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SOME CARBONIFEROUS RUGOSE CORALS FROM THE ICHINOTANI FORMATION, JAPAN

By

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By the efforts of T. KAMEI (1952) and H. IGO (1856), the development of Carboniferous deposits has already become well understood in the middle part of Ichinotani valley in Fukuji, Kami-takara-mura, Yoshiki-gun, Gifu Prefecture, Central Japan.



Fig. 1. Index map.

IGO (1956), divided the Carboniferous deposits of this area into 5 zones on the basis of the fusulinid remains; while MINATO (1957) reported in a previous paper in cooperation with the present writer that two distinct coral zones should be distinguishable in Ichinotani in the lowest division of IGO's, *Millerella kanmerai* subzone. The lower of the two coral zones is the *Siphonodendron hidense* zone, and the upper is the *Neokoninckophyllum nipponense* zone.

As has already been briefly reported, a dozen coral species have been detected from these two coral zones. These species are the following:

Siphonodendron hidense zone (lower)
- *Siphonodendron hidense* KATO*
- *Arachnolasma cylindricum* YÜ
- *Dibunophyllum* sp.
- *Palaeosmilia* cf. *murchisoni* (EDWARDS et HAIME)
- *Heterocaninia* sp.
- *Hexaphyllia* sp.
- *Syringopora* sp.**

Neokoninckophyllum nipponense zone (upper)
- *Lonsdaleia* aff. *duplicata duplicata* (MARTIN)*
- *Lonsdaleia* sp.**
- *Rhodophyllum* ? *minatoi* KATO*
- *Neokoninckophyllum nipponense* KATO*

In the present paper, four species marked with asterisks in the foregoing list will be described and illustrated in detail, which species seem to be new to science and stratigraphically more important than others.

Other species are only described without illustration, and two forms (marked by double asterisks) are excluded from the present description owing to the ill preserved and scanty materials.

It must be noted here however, that the most of these corallites were found to have been too firmly embedded in hard and massive limestone to extract, so the external characters of most specimens were almost wholly unobservable, and therefore thin sections only are available for their specific determination. About 110 thin sections in all were prepared for the present study.

In the course of microscopic observation, the writer is aware of the fact that the corals of the *Siphonodendron hidense* zone are commonly not in good preservation because of having wholly lost their epithecal parts and because of being irregularly scattered in matrix in association with a number of foraminiferal remains together with fragments of gastropod and brachiopod shells. On the other hand, the corals of the *Neokoninckophyllum nipponense* zone are rather in good preservation especially in their epithecal parts; also the foraminiferal remains are observed to be less numerous in this zone than in the lower zone.

Before going on with the description, the writer wishes to express his hearty thanks to Dr. M. MINATO, Professor of Hokkaido University, for his valuable criticism given during the course of the writer's study, free use of his private library.

Dr. I. HAYASAKA, Professor of Shimane University, Messrs. T. KAMEI (Shinshu Univ.) and H. IGO (Tokyo Univ. of Education) also helped the writer in various ways for the present study.

Messrs. K. YOKOTA, I. KAWASAKI and M. HIRAMA helped the writer in preparing many thin sections.

To all these persons the writer's cordial thanks are offered.

All the materials examined in the present study are now stored in the Department of Geology and Mineralogy, Faculty of Science, Hokkaido University; their registration numbers are indicated by the abbreviation of U.H.R.No. in the following description.

Description of Species

Genus *Neokoninckophyllum* FOMITCHEV, 1939

Neokoninckophyllum nipponense, sp. nov.

Pl. I, Figs. 1-8.

1957. *Neokoninckophyllum gracile nipponense*, MINATO & KATO: On the Carboniferous coral zones at Fukuji, Gifu Prefecture, Central Japan. Proc. Japan Acad., vol. 33, no. 9, pp. 549-551, figs. 3a-b. (listed and figured but not described).

Material: About 20 corallites, from which 16 corallites were sectioned and examined. U.H.R. 12991 (Holotype), 12992-13006.

Description: Corallum simple, medium in size. Both outer form and the nature of external surface are not directly observable. Judging through the observation of several serial thin sections made from each single corallite, however, the corallite may be fairly long, cylindrical, and gently tapering downwards.

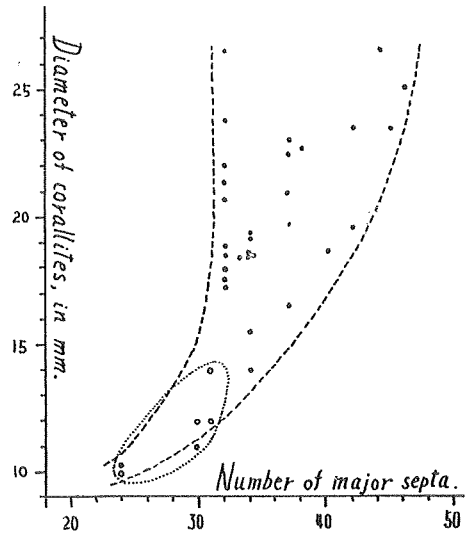


Fig. 2. Diagram showing the relationship of the number of major septa to the diameter of the corallite in *Neokoninckophyllum nipponense*, sp. nov. (black dot) and *Neokoninckophyllum gracile* MOORE & JEFFORDS, 1945 (white dot).

In transverse section, corallite round, with variable diameter ranging from 14 to 26.5 mm even in the ephebic stage. Epitheca comparatively thin. Septa in two orders, all belonging to the writer's A type.† Major septa rather thick in the middle portion and attenuate towards both ends. The counter and sometimes also cardinal ones fairly long but

another major septa are usually short, attaining about 2/3 the length of the half diameter of corallite. So, in common corallites the central part is observed to be wide and occupied by only a simple axial structure. Instead of it, there are a few specimens in which a relatively large number of major septa come to be longer and radially disposed to meet at their axial ends at the center of the corallite. Number of major septa also widely variable, ranging from 32 to 46 in ephebic stage. Minor septa present, although they are mostly rudimentary; but in rare cases they attain to a length as great as half the width of the dissepimentarium. Fossula usually not observable; but in some corallites the presence of cardinal fossula is indicated by a slight abortion along the margin of dissepimentarium or the shortening of the cardinal septum. The counter septum usually much longer than the other major ones and the end of its prolongation becomes a median lamella of axial structure. Diphymorphs commonly occur. Axial structure very simple, usually consists of a thin median lamella, an elongation of the counter septum as above stated, and occasionally of the cardinal septum; it bisects the central open space. Septal lamellae usually absent, but two lamellae which are opposite to each other and perpendicular to the median lamella are sporadically seen in some corallites. The width of dissepimentarium approximately 1/3 the radius of corallite. Dissepiments are generally arranged in herringbone pattern, being rather loose. But they become concentric in arrangement at the inner margin as well as the outer margin of dissepimentarium. Especially in the peripheral area where minor septa develop, they are observed to be concentric; besides, near the inner margin of the dissepimentarium they are not only arranged in concentric pattern but also more closely disposed with each other to represent a sclerothecal inner wall. Dilations commonly occur in all the skeletal elements. Intrathecal space sometimes filled up by stereoplasmic deposits which are observable in one transverse section made somewhat tangentially to the flat-domed and dilated tabulae surface.

In longitudinal section, epithecal surface finely rugosed. Septa are amplexoid at their axial ends. Axial structure seems to be a vertically continued median lamella which is somewhat flexuous. Tabularium cylindrical. Tabulae incomplete, flat-domed, gently ascending towards the axis, coarsely arranged, numbering 5 to 7 in a vertical distance of 5 mm. When diphymorphs occur, tabulae flattened, and further slightly sagged at their axial portion. Dissepiments rather large, being arranged in 3 to 6 rows (4 to 5 usually), and their shape and sizes are not so constant. In one neanic corallite dissepiments are narrow and arranged

in only 2 rows.

Comparison and remarks: As is shown in Text-fig. 2 and is already described above, the present form has somewhat mutable characters as a whole. However, most British *Koninckophylla* are easily distinguishable from the present form in having broad dissepimentaria which are occupied by fine, small dissepiments; and minor septa are usually well developed in British forms. *Lophophyllum stellatum* GORSKY (1935) from the upper Viséan of Novaya Zemlya resembles the present form in respect of a central open space, axial structure, tabulae form and dilation as

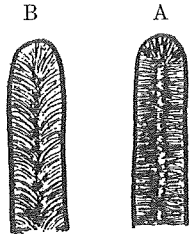


Fig. 3. Two different types of septal structure in transverse sections: A and B type.

† Two types of the Japanese Carboniferous corals seem to be discernible in respect to the structure of septa in transverse section, so far as the present writer is concerned; one of which is here designated as "A type". In this type of septa, a transparent layer is present along the imaginary middle line in transverse section of a septum; the two sides of this layer are bounded by two dark lines and outside of these lines there are areas occupied by fibrous tissues being approximately perpendicular to the mentioned dark lines. As a varietal form of this type, there seems to have existed such form in which the transparent layer is almost lacking, so the dark lines became to be single instead of two. This type of septa is widely detectable among the Onimaru corals and also the other coral assemblages from the Japanese Carboniferous.

The another type termed as "B type" shows neither transparent layer nor distinct dark lines like the A type in transverse section. Along the imaginary central line a set of fibrous tissues develop outwards, the elongation of which tissue seems to be oblique to the mentioned central line. Instead of regular fibrous tissues arranged perpendicular to the direction of a septum in A type, divergent fibrous tissues are observed to develop from the central line of a septum towards both sides of the septum in B type. This B type is also frequently observable in the Japanese Pennsylvanian corals.

well as corallite size and septal numbers; but it differs from the latter in having thick epitheca, no minor septa, short major septa and fine dissepiments.

Lophophyllum ashfelense var. *regulare* YÜ (1934) from the Fengninian of South China also has a certain resemblance to the present form but differs from the latter in having rather numerous thin septa in spite of its small sized corallite; also minor septa are possibly absent in the Chinese form.

Two American species of *Neokoninckophyllum, N. simplex* and *N. gracile,* described from the lower Pennsylvanian in Texas by MOORE and JEFFORDS (1945) seem to closely resemble the present form. The American species are both smaller than the Japanese form but their internal structures are quite like to the latter. Through careful observation however, *N. simplex* is seen to have corallite with relatively wider dissepimentarium occupied by more irregularly arranged dissepiments, providing more complicated axial structure with a few distinct septal lamellae, and cystosepiments, although the last named ones are observed sporadically; besides, the tabulae of the American form are more highly vesiculate, and tabularium is not so well differentiated from dissepimentarium. In respect to those characters above noted, the reverse is the condition in the Japanese form. So, *N. simplex* MOORE et JEFFORDS is distinguishable from the Japanese form in these characters as well as in size. In *N. gracile* MOORE et JEFFORDS, on the other hand, corallite is comparatively smaller, septa are less numerous and dissepimentarium is narrower than in the Japanese form. However, degree of development of these characters in *N. gracile* corresponds to those of immature corallites of the Japanese form. (Text-fig. 2) Accordingly, the morphological difference between *N. gracile* and the Japanese form lies only in the point of their limit of growth, viz. the size of corallite. *N. gracile* was yielded from *Fusulina* limestone of the mid-continent region of U.S.A.; the present Japanese form is obtained from the *Millerella* limestone of Central Honshu. So, their geological and geographical distributions also differ from each other. Furthermore, complete intra-specific relationship between the American and the Japanese forms has not yet been confirmed.

Here the writer wishes to treat provisionally the present Japanese form as a new species under the name *Neokoninckophyllum nipponense,* rather than as a subspecies of the American form as he formerly did.

Genus *Arachnolasma* GRABAU, 1922

Arachnolasma cylindricum YÜ

1934. *Arachnolasma cylindricum* YÜ: Lower Carboniferous Corals of China. Pal. Sinica, vol. XII, fasc. 3, pp. 35-36, pl. 11, figs. 1a-c, 2a-e, 3a-d.

Compare with;

1957. *Arachnolasma* cf. *cylindricum*, MINATO & KATO: Upper Viséan Corals from the Kirin Formation in the Vicinity of Mincheng, Kirin Province, N. E. China. Jour. Fac. Sci. Hokkaido Univ., ser. IV, vol. IX, no. 4, pp. 493-494, pl.1, fig. 10.

Material: Two mature corallites which lack their younger portions. U.H.R. 13024, 13023.

Description: Corallum simple, cylindrical as far as it is preserved. External characters are unobserved.

In transverse section, corallite round in outline, largest one attains 26.5 mm in diameter. Epitheca thin, smooth on its surface. Septa are in two orders, and their microscopic structure is distinctly of A type. Major septa long but scarcely joining to columella except for the cardinal and the counter septa; moderately thick and attenuated towards both the axial and peripheral ends, and slightly more dilated in tabularium than in dissepimentarium; straight, but rather flexuous in dissepimentarium; numbering as many as 38 in a corallite of 19 mm in diameter and about 34 in a corallite of 26.5 mm in diameter. Minor septa alternate with the major ones, short, attain about 1/2 or 1/3 of the breadth of dissepimentarium. Fossula indistinct. Axial structure simple, composed of a thick columella or a median plate and several vesicular cut edges of tabulae surrounding the columella. Distinct septal lamellae absent, and a small number of major septa prolonged near to the columella. Columella is a prolongation of the counter septum and often joined to the cardinal one, but scarcely touches the other major septa, rather uniformly thickened, so, is very elongated fusiform in shape. Dissepimentarium rather broad, occupies about 2/5 of the radius of the corallite, consists of loosely disposed dissepiments in several rows, which are usually in herringbone pattern. But partially it is in concentric pattern especially at the inner margin of dissepimentarium or at the point where minor septa develop. The density of dissepiments becomes slightly greater near the inner margin of dissepimentarium where it makes a sclerotheca in addition to some dilation which is usual in tabularium.

In longitudinal section, corallite cylindrical. Dissepiments large, rather regular and elongate in shape, arranged in several rather steeply inclined series. Tabularium broad, also cylindrical, and well defined from

dissepimentarium. Tabulae incomplete, spaced rather distantly from each other, gently ascending towards the center in flat dome shape. But, in a midst of the tabularium, there exist steeply elevated tabellae in cone form. Axial structure consists of a thick, straight and stout columella or a median plate and just described central tabellae cone which are penetrated by the former plate. Axial structure narrow and not very well differentiated from tabularium.

Comparison and remarks: This form quite resembles such Chinese species as *Arachnolasma sinense* (YABE et HAYASAKA) and *A. cylindricum* YÜ. Both Chinese species were claimed to be synonymous by YÜ in 1937, who first distinguished the two species and established the latter species in 1934. However, the present form has less numerous septa, less degree of dilation, no ridges on either side of the columella, indistinct fossula and less well differentiated axial structure in which no septal lamellae are differentiated in comparison with *A. sinense* (YABE et HAYASAKA). These characters are all those of *A. cylindricum,* so, the writer treats this form here as a member of *A. cylindricum* YÜ, although the septal elongation often enters the axial structure and unites with the columella in Chinese *A. cylindricum,* while this is not the case in the Japanese form.

A. sinense and *A. cylindricum* both denote the Shanssuan (upper Viséan and lower Namurian) in China.

Genus ***Dibunophyllum*** NICHOLSON et THOMSON, 1876

Dibunophyllum sp. indet.

Material: A single imperfect corallite. U.H.R. 13022.

Description: Corallum simple, cylindrical and attains about 6 cm as long as it is preserved. Epithecal part is largely destroyed, and surface characters are unknown.

In transverse section, corallite somewhat elliptical, 22 mm in shorter diameter. Epitheca thin, smooth on its surface. Triareal arrangement of internal elements is clearly seen. Septa are in two orders, and moderate in thickness similar to the thickness of epitheca. Major septa somewhat flexuous, and numbering over 38, but numbers cannot be counted exactly owing to the partial destruction of the corallite. Some major septa are gathered and located very close to each other in one portion of the corallite, possibly from some pathologic causes. At least they are not gathered together only by secondary deformation. Minor septa present but very short, alternating with the major ones. Structure of axis is well differentiated from tabularium, not large, and in irregular outline, consists

of a rather thick and straight median plate which does not completely bisect the axial structure, a number of short and irregular septal lamellae which start from the median plate vertically in the usual case, and a few axial tabellae. As a whole, the axial structure shows somewhat reticulate form. No fossula is observable. Dissepimentarium wide, occupied nearly a half the radius of corallite. Dissepiments are arranged coarsely in herringbone pattern at the periphery and in the inner margin of dissepimentarium, but in concentric pattern at the middle portion of dissepimentarium. Slight sclerothecal concentration of dissepiments found at the inner margin of dissepimentarium.

In longitudinal section, axial structure is composed of axial tabellae steeply ascending towards a stout and straight median plate. Tabulae incomplete, but often complete because of their distant nature, and gently inclined outward, numbering 5 to 7 in a vertical distance of 5 mm. Dissepiments coarse, but rather fine near the epitheca; inclination of dissepiments turning into vertical at the inner margin of the dissepimentarium.

Comparison and remarks: At first glance, general appearance of the present specimen reminds one of the characters of *Dibunophyllum reticuliforme* YÜ (1934). But YÜ's original specimen is not a well preserved one nor is the present specimen. So, the writer cannot identify precisely the Japanese form with the Chinese species. Axial structures in two forms quite resemble each other in reticulate pattern. The Chinese form said to have been collected from the Viséan formation, however, its exact horizon is still unknown.

Genus ***Rhodophyllum*** THOMSON, 1874

Rhodophyllum ? minatoi, sp. nov.

Pl. II, Fgs. 1-3.

1957. *Rhodophyllum ? minatoi*, MINATO & KATO: On the Carboniferous coral zones at Fukuji, Gifu Prefecture, Central Japan. Proc. Japan Acad., vol. 33, no. 9, pp. 548, 551, figs. 6a-b, 7. (listed and figured but not described).

Material: Two corallites. Younger portions of both of them have been lost. U.H.R. 13007 (Holotype), 13008.

Description: Corallum simple, large, long, cylindrical, shows marked rejuvenescence, gently tapering downwards, slightly curved, and preserved portion attains a length of about 9 cm. Septal grooves and fine transverse striations are observed on epitheca in partly excavated weathered surface.

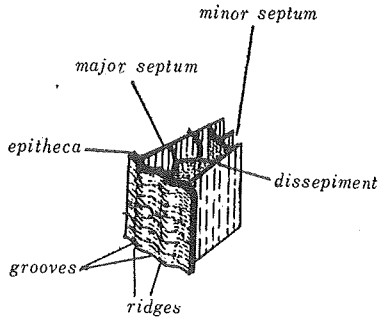


Fig. 4.

Two longitudinal ridges present between two neighbouriong septal grooves; and between these ridges a longitudinal groove which may correspond to a minor septum although it is not present close to epitheca but weakly developed in the inner margin of lonsdaleoid dissepiments.

In transverse section, corallite round, becomes as long as 33 mm in calicular diameter of old corallite on rejuvenescene. Epitheca very thick, undulated, and this causes the appearance of septal grooves and interseptal ridges. Both these grooves and ridges are still left even if the lonsdaleoid dissepiments occupy the whole peripheral area, whic is free from any kind of septa. Internally, triareal arrangement of skeletal elements is clearly observable. Septa are in two orders, both of them are thick, and under microscope are seen to belong to A type. Major septa long, and never intrude into the column. The number of major septa is 32 or 33 in a mature corallite. Major septa directly start from the epitheca in younger stage, but gradually retreat from the epitheca as lonsdaleoid dissepiments develop, as above stated. Minor septa present but rudimentary. They are usually separated from the epitheca, situated at the inner margin of the dissepimentarium, very short, are frequently obscure and absent in mature corallite. Axial structure is broad, well differentiated from tabularium, occupies 1/3 the radius of the corallite, polygonal in outline, composed of several irregularly twisted, thin septal lamellae, and many series of axial tabellae which are concave inward. Median plate is entirely lacking. Tabularium also broad, about 1/3 as wide as the half diameter of corallite. Cut edges of tabulae are scarcely seen owing to their comparatively slight degree of inclination and coarse disposition in longitudinal section. Dissepimentarium broad, occupies also 1/3 the radius of the corallite, well defined from the tabularium. Dissepiments large, in herringbone pattern, but their density of arrangement and their shape are very irregular and sometimes in bubble form between two neighbouring major septa. Lonsdaleoid dissepiments show rudimentary development in young corallite, grow larger as the corallite comes to mature stage. Minor septa always separated from the epitheca if they are present, so, dissepiments are also always lonsdaleoid even when the peripheral ends of the major septa

are firmly attached to the epitheca. Lonsdaleoid dissepiments which interrupt the elongation of the major septa from the epitheca are large, being flattened towards the calicular margin of the corallite upon the time of rejuvenescence as the inclination of dissepiments in outer series greatly increases at that time. This calicular margin of flattened dissepiments of an old corallite is bordered as if it formed a ring surrounding the new corallite which grew directly upon the old one. Dilations commonly occur in every part of the corallite, but degree of dilation is slightly greater in tabularium than in dissepimentarium. Then, inner wall is formed as a stereotheca. No fossula is observable.

In longitudinal section, triareal arrangement also very clear as in transverse section. Epitheca undulating. Axial structure is columnar, well differentiated from tabularium, composed of loosely piled up thin tabellae and also very flexuous, thin septal lamellae. Tabularium cylindrical, consists of rather complete and sparsely arranged tabulae, which are nearly horizontal but gently ascending towards the column in sometimes. Five to six tabulae are counted in a vertical distance of 5 mm. Dissepiments large, somewhat irregular in size and shape, gently inclined towards the axis. Sometimes, peripheral series of dissepiments turns into steeply ascending form towards the epitheca especially in a state just before the rejuvenescence in an old corallite. Width of axial column and the tabularium do not vary through rejuvenescence. Dissepimentarium absent at first in a young corallite after rejuvenescence but rapidly increases its diameter as the new corallite grows. Inner surface of calicular wall of the old corallite sheathes the new corallite.

Comparison and remarks: Systematic position under which the present form must be placed is difficult to settle at the present moment, because the present form provides some interesting but different characters from those of the hitherto known corals. The characters of "cystosepiments" and tabulae in the present form offer a resemblance to specimens of genus *Lonsdaleia*. But the present form is a large, simple one and not a small, compound form as in *Lonsdaleia*, and it has no distinct median plate in axial structure. Genus *Lonsdaleoides* is also fasciculate and its counter septum unites with the axial structure. So, it may be distinguishable from the present form. Genus *Carcinophyllum* is also distinguishable from the present form in a different kind of axial structure. Genus *Symplectophyllum* much resembles the present form at first glance, although careful observation does not permit their being considered completely similar. The genotype of *Symplectophyllum* has naos and cavernous trend in septa, fine dissepiments, numerous septa,

and well developed minor septa. These characters are absent in the Japanese form. Further, septal structure of *Symplectophyllum* consists of pinnately arranged fibres in transverse section according to HILL (1934) (which structure may be compared to B type of the writer), while it is of A type in the Japanese form. However, resemblance between the two really lies in the axial column of rose-bud-like pattern, lonsdaleoid dissepiments, thick wall, dilation of skeletal elements, and in the flat nature of tabulae.

On the other hand, such Asiatic *Rhodophylla* as *R. fukudai* MINATO et KATO (1957) and *"Heliophyllum" vesiculosum* MANSUY (1912) also much resemble the present form in size, septal number, and mode of axial column in rose-bud shape and development of minor septa. Small lonsdaleoid dissepiments which are indicated by the separation of minor septa from epitheca are also recognizable in both *R. fukudai* and *"H." vesiculosum*. But the present form differs from *R. fukudai* in its ill development of minor septa and its large lonsdaleoid dissepiments. These two characters also serve as the distinction between the present form and *"H." vesiculosum;* further, tabulae of the latter are incomplete in contrast to the complete tabulae in the Japanese form. MANSUY described lateral gemmation in *"H." vesiculosum*. Occurrence of this character, however, seem to the writer to be very curious in such *Rhodophyllum* type corals; and anyhow the character is not detected in *R. fukudai* nor in the present Japanese form. The writer wishes here to treat the present Japanese form under genus *Rhodophyllum* placing stress on its almost indubitable resemblance to asiatic *Rhodophylla*.

The present form may be explained as a descendant of some form of *Rhodophyllum* such as *R. fukudai* along a lonsdaleoid trend. It is probable that a new subgenus can be established upon the basis of the presence of lonsdaleoid dissepiments in such *Rhodophylla* as the present Japanese form. However, the development of lonsdaleoid dissepiments in the present case is a character which was added in a late stage of growth and is not a genuine character brought up from neanic stage as it is in typical *Lonsdaleia*.

At present, the writer considers the form now under consideration as a descendant form of some species of *Rhodophyllum* of upper Viséan age.

Genus ***Lonsdaleia*** M'COY, 1849

Lonsdaleia aff. *duplicata duplicata* (MARTIN)

Pl. III, Figs. 1-4.

1957. *Lonsdaleia* aff. *duplicata duplicata*, MINATO & KATO: On the Carboniferous coral zones at Fukuji, Gifu Prefecture, Central Japan. Proc. Japan Acad., vol. 33, no. 9, pp. 548-549, figs. 4-5. (listed and figured but not described).

Compare with:

1876. *Lonsdaleia duplicata*, THOMSON & NICHOLSON: Contributions to the Study of the chief Generic Types of the Palaeozoic Corals. Ann. Mag. Nat. Hist., vol. XVII, ser. 4, p. 301, pl. 16, figs. 2, 2a.

1915. *Lonsdaleia duplicata duplicata*, SMITH: The Genus *Lonsdaleia* and *Dibunophyllum rugosum* (MCCOY). Quart. Jour. Geol. Soc., vol. 71, pp. 238-241, pl. 17, figs.1-4.

1940. *Lonsdaleia duplicata duplicata*, HILL: A Monograph on the Carboniferous rugose corals of Scotland. Pal. Soc. London, vol. 44, p. 153, pl. 8, figs. 11, 12.

Material: Several colonies and isolated corallites. U.H.R. 13009-13017.

Description: Corallum compound, fasciculate. Corallites subcylindrical, gently tapering downwards, subparallel and closely but irregularly disposed, apart from each other as far as their own diameter, but often in contact.

In transverse section, corallite round, varies in its diameter from about 8 to 18 mm in ephebic stage. Epitheca very thick, crenulated inside. Triareal arrangement of internal structure is clearly seen; these internal structures are lonsdaleoid dissepiments, tabularium and axial structure. Septa are in two orders, moderately thick, never joining with the epitheca because of the interruption of lonsdaleoid dissepiments. Microscopic structure of septa is very obscure and indeterminable. All the septa invade for a short distance into the lonsdaleoid dissepiments. Major septa fall short of the axial structure, except for the counter septum; the prolongation of it makes an axial structure in neanic and in ephebic stage of some corallites. The number of major septa ranges from 18 to 25 in ephebic stage. Minor septa are as thick as, and as numerous as the major septa, rather long, present even in neanic stage. Fossula indistinct. Dilations usually occur on every structural element of corallite. Axial structure is a mere elongation of the counter septum in early neanic stage as above described, but is loosely built of a cobweb-like structure composed of a flexuous median lamella, a few septal lamellae and 3 to 5 thin axial tabellae. Axial structure well differentiated from the other skeletal elements of the corallite, but is widely variable in construction because the number of septal lamellae is also indefinite. Then, the cobweb-like structure is loose as usual, but has somewhat crowded lamellae sometimes, although these lamellae are not in regular pattern. Dissepimentarium wide, as broad as 1/2 the radius of corallite, consists

of large lonsdaleoid dissepiments which usually interrupt the elongation of septa to the epitheca. Lonsdaleoid dissepiments develop already in early neanic stage as a peripheral ring. One or two series of dissepiments are usually observed; but dissepimentarium is broadened sometimes and many series of rather irregular dissepiments are observed. Tabularium round in outline, well differentiated from the dissepimentarium by an inner wall made of the inner margin of the dissepimentarium with a small amount of dilation upon it. Increase by peripheral one, 1 to 3 new corallites contemporaneously grow on the dissepimentarium of mother corallite.

In longitudinal section, axial structure is represented by a median plate in very early stage, but gradually tends to take a column shape. Axial column composed of a flexuous median plate and regular tabellae in cone in cone arrangement in one case, but is rather loosely constructed in other corallites; well bounded from tabularium in any case. Density of tabellae ranges from 3 to 5 in 2 mm. Tabularium consists of rather complete tabulae which are nearly flat or gently ascending towards the axial column, numbering 2 to 3 in a vertical distance of 2 mm. Dissepiments are small and in a single row in early stage, becoming large, irregular, gently inclined in form.

Comparison and remarks: The present form very closely resembles *Lonsdaleia duplicata* group of the British isles. Especially, from *Lonsdaleia duplicata duplicata* (MARTIN) the present form is difficult to distinguish. Main distinguishing character between the Japanese and the British *Lonsdaleia duplicata* group lies in the degree of development of minor septa. In the Japanese form, minor septa conspicuously long, and present even in a corallite in neanic stage. On the other hand, in the British *L. duplicata* group, minor septa are very short or lacking; if present, are merely fringing the inner wall of corallite in later growth stage. *L. duplicata duplicata* and *L. duplicata alstonensis* SMITH (1915) have slightly more numerous major septa to the number of 28 to 32 and horizontal, descending tabulae towards the axial structure. In the Japanese form, major septa seldom exceed 25; tabulae nearly horizontal or gently ascending towards the axial structure; more complicate axial column than that of *L. duplicata duplicata* also occurs in some corallite; however, this complex type of axial column does not predominate in many corallites of the present Japanese form which is different from the situation in *L. duplicata alstonensis*. *L. duplicata mermerbiensis* SMITH (1915) has crowded tabulae, and no minor septa, is also easily distinguishable from the Japanese form. *L. siblyi* SMITH (1915) somewhat resembles

the present form in transverse section, especially in size and septal numbers, but it is also easily distinguishable from the latter in having a peculiar type of tabulae to be seen in longitudinal section. In this type of tabulae, the outer series of tabulae much inclined towards the axial column as those in genus *Waagenophyllum*. Another subspecies of *Lonsdaleia duplicata* group was once described by GORSKY in 1938 as *L. duplicata arctica*, regarding which the writer cannot comment at present.

Genus ***Siphonodendron*** M'COY, 1849

Siphonodendron hidense, sp. nov.

Pl. III, Fig. 5.

1957. *Siphonodendron hidense*, MINATO & KATO: On the Carboniferous coral zones at Fukuji, Gifu Prefecture, Central Japan. Proc. Japan Acad., vol. 33, no. 9, p. 548, fig. 2. (listed and figured but not described).

Material: A single colony. U.H.R. 13025 (Holotype).

Description: Corallum compound, fasciculate. Corallite cylindrical, subparallel, somewhat geniculated, rather closely disposed with respect to each other and very often in contact. The interspace between corallites does not exceed more than their own diameter. Surfaces of corallites are not observed.

In transverse section, corallites are arranged in somewhat linear pattern, and show round to polygonal outlines owing to their contactness to the neighbours. Corallite attains a diameter of about 4 mm in ephebic stage. Epitheca moderately thick as well as septa. Septa moderately thick, long, and in two orders. Major septa number 15 to 16 in mature corallites, slightly flexuous, long, reach or nearly reach the columella. Fossula absent. The counter septum to be united with the columella as usual. Minor septa also long, attain about 2/3 to 4/5 of length of the major septa, 1/2 of the radius of corallite, alternate with the major, and much prolonged into tabularium. Microscopic structure of septa is very obscure, and cannot be decided. Columella prominent, very thick fusiform with fringed periphery, unites with the counter septum and sometimes with the other major septa. Diphymorphs also sometimes occur. Dissepimentarium usually consists of 2 to 3 rows of concentric dissepiments, but is very irregular in degree of development. Weak dilation upon the innermost series of dissepiments makes an inner wall. Cut

edges of tabulae are seen as concentric bars between the major septa, and innermost cut edges of tabulae surrounding the columella sometimes interrupt the prolongation of major septa to the columella.

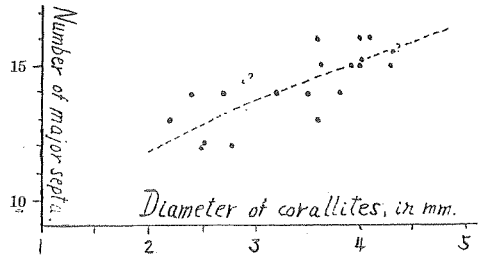


Fig. 5. Diagram showing the relationship of the number of major septa to the diameter of the corallite in *Siphonodendron hidense*, sp. nov.

In longitudinal section, columella straight and persistent. Tabulae incomplete, variable in shape. They are flat domed or have gently ascending dome or conical tabellae at the axial portion. The variation of tabulae form in longitudinal section is partially owing to the direction of thin section to the counter-cardinal plane. Four to six tabulae present in a vertical distance of 2 mm. Dissepiments somewhat irregular and in 2 or 3 rows, but rarely in one or in several rows. Width of dissepimentarium varies. Increase by lateral.

Comparison and remarks: An Australian species *Lithostrotion arundineum* ETHERIDGE (BENSON & SMITH, 1923: HILL, 1934) resembles *Siphonodendron hidense* in points of corallite size, long minor septa, thick columella and incomplete tabulae. The Australian form provides corallites of 4 to 5 mm diameter, 20 major septa, single row of small dissepiments and sometimes stereozone. But *S. hidense* has smaller corallites, less numerous septa, more numerous dissepiments than the Australian form and no stereozone. So, the distinction between them is clear. Chinese *Lithostrotion irregulare* var. *asiatica* YABE et HAYASAKA (1916, 1920) is the form closest to the present species. Resemblance between them lies in points of the small sizes of corallites, septal numbers, arched tabulae, and long minor septa. The Chinese form provides small corallites of 3.5 mm diameter, 16 to 18 major septa, rather long minor septa, gently domed tabulae, single row of dissepiments and a rather thin columella. On the other hand, *S. hidense* has less fewer septa to the number of 15 to 16, slightly longer minor septa, thicker columella and numerous series of dissepiments in comparison with the Chinese *L. irregulare* var. *asiatica*. Further, major septa in *L. irregulare* var. *asiatica* seldom reach the columella except for the counter and cardinal

septa; while in *S. hidense* major septa are often joined to the columella.

It is by no means certain, of course, whether the mode of aggregation of corallites in the present form reveals a genuine character or whether it may be a mere effect of adaptation to some definite ecological condition. Anyhow, at present, this character of close aggregation of corallites may also serve as a formal distinction of the present form from the other ones. *S. reticulatum* LEE et CHU (1930) from the Huanglung limestone of south China also resembles *S. hidense* in the mode of aggregation of corallites. Each corallite of these species may be laterally compressed owing to the condition of close contact with the neighbours; and hence the contact plane tends to become straight. But *S. reticulatum* differs from the latter in its small sized corallites (2 to 3 mm in diameter), large dissepiments in single row, and thin columella.

Genus ***Heterocaninia*** YABE et HAYASAKA, 1920

The genus was established by YABE and HAYASAKA in 1920 for one remarkable form of the lower Carboniferous corals of China. But they illustrated only one species of that genus, and neither generic diagnosis nor description of this species was given at that time. *Heterocaninia tholusitabulata* YABE et HAYASAKA is thus designated as the genotype by its monotypy.

GRABAU thought this genus as a subgenus of *Pinnatophyllum* in 1922.

Subsequently, CHU described a coral under the name of the above mentioned species in 1928, but his form was not conspecific with the genotype but was synonymous with *Kueichouphyllum sinense* YÜ, as YÜ once believed in their synonymy as stated in his list. (YÜ, 1934).

Genus *Heterocaninia* was re-investigated by YÜ in 1931, and he first diagnosed this genus; he also described some forms of this genus other than the genotype in 1934. Further he established a new genus, *Kueichouphyllum,* which is closely allied to *Heterocaninia. Kueichouphyllum* was introduced as a subgenus of *Palaeosmilia* at first, and was raised to generic rank soon after. YÜ thought *Kueichouphyllum* to be clearly differentiated from *Heterocaninia,* and the former to be rather closely related to *Palaeosmilia.* But in reality, the two genera are hardly distinguishable in longitudinal section from each other; both possess a tabularium which consists of incomplete vesicular tabulae ascending towards the axis of corallite. Then, they may be clearly distinguishable from *Palaeosmilia* which has a tabularium differentiated into two series, outer and inner. In transverse section also, *Heterocaninia* and *Kueichouphyllum* are distinguishable from each other; the former has a septal arrangement of the Hexanthinian type, while the latter has a septal arrangement of the Cyathaxonian type.

chouphyllum show close resemblance with each other. They have a large cardinal fossula, and intrathecal dilation of major septa occurs often in cardinal quadrants, by which characters the writer is reminded of the same features occurring among some caninids. The distinction between *Kueichouphyllum* and *Heterocaninia* exist mainly in the point whether minor septa develop well or not in the dissepimentarium of each genus. More definitely, *Heterocaninia* has no or very rudimentary developed minor septa, while minor septa usually very long in *Kueichouphyllum*.

HILL (1956), WANG, YÜ & YOH (1955) also distinguish these two genera on the basis of the character of minor septa.

Besides the feature of minor septa, YÜ pointed out a distinction of dissepimental arrangement in transverse section in the two genera. (1934) He said that the arrangement is concentric in *Kueichouphyllum* while it is angulo-concentric in *Heterocaninia*. But dissepiments are arranged in herringbone pattern in the genotype of *Heterocaninia*, and they are not angulo-concentric. In *Kueichouphyllum*, the arrangement is also in herringbone pattern when minor septa retreat slightly towards the epitheca. Further, concentric dissepiments are usually observed in species of *Heterocaninia*. Hence, the type of dissepimental arrangement relates to the degree of development of minor septa, and furnishes no essential differentiation between the two. Under such circumstances, the writer considers that these two genera are more clearly related with each other than YÜ originally thought. The geological and geographical distribution of the two genera also coincide with each other in China. If these two are in synonymy, the name *Kueichouphyllum* must be abandoned, or, *Kueichouphyllum* may possibly be regarded as a subgenus of the genus *Heterocaninia*.

At the present moment, the writer will consider *Kueichouphyllum* as a genus distinct from *Heterocaninia* despite their similarity.

Generally speaking, *Heterocaninia* has a rather more narrow dissepimentarium, and rather more coarse dissepiments, which are vertically elongated, than those in *Kueichouphyllum*. Dissepiments of *Kueichouphyllum* are usually fine and globose. But, the distinction between the two genera depends chiefly upon the character of minor septa as above stated.

Heterocaninia has been known from the Shanssuan in South China.

Heterocaninia sp. indet.

1957. *Heterocaninia* sp., MINATO & KATO: On the Carboniferous coral zones at

Fukuji, Gifu Prefecture, Central Japan. Proc. Japan Acad., vol. 33, no. 9, pp. 548-549, figs. 1a-b, 8. (listed and figured but not described.)

Compare with:

1934. *Heterocaninia tholusitabulata* var. *concentrica* Yü: Lower Carboniferous Corals of China. Pal. Sinica, vol. XII, fasc. 3, pp. 64-65, pl. 8, figs. 2a-b; pl. 12, figs. 2a-b.

Material: Two fragmentary corallites. One is large, long but has lost almost all of its epithecal portion, much compressed laterally, and accordingly its axial part also damaged. The other one is an immature corallite. U.H.R. 13019, 13021.

Description: Corallum simple, large, long, subcylindrical, over 18 cm length in the largest one as far as it is preserved. External characters cannot be observed.

In transverse section, corallite may originary have been round, but much suppressed laterally in the largest one, attains about 53 mm in longer diameter in a suppressed corallite. Epitheca thin in the immature corallite. Septa in two orders, their microscopic structure is of A type. Major septa long, a number of them prolonged to the center of corallite. Major septa rather thin in dissepimentarium and somewhat flexuous in it, more dilated at the outer margin of tabularium, but attenuated towards the center rather rapidly. Major septa are contorted at the center and damaged by lateral compression. Cardinal fossula distinct, elongated horseshoe in shape, intrudes into dissepimentarium. Thin, short cardinal septum bisects the cardinal fossula longitudinally. The counter septum clearly recognized in the immature corallite, is very long, and its prolongation bisects the central space and touches the other major septa which border the innermost head of the cardinal fossula. Minor septa very short, thin, developed only near by the epitheca. No distinct axial structure. Dissepimentarium rather narrow, especially seems to be more narrow in one side; which may possibly be the cardinal quadrants. Dissepiments evenly spaced, mostly in concentric pattern, sometimes herringbone in a part close to the epitheca. Intrathecal dilation occurs in all the major septa as above described, but degree of dilation of major septa does not so much differ between that of the cardinal quadrants and the counter quadrants, and the condition is especially holds in mature corallite. Tabularium very wide, is not very clearly differentiated from dissepimentarium in mature corallite.

In longitudinal section, dissepimentarium narrow, consists of several rows of rather large and rather steeply inclined dissepiments. In one side, in a portion of the cardinal quadrants, dissepimentarium extremely

narrow, consists of 2 or 3 rows of dissepiments. But it is not sure whether this narrow dissepimentarium is a native character of this form or a mere pathological case. Trabeculae are seen to be much inclined inward in oblique section of major septa. Tabulae incomplete, coarsely disposed, gently ascending towards the axial portion of corallite.

Comparison and remarks: Ill development of minor septa, concentric dissepiments in transverse section and comparatively small degree of dilation of the present form closely resemble corresponding characteristics of Chinese *H. tholusitabulata* var. *concentrica* YÜ; the two may be identical with each other, but the present specimens are too imperfect to admit their exact identification to the Chinese form. *H.* cf. *tholusitabulata* was listed by ONUKI (1937, 1938) from the Onimaru series of the southern Kitakami mountain region but has not been described until today. This form, however, has not been discovered by the subsequent students of that region. Large numbers of specimens of heterocaninoid corals have been accumulated in this institute of Hokkaido University, but they all belong to *Kueichouphyllum,* without any examples of *Heterocaninia* being contained among them. So, the writer of the opinion that the formerly listed *Heterocaninia* might be a form like *Kueichouphyllum yahagiense* MINATO (1955) which has less dilated major septa, and minor septa which slightly retreat from the inner margin of dissepimentarium towards the epitheca.

But the present occurrence of *Heterocaninia* in Ichinotani clearly shows that the genus also exists in Japan as well as in South China.

Genus ***Palaeosmilia*** EDWARDS et HAIME, 1848

Palaeosmilia cf. *murchisoni* (EDWARDS et HAIME)

Compare with:

1852. *Cyathophyllum murchisoni*, EDWARDS & HAIME: A Monograph of the British Fossil Corals. Part 3, pp. 178-179, pl. 33, figs. 3, 3a-b. Pal. Soc. London.

1905. *Cyathophyllum* φ VAUGHAN: The Palaeontological Sequence in the Carboniferous Limestone of the Bristol Area. Quart. Jour. Geol. Soc., vol. 61, pp. 274-275, pl. 23, figs. 3-3b.

1910. *Cyathophyllum* aff. *murchisoni*, WILMORE: On the Carboniferous Limestone South of the Craven Fault (Grassington-Hellifield District). Quart. Jour. Geol. Soc., vol. 66, p. 575, pl. 40, fig. 6.

1912. *Cyathophyllum multilamellatum*, GARWOOD: The Lower Carboniferous Succession in the North-West of England. Quart. Jour. Geol. Soc., vol. 68, p. 562, pl. 50, figs. 5-7.

1923. *Cyathophyllum* (*Palaeosmilia*) *murchisoni*, BENSON & SMITH: Rugose Corals from the Burindi Series. Quart. Jour. Geol. Soc., vol. 79, p. 163, pl. 9, fig. 1.

1926. ? *Cyathophyllum* (*Palaeosmilia*) *murchisoni* var. *pendlensis* PARKINSON: The Faunal Succession in the Carboniferous Limestone and Bowland Shales at Clitheroe and Pendle Hill (Lancashire). Quart. Jour. Geol. Soc., vol. 82, p. 231, pl. 12, figs. 2a-b.

1930. *Palaeosmilia multilamellata*, LEWIS: The Avonian Succession in the South of the Isle of Man. Quart. Jour. Geol. Soc., vol. 86, pp. 274-275, pl. 22, figs. 14a-e.

1937. *Palaeosmilia murchisoni*, YÜ: The Fengninian Corals of South China. Acad. Sinica, Mem. Nat. Res. Inst., Geol. 16, p. 14, pl. 3, figs. 4a-c.

1956. *Palaeosmilia murchisoni*, SATO: On the Tateishi Formation and its Carboniferous Coral Fauna, in the North-eastern Part of the Abukuma Massif, Japan. Sci. Rep. Tokyo Kyoiku Daigaku, sec. C, vol. 4, No. 36, pp. 258-259, pl. 12, figs. 3a-b.

1956. *Palaeosmilia murchisoni*, HILL: "Rugosa" in Treatise on Invertebrate Palaeontology, (F) Coelenterata, Geol. Soc. America, fig. 197-4a & 4b.

1957. *Palaeosmilia murchisoni*, COOPE: The Insertion of Septa in the Later Growth Stage of *Palaeosmilia murchisoni* (EDWARDS and HAIME). Geol. Mag., vol. XCIV, pp. 465-471, text-figs. 1-3, pl. 15, fig. a-b.

Material: One fragmental corallite from which two thin transverse sections are prepared. The portion of the corallite which has lost its epithecal part and whole of its younger portion, may represent only a mature part. U.H.R. 13020.

Description: Corallum simple. Its external shape and surface characters are quite unknown.

In transverse section, corallite nearly round, about 28 mm in longer diameter as far as it is preserved. Septa are in two orders. Major septa long, but do not reach the counter one, leaving an open space at the center; numbering as many as 82. The counter septum very long reaching the center of the corallite. Among the major septa, a shorter one often leans upon the neighbouring long one, becoming still shorter near the cardinal one. Cardinal fossula rather distinct, broadened at the center to join to the central open space and make a keyhole shape as a whole. Cardinal septum is much shorter than the other major ones. Minor septa alternate with the major, well developed and slightly intruded into tabularium beyond dissepimentarium. Septa are all rather thick; their microscopic structure is quite obscure but may be of B type. Dissepimentarium may be rather wide but its width is not correctly known for want of epithecal portion of the specimen, but seems to be more narrow near the cardinal fossula than in the another parts. Dissepiments uniformly arranged in concentric pattern. No special inner wall present. Cut edges of tabulae are seen as rectangular bars between the major septa.

Comparison and remarks: Rather thick septa of the present specimen

somewhat recall the same character of Chinese *Palaeosmilia yihi* LEE et YÜ (YÜ, 1934), but the general character of the former, especially in numerous major septa, is distinctly that of *Palaeosmilia murchisoni,* although its peripheral characters are not observed In reality, some foreign forms which have thick septa are usually assigned to be a form of *P. murchisoni,* so, the present form may also possibly be a form of that species, however, its longitudinal and peripheral characters could not be examined.

Genus *Palaeosmilia* is reported from the Huanglung limestone of South China, which limestone has long been said to be middle Carboniferous in age; this species may be the latest representative of the genus in the Far East. In Japan, *P. kitakamiensis* has been described from the Onimaru limestone (upper Viséan) by MINATO (1952), and *P. murchisoni* from the Abukuma (SATO, 1956) and the Hida Massif (KAMEI, 1955: IGO, 1956). These Japanese forms are also considered to denote the late Onimaru epoch in rough estimation.

Genus ***Hexaphyllia*** STUCKENBERG, 1904

Hexaphyllia sp. indet.

Material: Three corallites which are represented by three transverse thin sections. U.H.R. 13019-iiic, 13021-ib & c.

Description: Corallum simple. Corallite six-sided, attains 1.2 mm in diameter along its plane of bilateral symmetry. Septa are six in number, meet at the center as a cross bar, and opposite two pairs to the median plane which is assumed to be a joining of the cardinal and the counter septum are further forked towards wall; all septa slightly protruded through the wall which characteristic protrusion may appear as septal costae on the outer surface of the wall. Hence, the wall is slightly concave inward in outline. Microscopic structure of septa is of A type in transverse section. Wall thick, massive, about 0.12 mm in average thickness, and no differentiated layers are observable in it. No cut edges of tabulae are seen in transverse section. Dissepiments absent. In thick wall, two dark lines diverse outwards to the outer surface of the wall from each septa at their junction with the inner surface of the wall at each corner of the corallite.

Comparison and remarks: Foregoing description is mainly based upon the largest specimen; others are very small and may be infant corallite of the same species. Owing to the scantiness of material, the writer cannot decide exactly at present the specific name of the present

form. However, as far as its transverse section is concerned, the present form resembles such Scottish species as *H. mirabilis* (DUNCAN) and *H. marginata* (FLEMING) in points of size of corallite and septal costae. These Scottish species were redefined by HILL in 1940. In Japan, *Hexaphyllia* sp. of YABE and SUGIYAMA (1939) and *H.* sp. of KANMERA (especially his figs. 9 & 10 in plate VIII, 1952) show also much resemblance the above described one. Such other Japanese forms as *H. elegans* and *H. japonica,* which were both described also by YABE and SUGIYAMA (1939), are easily distinguishable from the present form in their round wall in transverse section, in the largeness of the corallite, and especially by their possession of septal grooves instead of costae.

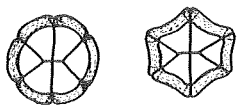


Fig. 6. *A-Hexaphyllia elegans* type *B-Hexaphyllia* sp. type

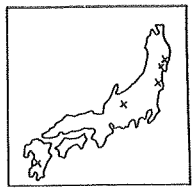


Fig. 7. Map showing the distribution of *Hexaphyllia* in Japan.

Genus *Hexaphyllia* has been said to be yielded from the upper Viséan and lower Namurian in Europe. In Japan, the occurrence of *Hexaphyllia* seems to be rather common. It has been reported several times from several localities (YABE & SUGIYAMA, 1939; KANMERA, 1952; SATO, 1956; IGO, 1956; YOSHIDA & KATO, 1957). So, *Hexaphyllia* is widely distributed in the Japanese islands and may serve as one of the most typical fossils of the upper Onimaru epoch in Japan.

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Explanation of Plate 1

Explanation of Plate I

All figures twice natural size. Longitudinal sections are at right angles to the counter-cardinal plane.

Fig. 1: *Neokoninckophyllum nipponense* KATO, sp. nov.
1a. Transverse section of a large corallite which provides numerous septa. U.H.R. 13002-iii
1b. Longitudinal section of the same corallite. U.H.R. 13002-ii

Fig. 2: *Neokoninckophyllum nipponense* KATO, sp. nov.
2a. Longitudinal section of Holotype. U.H.R. 12991-iii
2b-d. Transverse sections of Holotype. U.H.R. 12991-iv, vi, vii

Fig. 3: *Neokoninckophyllum nipponense* KATO, sp. nov.
Transverse section of a corallite showing dilation in tabularium. U.H.R. 12994-i

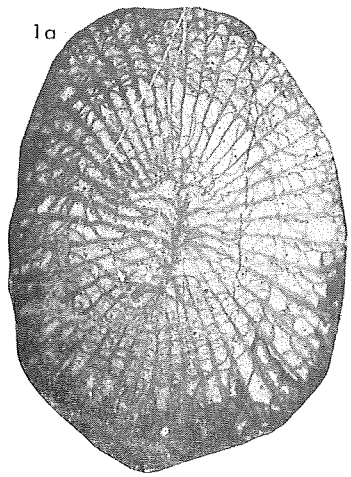
Fig. 4: *Neokoninckophyllum nipponense* KATO, sp. nov.
4a. Transverse section of a diphymorphic corallite, with *Lonsdaleia* sp. which has long minor septa. U.H.R. 12995-i
4b. Longitudinal section of the same corallite. U.H.R. 12995-ii

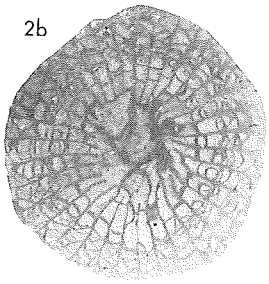
Fig. 5: *Neokoninckophyllum nipponense* KATO, sp. nov.
5a. Transverse section of a corallite which provides long major septa. U.H.R. 12997-iii
5b. Longitudinal section of the same corallite. U.H.R. 12997-ii

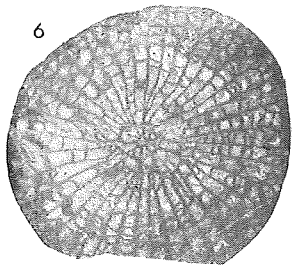
Fig. 6: *Neokoninckophyllum nipponense* KATO, sp. nov.
Transverse section of a corallite which provides long major septa. U.H.R. 13000-iii

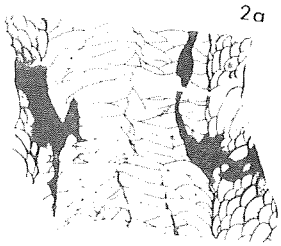
Fig. 7: *Neokoninckophyllum nipponense* KATO, sp. nov.
Transverse section of a large corallite which provides comparatively few numbers of major septa. U.H.R. 12999

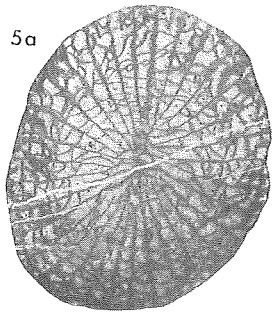
Fig. 8: *Neokoninckophyllum nipponense* KATO, sp. nov.
Longitudinal section of a small corallite showing a rather complicated axial structure. U.H.R. 12996-iv

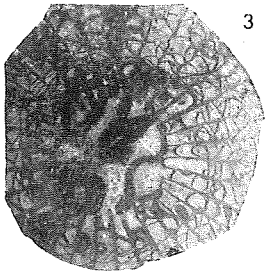

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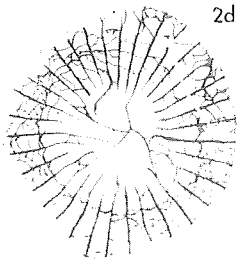

2b


6

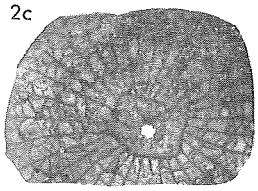

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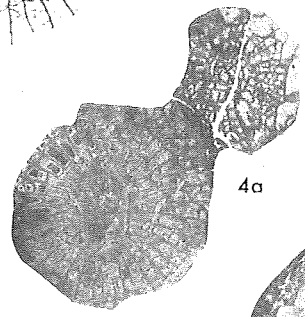

5a


3

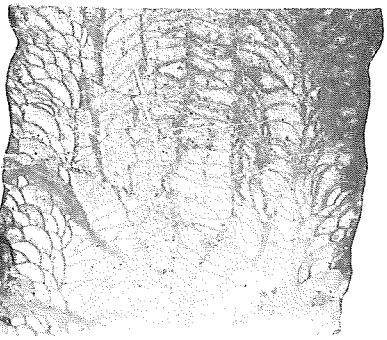

2d

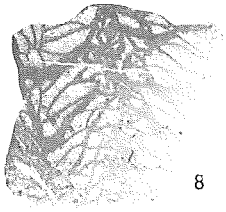

5b

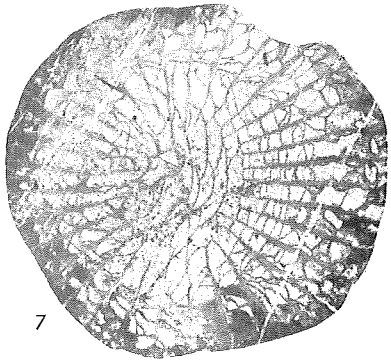

2c


4a


4b


1b


8


7

KATO Photo.

Explanation of Plate 2

Explanation of Plate II

All figures twice natural size except for fig. 1.

Fig. 1: *Rhodophyllum? minatoi* KATO, sp. nov.
Restored profile of Holotype showing relative position of each section in fig. 2. U.H.R. 13007. Natural size.

Fig. 2: *Rhodophyllum? minatoi* KATO, sp. nov.

2a. Transverse section. U.H.R. 13007-ii

2b. Longitudinal section. U.H.R. 13007-iii

2c. Transverse section showing rejuvenescence. U.H.R. 13007-iv

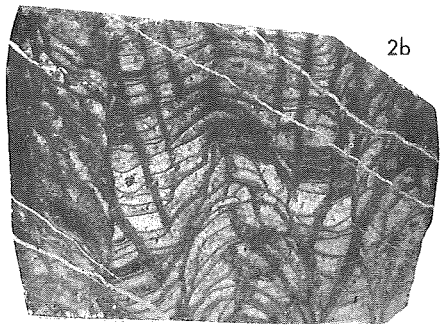
2d. Longitudinal section showing rejuvenescence.
The orientation of this section is vertical to that of the preceding 2b. U.H.R. 13007-v

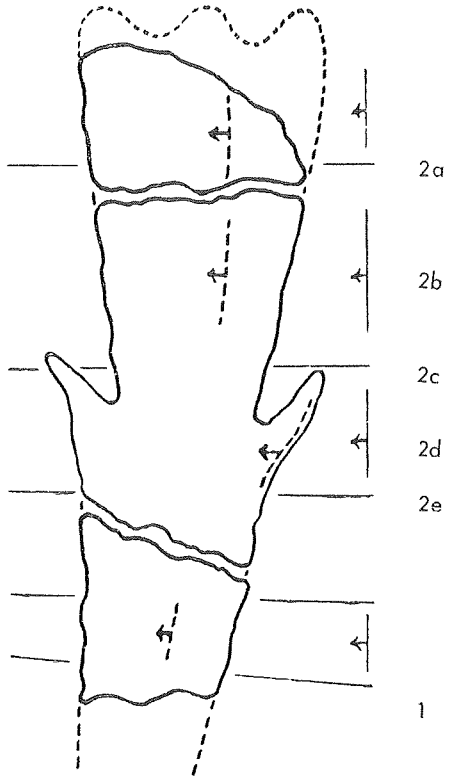
2e. Transverse section. U.H.R. 13007-vi

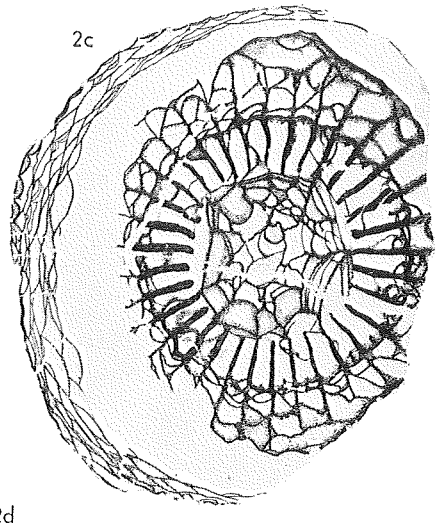
Fig. 3: *Rhodophyllum? minatoi* KATO, sp. nov.

3a. Transverse section of another corallite having rather long minor septa in comparison with the preceding specimen. U.H.R. 13008-i

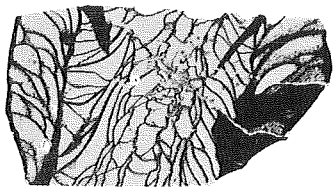
3b. Longitudinal section of the same corallite. U.H.R. 13008-ii

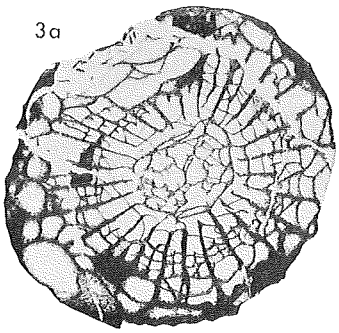


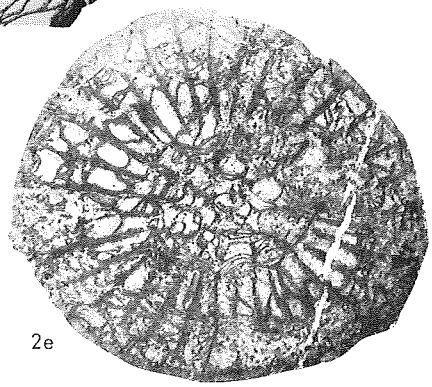


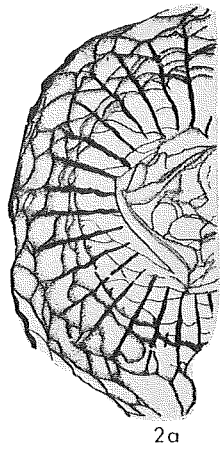












KATO Photo.

Explanation of Plate 3

Explanation of Plate III

Fig. 1: *Lonsdaleia* aff. *duplicata duplicata* (MARTIN)
Transverse section of a specimen.
Topmost large corallite shows numerous lonsdaleoid dissepiments: middle one is an ordinary corallite, and the lowest corallite has a compact axial column with numerous septal lamellae in it. U.H.R. 13018 ×2.5

Fig. 2: *Lonsdaleia* aff. *duplicata duplicata* (MARTIN)
Longitudinal section of one of the corallites of a specimen, showing a rather loosely constructed axial column. (slightly excentric) U.H.R. 13016 ×2

Fig. 3: *Lonsdaleia* aff. *duplicata duplicata* (MARTIN)

3a. Transverse section showing peripheral increase which occurs in one of the corallites of a specimen. U.H.R. 13012-ii ×2.5

3b. Transverse section of one of the corallites of the same specimen. U.H.R. 13012-iv ×2

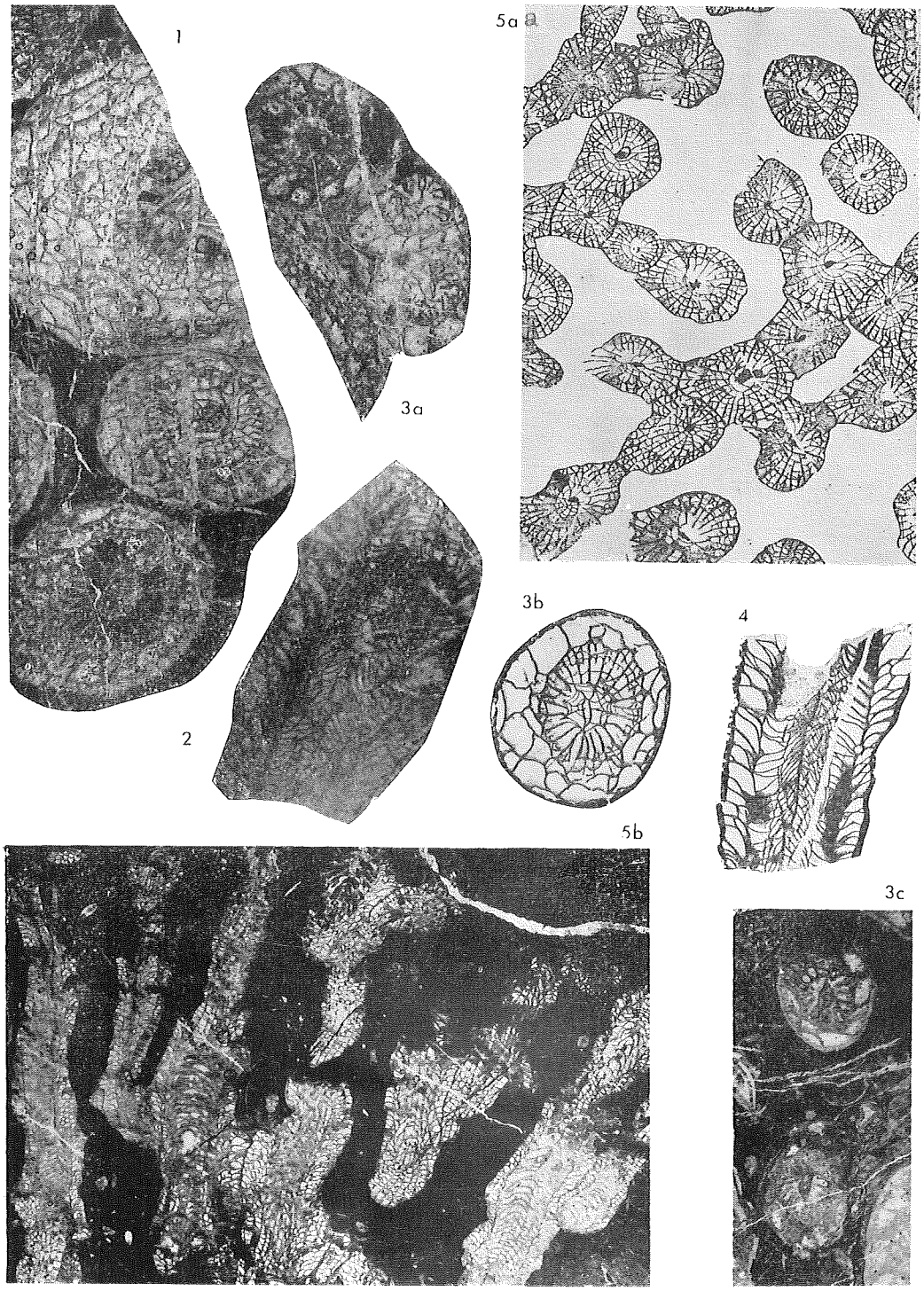
3c. Transverse section of young corallites of the same specimen. U.H.R. 13012-iii ×2.5

Fig: 4. *Lonsdaleia* aff. *duplicata duplicata* (MARTIN)
Longitudinal section of a detached corallite showing an axial column in typical cone in cone pattern. U.H.R. 13015 ×2

Fig. 5: *Siphonodendron hidense* KATO, sp. nov.

5a. Transverse section of Holotype. U.H.R. 13025-i ×2

5b. Longitudinal section of Holotype. U.H.R. 13025-ii ×3



KATO Photo.