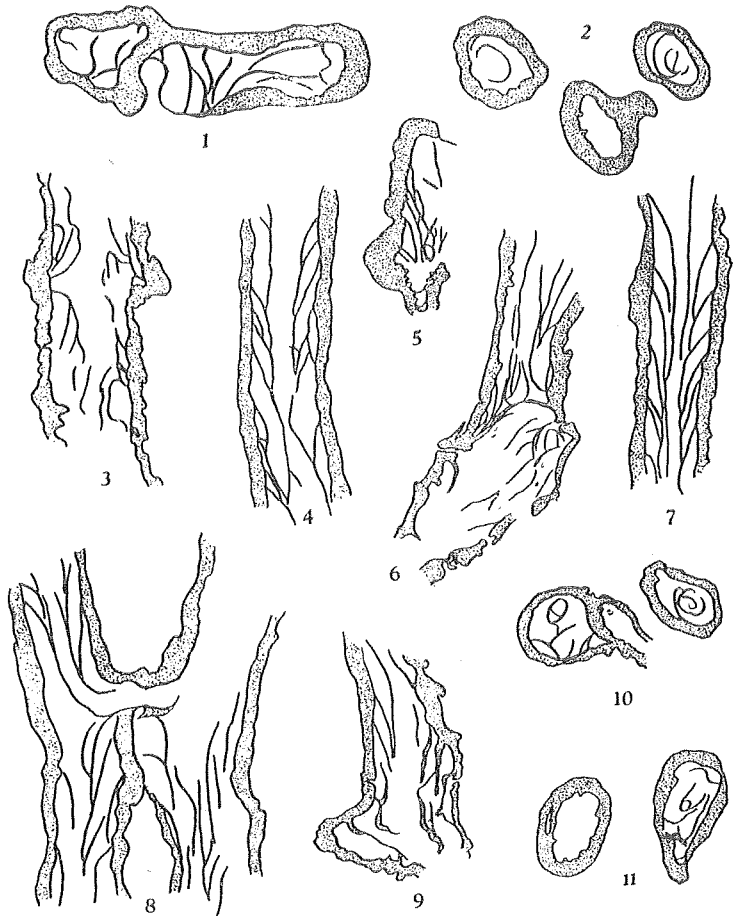
Pl. 31, figs. 3, 5, 6; Text-fig. 25.

Corallum syringoporoid in general appearance. Each corallite fairly long, being parallel in arrangement and rarely bifurcating or uniting with each other.

In some specimen, corallites are crowded in aggregation, while in others they are apart with intervals equal to or less than the diameter of corallite. Internally wall considerably thick, being provided with neither septa nor septal ridges. Tabulae are infundibuli or funnel in form, and the central part of the corallites remaind as a hollow tube.

In the longitudial section, infundibuli are also quite well observable, they are overlapping successively with each other, forming a long continuous tube in the axis of corallites.

Dimensions: Diamefer of corallite..... 1.9—1.8 mm
Diameter of tabulated area.....0.42—0.43 mm
Thickness of outer wall .....0.16—0.17 mm
Diameter of hollow tube .....0.45 mm



Text-fig. 25. *Kueichoupora setamaiensis* MINATO, sp. nov.

Remarks: This species does not show any essential difference from *Kueichowpora tushanensis* CHI[1], the genotype of this genus, but the corallites of these specimens, now under consideration are little larger than the Chinese species.

Hor.: Onimaru series, *Dibunophyllum* zone.
Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. nos.: 15165, 15166, 15167, 15168, 15173 and 15175.
Coll.: M. MINATO.

1) Y. S. CHI: Lower Carboniferous Syringoporas of China. Pal. Sinica, ser. B, vol. XII, fasc. 4, p. 22, pl. V, figs. 2a-d. 1933.

Family Chaetetidae EDWARDS and HAIME

Genus *Chaetetes* FISCHR, 1829

Chaetetes nagaiwaensis MINATO, sp. nov.

Pl. 19, fig. 1; Pl. 38, fig. 2.

1937. *Chaetetes asiatica*, YABE and HAYASAKA, ONUKI: On the Palaeozoic formation near Sakamotozawa, Kitakami mountainland, Jour. Geol. Soc. Japan, vol. 44, p. 168, listed.

1938. *Chaetetes asiatica*, ONUKI: On the Titibu system in Kesen-gun, Iwate Prefecture, Kitakami mountainland. ibid. vol. 45, p. 48, listed.

1939. *Chaetetes asiatica*, YABE: Palaeozoic formation of the Japanese islands. Proc. Sixth Pacific Sci. Congress, p. 377, listed.

1953. *Chaetetes* cf. *asiatica*, MINATO and others: Biostratigraphie des Karbons im Kitakami-Gebirge, Nordostliches Honshu, Japan. Jour. Geol. Soc. Japan, vol. 59, p. 385, listed.

Corallum massive, very large consisting of small, radiating corallites. The true shape of this species, however is not observable; most of specimens are fragments of quite large corallum which are seen to be already much worn before they were fossilized. Also the holotheca is not discerniable on any specimens.

In transverse section, the corallites usually irregularly rounded, polygonal to subcircular, but approximately equal in size. The diameter of these corallites ranging from 0.65 to 0.44 mm.

Wall rather thick, imperforated and measuring 0.064 to 0.048 mm; usually thickened by stereoplasmic deposits, approximately 0.032 to 0.048 mm in thickness. However the true wall and the stereoplasmic deposits are sometimes so completely fused with each other, that the boundary line between them is unobser vable. Inner surface of the corallites, usually smooth, but sometimes very rough in appearance. However neither any kinds of septa nor any septal ridges are detected, except the irregular shape of projections such as often exist in the inner surface of stereoplasmic deposits. The projections, however, may be mere crystal edges of the calcite cementing the interior of the corallites.

Tabulae are also very numerous, the interval between each pair of them is 0.113 mm where they are densely arranged, but the interval ranges from 0.21 to 0.24 is most common case.

Tabulae, complete, horizontal, and rather thick, 0.064 to 0.032 mm in thikness, usually completely amalgamated with stereoplasmic deposits. The boundary line between the thin true tabulae and the covering organic deposits is rarely observable.

Remarks: The present species has been long called in the circles of Japanese geologists, including the writer himself, under the name of *Chaetetes asiatica* YABE and HAYASAKA. This is one of the most well-known leading fossils of the Nagaiwa series, developing at Nagaiwa, the type locality and its adjacent area in the Kitakami mountain region. It is always to be found in association with *Thysanophyllum aseptatum*, and *Diphyphyllum flexuosum*.

So far as the present writer is aware, the specific name *Chaetetes asiatica* YABE and HAYASAKA first appeared in scientific literature in 1916, when HAYASAKA discussed the geological age of the invertebrate fauna in South Manchuria in the Journal of Geol. Soc. Japan vol. 23.* Perhaps it might have been used earlier, by YABE and HAYASAKA, when they were describing numerous corals in the same journal in 1915 to 1916, under the title of Palaeozoic corals of Japan, Korea and China. However at that time, there was not presented by them, any description or figure for this species.

Other than this, since then, no descriptions concerning this species have been made, until the present day.

Meanwhile, in certain papers presented by ONUKI and YABE in these past fifteen years, we have read on many occasions that this specific name is occasionally employed for the coralline remains collected from the Nagaiwa series of the Kitakami mountain district, although the name of *Chaetetes asiatica* was originally proposed by YABE and HAYASAKA for the specimens derived from the Middle Carboniferous of the Penchi basin, in Manchuria. In fact, for these several years, it is supposed on scarcely sufficient basis that the Kitakami specimens are quite conspecific with the Manchurian species.

In examining the specimens, now in concern, which were brought back from the type locality and near adjacent sites, the writer wished to compare them with the original specimens derived from the Penchi series of Manchuria, which might be expected to be stored at the Institute of Geology and Palaeontology, Tohoku University, in Sendai. However all these Manchurian chaetoid corals, including the holotype of *Chaetetes asiatica* have been lost.

Prof. ASANO was kind enough carefully to search for these original specimens for the writer, but in vain.

Thus the writer is unable at present to state whether the Kitakami specimens are fully conspecific with so-called *Chaetetes asiatica* or not.

Accordingly it may be reasonable to treat the Kitakami species under a name different from *Chaetetes asiatica*, until the time when the holotype of the latter may be found in future.

The Kitakami species may be new to science, if it is not conspecific with *Chaetetes asiatica*.

---

* listed only.

The Kitakami species somewhat resembles *Chaetetes raritabularis* LEE et CHU,[1] described and figured by them from the Huanglung limestone of Southern China, especially in the size and form of the corallites in transverse section; the latter of which provides irregularly rounded corallites.

However the wall of the latter is thinner than that of the Kitakami specimens; beside this, the tabulae of the latter are quite less numerous.

Hor.: Nagsiwa series, Profusulinella- ? *Fusulinella* zone.
Loc.: Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture.
Reg. nos.: 16432, 16464. Coll.: M. MINATO.

Chaetetes sp. indet.

1924. *Chaetetes* sp., HAYASAKA: On the fauna of the Anthracolithic limestone of Omi-mura in the Western part of Echigo. Sci. Rep. Tohoku Imp. Univ., Second ser. (Geology) vol. VIII, no. 1, p. 24, pl. IV, figs. 14, 15.

Description (HAYASAKA 1924): Zooecial tubes are widely variable in size and form: larger ones and smaller ones are grouped respectively in patches: some are obscurely polygonous, or rather roughly rounded, and the others are more or less strongly elongate to certain directions. Rounded cells measure about 0.4 mm in the inner diameter, while elongate ones are about the same in the longer diameter. Wall is very thick and compact, attaining to about 0.2 mm invariably.

Remarks: Judging from the figures given by HAYASAKA, the specimens treated by hims seem to the writer to be quite excellent in preservation. However HAYASAKA described neither the tabulae nor septal features on these specimens.

Perhaps this was because there are not any kinds of septa or septal ridges in the corallites treated by him. However it seems improbable that the corallites, now in concern are lacking tabulae, though, to be sure, they may be quite rare in the HAYASAKA species.

In such respect, this species may be completely different from the preceding species.

The Pennsylvanian species, *Ch. favosus* and *Ch. mutabilis*, described and figured by MOORE and JEFFORDS,[2] are somewhat like the species, now in consideration, especially in the poor development of tabulae. However *C. favosus*

1) J. S. LEE, S. CHEN and S. CHU: The Huanglung limestone and its fauna. Academia Sinica. Mem. National research institute of Geol. vol. IX, p. 139, pl. XIV, figs. 7-8, 1930.

2) R. C. MOORE and R. M. JEFFORDS: Description of Lower Pennsplvanian corals from Texas and adjacent states. Univ. Texas Publication, 4401, pp. 190-195, 1945.

provides comparatively more regular corallites in size and form, in the transverse section, while *Ch. mutabilis* has a larger number of smaller corallites.

The Huanglung limestone species,[1] such as *C. lungtanensis* LEE et CHU, *C. flexilis* LEE et CHU, and *C. raritabularis* are also characteristic in having less numerous tabulae, however, *C. lungtanensis* has a large number of regular corallites and the other two species are by no means conspecific with HAYASAKA's species in having thinner walls. Beside this, the growth habit of *Ch. flexilis* is quite different from that of the Japanese species.

Hor.: *Fusulinella* zone?
Loc.: Localities II, IV and VII of HAYASAKA, Omi Niigata Prefecture.

Chaetetes? sp.

1925. *Chaetetes* sp., OZAWA: Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato, Jour. Coll. Sci. Imp. Univ. Tokyo, vol. XLV, Art. 6, p. 81, Pl. XII, figs. 12b; PI. XIII, fig. 10b.

Description (OZAWA, 1925): Corallum irregularly expanded; corallites subcylindrical and more or less six-sided in cross section. Average diameter of corallite 0.1 mm. The internal structure consists of flat septa stretching completely across. Boundary wall thick and pierced by doubtful pores or transverse lines.

Remarks: The writer could not examine the original material of OZAWA, accordingly he wishes here to discuss this coral, basing his remarks on OZAWA's description and figures.

The specimens described and figured by OZAWA are unfortunately very imperfect material, being not in sufficently good preservation for accurate determination. The writer is in doubt whether the description given by OZAWA is correct or not. It seems to him, there may be some few mistakes in OZAWA's description concerning this coral.

However OZAWA recognized the presence of mural pores in the wall of the corallite, though they are described to be somewhat indistinct. If it is true, the specimens now in concern, may belong to some other genus.

Hor.: *Fusulinella* to *Yabeina* zone.
Loc.: Throughout Akiyoshi limestone, Yamaguchi Prefecture.

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1) J. S. LEE, S. CHEN and S. CHU: The Huanglung limestone and its fauna. Academia Sinica, Mem. National Research Inst. Geol. vol. IX, pp. 136-140, 1930.

7) *List of geographical names showing the localities where the coralline fossils described in this paper were collected. (Each number corresponds to the locality number in the annexed map) (Fig. 3)*

1)	Yamamoto, Yonesato-mura, Esashi-gun, Iwate Prefecture.	1) 岩手県江刺郡米里村山本
2)	Iwanosawa, Shimoarisu-mura, Kesen-gun, Iwate Prefecture.	2) 岩手県気仙郡下有住村イワノ沢
	Hinozuchi, 〃	〃 火ノ土
	Kingindo, 〃	〃 金銀洞
	Oogaisawa, 〃	〃 オオガイ沢
	Shiritakasawa, 〃	〃 尻高沢
	Takanosu, 〃	〃 鷹ノ巣
	Takase, 〃	〃 高瀬
	Takinosawa, 〃	〃 滝ノ沢
	Torigasaki, 〃	〃 トリガサキ
3)	Higuchisawa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture.	3) 岩手県気仙郡日頃市村樋口沢(大船渡市字日頃市)
	Ishibashi, 〃	〃 石橋
	Nagaiwa, 〃	〃 長岩
	Onimaru, 〃	〃 鬼丸
	Ohmori, 〃	〃 大森
	Sakamotosawa, 〃	〃 坂本沢
	Shiratorisawa, 〃	〃 白鳥沢
	Shiraishi-toge, (pass) 〃	〃 白石峠
	Tashiro, 〃	〃 田代
	Tashiroyashiki, 〃	〃 田代屋敷
	Yubanosawa, 〃	〃 ユバノ沢
4)	Akabatake, Setamai-machi, Kesen-gun, Iwate Prefecture.	4) 岩手県気仙郡世田米町赤畑
	Hiishi, 〃	〃 火石
	Inugashirayama, 〃	〃 犬頭山
	Kabayamasawa, 〃	〃 樺山沢
	Kashiwari, 〃	〃 柏里
	Kanokurasawa, 〃	〃 叶倉沢
	Komata, 〃	〃 小股
	Kattisawa, 〃	〃 合地沢
	Kawaguchi, 〃	〃 川口
	Kawamukai, 〃	〃 川向
	Nojiri, 〃	〃 野尻
	Shizu, 〃	〃 清水
	Unabata, 〃	〃 畷畑(ウナバタ)
	Usagisawa, 〃	〃 兎沢
5)	Fukurosawa, Yokota-mura, Kesen-gun, Iwate Prefecture.	5) 岩手県気仙郡横田村 袋沢
	Kozubo, 〃	〃 小坪
	Maide, 〃	〃 舞出
	Yukisawa, 〃	〃 雪沢

6) Deguchi, Yahagi-mura, Kesen-gun, Iwate Prefecture.
Hotokesaka, 〃
Yahagigawa, 〃
7) Nokkoshisaka, Takada-machi, Kesen-gun, Iwate Prefecture.
8) Sanmaiyashiki, Maikawa-mura, Higashiiwai-gun, Iwate Prefecture.
9) Takamoriyama, Kinomi-mura, Higashiiwai-gun, Iwate Prefecture.
10) Abu-toge, (pass) Matsukawa-mura, Higashiiwai-gun, Iwate Prefecture.
11) Iwaizaki, Hajikami-mura, Motoyoshi-gun, Miyagi Prefecture.
12) Tsukitate, Niitsuki-mura, Motoyoshi-gun, Miyagi Prefecture.
13) Oosawa, Maiya-machi, Tome-gun, Miyagi Prefecture.
Sashisawa (Sashizawa), 〃
Yamazaki, 〃
14) Rodai, Tome-machi, Tome-gun, Miyagi Prefecture.
15) Kohama, Ogachi-machi, Momou-gun, Miyagi Prefecture.
Yakejima, 〃
16) Hisahara, Kamimano-mura, Soma-gun, Fukushima Prefecture.
Kamitochikubo, 〃
Yumioresawa, 〃
17) Miyatagawa, Hitachi City, Taga-gun, Ibaragi Prefecture.
18) Shirai (Shiroi ?), Ueno-mura, Tano-gun, Gumma Prefecture.
19) Aisawa, Kuzu-machi, Aso-gun, Tochigi Prefecture.
20) Omi, Omi-machi, Nishikubiki-gun, Niigata Prefecture.
21) Hitoegane, Kamitakara-mura, Yoshiki-gun, Gifu Prefecture.
Ichinotani, Fukuchi, 〃
Kansaka (Kanzaka), 〃
22) Hunabuse (Funabuse), Yamagata-gun, Gifu Prefecture.
23) Kinsyozan, Akasaka-machi, Fuwa-gun, Gifu Prefecture.
24) Oishizawa, Iwate-mura, Fuwa-gun, Gifu Prefecture.
25) Yataka, Suisyo-mura, Sakata-gun, Shiga Prefecture.

6) 岩手県気仙郡矢作村 出口
〃 仏坂
〃 矢作川
7) 岩手県気仙郡高田町乗越坂
8) 岩手県東磐井郡舞川村三枚屋敷
9) 岩手県東磐井郡黄海(キノミ)村高森山
10) 岩手県東磐井郡松川村阿武峠
11) 宮城県本吉郡階上村岩井崎
12) 宮城県本吉郡新月村月立
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〃 山崎
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〃 八景島
16) 福島県相馬郡上真野村樗(ヒサ)原
〃 上栃窪
〃 弓折沢
17) 茨城県多賀郡日立市宮田川
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Hakuundo, 〃
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32) Shiramizu, Shinsaka-mura, Kameishi-gun, Hiroshima Prefecture.
33) Chichiiwa, Miyanoshita, Yamaguchi City, Yamaguchi Prefecture.
34) Ohkubo, Ohta-machi, Mine-gun, Yamaguchi Prefecture.
Tobinosu, 〃
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Shiraiwa, 〃
Yoshinaga, 〃
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Serida, 〃
37) Kaerimizu, Akago-mura, Mine-gun, Yamaguchi Prefecture.
38) Maruyama, Isa-mura, Mine-gun, Yamaguchi Prefecture.
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Yamanba, 〃
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45) Kasamatsu, Kawamata-mura, Yatsushiro-gun, Kumamoto Prefecture.

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M. MINATO

Japaness Carboniferous and Permian Corals

Plates and Explanations

Plate 1

Plate 1

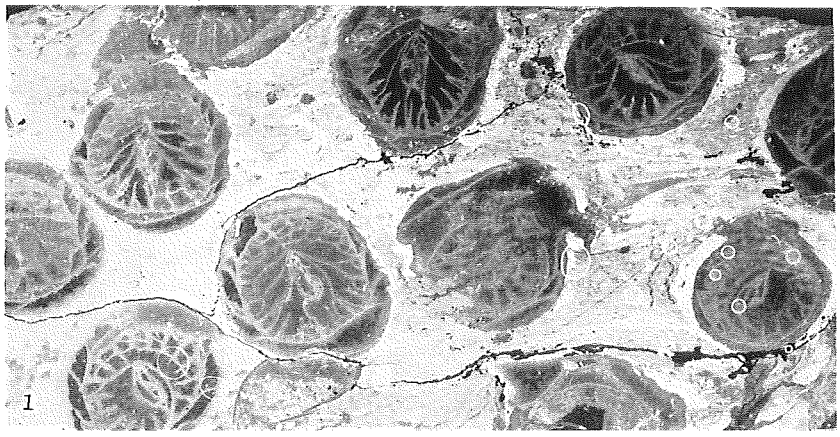
Pseudodorlodotia kakimii MINATO, gen. et sp. nov. ..... p. 90

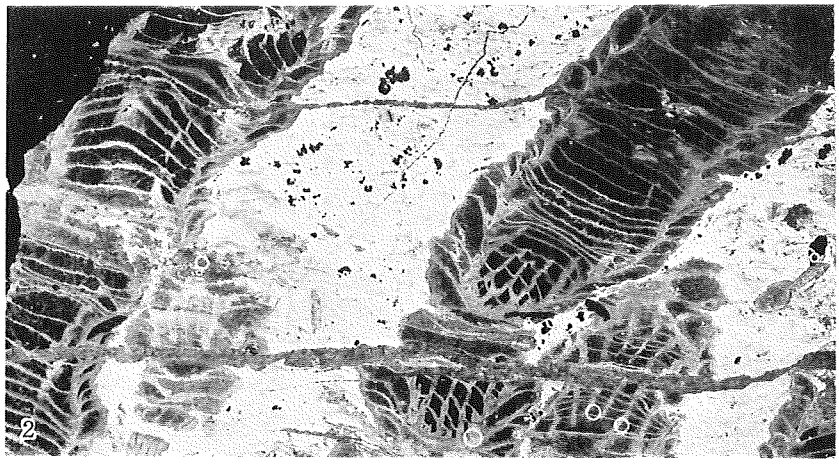
Fig. 1. Transverse section. (ca×3.6)
Hor.: *Dibunophyllum* zone. Loc.: Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 17317. Coll.: T. KAKIMI.

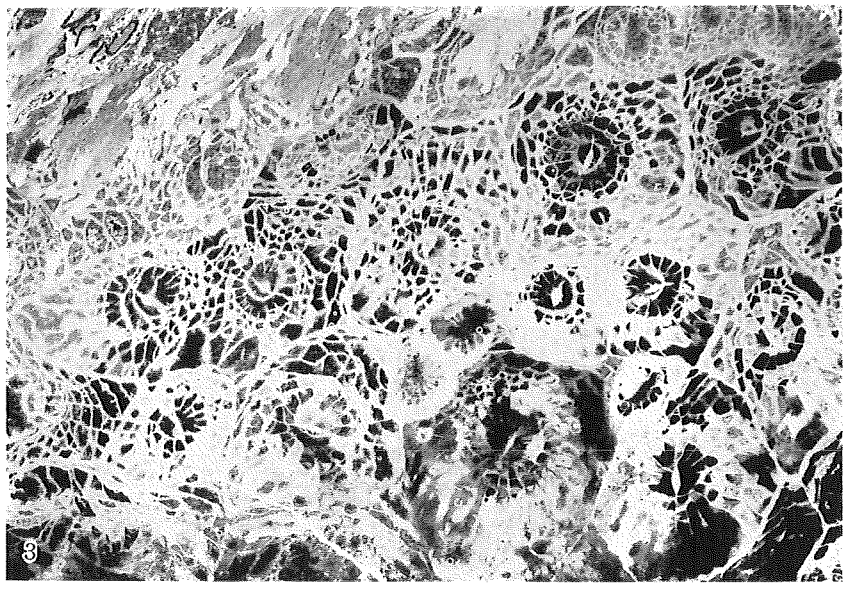
2. Longitudinal section. (ca×3.2)
Hor., loc., and coll. is same as the preceding fig. Reg. no.: 17319.

Lithostortionella sp. indet ..... p. 87

3. Transverse section. (ca×3.6)
Hor.: Unknown, but it may be perhaps far lower than the *Dibunophyllum* zone. Loc.: Unabata, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 17315. Coll.: H. SUETOMI.







MINATO and KUMANO *phot.*

Plate 2

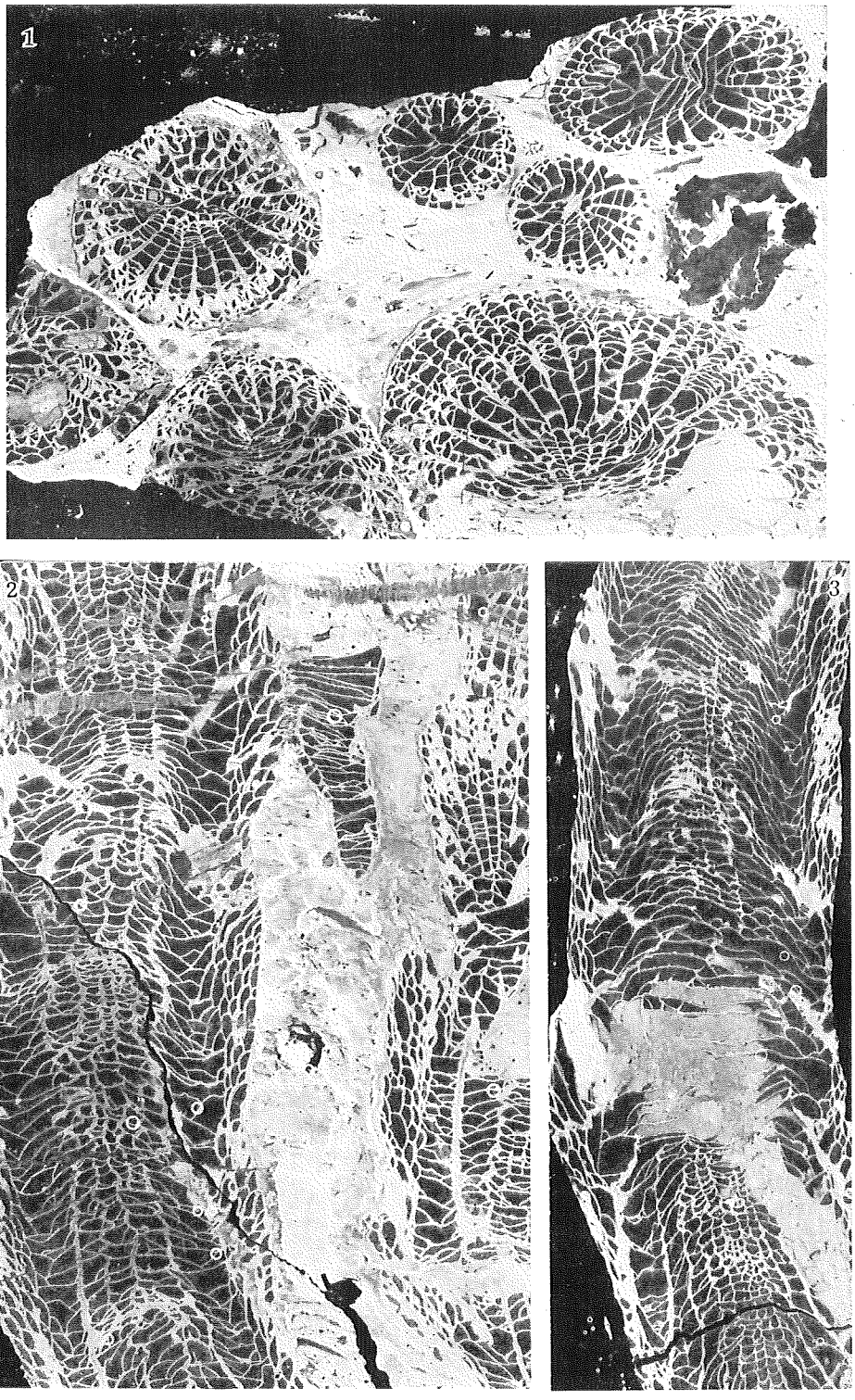
Plate 2

Huangia hasimotoi (NAGAO et MINATO) ..... p. 123

Fig. 1. Transverse section. (ca × 3.4)
Hor.: *Pseudoschwagerina* zone. Loc.: Sakamotosawa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 17654. Coll.: T. KAKIMI.

2. Longitudinal section (ca × 3.4)
Hor., loc. and coll.: same as preceding fig. Reg. no.: 17658.

3. Longitudinal section. (ca × 3.4)
Hor., Loc., and coll.: same as preceding two figs. Reg. no.: 17655.



MINATO and KUMANO *phot.*

Plate 3

Plate 3

Siphonodendron pseudomartini (YABE et HAYASAKA) ..... p. 71

Fig. 1. Transverse section. (ca × 1.6)
Hor.: *Dibunophyllum* zone. Loc.: Takase, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15547. Coll.: M. MINATO.

Siphonodendron densitabulata (YABE et HAYASAKA) ..... p. 72

2. Transverse and longitudinal section. (ca × 1.6)
Hor.: *Dibunophyllum* zone. Loc.: Takase, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15364. Coll.: M. MINATO.

Siphonodendron pauciradiale (M'COY)..... p. 74

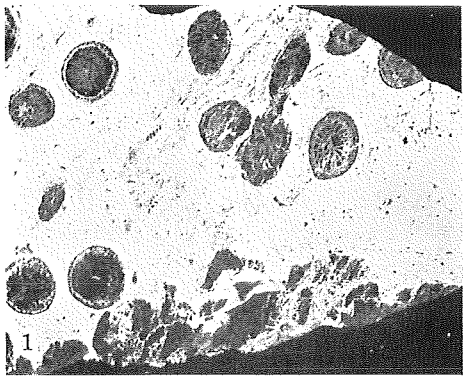
3. Transverse section. (ca × 1.6)
Hor.: *Dibunophyllum* zone. Loc.: Yukisawa, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16842. Coll.: M. MINATO.
4. Longitudinal section. (ca × 1.6)
Hor., loc. coll. and reg. no are same as the preceding fig.

Lonsdaleiastraea yamanbaensis MINATO ..... p. 135

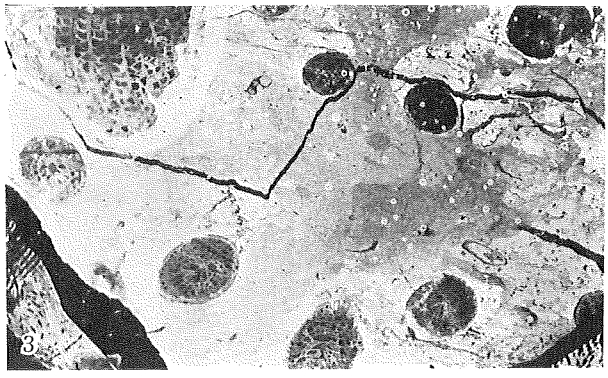
5. Transverse section. (ca × 3.3)
Hor.: *Parafusulina* zone? or *Neoschwagerina* zone? Loc.: Yamanba, near Sakawa, Kochi Prefecture. Reg. no.: 16529. Coll.: M. MINATO.

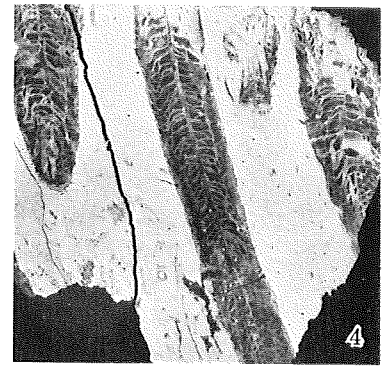
Lonsdaleoides toriyamai MINATO, sp. nov..... p. 165

6. Transverse section of the peripheral part. (ca × 3.3)
Hor.: *Fusulinella* zone. Loc.: Kyowa-mura, Yamaguchi Prefecture. Reg no.: 17809. Coll.: R. TORIYAMA.













MINATO and KUMANO *phot.*

Plate 4

Plate 4

Siphonodendron densitabulata (YABE et HAYASAKA) ..... p. 72

Fig. 1. Longitudinal section. (ca × 1.5)
Hor.: *Dibunophyllum* zone. Loc.: Takase, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15365. Coll.: M. MINATO.

Lithostrotionella kitakamiensis MINATO, sp. nov. ..... p. 88

2. Longitudinal section. (ca × 1.5)
Hor.: *Fusulinella* zone. Loc.: Sakamotosawa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 17613. Coll.: M. MINATO.

7. Transverse section. (ca × 3.5)
Hor., loc., and coll.: same as the preceding fig. Reg. no.: 17609.

8. Transverse section. (ca × 3.5)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 17224.

10. Transverse section. (ca × 1.8)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 17608.

Diphyphyllum equiseptatum YABE et HAYASAKA ..... p. 81

3. Longitudinal section. (ca × 1.8)
Hor.: *Profusulinella-? Fusulinella* zone. Loc.: Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 17310. Coll.: M. MINATO.

5. Transverse section. (ca × 1.8)
Hor., loc., and coll. is same as the preceding fig. Reg. no.: 17309.

6. Transverse section. (ca × 1.8)
Hor., loc. and coll.: same as fig. 3. Reg. no.: 17311.

Pseudodorlodotia kakimii MINATO, sp. nov. ..... p. 90

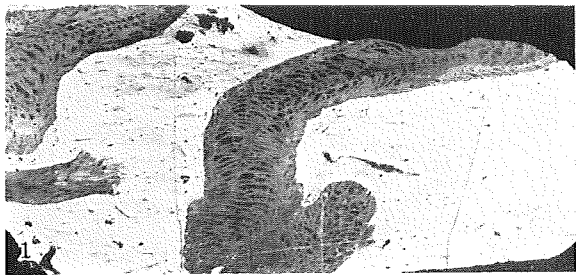
4. Transverse section. (ca × 3.5)
Hor.: *Dibunophyllum* zone. Loc.: Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 17315. Coll.: T. KAKIMI.

11. Transverse section. (ca × 1.8)
Hor., loc., and coll.: same as the preceding fig. Reg. no.: 17318.

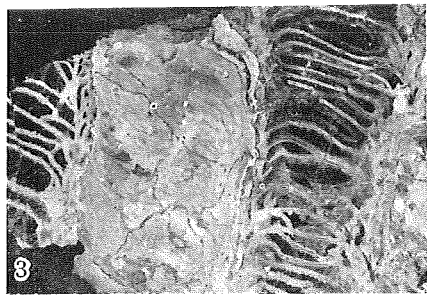
12. Longitudinal section. (ca × 1.8)
Hor., loc. and coll. is same as the preceding fig. Reg. no.: 17389.

Siphonodendron pseudomartini (YABE et HAYASAKA) ..... p. 71

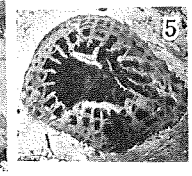
9. Longitudinal section. (ca × 1.5)
Hor.: *Dibunophyllum* zone. Loc.: Takase, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15359. Coll.: M. MINATO.

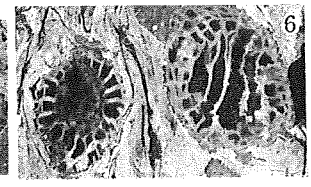


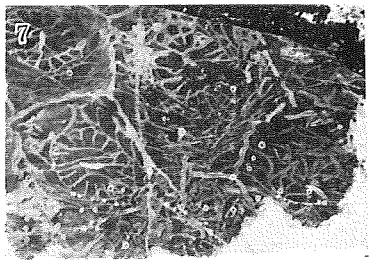




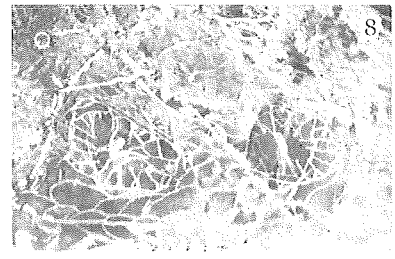


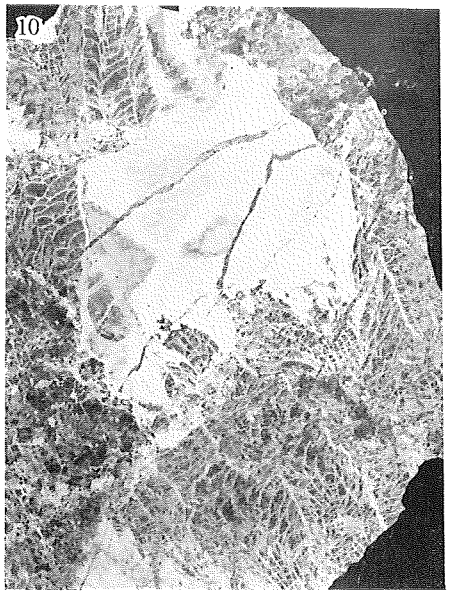




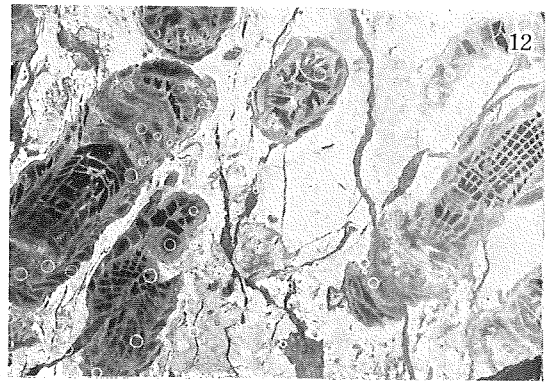












MINATO and KUMANO *phot.*

Plate 5

Plate 5

Clisaxophyllum awa MINATO ..... p. 137

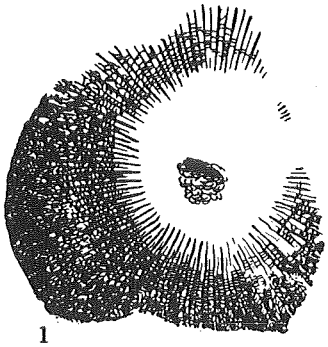
Fig. 1. Transverse section. (×3/4)
Hor.: *Fusulinella* zone. Loc.: Omi, Niigata Prefecture. Reg. no.: 15683. holotype. Coll.: unknown.

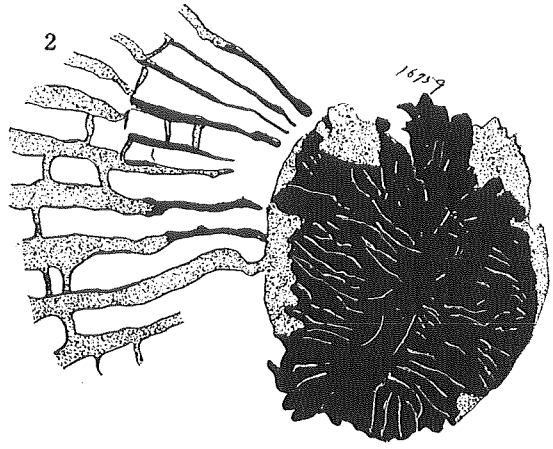
Amygdalophyllum sp. a ..... p. 147

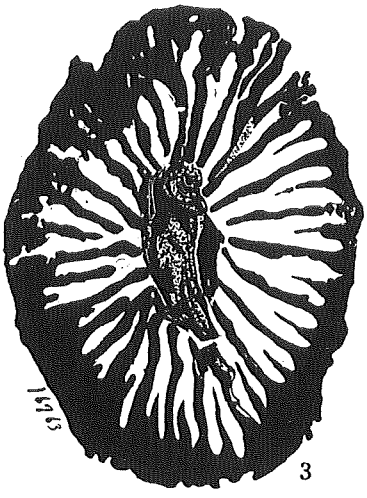
2. Transverse section. (×6.0)
Hor.: Unknown, but it may be far lower than the *Dibunophyllum* zone. Loc.: Ohmori, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16759. Coll.: M. MINATO.
3. Transverse section. (×6.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 16763.
5. Transverse section. (×6.0)
Hor., loc. and coll.: same as fig. 2. Reg. no.: 16412.
6. Tangential section. (×6.0)
Hor., loc. and coll.: same as fig. 2. Reg. no.: 16761.

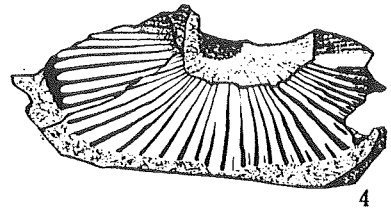
Sugiyamaella carbonarium YABE et MINATO..... p. 150

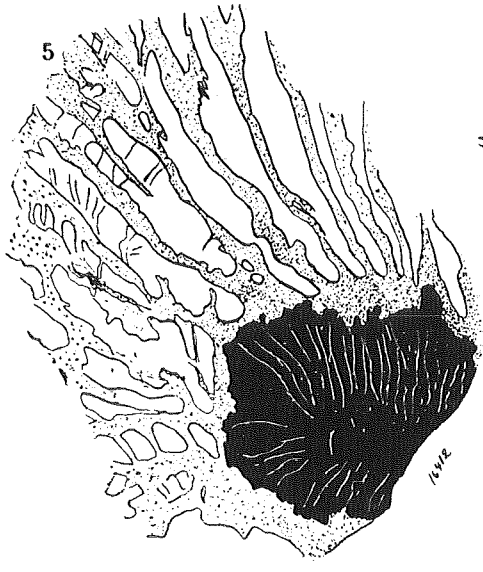
4. Polished section. (×2.0)
Hor.: *Sugiyamaella* zone. Loc.: Usagisawa, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 17839. Coll.: M. MINATO.


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Plate 6

Plate 6

Kueichouphyllum yabei MINATO ..... p. 172

Fig. 1. Weathered surface of the corallite. (×1.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Coll.: M. MINATO.

Syringopora sp. indet. ..... p. 188

2. Weathered surface of the corallum. (×1.0)
Hor.: *Amplexus nipponensis* OISHI et MINATO zone. Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15496. Coll.: M. MINATO.

Cyathophylloid coral ..... p. 174

3. Weathered surface of the corallite. (×1.0)
Hor.: *Brachythyrina nagaoi* MINATO zone. Loc.: Maide, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 17305. Coll.: M. MINATO.

Sugiyamaella carbonarium YABE et MINATO ..... p. 150

4. Mold of the corallite. (×1.0)
Hor.: *Sugiyamaella carbonarium* zone. Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Specimen is now stored at Tokyo Science Museum. Coll.: M. MINATO.

Amplexus sp. *b*..... p. 70

5. Corallite. (×1.0)
Hor.: *Syringothyris jumonjiensis* MINATO zone. Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15498. Coll.: M. MINATO.

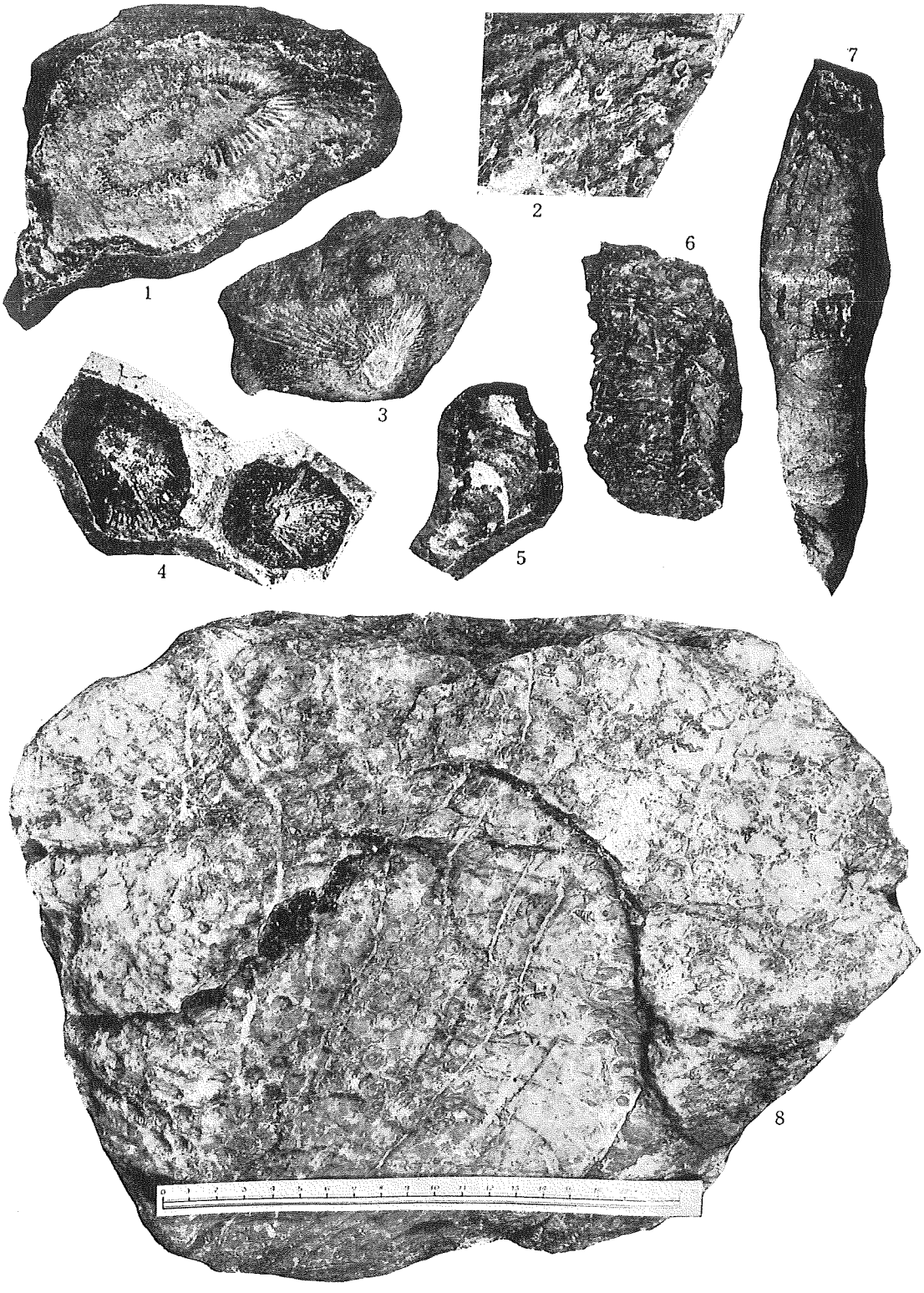
Amplexus nipponensis OISHI et MINATO ..... p. 69

6. Corallite showing the tabulae. (×1.0)
Hor.: *Amplexus nipponensis* zone. Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Specimen is now stored at Tokyo Science Museum. Coll.: M. MINATO.

7. Almost complete corallite, although lacking the proximal and distal part. (×1.0)
Hor., loc. and coll. is same as the preceding fig. Specimen is also stored at the same museum.

Stylidophyllum japonica (YABE et HAYASAKA) ..... p. 131

8. Weathered surface of the corallum. (ca×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Takase, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Coll.: M. MINATO. Specimen is now stored at Tokyo Science Museum.



MINATO and KUMANO *phat.*

Plate 7

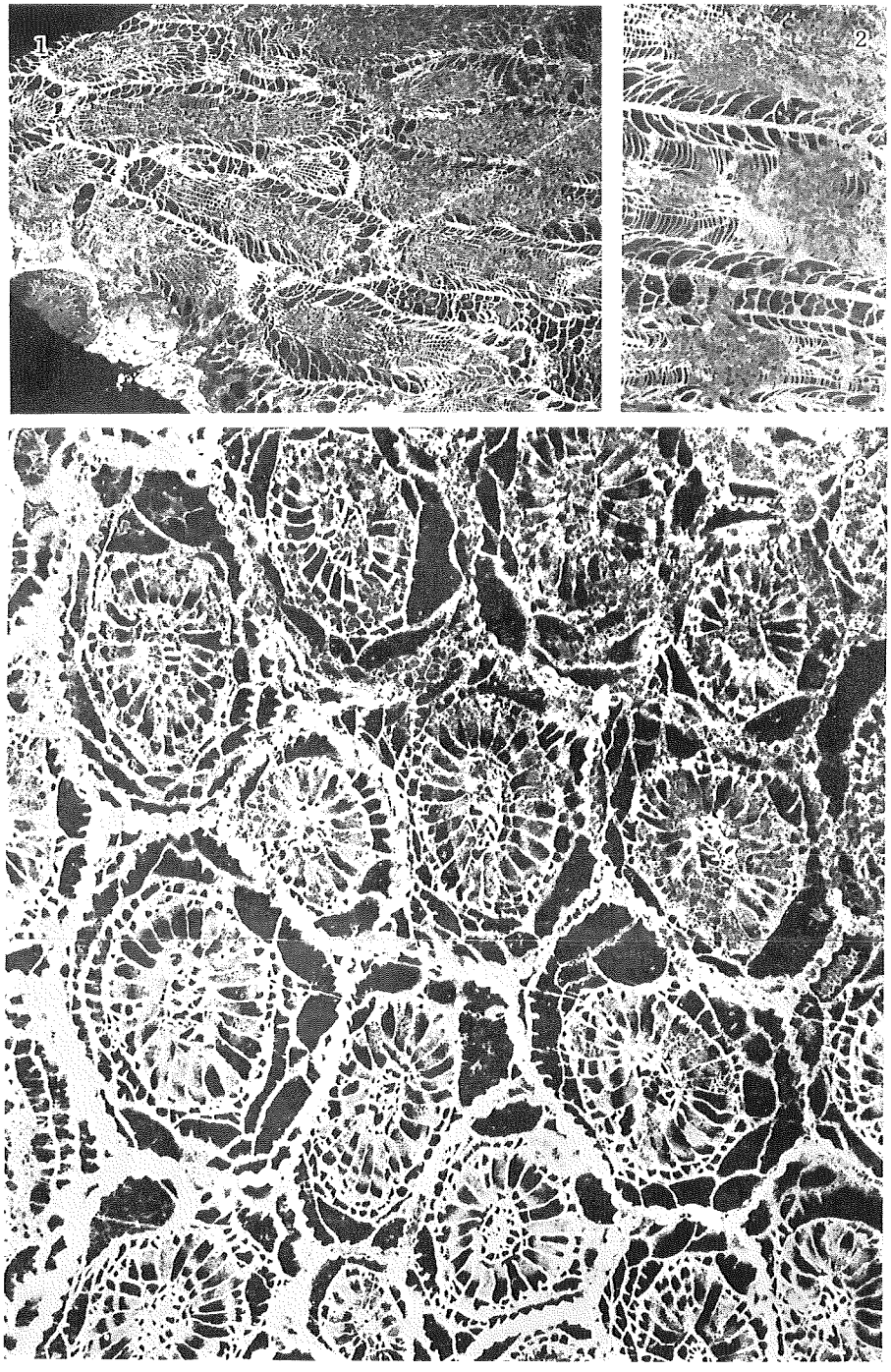
Plate 7

Stylidophyllum japonica (YABE et HAYASAKA))..... p. 131

Fig. 1. Longitudinal section. (×1.0)
Hor.: *Dibunophyllum* zone. Loc.: Hiishi, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15415. Coll.: M. MINATO.

2. Longitudinal section. (×2.0)
Hor., loc., and coll. is same as the preceding fig. Reg. no.: 15417.

3. Transverse section. (×5.0)
Hor., loc. and coll.: same as fig. 1. Reg. no.: 15423.



MINATO and KUMANO *phot.*

Plate 8

Plate 8

Dibunophyllum asiaticum MINATO, nom. nov. ..... p. 98

Fig. 1. Longitudinal section. (ca × 0.87)
Hor.: *Dibunophyllum* zone. Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15113. Coll.: M. MINATO.

Siphonodendron martini (EDWARDS et HAIME) ..... p. 73

2. Transverse section. (ca × 1.74)
Hor.: *Dibunophyllum* zone. Loc.: Kawamukai, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15337. Coll.: M. MINATO.

Kueichouphyllum yabei MINATO ..... p. 172

3. Corallite. (ca × 0.87)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no. : 15289. Coll.: M. MINATO.

7. Corallite. (ca × 0.87)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15150.

Siphonodendron sp. *a* ..... p. 77

4. Transverse section of one corallite. (ca × 1.74)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15411. Coll.: M. MINATO.

Siphonodendron inugasirayamaensis MINATO..... p. 76

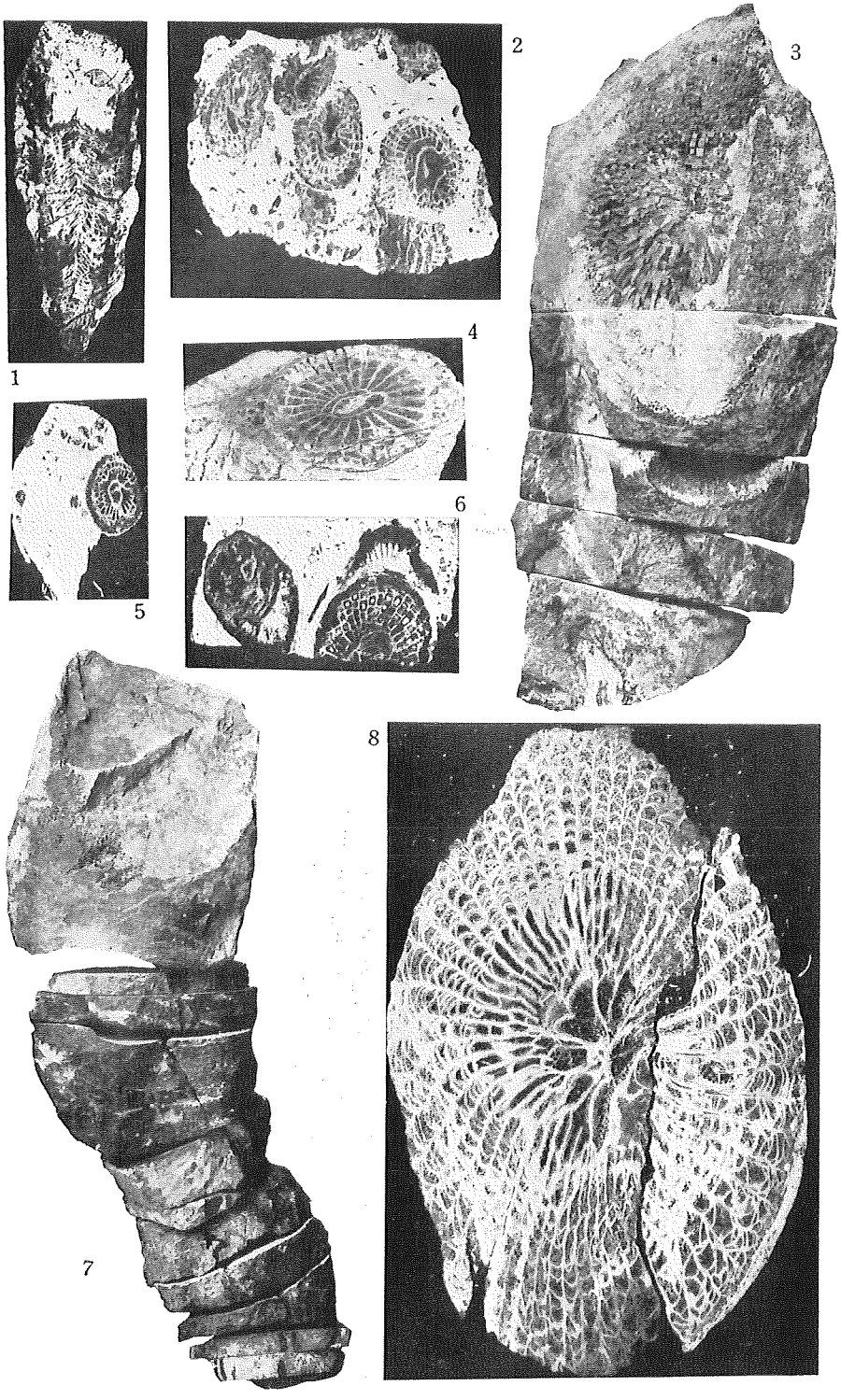
5. Transverse section of one corallite. (ca × 0.87)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15331. Coll.: M. MINATO.

Siphonodendron sp. *b*..... p. 77

6. Transverse section. (ca × 1.74)
Hor.: *Dibunophyllum* zone. Loc.: Matsubi, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15292. Coll.: M. MINATO.

Pseudocaninia sp. ..... p. 71

8. Transverse section. (ca × 1.74)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15245. Coll.: M. MINATO.



MINATO and KUMANO *phot.*

Plate 9

Plate 9

Setamainella hayasakai MINATO ..... p. 141

Fig. 1. Transverse section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15451. Coll.: M. MINATO.

Rhodophyllum sugiyamai MINATO..... p. 101

2. Transverse section. (ca×1.2)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15075. Coll.: M. MINATO.
3. Longitudinal section. (ca×1.0)
Hor., loc. and coll.: same as the preceding. Reg. no.: 15074.

Dibunophyllum bristolense GARWOOD et GOODYEAR..... p. 97

4. Transverse section. (×1.2)
Hor.: *Dibunophyllum* zone. Loc.: same as the preceding fig. Reg. no.: 16053. Coll.: M. MINATO.

Rhodophyllum yokoyamai MINATO..... p. 101

5. Transverse section. (×1.2)
Hor.: *Dibunophyllum* zone. Loc.: Same as the preceding fig. Reg. no.: 15076. Coll.: M. MINATO.

Kueichouphyllum yahagiense MINATO, sp. nov. ..... p. 172

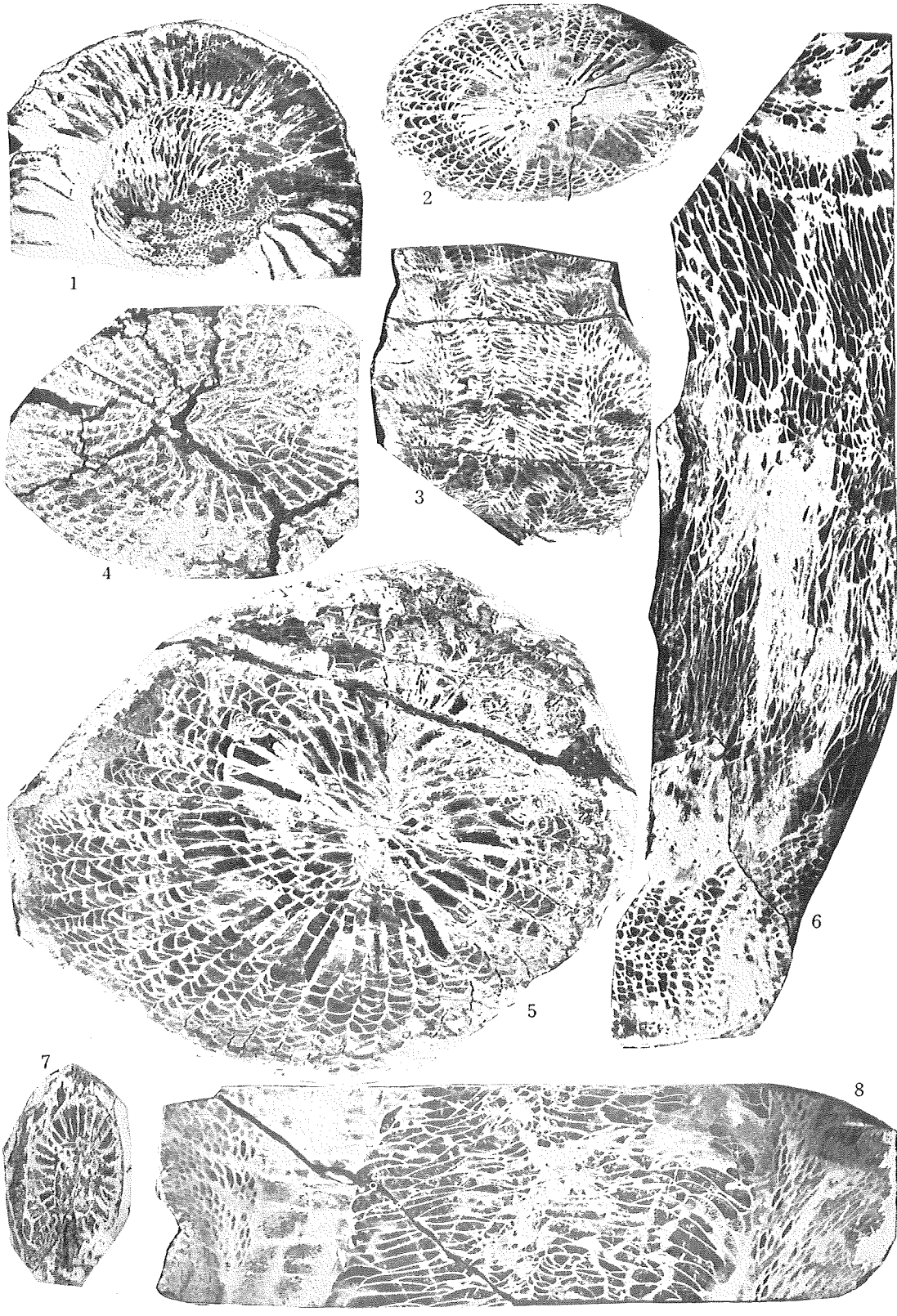
6. Longitudinal section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15151. Coll.: M. MINATO.

Dorlodotia? sp. indet. ..... p. 91

7. Transverse section. (×1.5)
Hor.: *Dibunophyllum* zone. Loc.: Sizu, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15204. Coll.: M. MINATO.

Kueichouphyllum yabei MINATO ..... p. 172

8. Longitudinal section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: same as the preceding. Reg. no.: 15140. Coll.: M. MINATO.



MINATO and KUMANO *phot.*

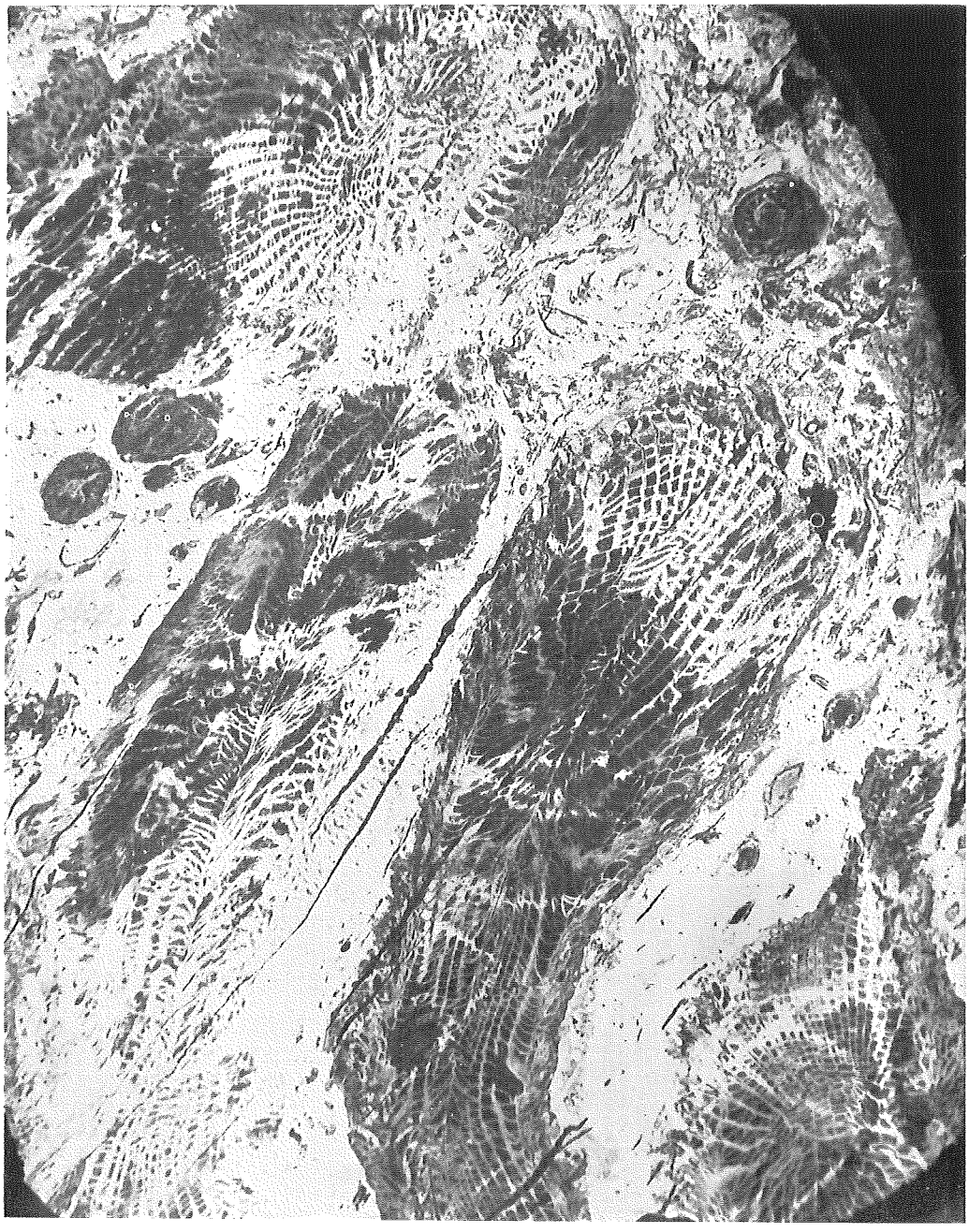
Plate 10

Plate 10

Dibunophyllum asiaticum MINATO, nom. nov. ..... p. 98

The oblique section. (×2.2) One of the longitudinal sections of the corallite is shown in reverse.

Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15120. Coll.: M. MINATO.



MINATO and KUMANO *phot.*

Plate 11

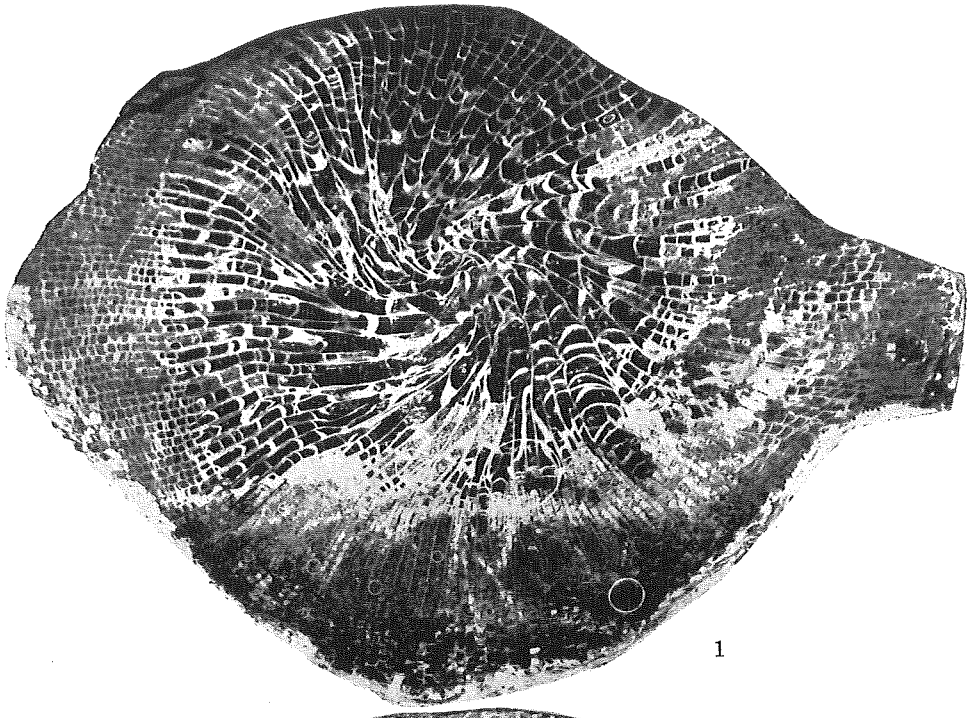
Plate 11

Kueichouphyllum kesenense MINATO, sp. nov. ..... p. 172

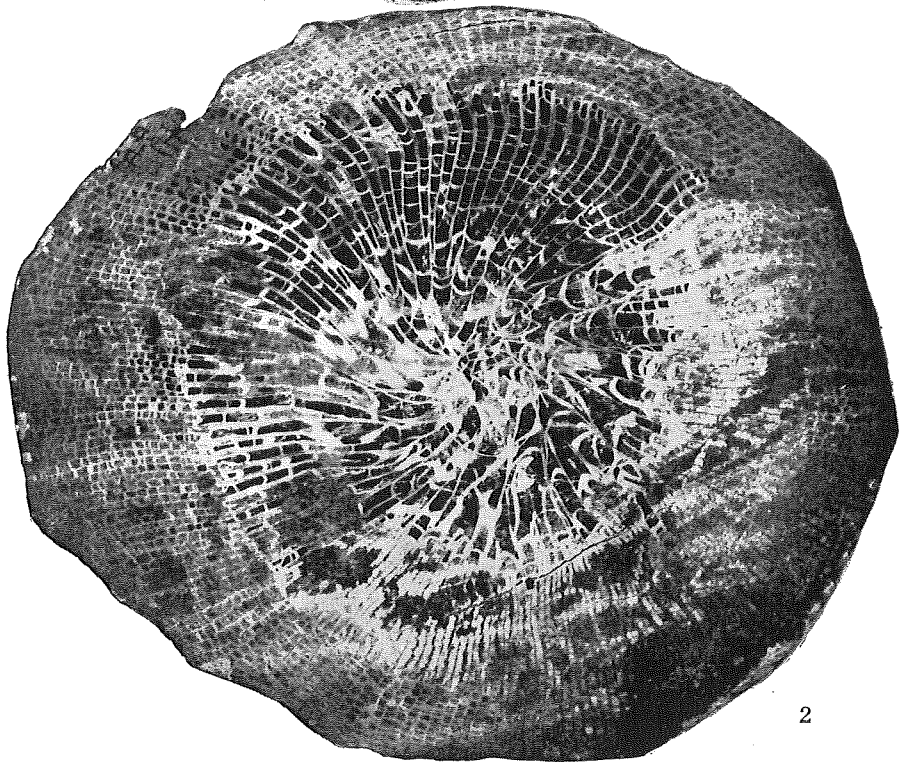
Fig. 1. Transverse section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15137. Coll.: M. MINATO.

Kueichouphyllum yabei MINATO ..... p. 172

2. Transverse section. (×2.0)
Hor., loc., and coll.: same as the preceding fig. Reg. no.: 15136.



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MINATO and KUMANO *phot.*

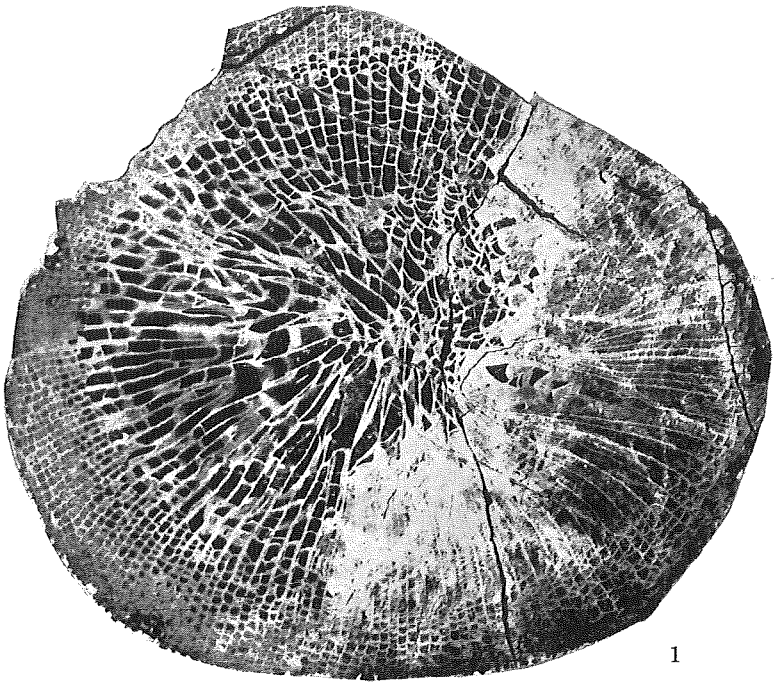
Plate 12

Plate 12

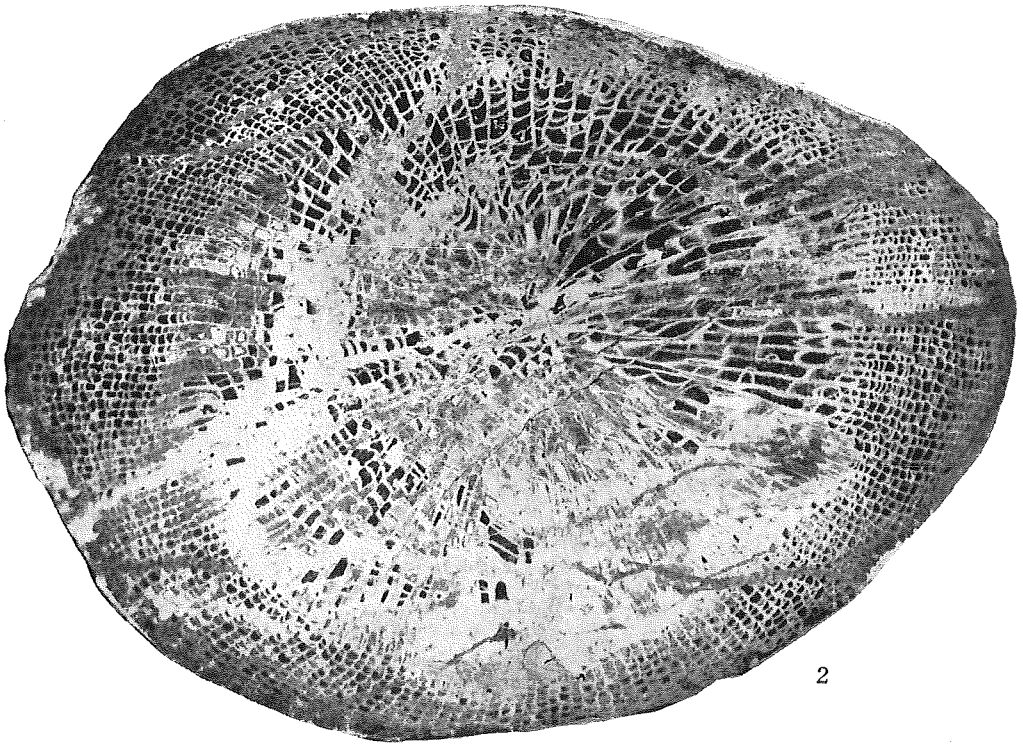
Kueichouphyllum yabei MINATO ..... p. 172

Fig. 1. Transverse section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15289. Coll.: M. MINATO. This thin section shows the immature stage of the corallite.

2. Transverse section. (×2.0)
Hor., loc. and coll.: same as the preceding. Reg. no.: 15288.



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MINATO and KUMANO *phot.*

Plate 13

Plate 13

Rhodophyllum sugiyamai MINATO ..... p. 101

Fig. 1. Transverse section. (ca × 0.9)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15075. Coll.: M. MINATO.

Cyathophyllum sp. indet. ..... p. 174

2. Longitudinal section. (× 0.9)
Hor.: *Dibunophyllum* zone. Loc. and coll.: same as the preceding fig. Reg. no.: 15424 b.

9. Tangential section. (× 0.9)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: no.: 15422.

Dibunophyllum bristolense GARWOOD et GOODYEAR ..... p. 97

3. Transverse section. (× 0.9)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama. Coll.: M. MINATO.
Reg. no.: 15201.

Caninia juddi (THOMSON) var. *ozawai* MINATO ..... p. 70

4. Transverse section (ca × 1.0)
Hor., loc. and coll.: same as the preceding. Reg. no.: 15445.

Siphonodendron martini (EDWARDS et HAIME) ..... p. 73

5 Longitudinal section. (× 2.0)
Hor.: *Dibunophyllum* zone. Loc.: Kawamukai, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15335. Coll.: M MINATO.

12. Tangential section. (× 2.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15337.

Dorlodotia? sp. indet. ..... p. 91

6. Transverse section. (× 1.0)
Hor.: *Dibunophyllum* zone. Loc.: Sizu, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15204. Coll.: M. MINATO.

13. Tangential section. (× 1.0)
Hor., loc. and coll.: same as the preceding. Reg. no.: 15205.

Sugiyamaella carbonarium YABE et MINATO ..... p. 150

7. Transverse section. (× 2.0)
Hor.: *Sugiyamaella carbonarium* zone. Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15130. Coll.: M. MINATO.

11. Longitudinal section. (× 2.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15133.

Rhodophyllum yokoyamai MINATO ..... p. 101

10. Transverse section. (× 0.9)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama. Reg. no.: 15076.
Coll.: M. MINATO.

15. Transverse section. (× 0.9)
Hor., loc. and coll.: same as the preceding fiig. Reg. no.: 15078.

Amygdalophyllum sp. b ..... p. 148

8. Transverse section. (× 1.0)
Hor.: *Dibunophyllum* zone. Loc.: Takase, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15199. Coll.: M. MINATO.

Dibunophyllum sp. indet. ..... p. 100

14. Oblique section. (× 0.9)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama. Reg. no.: 15073.
Coll.: M. MINATO.

Pseudocaninia sp. ..... p. 71

16. Transverse section. (× 1.5)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15245.

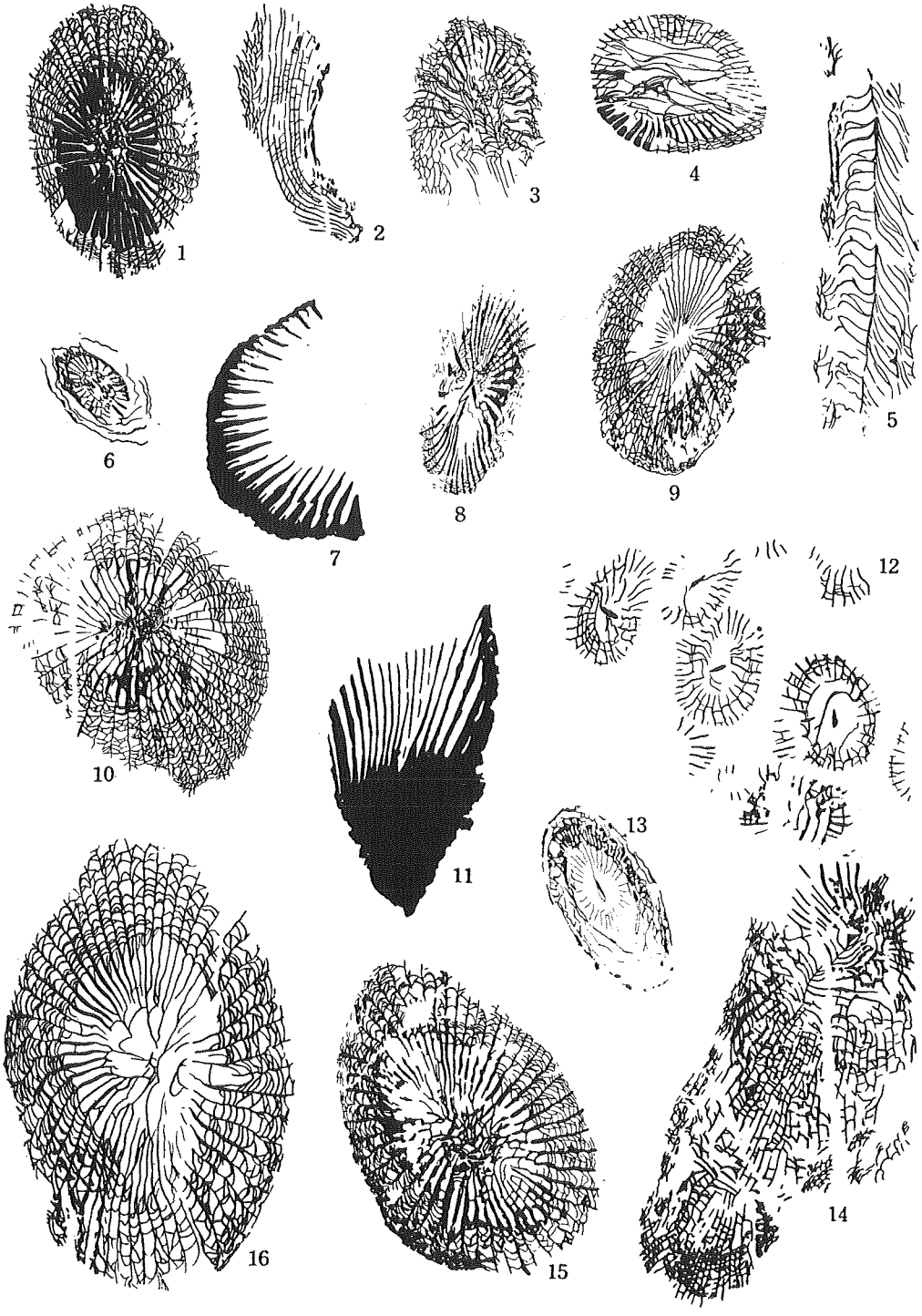

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Plate 14

Plate 14

Dibunophyllum bristolense GARWOOD et GOODYEAR ..... p. 97

Fig. 1. Transverse section. (slightly reduced)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15203. Coll.: M. MINATO.

2. Transverse section. (slightly reduced)
Hor., loc. and coll.: same at the preceding. Reg. no.: 16053.

13. Longitudinal section. (slightly reduced)
Hor., loc. and coll.: same as fig. 1. Reg. no.: 15200.

15. Longitudinal section. (slightly reduced)
Hor., loc. and coll.: same as fig. 1. Reg. no.: 15198.

Sugiyamaella carbonarium YABE et MINATO ..... p. 150

3. Transverse section. (×2.0)
Hor.: *Sugiyamaella carbonarium* zone. Loc.: Kozubo, Yokota-mura, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15132. Coll.: M. MINATO.

14. Longitudinal section. (×2.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15131.

16. Transverse section. (×2.0)
Hor., loc. and coll.: same as fig. 3. Reg. no.: 15134.

17. Tangential section. (×2.0)
Hor., loc. and coll.: same as fig. 3 Reg. no.: 15130.

Amygdalophyllum sp. b ..... p. 148

4. Transverse section. (×0.9)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setami-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15199. Coll.: M. MINATO.

Dibunophyllum inugasirayamaensis MINATO ..... p. 98

5. Transverse section. (×0.8)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15425. Coll.: M. MINATO.

Siphonodendron inugasirayamaensis MINATO ..... p. 76

6. Transverse section of one corallite. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama. Reg. no.: 15331.
Coll.: M. MINATO.

8. Tangential section. (×2.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15330.

19. Longitudinal section. (×2.0)
Hor., loc. and coll.: same as fig. 6. Reg. no.: 15330.

Siphonodendron sp. *b* ..... p. 77

7. Transverse section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Matsubi, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15291. Coll.: M. MINATO.

Siphonodendron sp. *a* ..... p. 77

9. Transverse section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Takase, Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15292. Coll.: M. MINATO.

Rhodophyllum yokohamai MINATO ..... p. 101

10. Longitudinal section. (slightly reduced)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15076, Coll.: M. MINATO.

Yuanophyllum yabei (NAGAO et MINATO) ..... p. 142

11. Longitudinal section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama. Reg. no.: 15442.
Coll.: M. MINATO.

Caninia juddi (THOMSON) var. *ozawai* MINATO ..... p. 70

12. Longitudinal section. (×1.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama. Reg. no.: 15452.
Coll.: M. MINATO.

Rhodophyllum sugiyamai MINATO ..... p. 101

18. Longitudinal section. (slightly reduced)
Hor.: *Dibunophyllum* zone. Loc. and coll.: same as the preceding fig. Reg. no.: 15074.

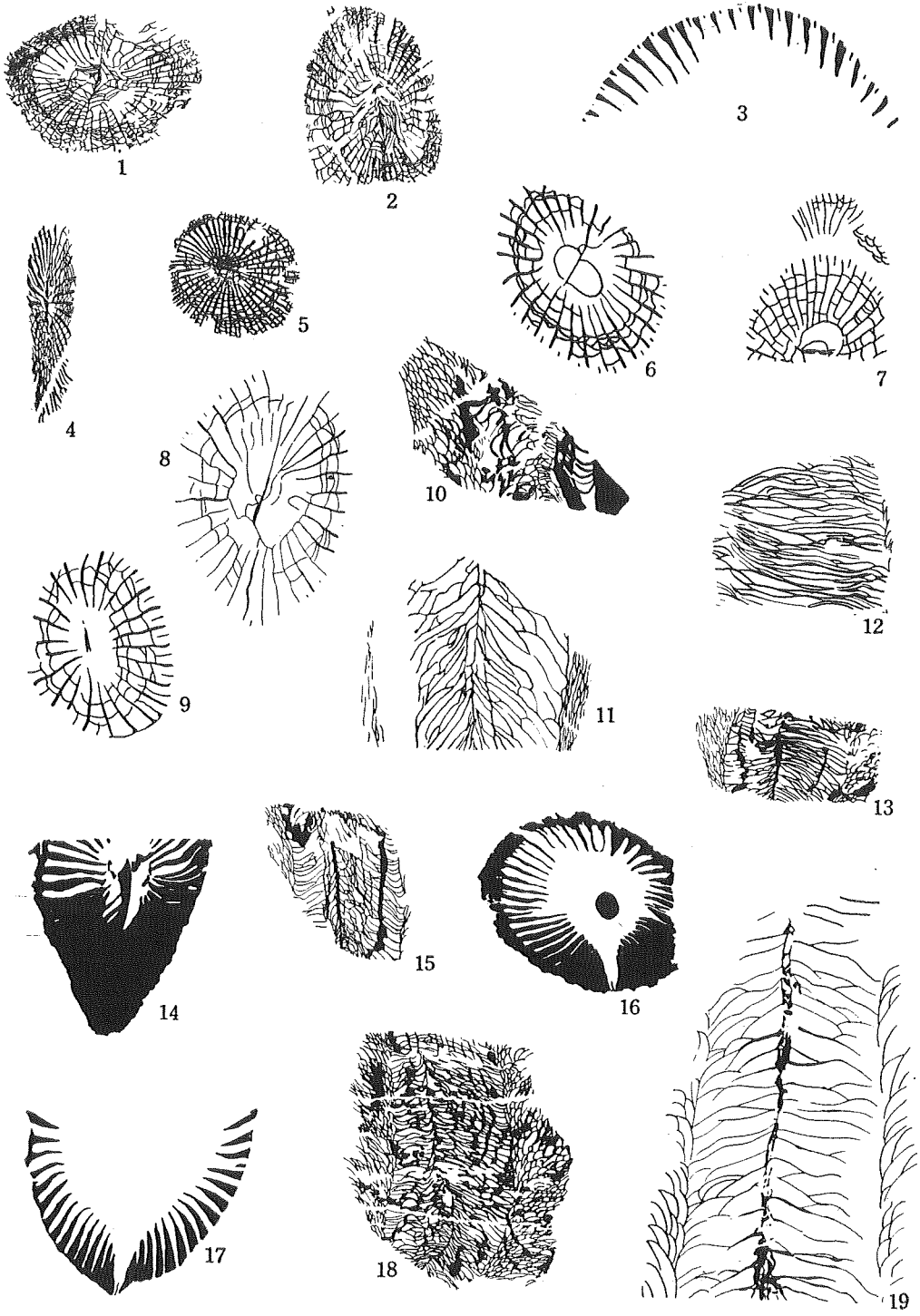

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Plate 15

Plate 15

Yuanophyllum yabei (NAGAO et MINATO) ..... p. 142

Fig. 1a-f. Transverse sections, showing the ontogenic development of the corallites. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15448. Coll.: M. MINATO.

Sugiyamaella carbonarium YABE et MINATO ..... p. 150

2. Transverse section. (×2.0) This thin section was crushed, and the columella was split into three parts.
Hor.: *Sugiyamaella carbonarium* zone. Loc.: Kozubo, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15127.
3. Tangential section. (×2.0)
Hor.: and loc.: same as the preceding fig. Reg. no.: 15135.
Coll.: M. MINATO.
4. Transverse section, showing the corallite in the early stage. (×2.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15128.
5. Transverse section, showing the most early stage of the corallite. (×2.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15129.

Kueichouphyllum yabei MINATO ..... p. 172

6a-f, i-k Transverse section, (2/3) showing the ontogentic development of the corallite.
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama.
Reg. no.: 15150. Coll.: M. MINATO.

Schema of two species of *Kueichouphyllum*, showing the type of axial ends of Septa.

7a-b. *Kueichouphyllum yabei* MINATO ..... p. 172

7c. *Kueichouphyllum kesenense* MINATO, sp. nov. ..... p. 172

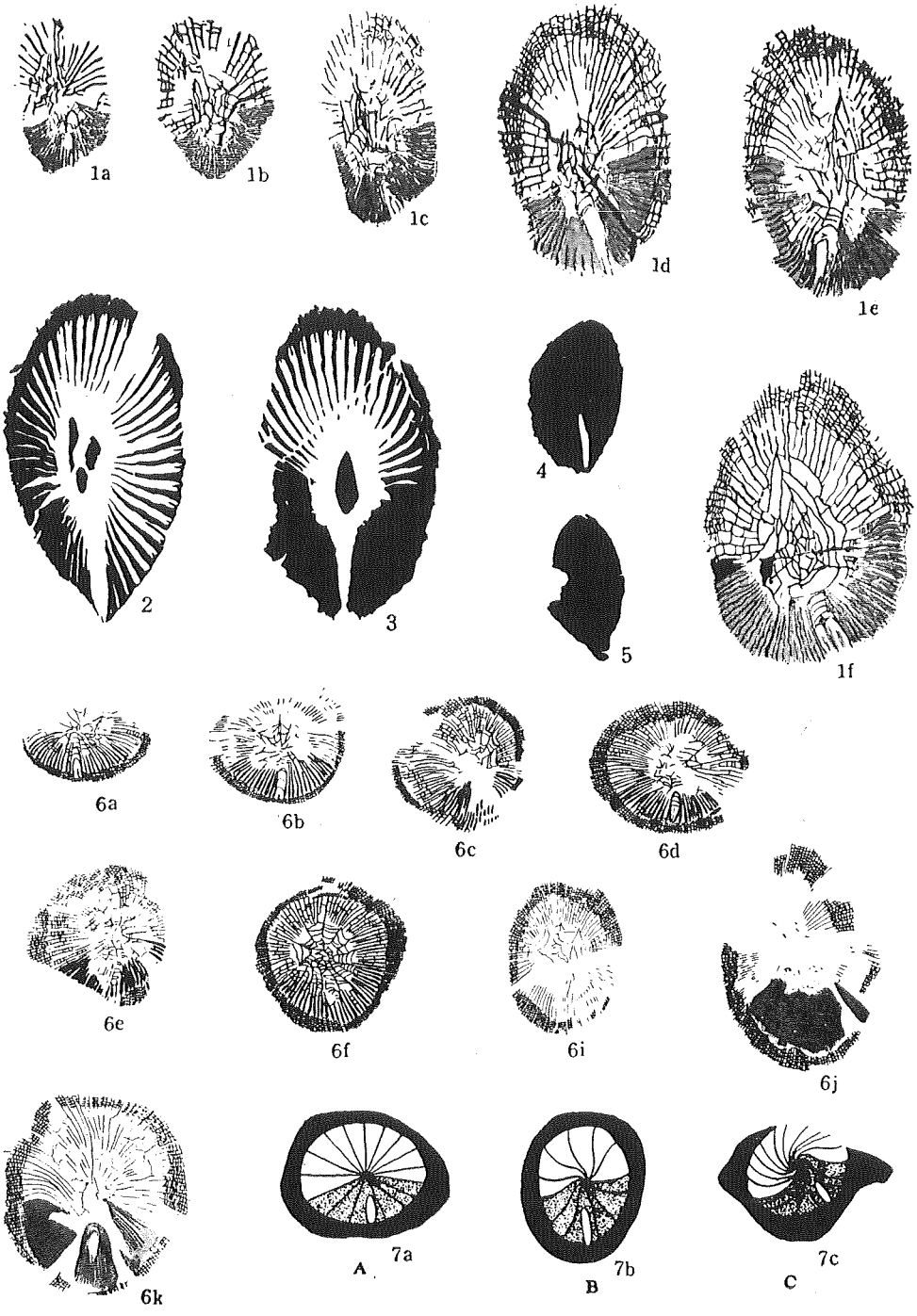

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7b
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7c
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Plate 16

Plate 16

Geyerophyllum hunabuseum MINATO, sp. nov. ..... p. 158

Fig. 1. Transverse section. (×6.0)
Hor.: *Yabeina* zone? Loc.: Mt Funabuse (Hunabuse), Gifu Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ.
Coll.: G. IIZAKA.

6. Transvers seotion. (×6.0)
Hor., loc. and coll.: same as the preceding fig.

9. Longitudinal section. (×6.0)
Hor., loc. and coll.: same as the preceding fig.

Lophophyllidium sp. *d* ..... p. 155

2. Transverse section. (×4.0)
Hor.: *Pseudoschwagerina* zone. Loc.: Komata, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 17847. Coll.: M. MINATO.

Akiyosiphyllum stylophorum YABE et SUGIYAMA ..... p. 167

3. Longitudinal section. (×7.0)
Hor.: *Yabeina* zone. Loc.: Omi, Niigata Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: G. IIZAKA.

Leonardophyllum ? sp. ..... p. 127

4. Transverse section. (×7.0)
Hor.: *Neoschwagerina*? *Yabeina*? zone. Loc.: Titi-iwa, (Chichi-iwa), Yamaguchi Prefecture. Reg. no.: 15695.
Coll.: E. TAKAHASHI.

5. Transverse section. (×7.0)
Hor., coll. and loc.: same as the preceding fig.

Lonsdaleoides toriyamai MINATO, sp. nov. ..... p. 165

7. Transverse section. (×4.0)
Hor.: *Fusulinella* zone. Loc.: Omi, Niigata Prefecture.
Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: G. IIZAKA.

Lophophyllidium sp. *b* ..... p. 154

8. Transverse section. (ca×7.0)
Hor.: *Yabeina* zone? Loc.: Funabuse, (Hunabuse), Gifu Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: G. IIZAKA.

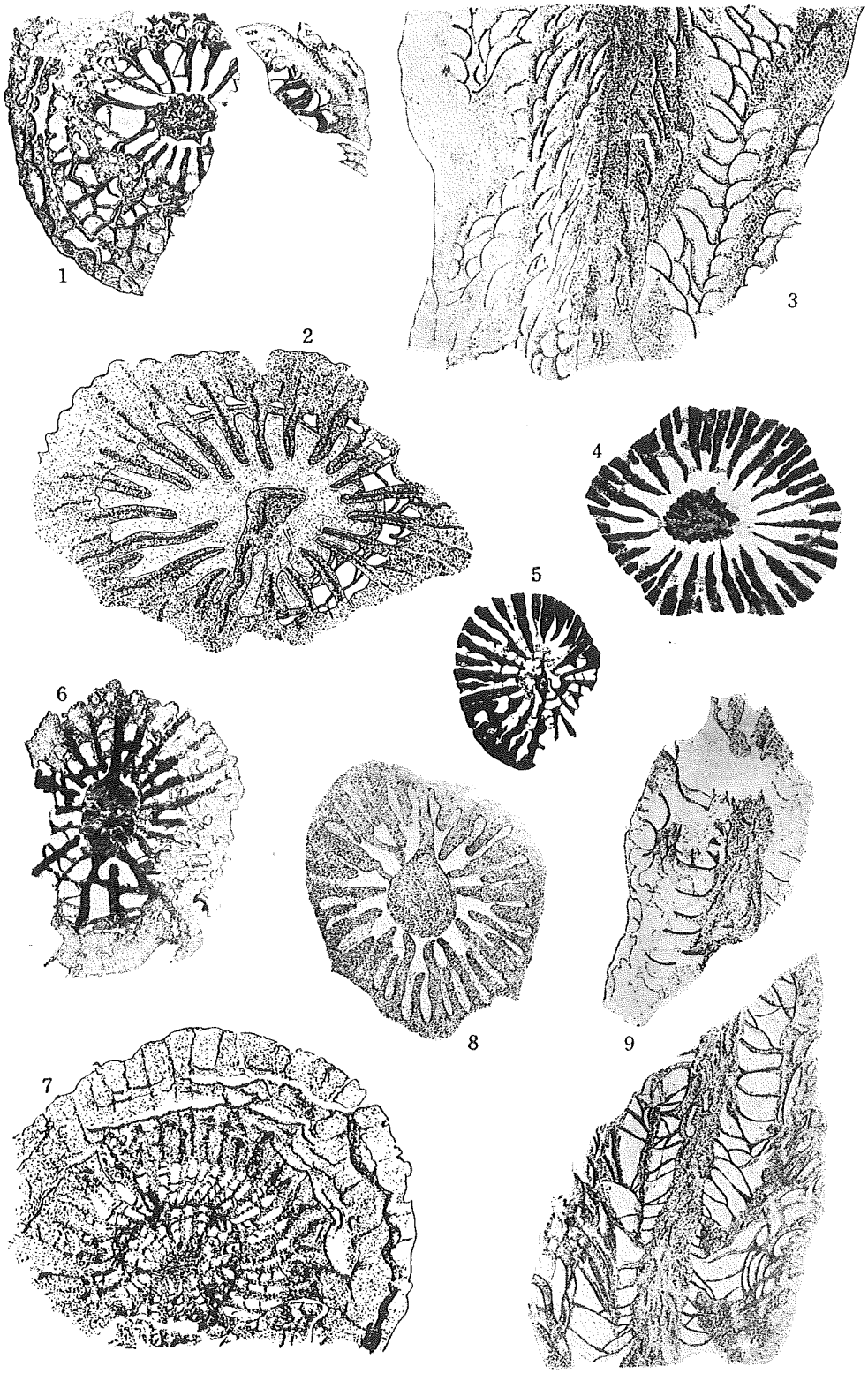

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Plate 17

Plate 17

Palaeosmilia kitakamiensis MINATO ..... p. 169

Fig. 1. Transverse section. (×1.8)
Hor.: *Dibunophyllum* zone. Loc.: Usagisawa, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15518. Coll.: M. MINATO.

2. Longitudinal section. (×1.8)
Hor., Loc. and Coll.: same as the proceding fig. Reg. no.: 15511.

Pseudoromingeria kotoi (YABE et HAYASAKA) ..... p. 186

3. Transverse section.
This figure is reproduced from YABE and SUGIYAMA's paper.
Hor.: *Yabeina* zone. Loc.: Kinsyozan, Akasaka, Gifu Prefecture.

Carcinophyllum onukii MINATO, sp. nov. ..... p. 140

4. Transverse section. (×3.0)
Hor.: *Dibunophyllum* zone. Loc.: Sizu, Setamai-machi, Kesen-gun, Iwate Prefecture. Specimen now stored at Inst. Geol. and Palaeont., Tohoku Univ. Coll.: Y. ONUKI.

5. Transverse section. (×3.0)
Hor., loc. and coll.: same as the preceding fig.

6. Transverse section. (×3.0)
Hor., loc. and coll.: same as fig. 4.

Clisaxophyllum awa MINATO ..... p. 137

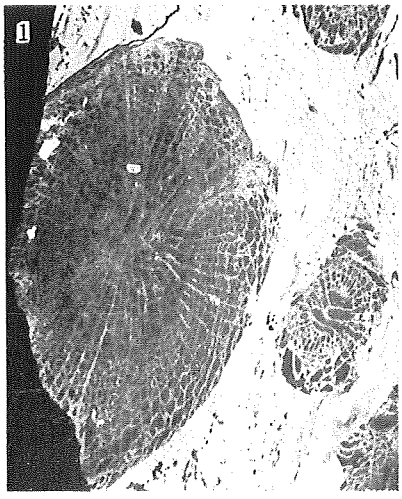
7. Longitudinal section. (×2.0)
Hor.: *Fusulinella* zone. Loc.: Omi, Niigata Prefecture.
Reg. no.: 15686. Coll.: unknown.

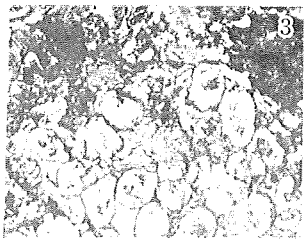
Arachnolasma cf. *sinense* (YABE et HAYASAKA) ..... p. 141

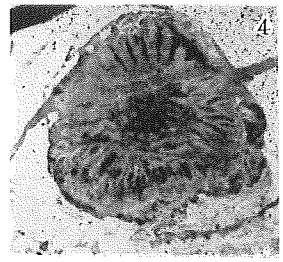
8. Transvers section. (×2.0)
Hor.: *Dibunophyllum*? zone. Loc.: West of Siroi (Sirai), Ueno-mura, Tano-gun, Gunma Prefecture. Specimen now stored at Inst. Geol. and Palaeont., Tohoku Univ. Coll.: S. OISHI.

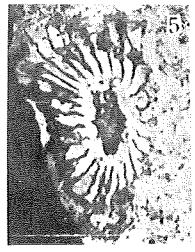
Amygdalophyllum giganteum (YABE et HAYASAKA) ..... p. 149

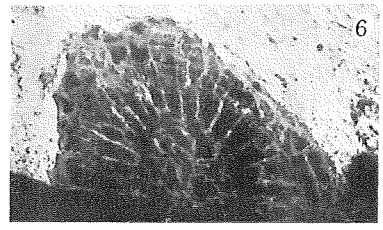
9. Transverse section. (×2.0)
Hor.: *Dibunophyllum* zone? Loc.: Omi, Niigata Prefecture.
Specimen now stored at Inst. Geol. and Palaeont., Tohoku Univ.
Coll.: I. HAYASAKA.

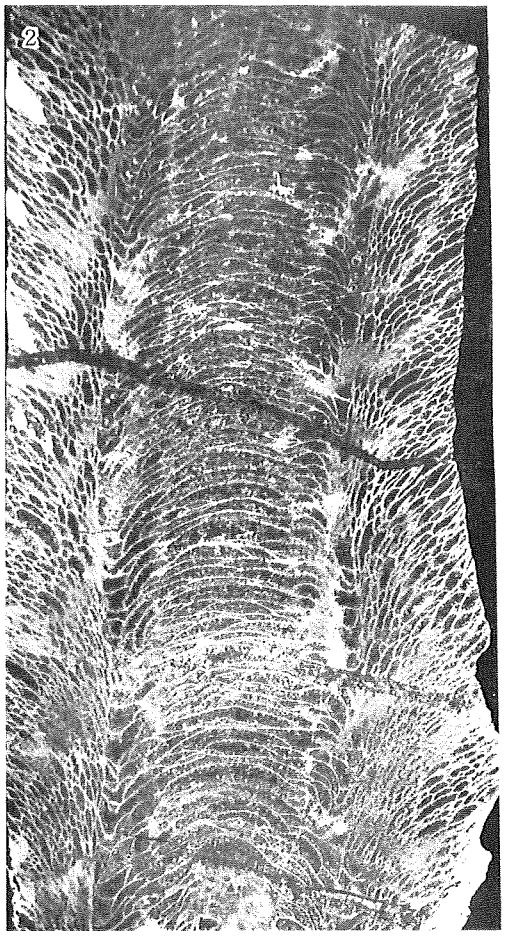


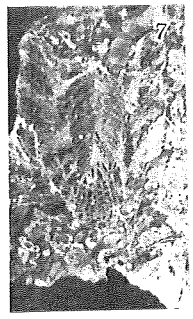


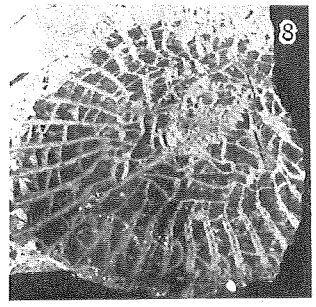


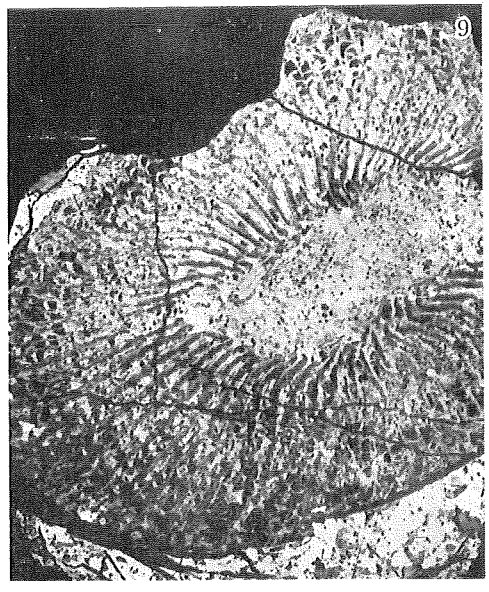












MINATO and KUMANO *phot.*

Plate 18

Plate 18

Verbeekiella japonicum YABE et MINATO ..... p. 126

Fig. 1. Transvers section. (ca × 4.0)
Hor.: *Yabeina* zone. Loc.: Kohama, Jugohama-mura, Momoou-gun, Miyagi Prefecture. Reg. no.: 15458. Coll.: M. MINATO.

2. Transverse section. (ca × 4.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15471.

3. Longitudinal section. (ca × 4.0)
Hor., loc. and coll.: same as fig. 1. Specimen now deposited at Inst. Geol. and Palaeont., Tohoku Univ.

4. Transverse section. (ca × 4.0)
Hor., loc. and coll.: same as fig. 1. Reg. no.: 15471.

5. Tangential section. (ca × 4.0)
Hor., loc. and coll.: same as fig. 1. Reg. no.: 15469.

6. Transverse section. (ca × 4.0)
Hor., loc. and coll.: same as fig. 1. Specimen is now deposited at Inst. Geol. and Palaeont, Tohoku Univ.

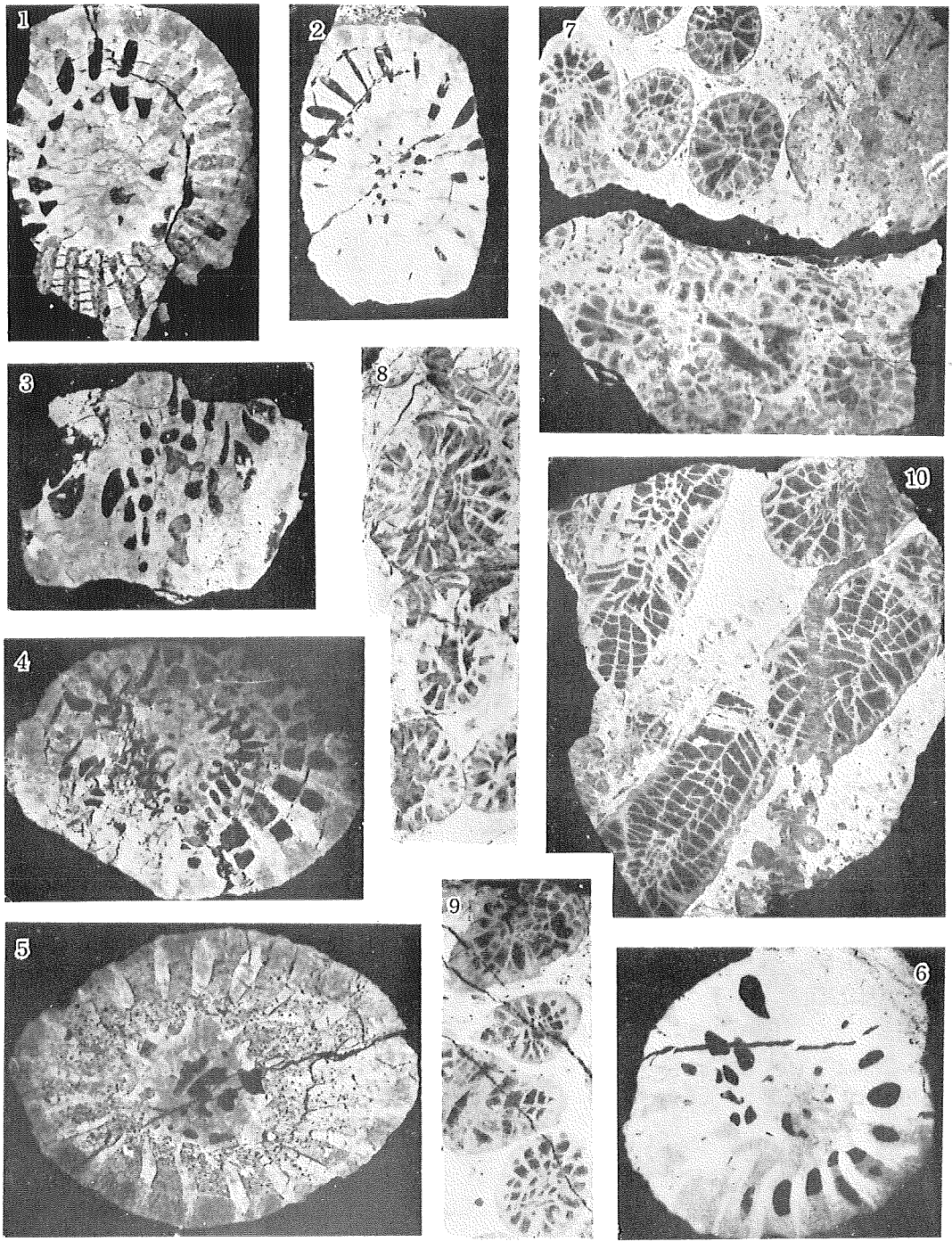
Yatsengia kiangusuensis YOH var. *mabutii* MINATO, var. nov. ..... p. 117

7. Transverse section. (ca × 2.0)
Hor. : *Yabeina* zone. Loc.: Iwaizaki, Hajikami-mura, Motoyoshi-gun, Miyagi Prefecture. Reg. no.: 16974. Coll.: M. MINATO.

8. Trangential section. (ca × 2.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15179.

9. Transverse section. (ca × 2.0)
Hor., loc. and coll.: same as fig. 7. Reg. no.: 15461.

10. Longitudinal section. (ca × 2.0)
Hor., loc. and coll.: same as fig. 7. Reg. no.: 15465.



MINATO and KUMANO *phot.*

Plate 19

Plate 19

Chaetete nagaiwaensis MINATO, sp. nov. ..... p. 190

Fig. 1. Longitudinal section. (×2.0)
Hor.: *Profusulinella- ? Fusulinella* zone. Loc. Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no. : 16464. Coll.: M. MINATO.

Akiyosiphyllum stylophorum YABE et SUGIYAMA ..... p. 167

2. Transverse section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Ohkubo, Ohta-machi, Mine-gun, Yamaguchi Prefecture. Reg. no.: 65033 of the Inst. Geol. Palaeont., Tohoku Univ. Coll.: M. KAWANO.

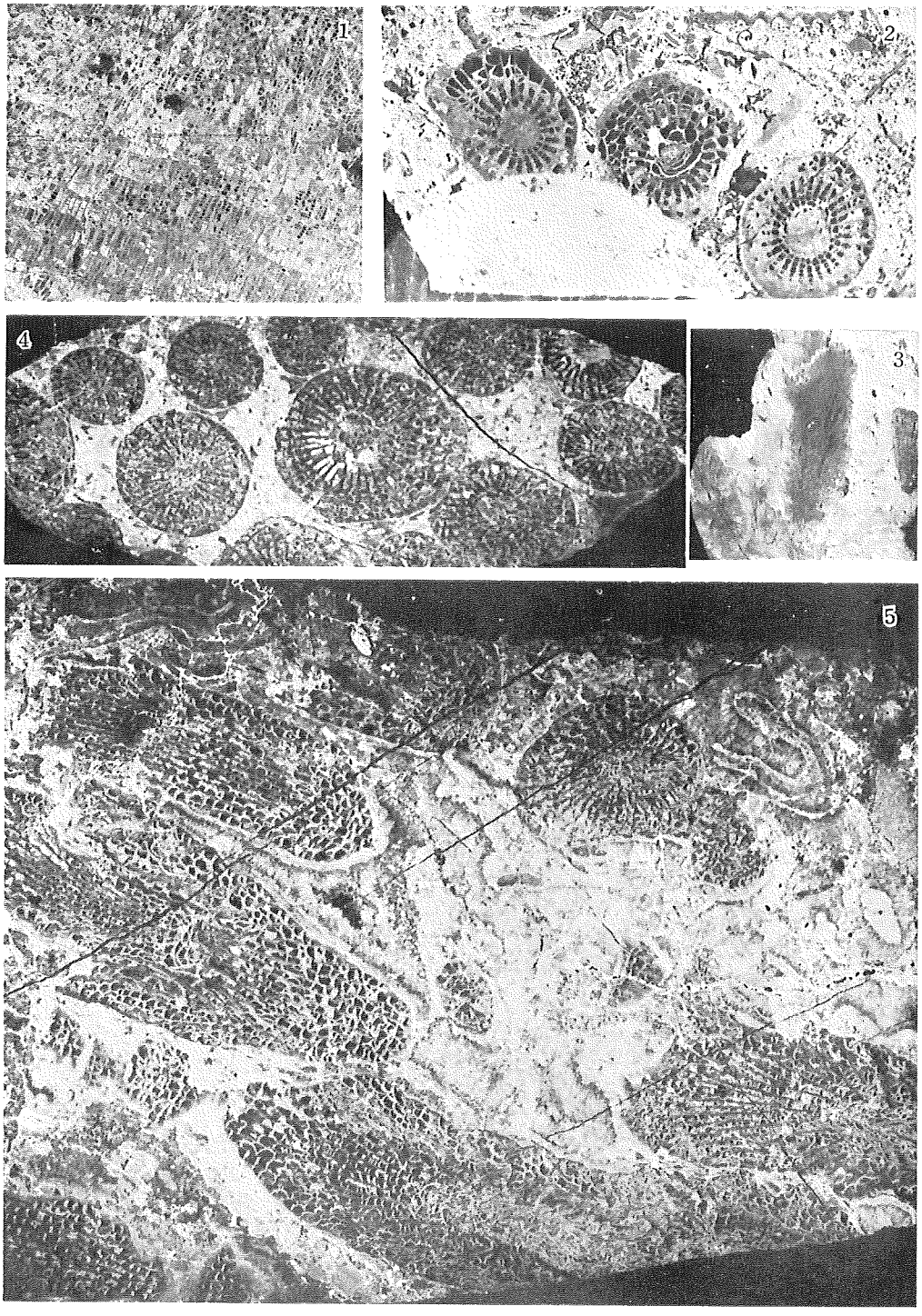
Waagenophyllum indicum var. *usuginuensis* MINATO, var. nov. ..... p. 103

3. Longitudinal section. (×2.0)
Hor.: *Yabeina* zone. Loc.: Kattisawa, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15556. Coll.: M. MINATO.

Corwenia? omiensis (YABE et HAYASAKA) ..... p. 129

4. Transverse section. (×3.0)
Hor.: *Dibunophyllum* zone. Loc.: Omi, Kubiki-gun, Niigata Prefecture. Specimen now stored at Inst. Geol. and Palaeont, Tohoku Univ.
Coll.: I. HAYASAKA

5. Oblique section. (×3.0)
Hor. and loc.: same as the preceding fig.



MINATO and KUMANO *phot.*

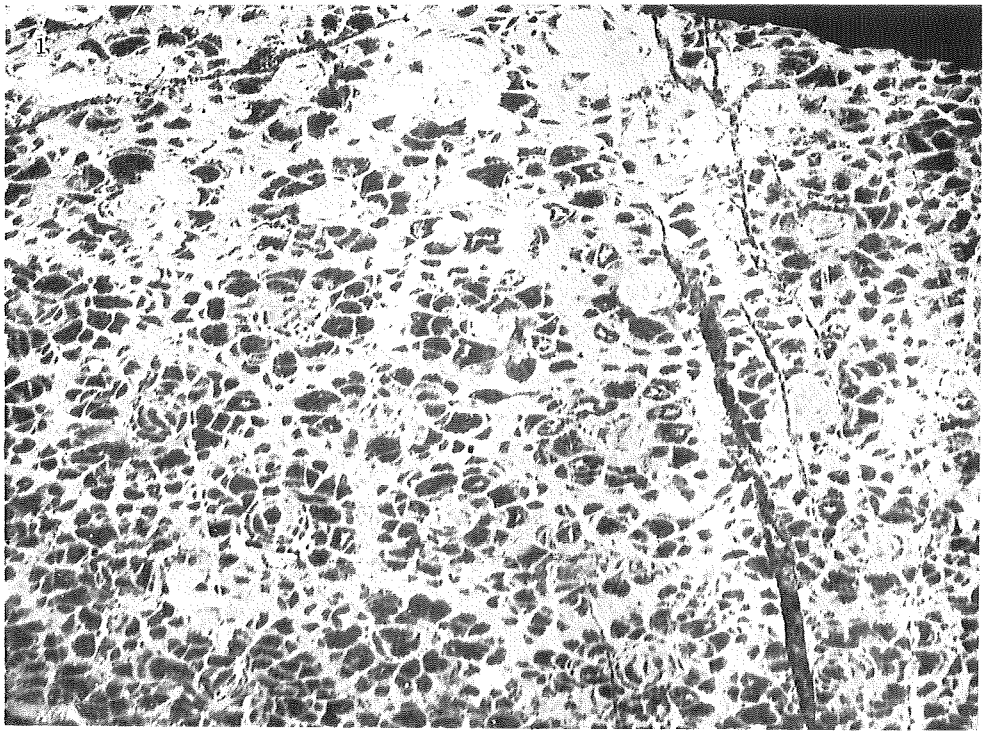
Plate 20

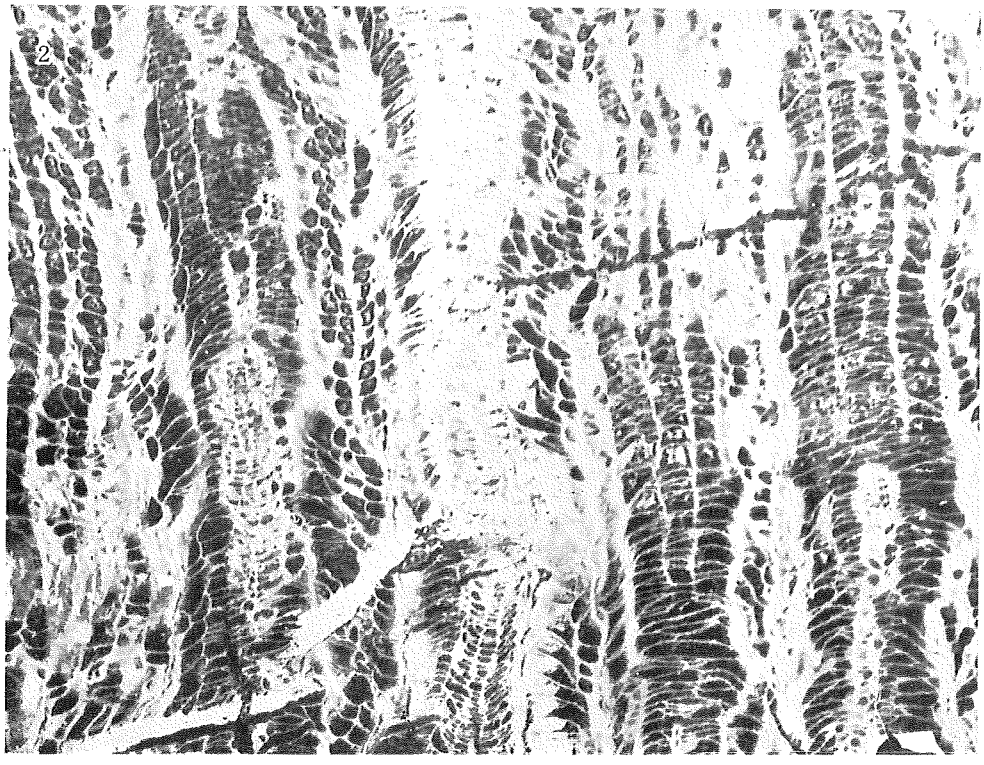
Plate 20

Wentzelella iwaizakiensis YABE et MINATO ..... p. 110

Fig. 1. Transverse section. (×ca 5.0)
Hor.: *Yabeina* zone. Loc.: Iwaizaki, Hajikami-mura, Motoyoshi-gun, Miyagi Prefecture. Specimen now stored at Inst. Geol. and Palaeont., Tohoku Univ. Coll.: S. MABUTI

2. Longitudinal section. (×ca 5.0)
Hor., loc., and coll.: same at the preceding fig.





MINATO and KUMANO *phot.*

Plate 21

Plate 21

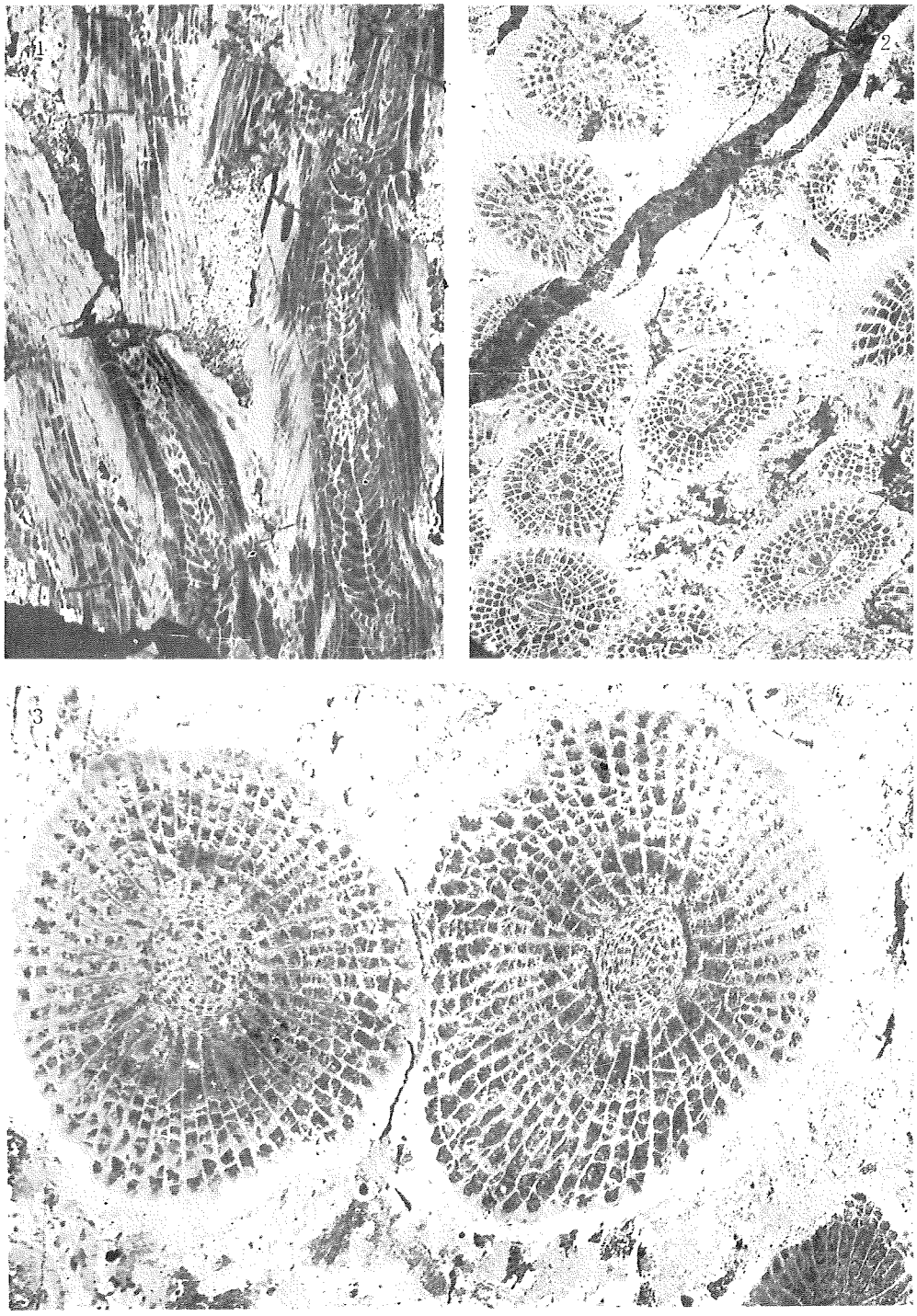
Waagenophyllum indicum (WAAGEN et WENTZEL) ..... p. 102

Fig. 1. Longitudinal section. (×5.0)
Hor.: *Yabeina* zone. Loc.: Iwaizaki, Hajikami-mura, Motoyoshi-gun, Miyagi Prefecture. Reg. no.: 15523. Coll.: M. MINATO.

2. Transverse section. (×5.0)
Hor., loc. and coll.: same as the preceding. Reg. no.: 15222.

Waagenophyllum polyseptata MINATO, sp. nov. ..... p. 105

3. Transverse section. (×5.0)
Hor.: *Neoschwagerina* zone. Loc.: Tsukitate, Tsukitate-mura, Motoyoshi-gun, Miyagi Prefecture. Coll.: M. MINATO.
Reg. no.: 15525.



MINATO and KUMANO *phot.*

Plate 22

Plate 22

Leonardophyllum sp. indet. ..... p. 127

Fig. 1. Transverse section. (×4.0)
Hor.: *Yabeina*? *Neoschwagerina*? zone. Loc.: Chichi-iwa, Yamaguchi City, Yamaguchi Prefecture. Reg. no.: 1569-5. Coll.: E. TAKAHASHI.

2. Transverse section. (×4.0)
Hor., loc. and coll.: same as the preceding.

Huangia hasimotoi (NAGAO et MINATO) ..... p. 123

3. Transverse section. (×2.0)
Hor.: *Pseudoschwagerina* zone. Loc.: Limestone quarry near Tosayama, about 14km north of Kochi city, Kochi Prefecture.
Coll.: K. HASHIMOTO.

4. Longitudinal section. (×2.0)
Hor., loc. and Coll.: same as the preceding fig.

6. Longitudinal section. (×2.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 15237.

Stylidophyllum ? sp. indet. ..... p. 131

5. Transverse section. (×2.0)
Hor.: *Fusulinella* zone. Loc.: Omi, Kubiki-gun, Niigata Prefecture.
Specimen now deposited at Inst. Geol. Tokyo Univ. Coll.: G. IIZAKA.

10. Transverse section. (×2.0)
Hor., loc. and coll.: same as the preceding. This specimen is also stored at the same institute above mentioned.

Pseudodorlodotia kakimii MINATO, gen. et sp. nov. ..... p. 90

7. Transverse section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Upper course of Higuchisawa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 17845. Coll.: T. HASHIMOTO.

Wentzelella subtimorica HUANG ..... p. 113

8. Transverse section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Shiraiwa, Omine-mura, Yamaguichi Prefecture.
Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

Huangia ? sp. indet. ..... p. 125

9. Transverse section. (×2.0)
Hor.: *Pseudoschwagerina* zone. Loc.: Terao, Doi-mura, Higashiuwa-gun, Ehime Prefecture. Reg. no.: 17817. Coll.: K. ICHIKAWA.

Nagatophyllum satoi OZAWA. ..... p. 138

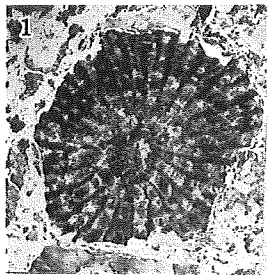
11. Transverse section. (×3.0)
Hor.: *Fusulinella* zone. Loc.: Tobinosu, Ohta-machi, Uine-gun, Yamaguchi Prefecture. This specimen now stored at Inst. Geol. Tokyo Univ. Coll.: T. OZAWA.

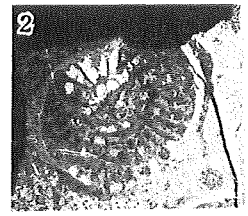
Taisyakuphyllum rostfer MINATO, gen. et sp. nov. ..... p. 143

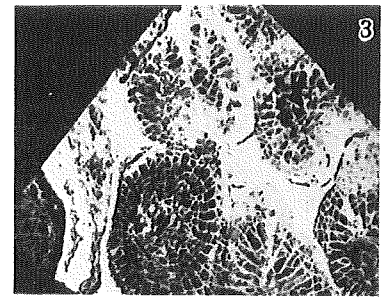
12. Transverse section. (×3.0)
Hor.: *Fusulinella* zone. Loc.: Ofukudai, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA

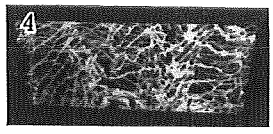
Lophophyllidium sp. *d* ..... p. 155

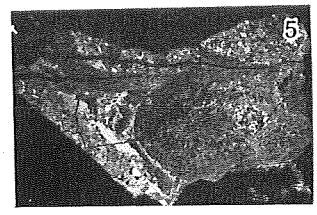
13. Transverse section. (ca ×5.0)
Hor.: *Pseudoschwagerina* zone.
Loc.: Komata, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 17847. Coll.: M. MINATO.

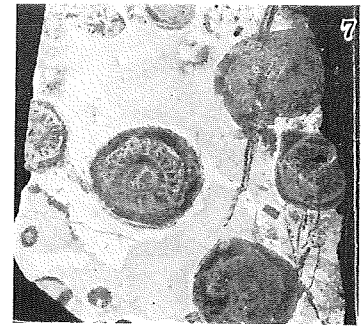


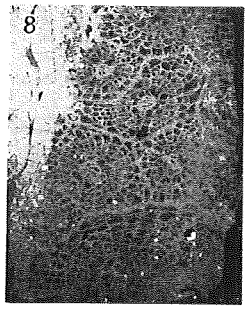




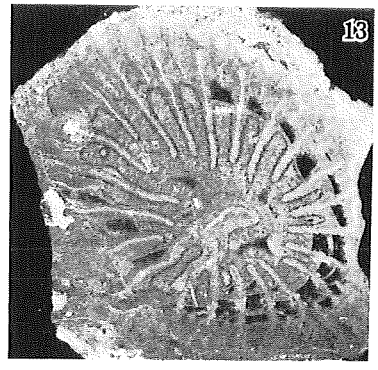


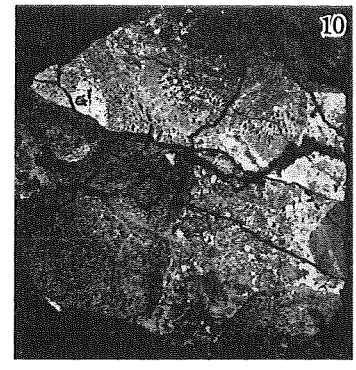


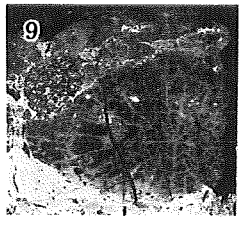


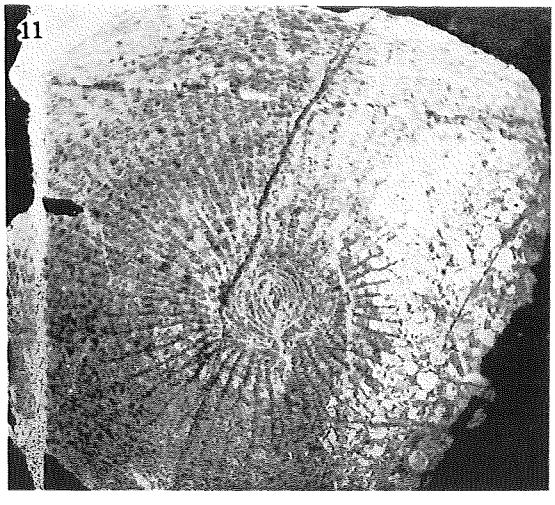


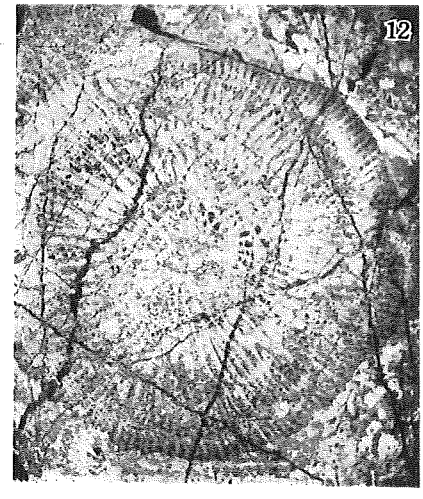












MINATO and KUMANO *phot.*

Plate 23

Plate 23

Lonsdaleoides toriyamai MINATO, sp. nov. ..... p. 165

Fig. 1. Transverse section of one corallite. (×4.0)
Hor.: *Fusulinella* zone. Loc.: Kyowa-mura, Yamaguchi Prefecture. Reg. no.: 17809. Coll.: R. TORIYAMA.

2. Transverse section. (×4.0)
Hor., loc., reg. no. and coll.: same as the preceding fig.

3. Transverse section of one corallite in the mature stage. (×4.0)
Hor., loc., reg. no. and coll.: same as the fig. 1.

Lonsdaleoides enormis (OZAWA) ..... p. 164

4. Transverse section. (×4.0)
Hor.: *Fusulinella* zone. Loc.: Tobinosu, Ohta-machi, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

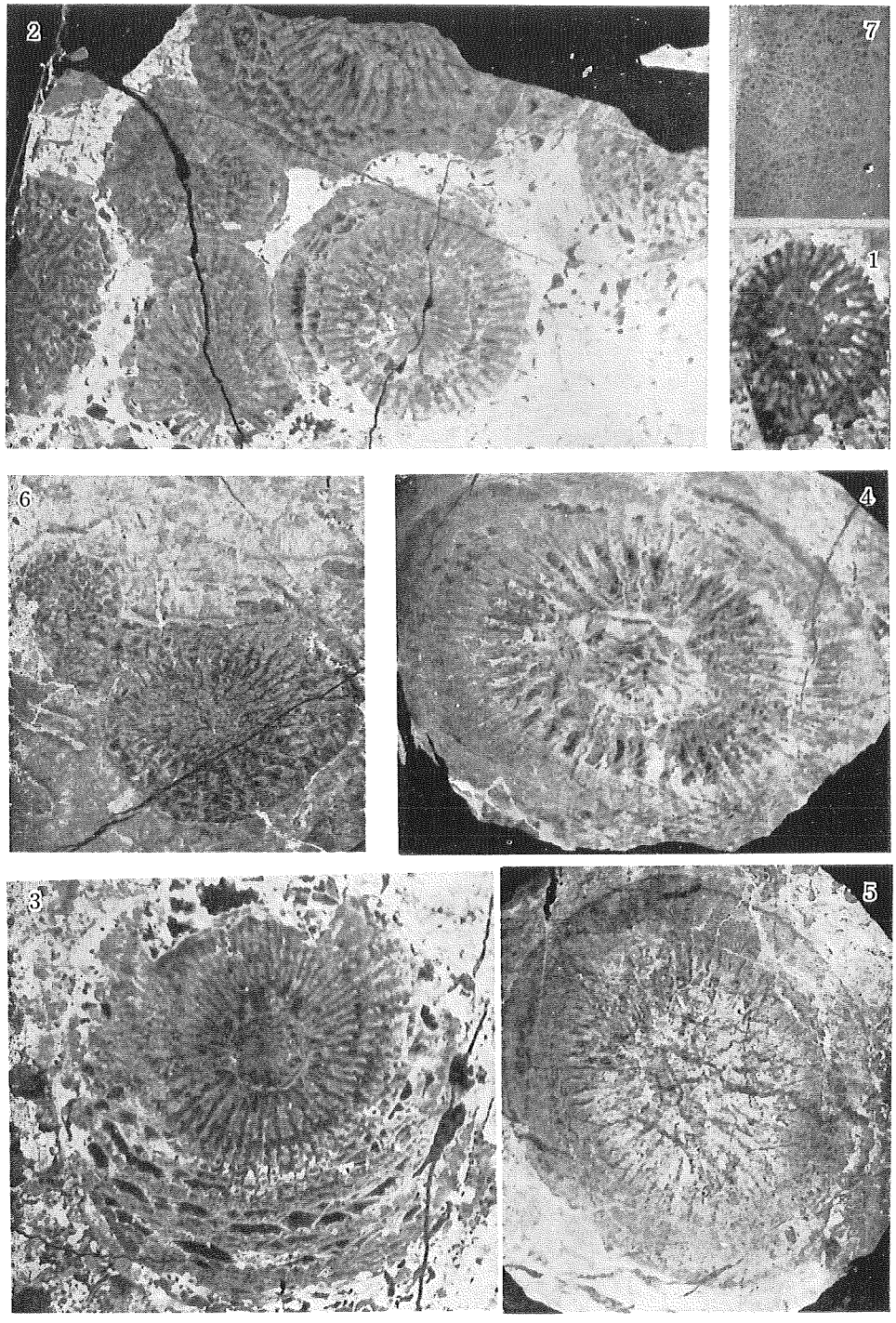
5. Transverse section. (×4.0)
Hor., loc. and coll.: same as the preceding fig.

Corwenia ? omiensis (YABE et HAYASAKA) ..... p. 129

6. Transverse section. (×3.0)
Hor.: *Dibunophyllum* zone. Loc.: Omi, Kubiki-gun, Niigata Prefecture. Specimen now stored at Inst. Geol. and Palaeont., Tohoku Univ. Coll.: I. HAYASAKA.

Wentzelella subtimorica HUANG ..... p. 113

7. Transverse section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Shiraiwa, Omine-mura, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.



MINATO and KUMANO *phot.*

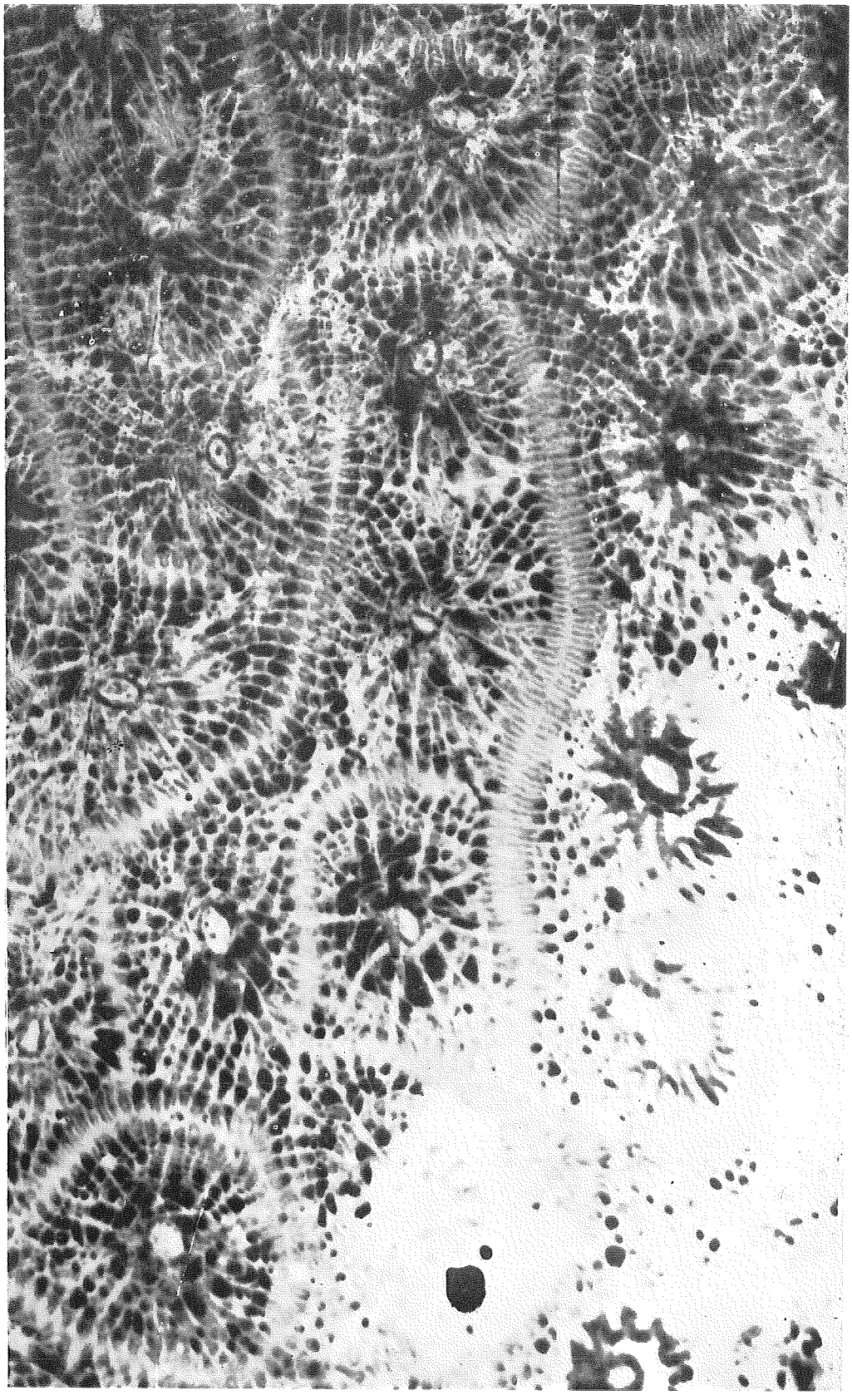
Plate 24

Plate 24

Wentzelloides maiyaensis YABE et MINATO ..... p. 114

Transverse section (ca ×9.0)

Hor.: *Yabeina* zone. Loc.: Yamazaki, Maiya-machi, Toyoma-gun, Miyagi Prefecture. Reg. no.: 15682. Coll.: M. MINATO.



MINATO and KUMANO *phot.*

Plate 25

Plate 25

"Lonsdaleia" katoi OZAWA ..... p. 128

Fig. 1. Transverse section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Shiraiwa, Omine-mura, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

Wentzelella subtimorica HUANG ..... p. 113

2. Longitudinal section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Serida, Beppu (Kyowa)-mura, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

Geyerophyllum hunabuseum MINATO, sp. nov. ..... p. 158

3. Transverse section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Funbuse (Hunabuse), Gifu Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: G. IIZAKA.

Taisyakuphyllum rostfer MINATO, gen. et sp. nov. ..... p. 143

4. Longitudinal section. (×3.0)
Hor.: *Fusulinella* zone. Loc.: Ofukudai. Yamaguchi Prefecture. Specimen new stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

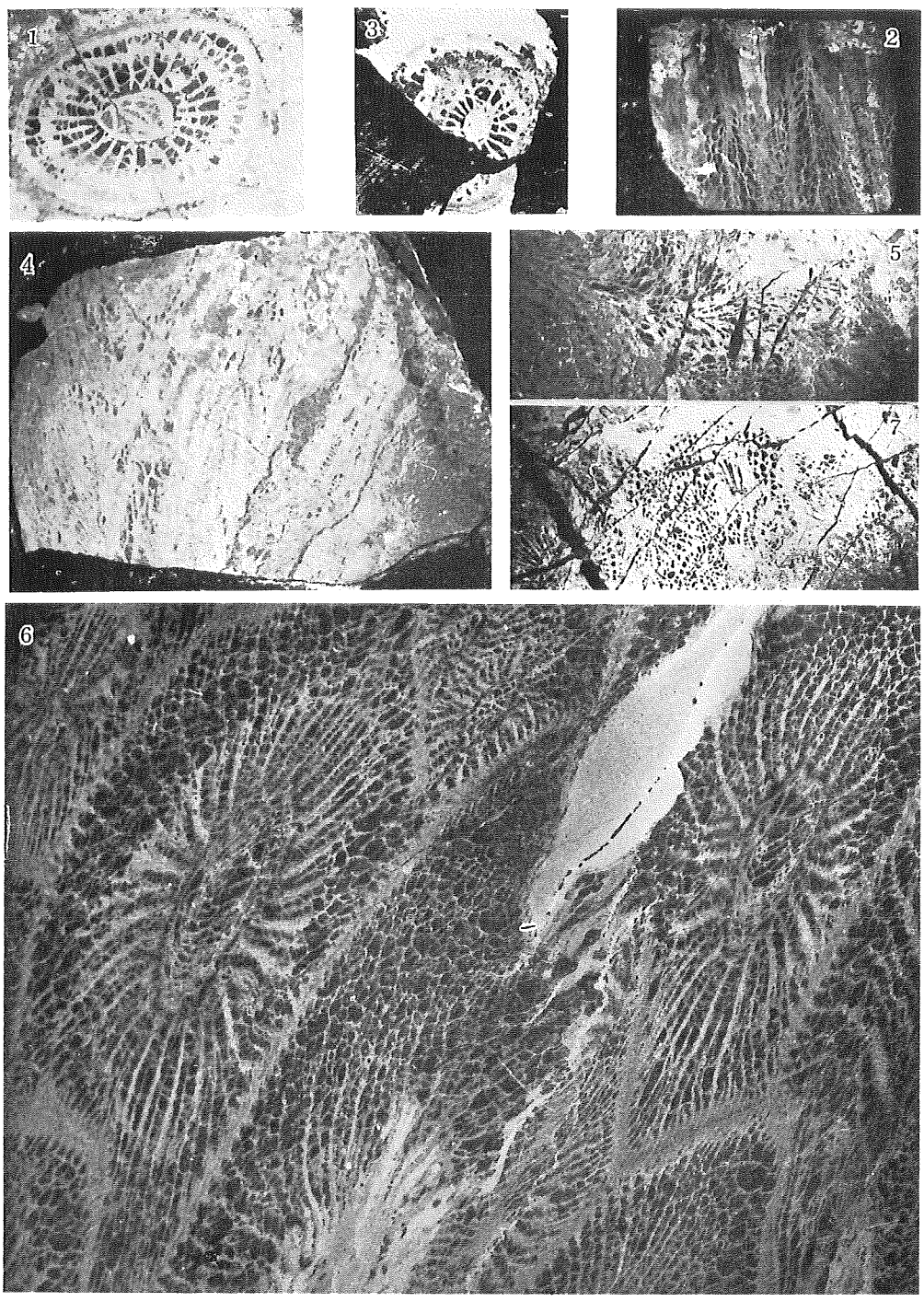
Wentzelella ozawai MINATO, sp. nov. ..... p. 110

5. Oblique section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Sibukura, Omine-mura, Yamaguchi Prefecture. Specimen now stored at the Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

7. Transverse section. (×3.0)
Hor., loc. and coll.: same as the preceding fig.

Wentzelella kitakamiensis YABE et MINATO ..... p. 111

6. Transverse section. (×5.0)
Hor.: *Yabeina* zone. Loc.: Kattisawa, Setami-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15235. Coll.: M. MINATO.



MINATO and KUMANO *phot.*

Plate 26

Plate 26

Akiyosiphyllum stylophorum YABE et SUGIYAMA ..... p. 167

Fig. 1. Longitudinal section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Ohkubo, Ohta-machi, Mine-gun, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. and Palaeont. Tohoku Univ. Coll.: M. KAWANO.

Waagenophyllum indicum (WAAGEN et WENTZEL) ..... p. 102

2. Transverse section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Iwaizaki, Hajikami-mura, Motoyoshi-gun, Miyagi Prefecture. Reg. no.: 15522. Coll.: M. MINATO.

4. Transvers section. (×3.0)
Hor., loc., reg. no. and coll.: same as the preceding fig.

5. Transversee section. (×3.0)
Hor., loc., reg. no. and coll.: same as the fig. 4.

6. Longitudial section. (×3.0)
Hor.: Yabeina zone. Loc.: Mimikirai, Sakawa-machi, Kochi Prefecture. Reg. no.: 41314 of Inst. Geol. and Palaeont., Tohoku Univ. Coll.: unknown.

8. Longitudinal section. (×3.0)
Hor., loc., reg. no. and coll.: same as fig. 5.

Wentzelella subtimorica HUANG ..... p. 113

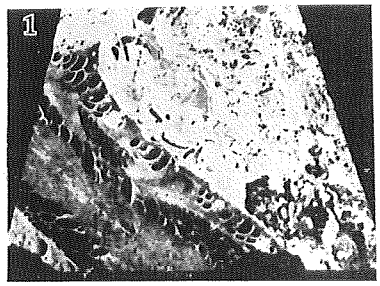
3. Transverse section. (×3.0)
Hor.: *Yabeina* zone. Loc.: Serida, Kyowa-mura, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

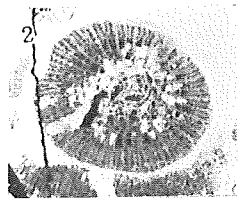
Lophophyllidium suetomii MINATO, sp. nov. ..... p. 151

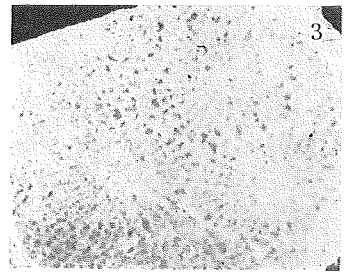
7. Transverse section. (×4.5)
Hor.: *Pseudoschwagerina* zone, especially it early stage.
Loc.: Kawaguchi, Setamai-machi, Kesen-gun, Iwate Prefecture.
Reg. no.: 17399. Coll.: H. SUETOMI.
Note: The specimen, here treated, shows the marginal part of septa to be quite translucent in thin section, as one may observe in this photograph, and accordingly all those septa of this sepecimen seem apparently to be thinning distally, however they are, in fact, rhopaloid, as is shown in text-fig.

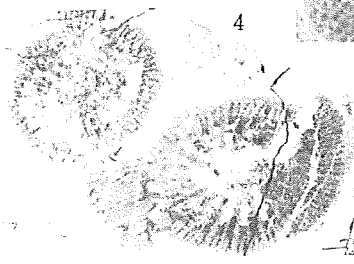
Wentzetella sekii MINATO, sp. nov. ..... p. 108

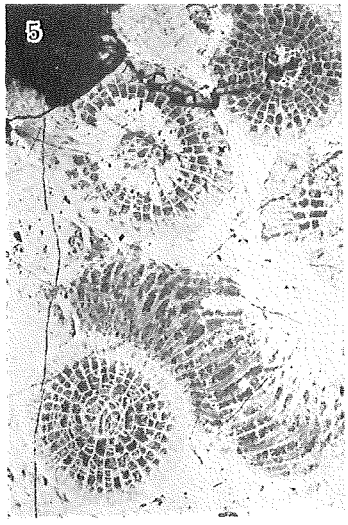
9. Transverse section. (×3.0)
Hor.: *Parafusulina* zone. Loc.: Oishi-zawa, Iwate-mura, Fuwa-gun, Gifu Prefecture. Specimen now stored at Inst. Geol. and Palaeont., Tohoku Univ. Coll.: T. SEKI.

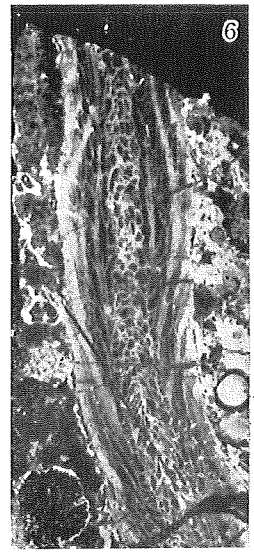

1

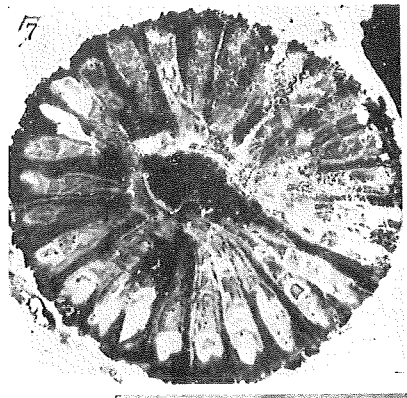

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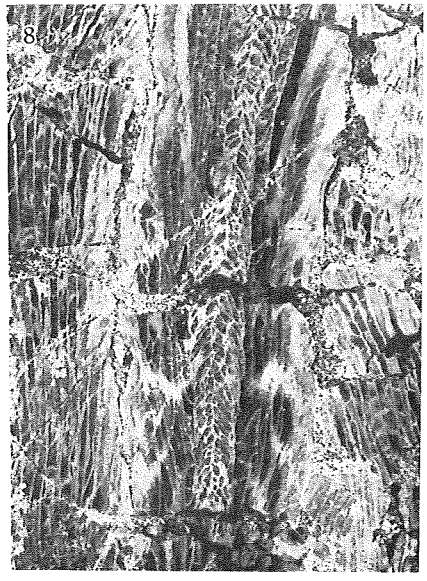

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MINATO and KUMANO *phot.*

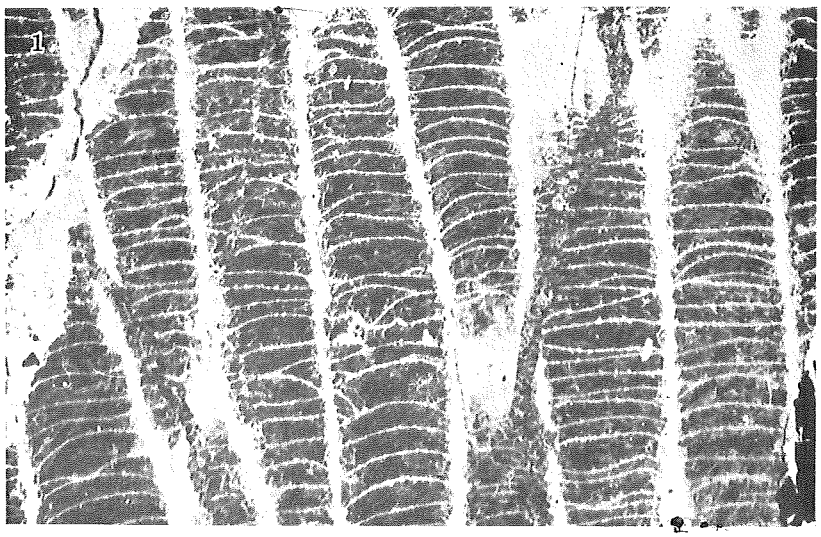
Plate 27

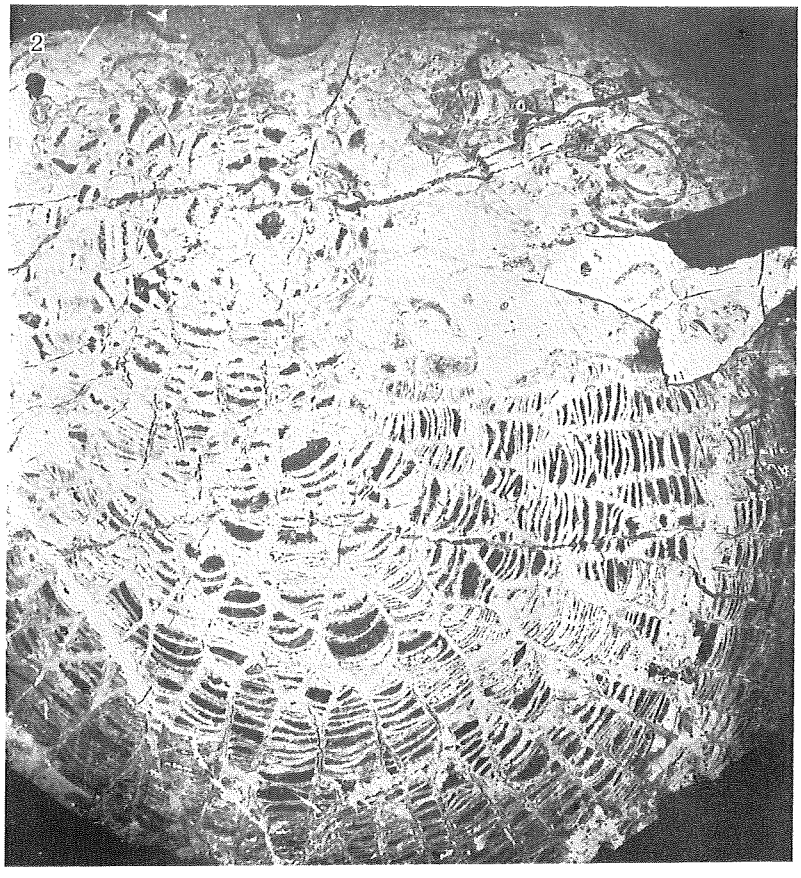
Plate 27

Michelinia (*Protomichelinia*) *multitabulata* (YABE et HAYASAKA) ..... p. 182

Fig. 1. Longitudinal section. (ca ×5.0)
Hor.: *Parafusulina* zone. Loc.: Tsukitate, Motoyoshi-gun, Miyagi Prefecture. Reg. no.: 15433. Coll.: M. MINATO.

2. Transverse section. (ca×2.0)
Hor.: *Parafusulina* zone. Loc.: East of Maiya-machi, Tome-gun, Miyagi Prefecture. Reg. no.: 15701. Coll.: M. MINATO.





MINATO and KUMANO *phot.*

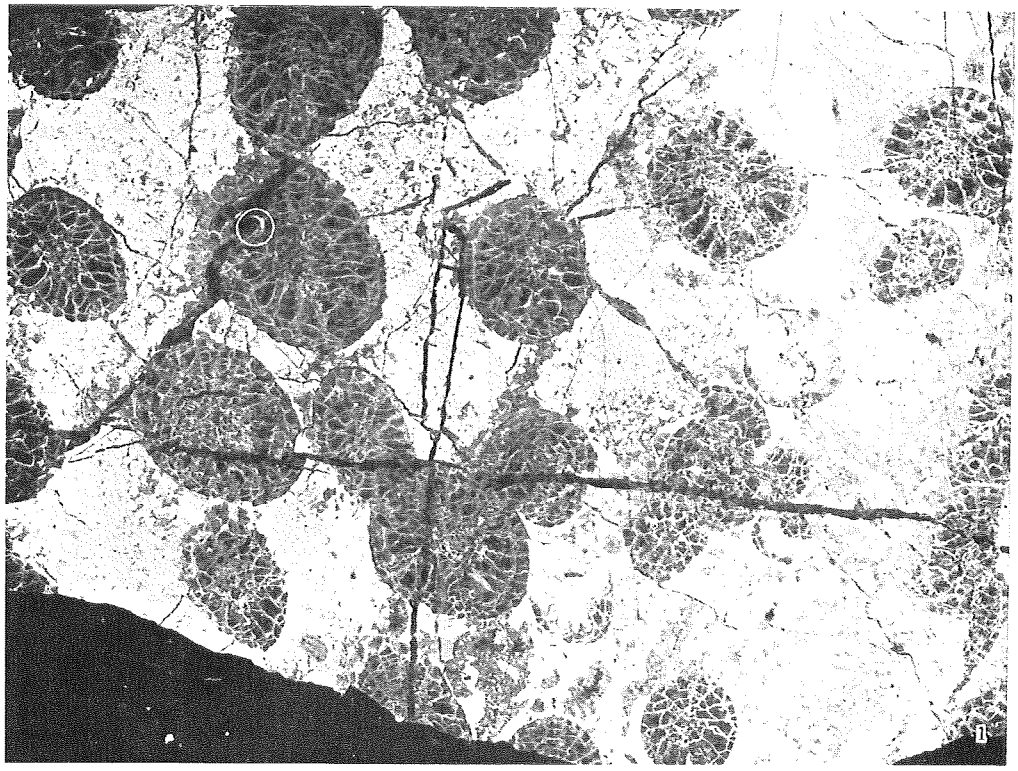
Plate 28

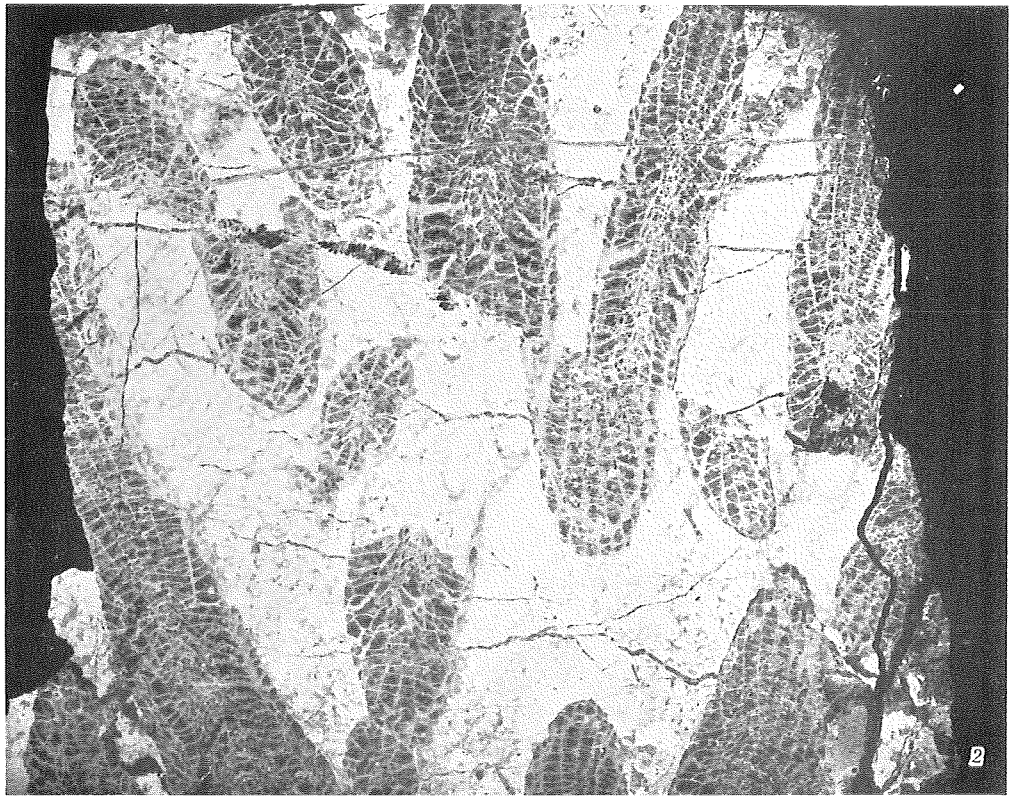
Plate 28

Yatsengia ibukiensis MINATO, sp. nov. ..... p. 118

Fig. 1. Transverse section. (×3.0)
Hor.: *Parafusulina* zone. Loc.: North of Yataka, Suisyo-mura, Gifu Prefecture. Specimen now stored at Inst. Geol. and Palaeont., Tohoku Univ. Coll.: T. SEKI.

2. Longitudinal section. (×3.0)
Hor., loc. and coll.: same as the preceding fig. Specimen is also stored at the same institute.





MINATO and KUMANO *phot.*

Plate 29

Plate 29

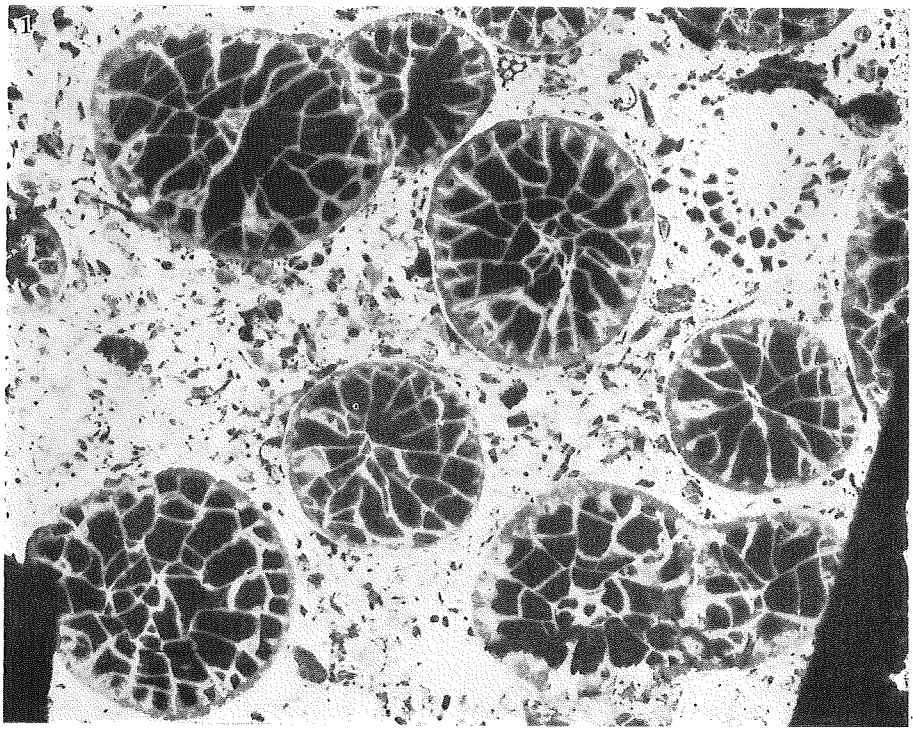
Yatsengia kiangsuensis YOH var. *mabutii* MINATO, var. nov..... p. 117

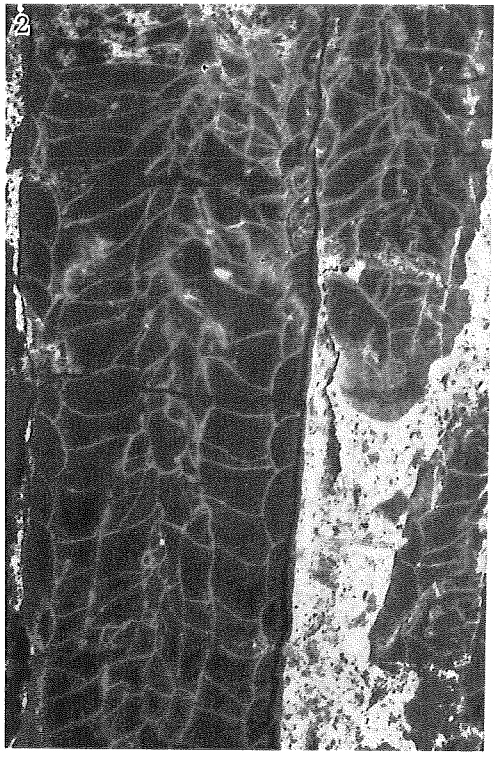
Fig. 1. Transverse section. (×8.0)
Hor.. *Yabeina* zone. Loc.: Iwaizakim Kaijo-mura, Motoyoshi-gun, Miyagi Prefecture. Reg. no.: 15181. Coll.: M. MINATO.

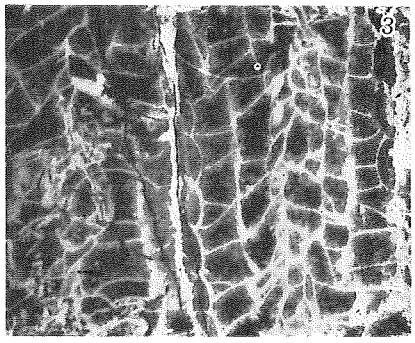
2. Longitudinal section. (×8.0)
Hor., loc., and coll.: same as the preceding fig. Reg. no.: 15177.

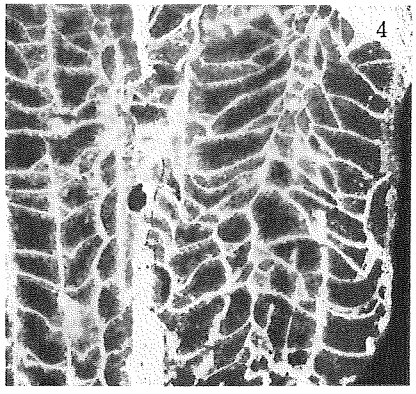
3. Longitudinal section. (×8.0)
Hor., loc., and coll.: same as fig. 1.

4. Longitudinal section. (×8.0)
Hor., loc., and coll.: same as fig. 1. Reg. no.: 15178.









MINATO and KUMANO *phot.*

Plate 30

Plate 30

Amygdalophyllum naosoidea MINATO ..... p. 145

Fig. 1. Longitudinal section. (ca × 3.0)
Hor.: *Fusulinella* zone. Loc.: Ohkubo, Ohta-machi, Mine-gun, Yamaguchi Prefectore. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

2. Transverse section. (ca × 3.0)
Hor., loc. and coll.: same as the precding fig.

Akiyosiphyllum stylophorum YABE et SUGIYAMA ..... p. 167

3. Transverse section. (ca × 3.0)
Hor.: *Yabeina* zone. Loc.: Nukata, Shimoyokuno-mura, Amata-gun, Kyoto Prefecture. Reg. no.: 65034. of Inst. Geol. and Palaeont., Tohoku Univ. Coll.: unknown.

Waagenophyllum akagoensis (OZAWA) ..... p. 104

4. Transverse section. (ca × 3.0)
Hor.: *Yabeina* zone. Loc.: Kaerimizu, Yamaguchi Prefecture.
Coll.: Unknown.

Lonsdaleiastraea nipponica MINATO, sp. now. ..... p. 134

5. Transverse section (ca × 3.0)
Hor.: *Yabeina* zone. Loc.: Kanoide, Kyowa-mura, Yamaguchi Prefecture. Reg. no.: 276 of the Inst. Geol. Kyushu Univ. Coll.: R. TORIYAMA.

Wentzelella subtimorica (HUANG) ..... p. 113

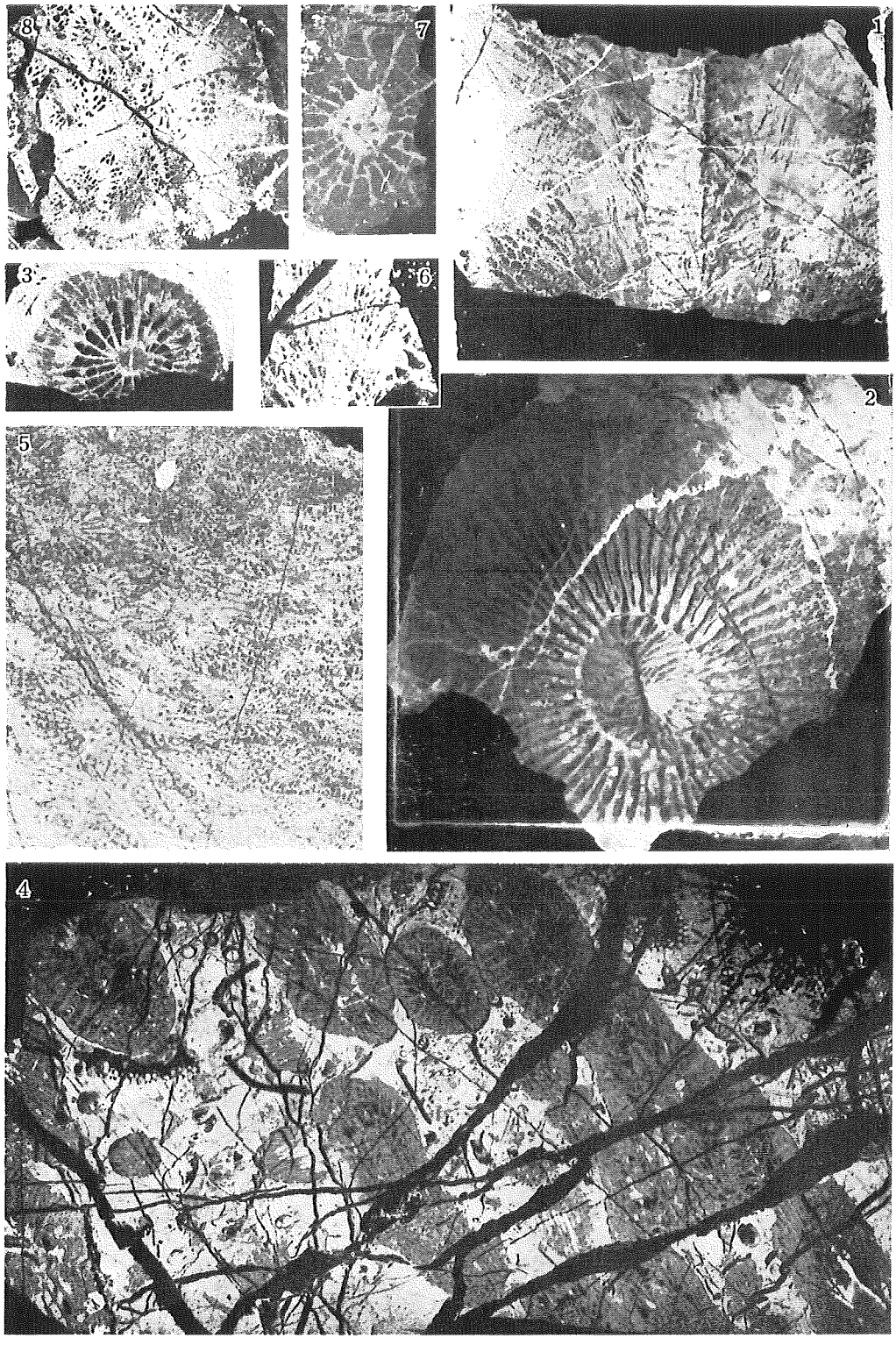
6. Longitudinal section. (ca × 3.0)
Hor.: *Yabena* zone. Loc.: Serida, Kyowa-mura, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

Geyerophyllum hunabuseum MINATO, sp. nov. ..... p. 158

7. Transverse section (ca × 6 0)
Hor.: *Yabeina* zone. Loc.: Hunabuse (Funabuse), Gifu Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: G. IIZAKA.

Wentzelella ozawai MINATO, sp. nov. ..... p. 110

8. Transverse section. (ca × 3.0)
Hor.: *Yabeina* zone. Loc.: Shibukura, Omine-mura, Yamaguchi Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.



MINATO and KUMANO *phot.*

Plate 31

Plate 31

Waagenophyllum indicum var. *usuginuensis* MINATO, var. nov..... p. 103

Fig. 1. Transverse section. (×2.0)
Hor.: *Yabeina* zone. Loc.: Sanmai-yashiki, Maikawa-mura, Higashiiwai-gun, Iwate Prefecture. Reg. no.: 15552.
Coll.: M. MINATO.

Michelinia (*Protomichelinia*) *multitabulata* (YABE et HAYASAKA) ... . p. 182

2. Longitudiual section. (×2.0)
Hor.: *Parafusulina* zone. Loc.: Tsukitate, Motoyoshi-gun, Miyagi Prefecture. Reg. no.: 17846. Coll.: M. MINATO.

Kueichoupora setamaiensis MINATO, sp. nov. ..... p. 188

3. Transverse section. (×5.0)
Hor.: *Dibunophyllum* zone. Loc.: Inugasirayama, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15165. Coll.: M. MINATO.

5. Longitudinal section. (×5.0)
Hor.: Dibunophyllum zone. Loc. and Coll.: same as the preceding fig. Reg. no.: 15166.

6. Transverse section. (×5.0)
Hor., coll., reg. no. and loc.: same as fig. 3.

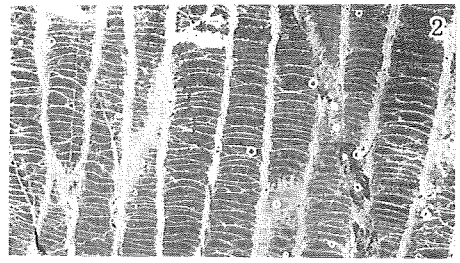
Iranophyllum permicum MINATO, sp. nov. ..... p. 115

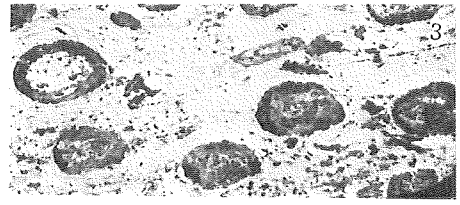
4. Transverse section. (×5.0)
Hor.: *Pseudoschwagerina* zone. Loc.: Sasizawa, Maiya-machi, Miyagi Prefecture. Reg. no.: 15519. Coll.: M. MINATO.

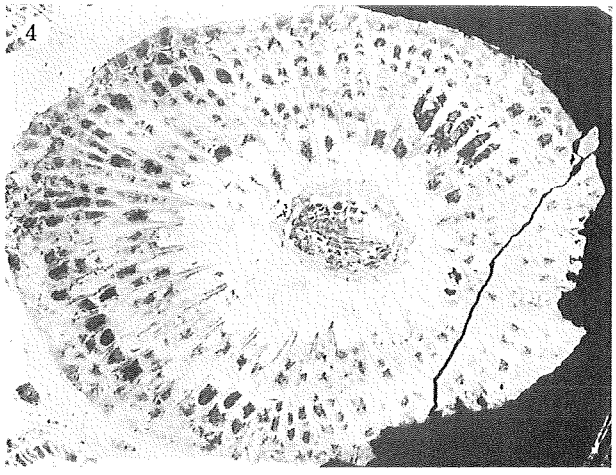
Siphonodendron pseudomartini (YABE et HAYASAKA) ..... p. 71

7. Longitudinal section. (×5.0)
Hor.: Dibunophyllum zone. Loc,: Yukisawa, Yokota-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 15693. Coll.: M. MINATO.



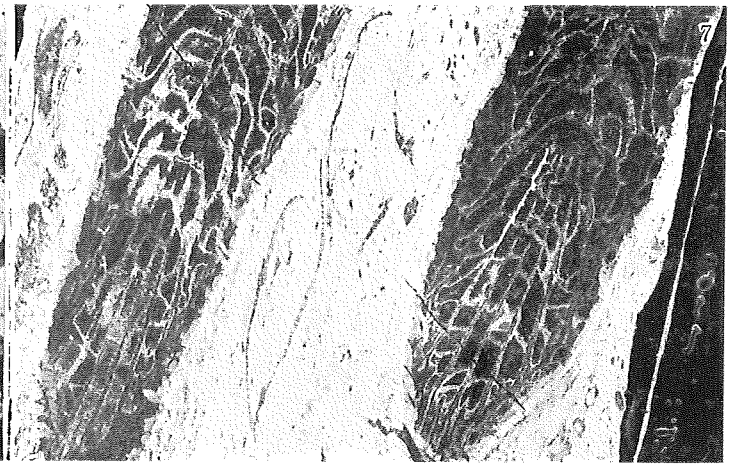












MINATO and KUMANO *phot.*

Plate 32

Plate 32

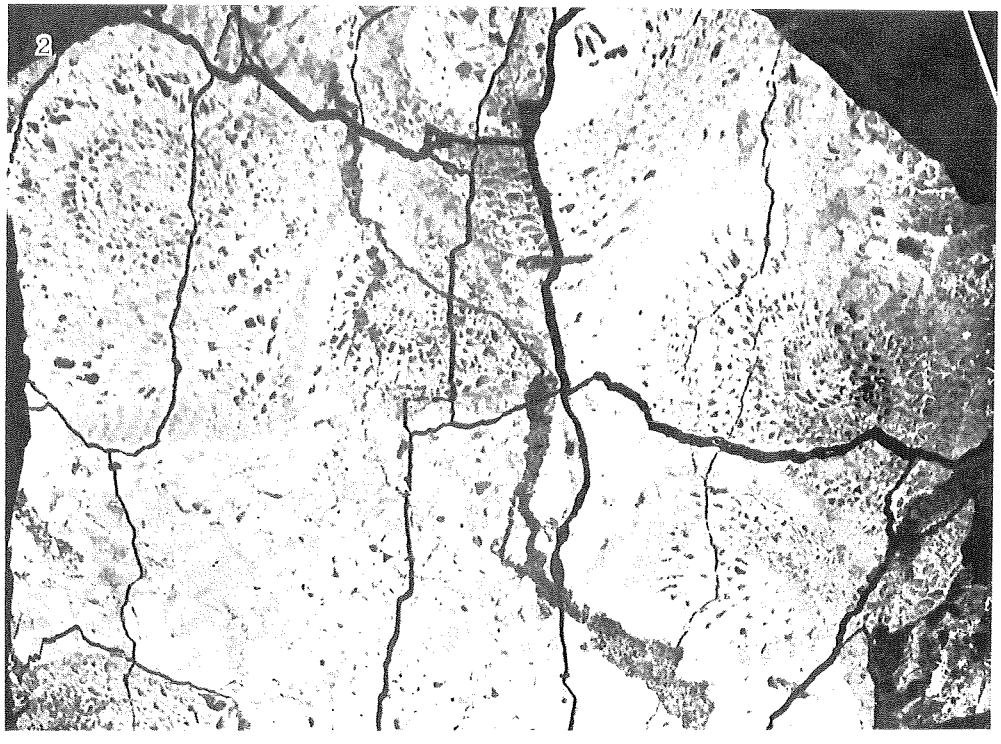
Stylidophyllum sikokuense MINATO nom. nov. ..... p. 132

Fig. 1. Transverse section. (×5.0)
Hor.: *Yabeina*? zone. Loc.: Koike, near Sakawa-machi, Kochi Prefecture. This specimen now deposited at the Inst. Geol. and Palaeont., Tohoku Univ. Coll.: unknown.

Stylidophyllum ? sp. indet. ..... p. 131

2. Transverse section. (×5.0)
Hor.: *Fusulinella* zone. Loc.: Omi, Niigata Prefecture. Reg. no.: 15685. Coll. unknown.





MINATO and KUMANO *phot.*

Plate 33

Plate 33

Waagenophyllum akageonsis (OZAWA) ..... p. 107

Fig. 1. Transverse section. (×3.0)
Hor.: Parafusulina zone. Loc.: Kaerimizu, Akago-mura, Yamaguchi Prefecture. Reg. no.: 7923 of the Inst. Geol. and Palaeont., Tohoku Univ. Coll.: H. YABE.

Khmeria problematica MANSYU ..... p. 178

2.
3.
4a.
4b.
All figures are reproduced from Yabe and Ma's paper.

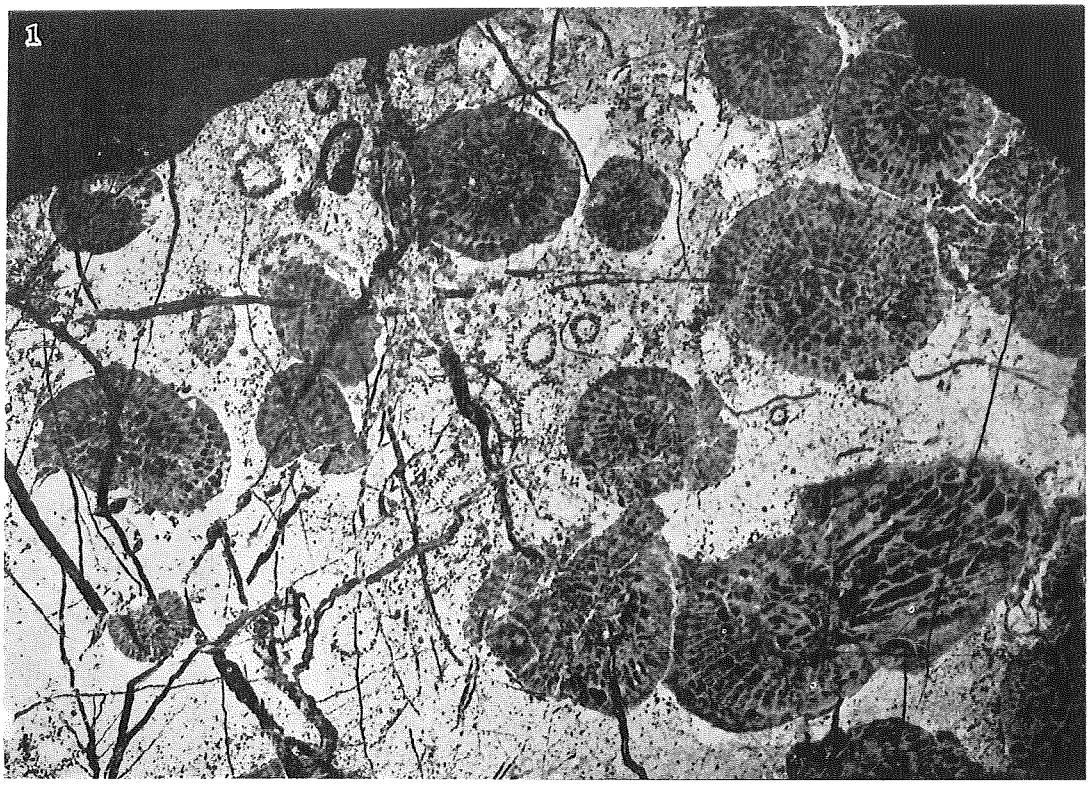
Hor.: Yabeina zone. Loc.: Yoshinaga (Yoshinori?), Omine-mura, Mine-gun, Yamaguchi Prefecture. Coll.: Y. OZAWA.

Clisaxophyllum ofukensis (OZAWA) ..... p. 136

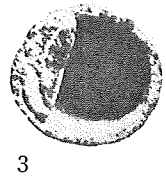
5. Transverse section. (×3.0)
Hor.: *Fusulinella* zone. Loc.: Ofukudai, Yamaguchi Prefecture. Specimen is now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.
6. Longitudinal section. (×3.0)
Hor., loc, and coll.: same as the preceding fig.
7. Transverse section. (×3.0)
Hor., loc., and coll.: same as the preceding fig.
8. Tangential section. (×3.0)
Hor., loc., and coll.: same as the preceding fig.

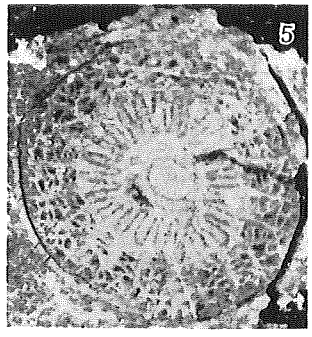
Clisaxophyllum awa MINATO ..... p. 137

9. Transverse section. (×3.0)
Hor.: Fusulinella zone. Loc.: Serida, Kyowa-mura, Yamaguchi Prefecture. Specimen is now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.



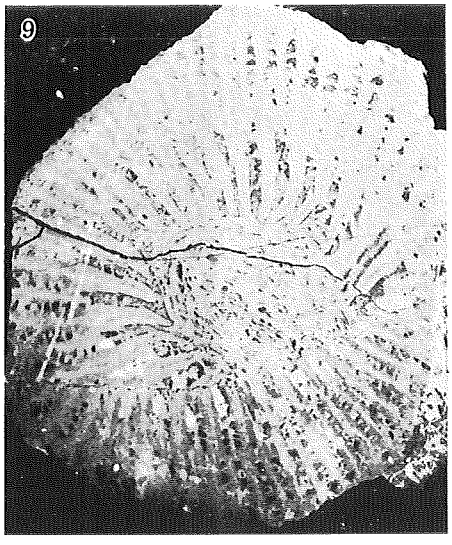


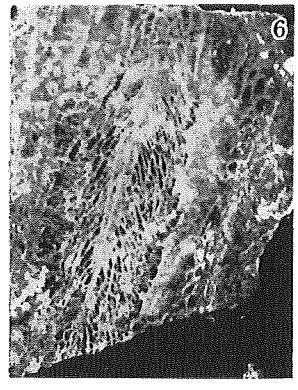


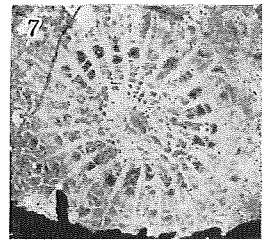


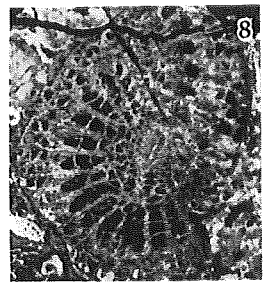












MINATO nad KUMANO *phot.*

Plate 34

Plate 34

Cystophora manchurica forma *kikkawai* (YABE et HAYASAKA)..... p. 92

Fig. 1. Transverse section. (ca × 2.0)
Hor.: Pseudoschwagerina zone. Loc.: Ichinotani, Fukuchi, Kamitakara-mura, Yoshiki-gun, Gifu Prefecture. Reg. no.: 16704. Coll.: M. MINATO.

4. Transverse section of columella. (ca × 2.0)
Hor., loc., coll. and Reg. no.: same as the preceding fig.

9. Longitudinal section. (ca × 2.0)
Hor., loc., reg. no. and coll.: same as fig. 1.

Lithostrotionella kitakamiensis MINATO, sp. nov..... p. 88

2. Transverse section. (× 2.0)
Hor.: *Fusulinella* zone. Loc.: Sakamotosawa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 17224. Coll.: M. MINATO.

3. Transverse section. (× 2.0)
Hor., loc., and coll.: same as the preceding. Reg. no.: 17609.

Amygdalophyllum sp. *a*..... p. 147

5. Transverse section of the columella, uniting with septal ends. (ca × 10)
Hor.: unknown. Probably pre-upper Visean. Loc.: Ohmori, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Coll.: unknown.

Lonsdaleiastraea nipponica MINATO, sp. nov. ..... p. 137

6. Transverse section. (× 5.0)
Hor.: *Yabeina* zone. Loc.: Shiraiwa, Omine-mura, Mine-gun, Yamaguchi Prefecture. Specimen is now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

Amygdalophyllum naosoidea MINATO ..... p. 145

7. Longitudinal section. (× 5.0)
Hor.: Fusulinella zone. Loc.: Ofukudai, Yamaguchi Prefecture. Specimen is now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

Taisyakuphyllum rostfer MINATO, gen. et sp. nov..... p. 143

8. Longitudinal section. (ca × 5.0)
Hor.: *Fusulinella* zone. Loc.: Ohkubo, Ohta-machi, Yamaguchi Prefecture, Specimen is now stored at Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

Orionastraea sp. ..... p. 92

10. Longitudinal section.
12. Transverse section.
These figures are reproduced from HAYASAKA's paper.
Hor.: *Dibunophyllum* zone. Loc.: Omi-mura, Niigata Prefecture. Coll.: I. HAYASAKA.

Lithostrotionella sp. indet. ..... p. 87

11. Transverse section. (× 2.0)
Hor.: Unknown. Probably pre-upper Viséan. Loc.: Unabata, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 17315. Coll.: M. MINATO.

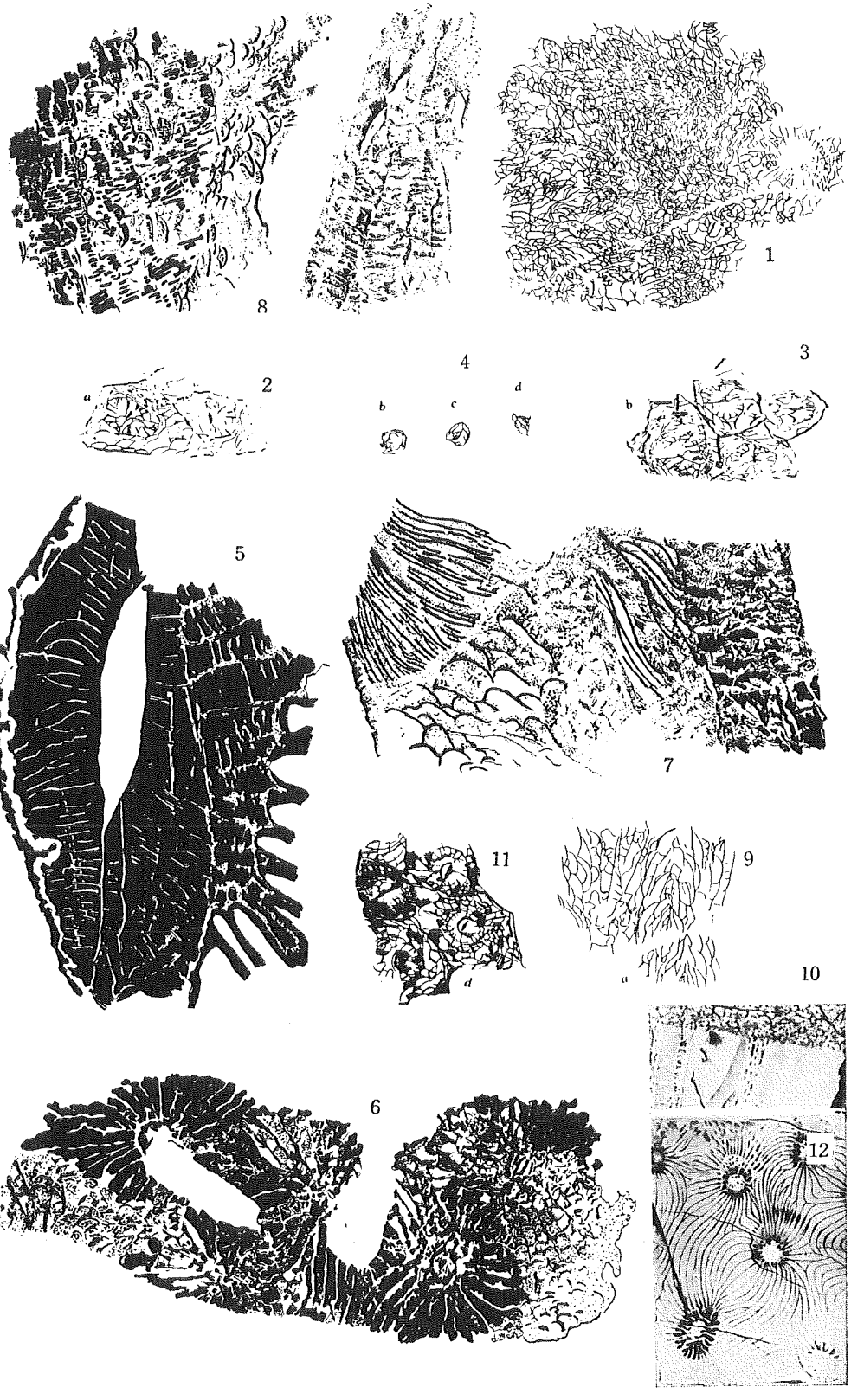

8
1
2
a
4
b
c
d
3
b
5
7
11
d
9
a
10
6
12

Plate 35

Plate 35

Lithostrotion somaense YABE et HAYASAKA ..... p. 77

Fig. 1. Transverse section. (×3.0)
Hor.: *Dibunophyllum* zone. Loc.: Omi, Nishi-kubiki-gun, Niigata Prefecture. Specimen now stored at Inst. Geol. and Palaeont., Tohoku Univ. Coll.: I. HAYASAKA.

4. Oblique section. (×3.0)
Hor., loc., and coll.: same as the preceding fig.

6. Tangential section. (×3.0)
Hor., loc., and coll.: same as the preceding fig.

Thysanophyllum aseptatum DOBROLYUBOVA ..... p. 87

2. Transverse section. (×2.0)
Hor.: *Fusulinella* zone. Loc.: Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16433. Coll.: M. MINATO.

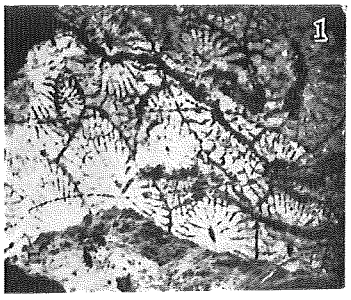
Amygdalophyllum setamaiensis YABE et MINATO ..... p. 147

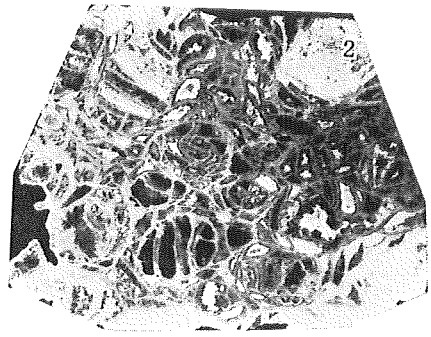
3. Longitudinal section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Takenohara, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15856. Coll.: M. MINATO.

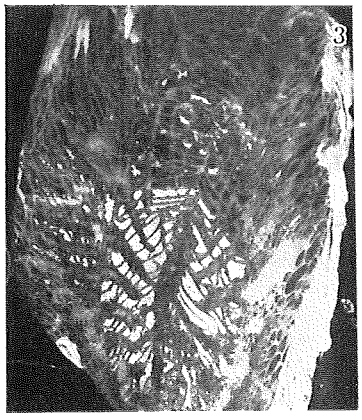
7. Transverse section. (×2.0)
Hor.: Dibunophyllum zone. Loc.: Takenohara, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15855. Coll.: M. MINATO.

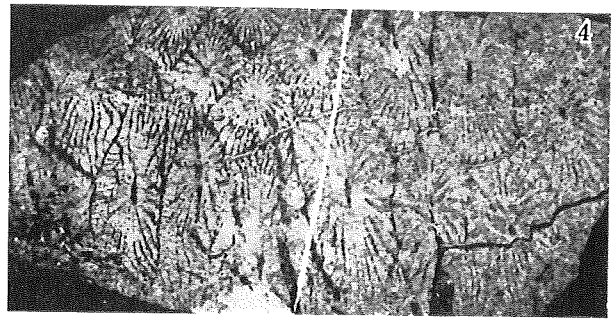
Amygdalophyllum sp. *a* ..... p. 147

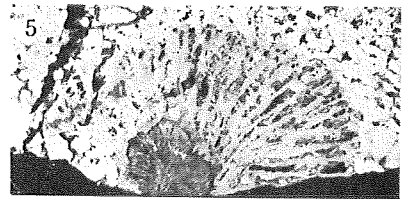
5. Transverse section. (ca×2.0)
Hor.: unknown. Loc.: Ohmori, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16412. Coll.: M. MINATO.

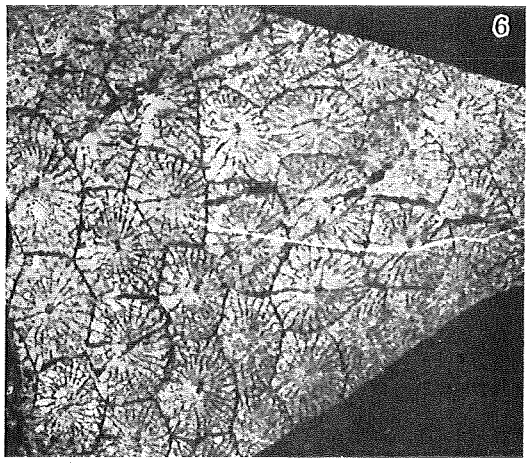


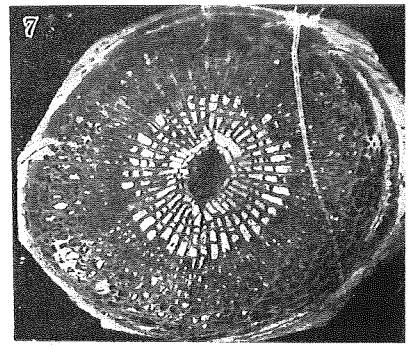












MINATO and KUMANO *phot.*

Plate 36

Plate 36

Lithostrotion hinozuchiense MINATO, sp. nov. ..... p. 78

Fig. 1. Transverse section, (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: Hinozuchi (Hinozuti), Shimoarisu-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16754. Coll.: M MINATO.

2. Oblique section. (×2.0)
Hor., loc. and coll.: same as the preceding fig. Reg. no.: 16755.

Amygdalophyllum sp. a ..... p. 147

3. Transverse section. (×2.0)
Hor.: unknown. Loc.: Ohmori, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16761. Coll.: M. MINATO.

7. Tangential section. (×2.0)
Hor., loc. and coll,: same as the preceding fig. Reg. no.: 16759.

Lonsdaleoides enormis (OZAWA) ..... p. 164

4. Transverse section.
This figure is reproduced from Ozawa's paper.
Hor.: *Fusulinella* zone. Loc.: Tobinosu, Ohta-machi, Yamaguchi Prefecture. Coll.: Y. OZAWA.

Stylidophyllum? sp. ..... p. 131

5. Transverse section. (×2 0)
Hor.: *Fusulinella* zone. Loc.: Omi, Niigata Prefecture. Reg. no.: 15681. Coll.: unknown.

Cystophora manchurica forma *kikkawai* (YABE et HAYASAKA) ..... p. 92

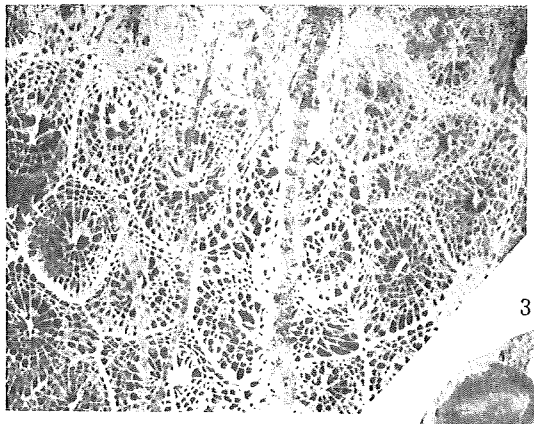
6. Transverse section. (×3.0)
Hor.: *Pseudoschwagerina* zone. Loc.: Ichinotani, Fukuchi (Fukuti), Kamitakara-mura, Yoshiki-gun, Gifu Prefecture. Reg. no.: 16704. Coll.: M. MINATO.

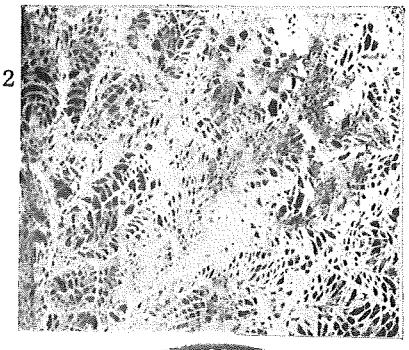
Clisaxophyllum awa MINATO ..... p. 137

8. Transverse section. (×2.0)
Hor.: *Fusulinella* zone. Loc.: Hakuundon, Taisyaku plateau, Hiroshima Prefecture. Specimen now stored at Inst. Geol. Tokyo Univ. of Education. Coll.: H. FUJIMOTO.

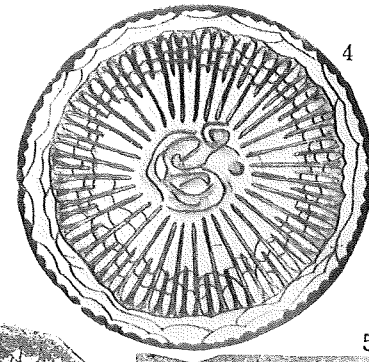
"*Lonsdaleia*" *katoi* OZAWA ..... p. 128

9. Transverse section. This figures is reproduced from Ozawa's paper.
Hor.: *Yabeina* zone. Loc.: Shiraiwa, Yamaguchi Prefecture. Coll.: Y. OZAWA.

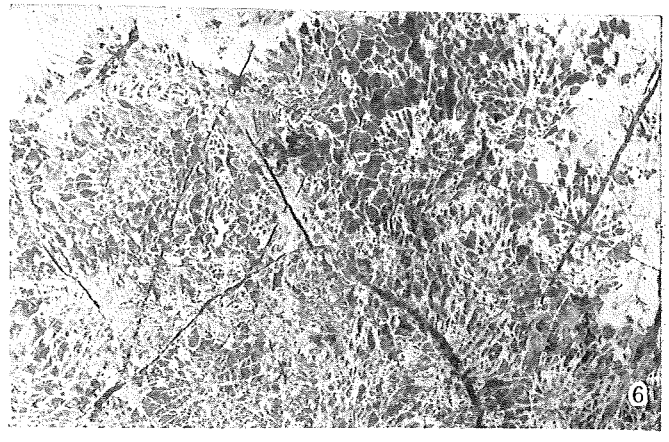

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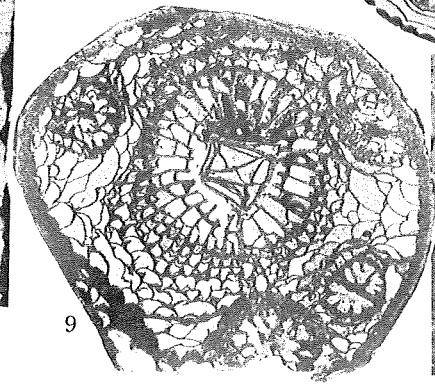

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MINATO and KUMANO *phot.*

Plate 37

Plate 37

Meniscophyllum longiseptata MINATO, sp. nov. ..... p. 68

Fig. 1. Transverse section. (×6.0)
Hor.: *Fusulinella*? zone. Loc.: Ohkubo, Ohta-machi, Mine-gun, Yamaguchi Prefecture. Specimen now stored at the Inst. Geol. and Palaeont., Tohoku Univ. Coll.: unknown.

Sochikineophyllum s-hasimotoi MINATO, sp. nov..... p. 67

2a–2c. Outer form. (ca × 1.0)
Hor.: *Yabeina*? zone. Loc.: Nokkoshi-saka, west of the town Takada-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 15879. Coll.: S. HASIMOTO.

2d. Transverse section. (×1.5)
Hor., loc., and coll.: same as the preceding figs. Reg. no.: 15879.

2e. Transverse section. (×1.5)
Hor., loc., reg. no. and coll.: same as the preceding fig.

Iranophyllum permicum MINATO, sp. nov. ..... p. 115

3. Transverse section, showing the part of the corallite, including the columella. (ca × 4.0)
Hor.: *Pseudoschwagerina* zone. Loc.: Sasizawa, Maiya-machi, Toyoma-gun, Miyagi Prefecture. Reg. no.: 15519. Coll.: M MINATO.

Clisaxophyllum awa MINATO ..... p. 137

4. Transverse section. (×3/4)
Hor.: Fusulinella zone. Loc.: Omi, Niigata Prefecture. Reg. no.: 15683. Coll.: unknown.

Akiyosiphyllum stylophorum YABE et HAYASAKA ..... p. 167

5a–5c. Transverse section of columella.
Hor.: *Yobeina* zone. Loc.: Ohkubo, Ohta-machi, Mine-gun, Yamaguchi Prefecture. Reg. no.: 65033 of the Inst. Geol. and Palaeont., Tohoku Univ. Coll.: M. KAWANO.

Waagenophyllum akasakaensis (YABE) ..... p. 104

6a–6e. Transverse section, showing the ontogenitic development of the corallites. (×5.0).
Hor.: *Yabeina* zone. Loc : Siraiwa, Omine-mura, Akiyoshi-dai, Yamaguchi Prefecture. Specimen now stored at the Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

7. Transverse section.
This figure is reproduced from the original fig. of YABE (1909).

Lophophyllidium sp. *c* ..... p. 154

8. Transverse section. (ca ×5.0)
Hor.: *Yabeina* zone.
Loc.: Hunabuse, Yamagata-gun, Gifu Prefecture. Coll.: G. IIZAKA.

Lithostrotionella sp. indet. ..... p. 87

8. Transverse section. (×2 0)
Hor.: unknown. Loc.: Unabata, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 17315. Coll.: M. MINATO.

Yatsengia kabayamaensis MINATO, sp. nov. ..... p. 120

10. Transxcrse section. (×5.0)
Hor.: *Parafusulina* zone. Loc.: Maiya, Tome-gun, Miyagi Prefecture. Coll.: M. MINATO.

Lophophyllidium sp. *a* ..... p. 153

11. Transverse section. (ca ×4.0)
Hor.: *Pseudoschwagerina* zone. Loc.: Kattisawa, Setamai-machi, Kesen-gun, Iwate Prefecture. Coll.: M. MINATO.

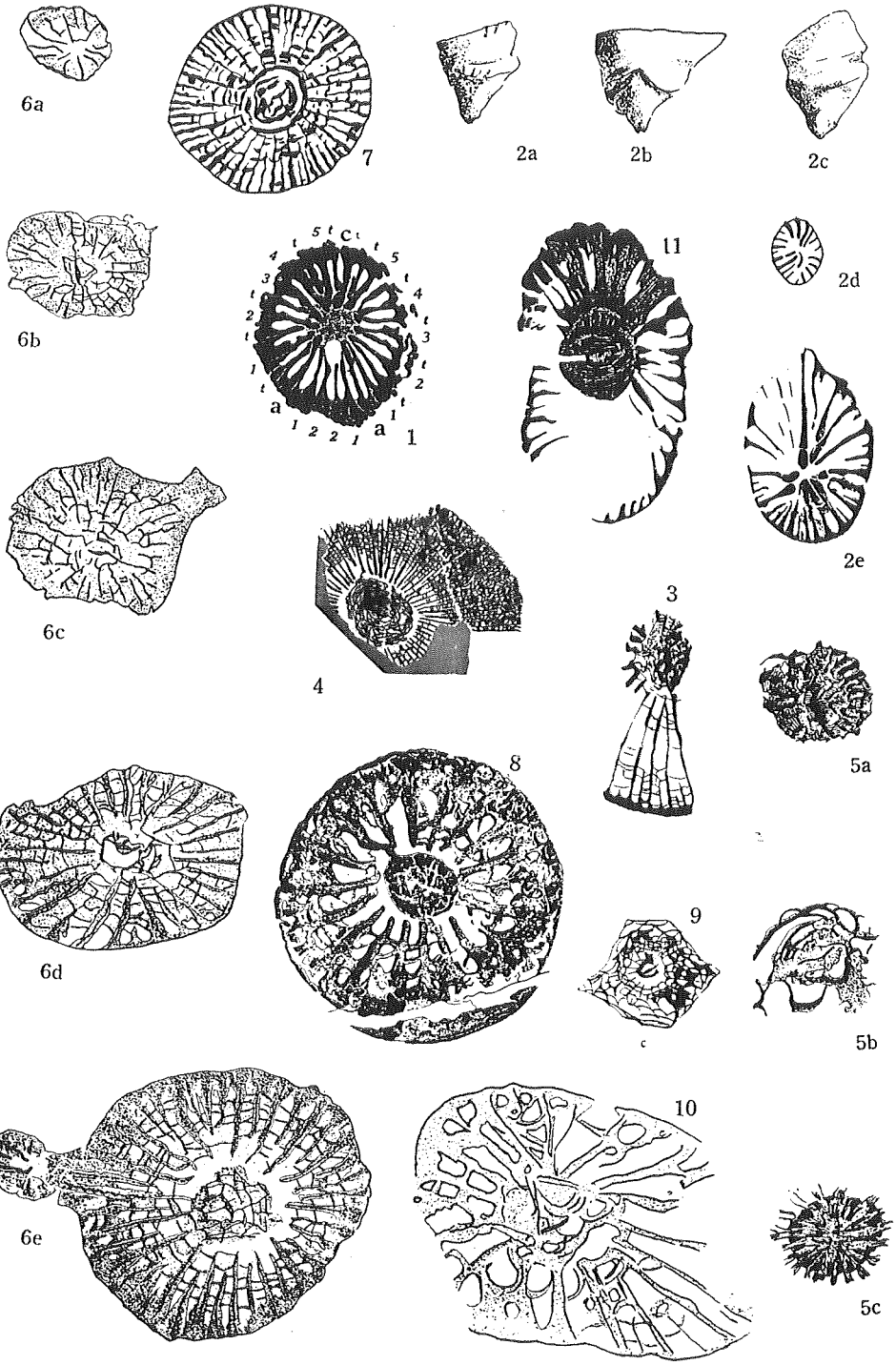

6a
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2b
2c
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Plate 38

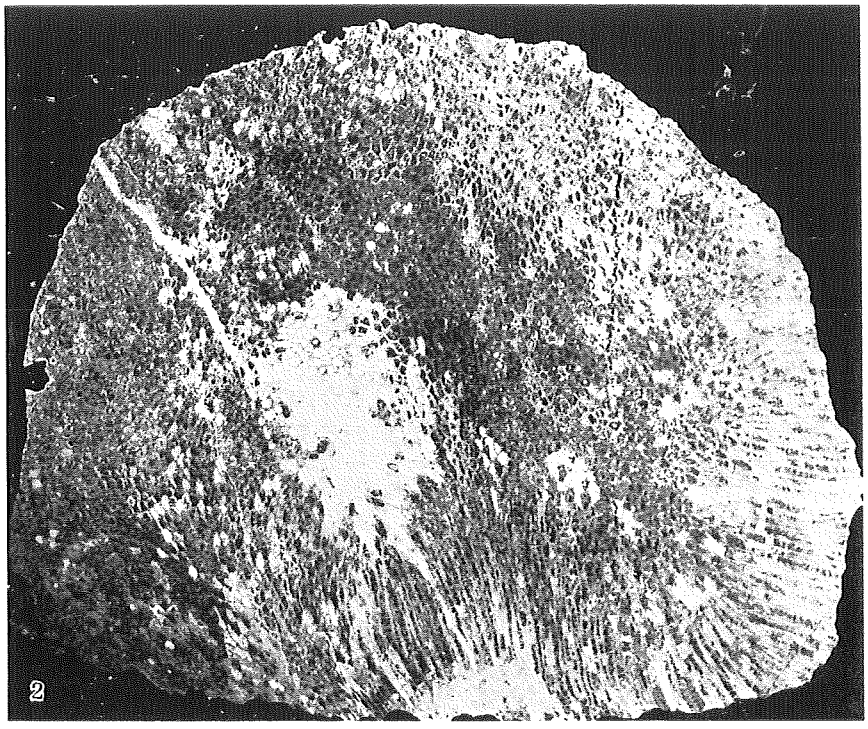
Plate 38

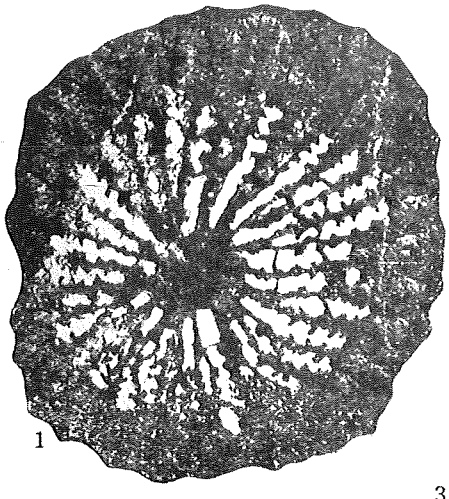
Omphalophyllia yamanbaensis YABE et SUGIYAMA ..... p. 179

Fig. 1, 3. All figures were reproduced from YABE and SUGIYAMA's paper.
Hor.: *Neoschwagenina* ? *Parafusulina* zone. Loc.: Yamanba near Sakawa-machi, Takaoka-gun, Kochi Prefecture.
Reg. no.: 43473 of the Inst. Geol. and Palaeont., Tohoku Univ. Coll.: H. YABE and T. SUGIYAMA.

Chaetetes nagaiwaensis MINATO, sp. nov. ..... p. 190

2. Transverse section. (×2.0)
Hor.: *Profusulinella—? Fusulinella* zone. Loc.: Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16432. Coll.: M. MINATO.







MINATO and KUMANO *phot.*

Plate 39

Plate 39

Heterophyllia kitakamiensis YABE et SUGIYAMA ..... p. 177

Fig. 1, 2, 3, 4, 5, 6a, 6a′, 6b, 6b′, 7.

All figure were reproduced from Yabe and Sugiyama's paper.

Hor.: *Dibunophyllum* zone. Loc.: Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Coll.: A. SUZUKI.

Hexaphyllia elegans YABE et SUGIYAMA ..... p. 175

8, 9, 10a, 10b.

All figures were reproduced from YABE and SUGIYAMA's paper.

Hor.: *Dibunophyllum*. Loc.: Hikoroichi-Mura, Kesen-gun, Iwate Prefeeture. Coll.: A. SUZUKI,

Hexaphyllia japonica YABE and SUGIYAMA ..... p. 176

11, 12.

Figures were reproduced also from YABE and SUGIYAMA's paper.

Hor.: *Dibunophyllum* zone. Loc.: Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Coll.: A. SUZUKI.

Hexaphyllia sp. indet. ..... p. 176

13, 14.

Figures were reproduced from KANMERA's paper.

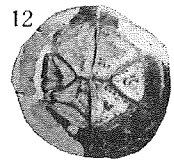
Hor.: *Dibunophyllum* zone. Loc.: Tsutsui, Kakisako-mura, Yatsusiro-gun, Kumamoto Prefecture. Coll.: K. KANMERA.


1

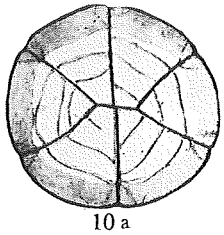

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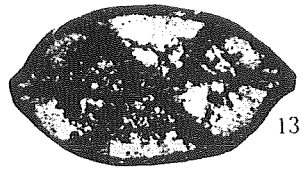

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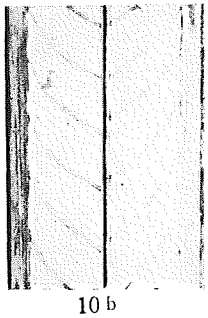

12

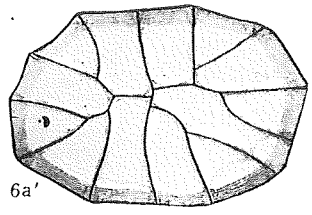

6b

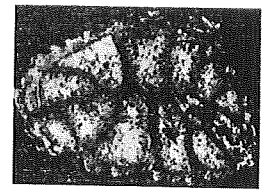

10 a

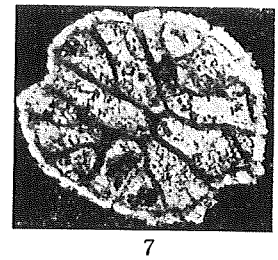

13


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10 b

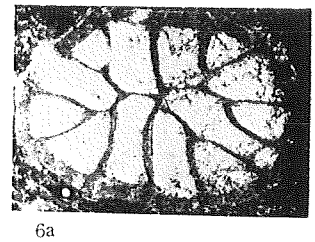

6a′

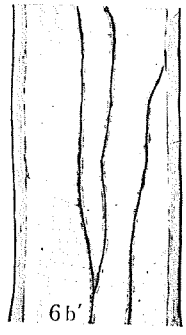

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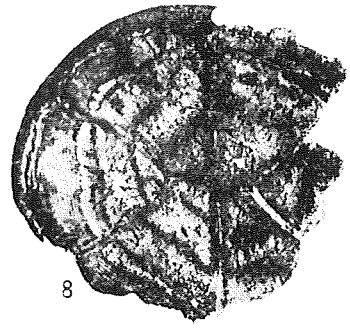

8

Plate 40

Plate 40

Dibunophyllum cf. *kankouense* YÜ ..... p. 96

Fig. 1, 2, 3, 4, 5, 6.
All figures were reproduced from KANMERA's paper.
Hor.: *Dibunophyllum* zone. Loc.: Tsutsui, Kakisako-mura, Yatsusiro-gun, Kumamoto Prefecture. Coll.: K. KANMERA.

Kueichouphyllum latifossulatum KANMERA ..... p. 170

7, 8.
These two figures were also reproduced from KANMERA's paper.
Hor.: *Dibunophyllum* zone. Loc. and coll.: same as the preceding species.

Diphyphyllum platiforme YÜ var. *kakisakoense* KANMERA ..... p. 83

9, 10, 11, 12, 13.
All figures were reproduced from KANMERA's paper.
Hor.: *Dibunophyllum* zone. Loc. and coll.: same as the preceding species.

Thamnopora ? *chaetoidea* (HAYASAKA)..... p. 185

14. Longitudinal section. (×30)
Hor.: *Yabeina* zone ? Loc.: Yakezima, Zugohama-mura, Miyagi Prefecture. Reg. no.: 16493. Coll.: M. MINATO.

Khmeria problematica MAUSUY ..... p. 178

15. Outer view of the corallite.
Hor.: Y. *Yabeina* zone. Loc.: Yoshinori (?) (Yoshinaga), Omine-mura, Mine-gun, Pref. Nagato, Yamaguchi Pref. Coll.: Y. OZAWA.

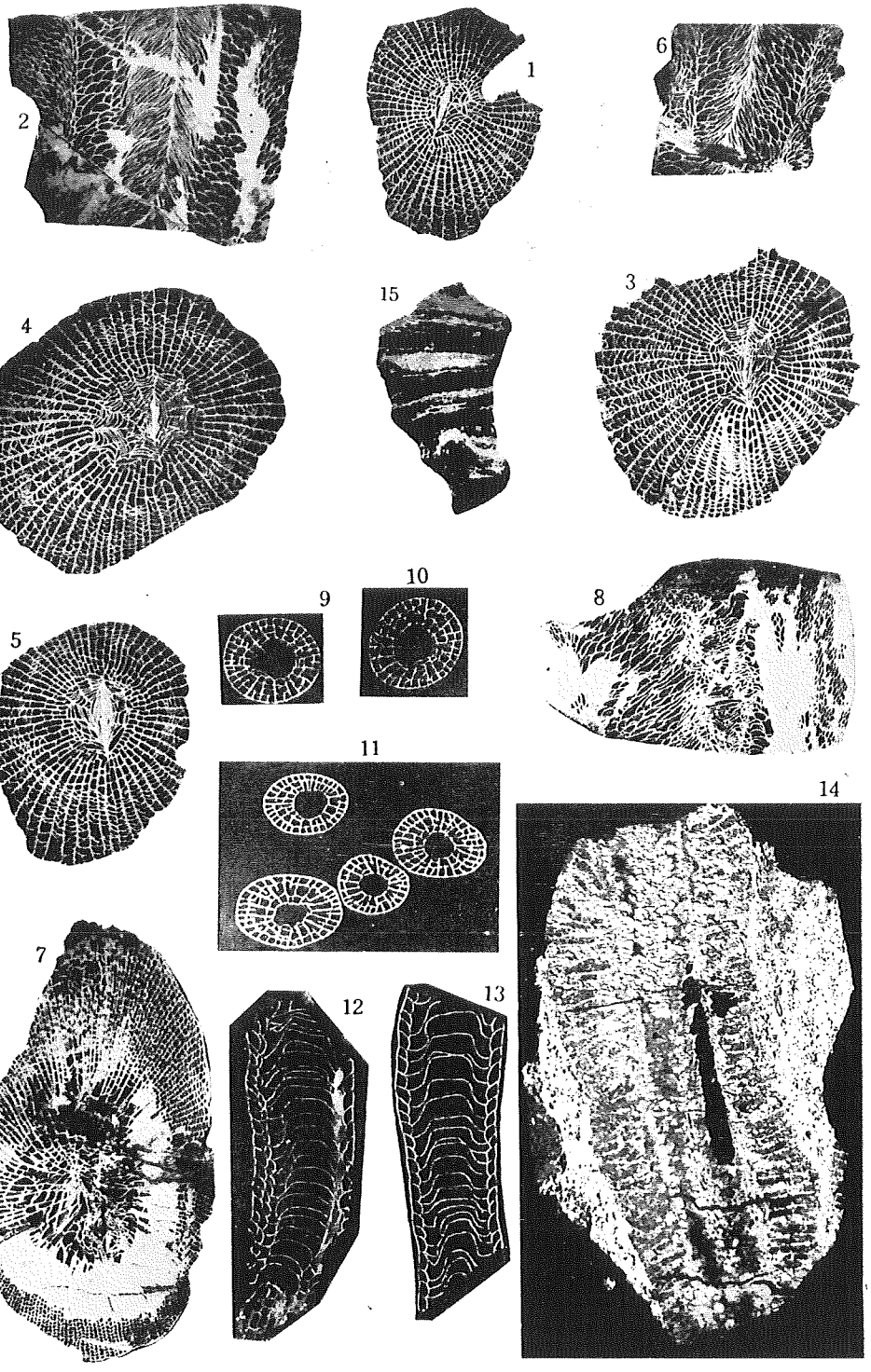

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Plate 41

Plate 41

Pseudopavona taisyakuana YABE, SUGIYAMA et EGUCHI ..... p. 180

Fig. 1a, 1b.
Figures were reproduced from YABE, SUGIYAMA and EGUCHI's paper.
Hor.: *Fusulinella* zone. Loc.: Taisyaku, Hiroshima Prefecture. Coll.: K. HARADA.

Stylidophyllum yokoyamai (OZAWA) ..... p. 134

2. Transvers section. (ca ×3.0)
Hor.: *Parafusulina* zone. Loc.: Kaerimizu, Akago-mura, Yamaguchi Prefecture. Specimen now stored at the Inst. Geol. Tokyo Univ. Coll.: Y. OZAWA.

Yatsengia kabayamaensis MINATO, sp. nov. ..... p. 120

3. Transverse section. (ca×2.0)
Hor.: *Parafusulina* zone. Loc.: Kabayama-sawa, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 17720. Coll.: M. MINATO.

Kueichouphyllum yahagiense MINATO, sp. nov. ..... p. 172

4. Longitudinal section. (ca×2.0)
Hor.: *Dibunophyllum* zone. Loc.: North of Hotokesaka, Yahagi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16850. Coll.: M. MINATO.

Geyerophyllum gerthi (OZAWA) ..... p. 159

5. This figure is reproduced from OZAWA's paper.
Hor.: *Yabeina* zone. Loc.: Shiraiwa, Omine-mura, Yamaguchi Prefecture. Coll.: Y. OZAWA.

Thamnopora ? *nipponica* (HAYASAKA) ..... p. 184

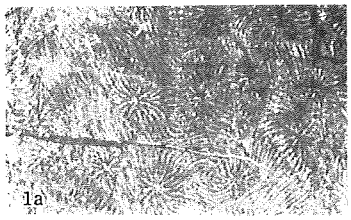
6. This figure is reproduced HAYASAKA's paper.
Hor.: *Yabeina* zone ? Loc.: Yakezima, Ogachi-machi, Miyagi Pref. Coll.: I. HAYASAKA.

Thamnopora ? *chaetoidea* (HAYASAKA) ..... p. 185

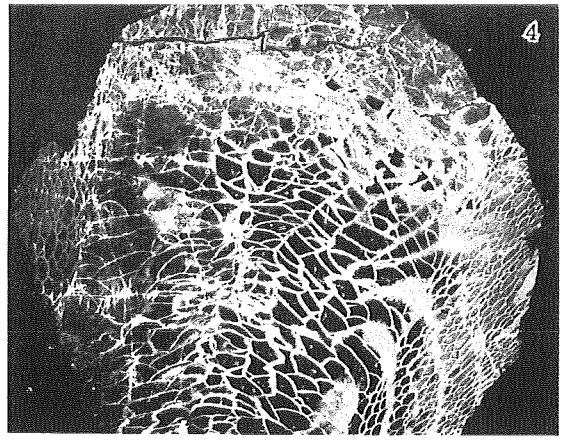
7. Transverse section. (×3.0)
Hor.: *Yabeina* ? zone. Loc.: same as the preceding species.
Reg. no.: 16484. Coll.: M. MINATO.

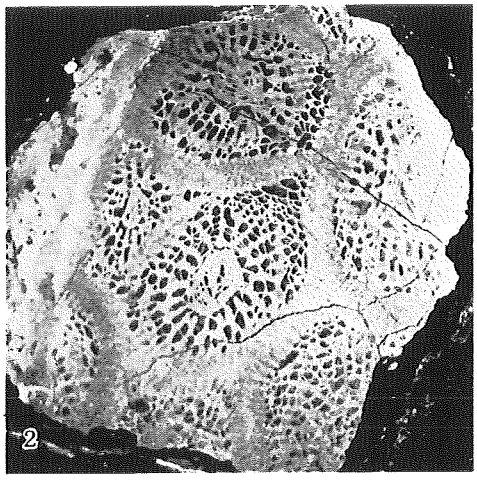
Stylidophyllum ? sp. indet. ..... p. 131

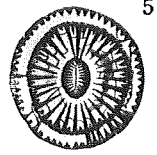
8. Transverse section. (×2.0)
Hor.: *Fusulinella* zone. Loc.: Omi, Niigata Prefecture. Specimen now stored at the Inst. Geol. Tokyo Univ. Coll.: G. IIZAKA.

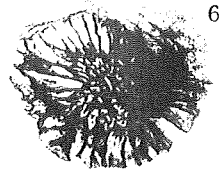


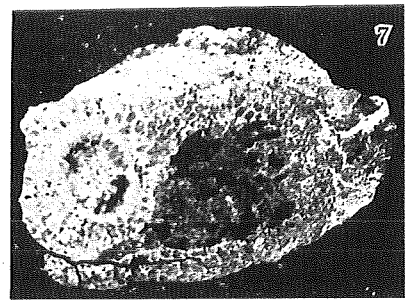


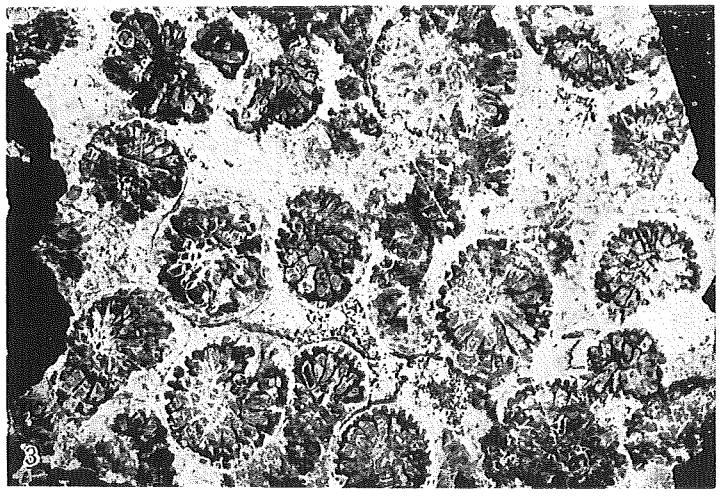














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Plate 42

Plate 42

Pseudoyatsengia kuzuensis YABE ..... p. 121

Fig. 1, 2.

These figures were reproduced from Yabe's paper. (×1.2)
Hor.: *Parafusulina* zone. Loc.: Aisawa limestone quarry of the Komagata lime plant, Aisawa, Kuzu-machi, Tochigi Prefecture.

Diphyphyllum flexuosum YABE at HAYASAKA ..... p. 83

3. Longitudinal section. (ca×3.0)
Hor.: *Dibunophyllum* zone. Loc.: Nagaiwa, Hikoroichi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 17395. Coll.: M. MINATO.
4. Transverse section. (×3.0)
Hor., loc., reg. no. and Coll.: same as the preceding fig.

Kueichouphyllum yahagiense MINATO, sp. nov. ..... p. 172

5. Transverse section. (×2.0)
Hor.: *Dibunophyllum* zone. Loc.: North of Hotokesaka, Yahagi-mura, Kesen-gun, Iwate Prefecture. Reg. no.: 16850.
Coll.: M. MINATO.

Thamnopora? chaetoidea (HAYASAKA) ..... p. 185

6. Transverse section. (×2.0)
Hor.: *Yabeina?* zone. Loc.: Yakezima, Zgohama-mura, Miyagi Pref. This figure was reproduced from Hayasaka's paper. Coll.: I. HAYASAKA.
9. Trangential section. (×2.0)
Hor., loc., and coll.: same as the preceding fig.

Thamnopora? nipponica (HAYASAKA) ..... p. 184

7. Longitudinal section. (×1.0)
Hor.: *Yabeina?* zone. Loc., and Coll.: same as the preceding fig.

Geyerophyllum gerthi (OZAWA) ..... p. 159

8a, 8b, 10.

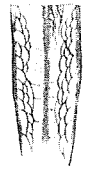
All figures were reproduced from OZAWA's paper.
Hor.: *Yabeina* zone. Loc.: Shiraiwa, Omine-mura, Yamaguchi Pref.
Coll.: Y. OZAWA.









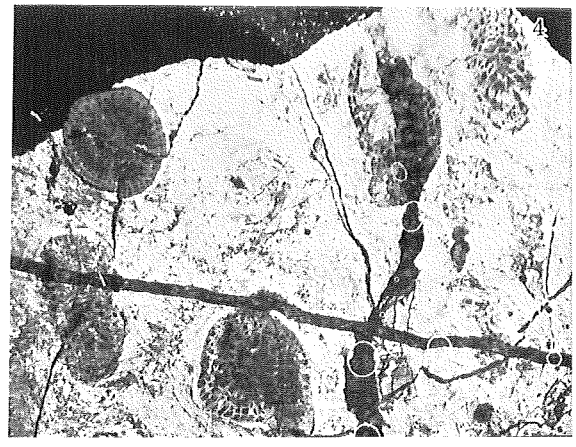


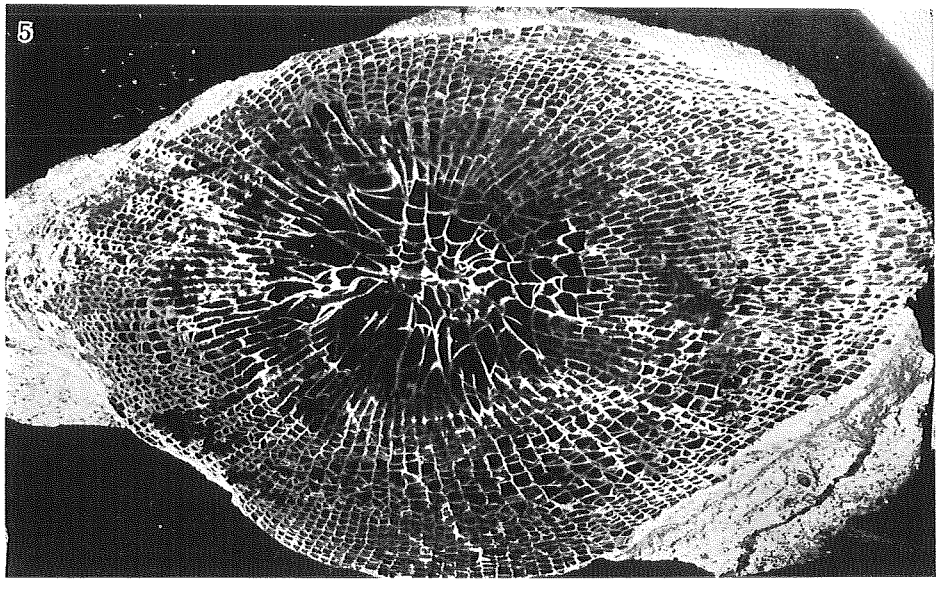












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Plate 43

Plate 43

Pseudoromingeria kotoi (YABE et HAYASAKA) ..... p. 186

Fig. 1. Transverse section.
4. Longitudinal section.
These figures are resproduced from YABE and SUGIYAMA's paper.
Hor.: *Yabeina* zone. Loc.: Kinsyozan, Akasaka, Gifu Prefecture.

Lonsdaleiastraea nipponica MINATO, sp. nov. ..... p. 134

2. Transverse section. (×3.0)
Loc.: Shiraiwa, Omine-mura, Yamaguchi, Prefecture.
Coll.: Y. OZAWA.

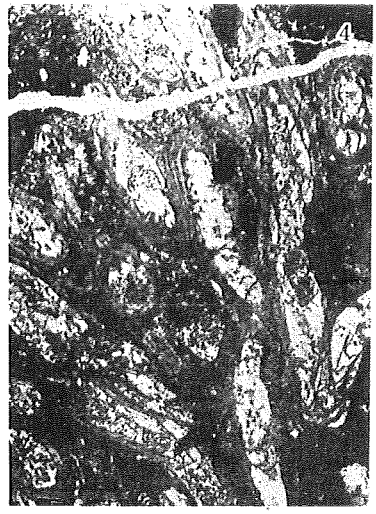
Yatsengia kabayamaensis MINATO, sp. nov. ..... p. 120

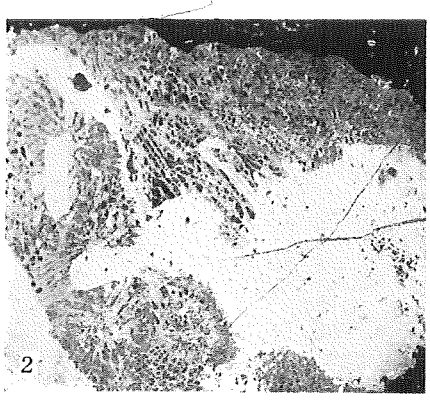
3 Longitudinal section. (×2.0)
Hor.: *Parafusulina* zone. Loc.: Kabayama-sawa, Setamai-machi, Kesen-gun, Iwate Prefecture. Reg. no.: 17222. Coll.: M. MINATO.

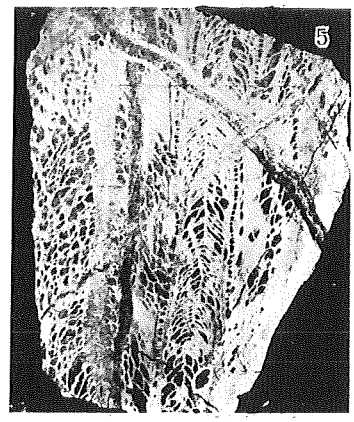
Stylidophyllum yokoyamai (OZAWA)..... p. 134

5. Longitudinal section. (×3.0)
Hor.: *Parafusulina* zone. Loc.: Kaerimizu, Akago-mura, Yamaguchi Prefecture. Coll.: Y. OZAWA.











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