Triassic Coral Faunas from the Konosé Group in Kyushu : With Notes on Stratigraphy

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Abstract

This paper presents the first description on the Triassic coral faunas from Japan. The material came from the upper part of the Konosé Group which is typically distributed in the middle course of the Kuma river, southern Kyushu. The faunas include three species each of *Montlivaltia*, *Thecosmilia* and *Procyclolites*, two species of *Thamnasteria*, and one species each of *Oppelismilia*?, *Elysastrea*? and *Conophyllia*?. Two species of *Thecosmilia* and one species of *Thamnasteria* are new. Most of the described species show a close affinity to the corals of the Norian and Rhaetian Zlambach beds of Austria, the Upper Triassic of Timor and the Carno-Norian of the northwestern North America.

The Konosé Group is a thick conformable series of eugeosynclinal lithologic assemblage, typified by dominant submarine volcanic ejecta, chert and limestone and subordinate slate. The obtained fossils (fusulines, ammonoids etc. in addition to corals) reveal that it ranges in age from the Upper Permian to the Upper Triassic. Its Triassic part shows a remarkable contrast in facies to the correlatives of the Inner Side of Japan, which are predominantly clastic sediments of neritic, paralic and limnic basins.

Introduction

It is well known that the Upper Triassic coral faunas characterized by a particular assemblage of species of montlivaltiid, procyclolitid, thamnasteriid etc. are distributed in a broad belt on the world as shown in Fig. 1. As is understood from this distribution map, however, for a great extent between East Central Iran and Alaska or between Timor and Alaska, the actual record has hitherto been almost blank. For instance, despite the wide-spread distribution of the Upper Triassic marine formations in the Japanese Islands, the existence of the coral fauna of a similar assemblage has been almost entirely unnoticed, except for a single record of occurrence of an undescribed species

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each of *Thecosmilia* and *Montlivaltia* from the Sambosan Limestone of southern Shikoku (EGUCHI, 1951).

The coral species described in this paper were obtained from two levels in the Konosé Group which is typically exposed in the middle course of the Kuma river in southern Kyushu. The faunas show their close affinities to the Upper Triassic coral faunas from the areas indicated in Fig. 1. This is of particular

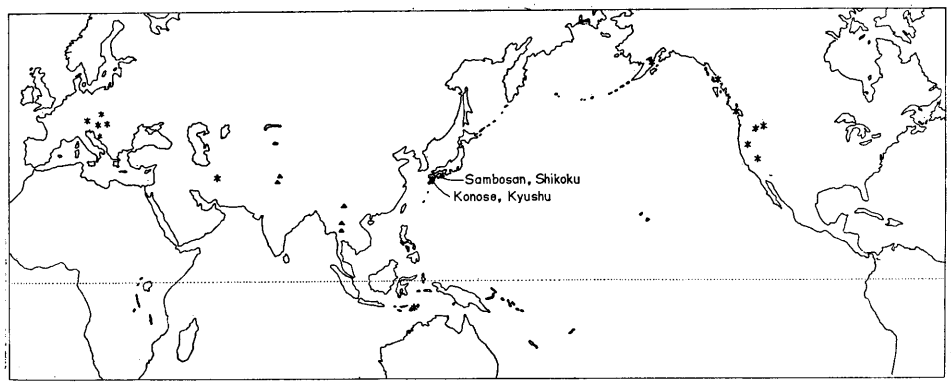

Fig. 1. Map showing the distribution of the Upper Triassic coral faunas (*)
(▲: Probably of the Upper Triassic, but not well investigated)

interest in that they can fill a large gap in our knowledge on the distribution of the Triassic corals and give important data for stratigraphic correlation. It is furthermore valuable for analysing facies and tectonic history of the Triassic formations in Japan. The Konosé Group and its extensions are distributed for a great extent in the southern belt of the Chichibu Terrain of the Outer Zone of Southwest Japan. They comprise sediments of eugeosynclinal facies with dominantly submarine volcanic ejecta, limestone and chert but their age and sedimentary environments have long been uncertain for the most part. In southern Shikoku KOBAYASHI (1931) reported the existence of a Ladino-Carnian limestone [later referred to Carnian by TOKUYAMA (1957)] in the Sambosan Group which occupies the same tectonic belt as the Konosé, and he (1941, 1951-1957) inferred the group as deep sea or abyssal sediments ranging probably from the Permian to the Lower Jurassic.

It is the purpose of this paper to describe the corals from the Konosé Group, with accounts on the faunal affinity and the stratigraphic significance.

Repository.—The specimens described in this paper are kept in the Type-Specimen Room of the Department of Geology, Faculty of Science, Kyushu University, Fukuoka. The registered numbers of the specimens are indicated in the systematic part of this paper and those of the figured specimens are given also in the explanations of Plates.

Acknowledgements.—I am much indebted to Prof. M. EGUCHI of Tohoku

University who critically read the typescript of the palaeontologic description of this paper and gave valuable instruction for the identification of species. I express gratitude to Mr. H. FURUKAWA of the Regional Agricultural Administration Office in Kumamoto, who collaborated in a part of field work and join me in describing *Notes on Stratigraphy* of this paper. Thanks are due to Prof. T. MATSUMOTO of Kyushu University for his constructive advice and suggestion in many ways and critically read the typescript, and to Prof. K. NAKAZAWA of Kyoto University, Assistant Prof. K. ICHIKAWA of Osaka City University, and Dr. N. KAMBE of Geological Survey of Japan, for their helps in a survey of literature. Misses T. MIYAZAKI and M. KIDO assisted me in type-writing and drafting. The financial aids were mainly granted by the Ministry of Education.

Preservation of the corals

All the specimens obtained are embedded in hard indurated limestone. Therefore, they have been examined through thin sections and on polished surfaces. In the present case etching method was not adequate for extracting specimens and making replicas.

Of the described species three are new, which are founded on relatively better preserved and sufficient materials. Many of other species are represented by a small number of more or less poorly preserved specimens. Therefore, it is difficult to determine accurately their specific names. Skeletal parts of the coralla are almost completely changed to sparry calcite, and nothing is shown about their microstructures.

Palaeontologic Description

Order Scleractinia
Superfamily Stylophyllicae VOLZ, 1896
Family Stylophyllidae VOLZ, 1896
Genus *Oppelismilia* DUNCAN, 1867

Type-species.—*Oppelismilia gemmans* DUNCAN, 1867

Oppelismilia? sp.
Pl. 13, fig. 10

Material.—One incomplete, slightly diagonal transverse section of a specimen; GK. F358, from loc. Ko. 724. The skeletal part of the corallum is completely recrystallized.

Descriptive remarks.—Corallum simple, ovoid in cross-section, 14 mm by 10 mm (slightly deformed) in diameter. Outer wall partly recognized. Septa not exsert.

The accurate septal count and the succession of septal cycles cannot be

known. There are, however, about 40 to 42 septa in a half circle of the corallite, therefore, there must be 80, or some more or less, septa in all. Not a few of the longer septa reach the central part of the corallite.

Septa thin, straight, and distinctly discontinuous. Septal perforations not frequent. There appear to be no septal granulation on their surfaces. It is not clear whether a columella is present or not, but there is an oval-shaped trace-mark like the vestige of a columella at the center of the corallite.

Due to the incompleteness of the material, the specific as well as the generic identification of this species cannot be made, but its general features show a similarity to *Oppelismilia polyactis* (FRECH) (1890, p. 48, pl. 12, fig. 3; pl. 15, figs. 17-23) from the Zlambach beds of Austria.

Superfamily Faviicae GREGORY, 1900
Family Montlivaltiidae DIETRICH, 1926
Subfamily Montlivaltiinae DIETRICH, 1926
Genus *Montlivaltia* LAMOUROUX, 1821

Type-species.—*Montlivaltia caryophyllata* LAMOUROUX, 1821

Montlivaltia sp. cf. *M. norica* FRECH
Pl. 12, figs. 6-10

Compare.—

1854 *Montlivaultia capuliformis* REUSS (not M.-EDWARDS and HAIME, 1851), Denkschr. K. Akad. Wiss. Wien, Bd. 7, p. 102, pl. 6, figs. 16, 17.
1890 *Montlivaltia norica* FRECH, Palaeontographica, Bd. 37, p. 39-40, pl. 3, figs. 8, 9A, B; pl. 10, figs. 1-5; pl. 13, figs. 1-7; pl. 18, figs. 17, 17a.
1927 *Montlivaultia norica*, SMITH, U. S. Geol. Survey, Prof. Paper 141, p. 126-127, pl. 111, fig. 6.
1927 *Stylophyllopsis mojsvari* SMITH, Ibid., p. 127, pl. 118, fig. 10.
1956 *Montlivaltia norica*, SQUIRES, Amer. Mus. Novitates, no. 1797, p. 21-22, figs. 32-47.

Types of Montlivaltia norica.—This species was founded on the specimens from the Zlambach and Gosau beds, and includes forms which may be divided into subspecies or even to different species. As already pointed out by FLÜGEL (1960, p. 246), the designation of the lectotype and the subsequent revision of the species are requisite for future identification. Someone who is able to examine the syntypes should do this work.

Material.—Three incomplete, largely recrystallized specimens, GK. F331, 336 and 338 from loc. Ko. 278.

Description.—Corallum simple, conical; elliptical to subcircular in cross-section, about 15 mm by 9 mm in diameter for the largest specimen obtained; exact height unknown, but more than 20 mm in the same specimen.

Outer wall extremely thin, recognizable in part.

Septa very numerous; although exact septal counts cannot be given, there are about 50 septa in a half circle of the corallite of 8 mm by 12 mm in diameter (GK. F331), so that there must be about 100, or a little more or less, septa in

the entire circle of the specimen. In another expression, there are 11 to 15 septa in a distance of 5 mm. In the same corallite 22 septa are present in a half circle of the section of 4.5 mm by 6.5 mm in diameter.

Septa thin and long, and at least 5 cycles are recognized. Those of the first two cycles are the thickest, nearly the same in development, and reach the corallite center, but are not joined with together. The third cycle septa are thinner and slightly shorter, but extend also closely to the center. The septa of the fourth cycle are about a half to two-thirds of the radius of the corallite, and of the fifth cycle are shorter than one-third of the radius. Very short, rudimentary septa of the sixth cycle occur in the sectants of the longer axis sides of the corallite. The septa of the first cycle are thicker in the young stage than in the mature stage.

Dissepiments seem to be somewhat elongate and gently inclined.

Comparison.—As stated above, this species originally includes diverse forms, of which the specimens (pl. 10, figs. 3-5; pl. 13, fig. 5) from the Zlambach beds of the Fischerwiese are adopted as a normal form of this species according to FRECH'S designation.

The obtained specimens show a close resemblance to the above mentioned form of this species in many features, especially in having numerous long septa of more than six cycles, of which those of the first three cycles reach the center of the corallite. Nevertheless they are smaller in size and subsequently have fewer septa. These differences may be due to the incompleteness of the material, because the largest specimen obtained has lost not a small terminal portion of the corallite owing partly to the destruction on occasion of collecting and partly to the erosion before the collection as the specimen had been exposed on the river bottom facing its calical side upwards. The other specimens are just accidental slices of fragmental materials.

Another difference is in that the present specimens have a thin outer wall in part, especially in the young stage, although whether the outer wall was originally complete or of limited development is uncertain.

Montlivaltia sp. cf. *M. timorica* VINASSA

Pl. 12, figs. 4, 5; Text-fig. 2

Compare.—

1915 *Montlivaltia timorica* VINASSA, Palaeontologie von Timor, Lief. 4, Abb. 8, p. 97, pl. 70 (8), figs. 4-7.

Type of M. timorica.—One of the illustrated syntypes of VINASSA [1915, pl. 70(8), fig. 4(=6)] is here designated as the lectotype of this species.

Material.—Three transverse sections obtained from a single incomplete specimen, GK. F330, from loc. Ko. 325. Not a small part of the interior of the corallite has been recrystallized to mosaic calcite.

Description.—Corallum simple, subcircular in cross-section, with a lobate outline in part and a diameter of 11 mm by 16 mm. Height of the corallite unknown. Epitheca very thin, encircling the corallite nearly completely.

Septa characteristically thin and minutely flexuous, always extended towards the center of the greater diameter of the corallite. They seem to consist probably of one fan system of simple trabeculae.

The septa have distinct, short synapticulae spines or processes on their lateral surfaces. The spines occur almost always on the ridges of alternate exterior angles at the flexure-points of the septa, but never occur in the insides of interior angles; namely, those spines are not arranged in a pair on both the lateral sides of a septum. Thus, this structure assumes a distinct zigzag aspect in transverse sections of the septa (Fig. 2). In transverse sections certain

Fig. 2. Enlarged figure of a part of *Montlivaltia* sp. cf. *M. timorica* VINASSA, showing the zigzag septal structure. ×10

septa are provided with spines for a fairly long distance, but others are not. This structure shows that the spines are arranged in nearly horizontal rows. The spines occur mostly in the peripheral and middle parts of the septa, but are very rare in the proximal part of the septa.

There are at least 96 septa, excluding very short or rudimentary septa (more than 10) of the sixth cycle, in a section of 11 mm by 16 mm in diameter. In another expression, there are usually 4, rarely 3 or 5, septa in a distance of 1 mm at the peripheral area of the corallite.

6 or 8 of the septa are the longest and reach the corallite center, but not joined with together at their proximal ends. Most of the second cycle septa also extend near the center. The septa of the third cycle are slightly shorter and those of the fourth are about two-thirds to a half of the radius of the corallite. The septa of the fifth are about a half of the radius and those of the sixth shorter than a half of the radius or rudimentary.

The septa are very thin at their distal parts, and especially the septa of the fourth and later cycles are very thin throughout their length and are less zigzag than those of the earlier cycles.

The dissepimentarium occupies the most part of the endotheca except the central fossular area. So far as is seen in transverse sections, the dissepiments

of the outer series are small, closely spaced, and concentrically arranged, and those of the inner series larger and widely spaced.

No columella is present and the central fossula is rather wide.

Comparison.—This species is characterized by its compressed or lobate transverse outline of the corallite and thin, numerous, minutely flexuous septa with spines in zigzag positions on their surfaces. In these characteristics this species belongs to a group of *Montlivaltia verae* VOLZ (1896, p. 45, pl. 3, figs. 17-21) from the Upper Ladinian Cassian beds of Southern Tyrol. However it is distinguished in having much more numerous septa (about twice) and in that the septa are not exsert.

In many important characteristics the present specimens are very close to the types of *Montlivaltia timorica* VINASSA (1915, p. 97, pl. 70, figs. 4-7) from the Upper Triassic of Timor. They well agree with each other, particularly in the septal structure and the number of the septa. Small differences are recognized in that the Konosé specimens have an irregular transverse outline and are slightly smaller. These differences may be regarded as mere variation within the species in question. However, owing to the insufficiency of the material, the definite identification is postponed until the sufficient material is obtained.

Montlivaltia sp. cf. *M. stylophylloides* VINASSA
Pl. 12, figs. 1-3

Compare.—

1915 *Montlivaltia stylophylloides* VINASSA, Palaeontologie von Timor, Lief. 4, Abb. 8, p. 100, pl. 68, figs. 3-6.

Types of M. stylophylloides.—This species was erected on two syntypes, and VINASSA's description is largely based on the sectioned specimen. Therefore the specimen illustrated as fig. 4 of pl. 68 is here designated as the lectotype.

Material.—A single incomplete specimen (GK. F337), from which two transverse sections, one through near its upper end and the other through its young part, and one longitudinal section were obtained. Since the specimen had been exposed facing its calical side on the river bottom, a certain length of the upper part of the corallite must have been eroded away. Loc. Ko. 278.

Description.—Corallum simple, curved trochoid, with an elliptical outline. The corallite is incomplete, but it attains 17 mm by 23 mm in diameter and 20 mm in length. Nothing is known of the outer surfaces including outer wall.

Septa straight, or slightly flexuous, and characteristically very thick. There are about 42 septa, although, besides these, there are some vestiges much like septa. The succession of the septal cycles cannot be clearly understood, but the longer and shorter septa are not always arranged in a regular system. About 10 septa are the longest and thickest, and reach the center of the corallite. Being inserted between them there are about 10 septa of the following order in length and thickness. Alternating with these longer septa, but not always,

there are shorter and thinner septa which are about two-thirds to a half of the radius of the corallite.

A longitudinal section demonstrates that the dissepiments are elongate vesicular and gently inclined. No columella is present.

Comparison.—Although the material is too poorly preserved and insufficient for identification, its general form, its stout septa and the arrangement of the septa strongly suggest that it is very close to *Montlivaltia styllophylloides* VINASSA from the Upper Triassic of Timor. The sparse distribution of intercepts of dissepiments in VINASSA's specimen (pl. 68, fig. 4) shows that the types have probably gently inclined dissepiments as in the Konosé specimen.

The present specimen is slightly smaller than the types of the above mentioned species but, as stated above, a certain length of its calical part must have been eroded away. It may probably be referable to the species under consideration.

Genus *Thecosmilia* M.-EDWARDS and HAIME, 1848

Type-species.—Lithodendron trichotomum GOLDFUSS, 1826

Thecosmilia eguchii, sp. nov.
Pl. 17, figs. 1-7; Pl. 18, fig. 7

Material.—Holotype, GK. F341; paratypes, GK. F342, 343 and 344. All came from loc. Ko. 278. The skeletal parts of coralla are almost completely replaced by calcite crystals, so that their microstructures cannot be known.

Description.—Coralla phaceloid, composed of moderately large, long cylindrical and slightly curved corallites. The largest corallum obtained is approximately 60 mm in diameter and at least 110 mm in height, but since it was embedded in compact limestone, its size and shape and the nature of the outside surfaces of the corallites cannot be known.

Corallite walls thin, mostly 0.1 mm, rarely attain 0.15 mm. Corallites rather irregularly arranged, usually circular to elliptical in cross-section. Just before a new branch appears the corallite assumes a compressed shape with a slight contraction at the middle part of the elongated side. In this distmodaeal budding two long opposite septa on the compressed side of a corallite are connected with each other and the septa on the elongated side are retreated, and then the corallite is divided into two parts, each of which is provided with its own axis and becomes individualized as separate corallites in parallel position.

Mature corallites 4.5 to 6.5 mm and 5.7 to 9 mm, respectively, in the shortest and longest diameter. The corallites with a circular shape in cross-section are mostly 5 to 7 mm in diameter.

Mature corallites have septa of 4 or 5 cycles, of which those of the fifth cycle are incomplete in many of the corallites. The number of the septa with relation to the size of the corallites is as follows:

Diameter (mm)	Number of septa
2.2 × 2.8	29 (with some rudimentary septa)
4.8 5.2	44
4.5 5.2	46
4.5 5.7	48 (with some rudimentary septa)
4.2 6.7	52
5.8 6.0	56
6.5 6.5	58
5.3 6.3	60
5.0 7.5	64
5.0 7.0	64
5.0 7.8	64
7.0 7.0	64

In the mature corallite some of the septa of the second cycle have attained a level of development equal to the septa of the first cycle and reach the center of the corallite. Thus the septa show the octameral or decameral arrangement. The septa of the third cycle are usually a little shorter and thinner, but in the full-grown stage some of them reach the center and are as long as those of the first two cycles. The fourth cycle septa are four-fifths or two-thirds the radii of the corallites, and are thin at their distal parts, but are as thick as those of earlier cycles at their basal parts. The septa of the fifth cycle are thinner and about a half of the radii of the corallites.

Essentially no columella, but sometimes two, rarely three, septa are joined with together at their distal ends and form a thin lamella seemingly like a columella.

Dissepimentarium occupies about four-fifths the radius of the corallite. In the longitudinal sections, there are at least five series of vesicular dissepiments. Those of the outer series are semi-globose and gently inclined, of the middle series elongated and steeply inclined, and of the innermost series dip again gently and anastomose with one another at the central part of the corallite.

Comparison.—The present species is similar to the species identified by SMITH as *Thecosmilia norica* FRECH (1927, p. 128, pl. 61, figs. 1-4) from the Blue Mountains, Oregon, but it is distinguished by its smaller corallites. It is also different from the types of *Th. norica* described by FRECH (1890, p. 9, pl. 1, figs. 14-24a; pl. 10, figs. 6, 6a) from the Zlambach beds in its much smaller corallites and its more complete outer wall.

The present species is also similar to *Th. caespitosa* REUSS from the Zlambach beds (FRECH, 1890, p. 7, pl. 1, figs. 1-13) but differs in its closer arrangement of the corallites and its more numerous septa.

This species is dedicated to Prof. M. EGUCHI, who has greatly contributed to our knowledge on the Mesozoic corals from Japan.

Thecosmilia sp.

Pl. 13, fig. 12; Pl. 14, figs. 1-13

Material.—GK. F356, from loc. Ko. 232. This specimen is a large colony

spreading over 300 mm in diameter and height, but unfortunately its internal structures have been largely obliterated due to recrystallization.

Description.—Corallum phaceloid, with cylindrical and irregularly flexuous corallites which are rather crowded and irregularly distant. They are unequal in diameter, due to the prevalence of frequent budding, which is distmodeal, always one new bud arising.

Corallites usually subcircular, but tend to be elongate in cross-section; adult corallites measuring mostly 6 to 9 mm, rarely 10 to 12 mm. At the budding site the corallites assume a highly compressed form and attain 12 to 14 mm in the longest diameter.

Outer wall thick in the young corallites, but becomes thinner, or may be not present, in the adult.

Septa are numerous in the adult corallites. So far as is measured, there are at least 76 septa in a corallite of 9.5 mm by 12 mm in diameter. A young corallite of 7 mm by 8.5 mm in diameter has 44 septa including rudimentary ones, and that of 5.7 mm by 8 mm in diameter has 40 septa. In the peripheral area of the adult corallites there are usually 6 to 7, rarely 5, septa in a distance of 2 mm.

The succession of the septal cycles is hardly discriminated because of poor preservation of the material. However, in one adult corallite of 9.5 mm by 12 mm in diameter with at least 76 septa, most of the longer septa which include probably the first three cycles extend to or near the center of the corallite, and a few or several neighbouring longer septa sometimes appear to join with together at their distal ends. Between these longer septa there are shorter septa probably of the following cycle. The shortest septa are usually a half of the radius or slightly longer.

All the septa of adult corallites are very thin and almost equal in thickness throughout their length, but those of young corallites, particularly of less than 5 mm in diameter, are thicker and the longer septa often join with together at the center of the corallites. It is uncertain whether the septa are granulated or not on their surfaces, but so far as is seen, they appear to be smooth.

Adult corallites have no columella, but as stated above, some of the septa of the early cycle in the young corallites tend to be joined with together at the corallite center, forming there a probably trabecular columella or a short lamellar plate.

Dissepiments appear to be concentrically arranged and closely spaced in the peripheral area, but due to the recrystallization of the interseptal loculi nothing more can be given on dissepiments.

Comparison.—Due to the poor preservation of the material, this species is tentatively placed in this genus. The general form of this species is thecosmiliid, but no closely allied species has been known so far as the accessible papers are concerned.

This species is most close to the species described by SMITH (1927) as *Thecosmilia norica* FRECH (p. 128, pl. 111, figs. 1-4) and *Stylophyllopsis zitteli* FRECH (p. 127, pl. 111, figs. 7-9) from Martin Bridge, Blue Mountains, Oregon. As already pointed out by SQUIRES (1956, p. 19 and 23), both are nothing but

one and the same species, and are distinguished from FRECH's species as a new species of *Thecosmilia*. The Konosé species differs from this in its smaller corallites, thinner septa and less developed outer wall.

Thecosmilia konosensis, sp. nov.
Pl. 15, figs. 1-8; Pl. 16, figs. 1-9

Material.—Holotype, GK. F348 (monotypy), from loc. Ko. 325. This specimen is about 250 mm in diameter and at least 150 mm in height. It is embedded in compact limestone, and distal sides of the corallites face in some swarms towards different directions. From this aspect the specimen might be taken to include several colonies, but it is regarded here as representing one and the same colony, because it occurred as a single isolated specimen. It is rather well preserved, but peripheral areas of the corallites are often replaced with calcite by secondary mineralization.

Description.—Corallum phaceloid, partly semi-prismatic; corallites somewhat flexuous and cylindrical, and arranged in subparallel and irregular distances. Since budding is frequent, they may be in contact for some distance, usually 10 to 15 mm, at the budding site, where usually three, sometimes four, new corallites have in part semi-prismatic common walls between adjacent ones and in other part semi-circular peripheries.

Mature corallites are 6 to 7.5 mm in diameter and have 48 septa of 4 cycles. The number of septa with respect to the diameters of the corallites is as follows:

Diameter (mm)	Number of septa
4 × 4	20
4 7	22 (excluding rudimentary projections between the longer septa)
3.7 6	28 (〃)
5 6	28 (〃)
4.2 5	30 (〃)
5.5 6	32 (〃)
6 6	32 (〃)
6 6	40 (〃)
6 7	42 (〃)
7 7.5	48 (excluding 48 rudimentary projections between the longer septa)
7.2 10 (slightly deformed)	48 (〃)

The septa of the fifth cycle remain as septal ridges even in the mature corallites. If they are taken into account, the total number of the septa attains 96 in 5 cycles.

In the early mature stage the corallites have usually 32 septa, of which those of the second cycle probably in the dorsal and ventral sectants reach the center of the corallite and are nearly as thick as those of the first cycle; in consequence the septa show often octameral, sometimes decameral, arrangements.

In the mature corallites with 48 septa the hexameral arrangement of the septa is common, and three alternating protosepta are often connected with together at their distal ends and divide the corallite into three sectants. The corallites with the septa of the octameral arrangement are sometimes divided into four sectants.

The septa of the third cycle are thinner and two-thirds to a half as long as the radii of the corallites. Those of the fourth cycle are very thin and are a little shorter than a half of the radii of the corallites.

The septa are slightly flexuous, but tend to be straight as the corallites grow. No particular surface structure of the septa is recognized. The septa are often fairly to strongly thickened in the peripheral zone so as to be laterally in contact with the neighbouring ones.* The microstructure of the septa cannot be known.

There is no essential columella, but just before budding, as mentioned above, the conjugate point of the septa at the center of the corallite forms seemingly a columella- or lamella-like axial structure.

Dissepimentarium varies in width with the length of the septa of the third and fourth cycles. In the mature stage it is about two-thirds to a half as wide as the radii of the corallites and occupied by dissepiments of two or three series. Those of the outermost series are large, usually globose, sometimes elongated, and inclined at about 45 degrees or more. Those of the second series are generally smaller, globose or elongated, and inclined steeply. Those of the innermost series are again large, elongated, slightly undulating, inclined rather steeply, and inosculate with those of the opposite side at the central part of the corallite. In the young stage where the septa of the third and fourth cycles are still short, there is only one series of vesicular dissepiments and the central part of the corallite is occupied by rather steeply inclined platy partitions which inosculate with one another. In the immature stage such as smaller than 4 mm in the shortest diameter there are no vesicular dissepiments, but are flat or slightly undulating partitions which may be better called tabulae.

In the transverse sections the dissepiments are arranged concentrically, but not regular. Those of the peripheral series are concave towards the center of the corallite, but those of the inner series are convex.

Notes on budding of new corallites.—As mentioned above, for the most case three, rarely four, protosepta are joined with together at the center of the mature corallite and divide it into three or four sectants. These dividing septa are much more thickened than others and become common walls between the neighbouring sectants which in due course grow up as new buds to cylindrical corallites. In the central and middle parts of the parent corallite four new short spines or rudimentary new septa appear at the same time on both sides of each dividing wall. As the sectants become larger, these septa become thicker and elongated towards the center of each sectant, and there appear septa of the next cycle alternating them, and the septa in the peripheral part of the parent corallite

* The septa in the peripheral area are not uncommonly discontinuous owing to secondary replacement by sparry calcite.

become slightly retreated. Thus three or four new buds arise simultaneously, and each bud is provided with sixteen new septa in addition to the septa of the peripheral side of parent corallite and with its own corallite center. The eight septa mentioned above attain a level of development equal to those of the first two cycles of the parent corallite.

Comparison.—The present new species is closely allied to *Thecosmilia subdichotoma* MÜNSTER described by VOLZ (1890, p. 22, pl. 1, figs. 17-21; text-figs. 7, 16, 19, 20) from the Upper Ladinian Cassian beds of Southern Tyrol and also by VINASSA de REGNY (1915, p. 91, pl. 68, fig. 7) from the Upper Triassic of Timor. However it can be distinguished in its more numerous septa and especially in its different mode of budding.

Genus *Elysastraea* LAUBE, 1865

Type-species.—*Elysastraea fisheri* LAUBE, 1865.

Elysastraea? sp.
Pl. 13, fig. 11

Material.—A small colony of 3.5 mm by 20 mm in diameter and 20 mm in height; GK. F357, from loc. Ko. 278. It is so strongly recrystallized that only a few corallites in the marginal part of the colony are examined.

Descriptive remarks.—Corallum massive, cerioid, mostly with pentagonal or hexagonal corallites, which are mostly 3 to 3.5 mm in diameter. Common walls seem to be rather thin.

There are about 42 septa in a corallite of 3 mm in diameter, of which about 12 septa reach the central part of the corallite. Three or four neighbouring septa including shorter ones seem to sometimes be joined at their inner ends.

Septa rather thin and straight, becoming slightly thicker in the peripheral area. Some of the longest septa seem to be joined with together at their inner ends and may form a trabecular columella.

Nothing can be known of other elements of the corallum.

This species is tentatively placed in this genus. It is somewhat similar to *Elysastraea profunda* (REUSS) from Idaho (SQUIRES, 1956, p. 25, figs. 48-51) in the corallite size and the number of the septa, but exact comparison cannot be made because of poor preservation of the material.

Superfamily Agariciicae GRAY, 1849
Family Procyclolitidae VAUGHAN and WELLS, 1943
Genus *Procyclolites* FRECH, 1890

Type-species.—*Procyclolites triadicus* FRECH, 1890

Procyclolites sp. cf. *P. triadicus* FRECH
Pl. 12, figs. 11-15; Text-fig. 3

Compare.—

1890 *Procyclolites triadicus* FRECH, Palaeontographica, Bd. 37, p. 64, pl. 18, figs. 1-16.
1915 *Procyclolites triadicus*, VINASSA de REGNY, Palaeontologie von Timor, Lief. IV, Abh. 8, p. 102, pl. 71 (9), fig. 14.

Type of P. triadicus.—The specimen illustrated by FRECH (1890) as fig. 7 of pl. 18 should be designated as the lectotype. Since, however, I have not seen the type-specimens, I hesitate to do that.

Material.—Four poorly preserved specimens have been obtained, GK. F332, 333, 334 and 352, from loc. Ko. 278.

Description.—Of the obtained specimens, the largest corallum is 55 mm by 35 mm wide and about 40 mm high, consisting of a large central corallite and four small lateral ones. No walls between the corallites. The corallite centers are linked to each other by septal plates (lamellar linkage). Four of them, including that of the central corallite, are disposed in a curved linear row, and the remaining one stands in a forked link from the central corallite. The central corallite is much larger than the lateral ones, measuring 30 mm in the longest diameter.

The smaller specimen of 25 mm by 15 mm wide and 20 mm high is made of a large central corallite and two smaller lateral ones, the latter are joined to the former respectively with a lamellar linkage.

The margins of the coralla are gently undulated in young stages, but strongly lobed in part in the mature stage. Outer wall is recognized in part, being 0.1 mm thick.

Due to strong secondary recrystallization it is difficult to know the true number of septa and to distinguish the septal cycle for each septum. So far as is observed, however, about 130 to 135 septa are enumerated in the peripheral area of the central corallite of the largest specimen. At the peripheral margin there are 16 to 18 septa in a distance of 5 mm. At least 12, commonly 16 to 18, septa reach the corallite center and the alternating septa are extended very close to it.

Septa very thin, lamellar, nearly the same in thickness throughout their length and ontogeny, although their peripheral ends are slightly thicker. The septa which extend more than a half of the radius are 0.1 to 0.15 mm thick and the shorter ones of the later cycles are 0.05 to 0.1 mm thick. They are delicately serrated on their surfaces. This structure is found only in the mature stage. Secondary mineralization has not only completely destroyed the minute septal structure but also largely smothered the serrated structure so as to superficially be smooth. As is shown in Fig. 3, however, distinct rods which are considered to be relicts of original synapticulae are not uncommonly recognized.

Dissepimentarium seems to occupy nearly the whole endotheca except for a narrow central area of the corallite. Dissepimental vesicles are slightly elongated and are arranged almost horizontally or very gently. There is no axial structure.

Comparison.—Due to the strong secondary replacement, many important

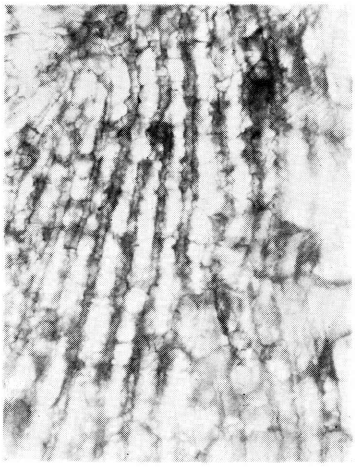

Fig. 3. Enlarged figure of a part of *Procyclolites* sp. cf. *P. triadicus* FRECH, showing the septal structure. ×10

characters of this species have been largely obliterated. However, the characteristics observed show a close resemblance to those of *Procyclolites triadicus* FRECH from the Zlambach beds of Austria. A minor difference is seen in that the Konosé specimens have probably no septal perforations. However, FRECH (1896, in the explanation text of pl. 18) indicated that the septal perforations in the type-specimens are developed only in the peripheral area and the upper part of the corallite and are variable.

I believe that the present species is assignable to *P. triadicus*, but I still hesitate to definitely identify, because of poor preservation of the material.

Procyclolites? sp. aff. *P. timoricus* (VINASSA)
Pl. 13, figs. 1-5

Material.—Only one specimen, GK. F355, from loc. Ko. 278. Its interior structures are largely obliterated by recrystallization.

Description.—Corallum probably simple, cylindrical; about 20 mm in height and 12 mm in diameter. The longitudinal section shows that the corallite has broad and high wrinkles at irregular interavls, and the transverse sections demonstrate that a very thin epitheca encircles the corallite.

Septa thin and almost straight. Although exact septal counts cannot be obtained, there are as many as at least 110. In another measuring way there are 7 to 8 septa in a distance of 2 mm at the peripheral area. The septa of at least the first three cycles reach the center of the corallite or near there. The septa have strong ridges on their lateral surfaces and not a few of the ridges are connected with those of the neighbouring septa, forming synapticulae. However, nothing more in detail on the septal structure and also on the dissepiments can be added due to secondary replacement.

Comparison.—Due to the incompleteness of the material, it is uncertain whether this species is truely of a simple form or dendroid.

This species resembles *Procyclolites timoricus* (VINASSA) (1915, p. 101-102, pl. 71, figs. 11-13) more closely than to any other forms, but it differs in its much more elongate cylindrical and smaller corallite. This species is also similar to *P. gracilis* (LAUBE) (1865, p. 252, pl. 3, fig. 5b; VOLZ, 1896, p. 76, pl. 9, figs. 10-15) from the upper Ladinian Cassian beds of Southern Tyrol, but it is distinguished in its less numerous septa (about half of those of the latter).

Procyclolites? sp.
Pl. 18, figs. 1, 2

Material.—GK. F353, from loc. Ko. 278. Six corallites embedded in a single small rock-specimen are referable to this species. They are so poor in preservation that the generic as well as specific identification is uncertain.

Description.—Six corallites obtained are disposed at irregular distances from one another within about 30 mm square. This species is probably of small dendroid habit with cylindrical corallites, which are 4.5 to 6 mm in diameter and are circular to subcircular in cross-section, except for branching sites where the corallites assume a more compressed, elongate oval-shape. The height of the corallites is unknown.

A new bud gives rise to the narrower end of an elongate oval corallite. As it grows, the contraction of the corallite ring is taken place at the boundary zone between the new bud and the parent corallite.

Outer wall not recognizable, although it may be developed in part.

Septa exsert, moderately thin, and nearly equal in thickness throughout their length, except their distal ends where they become thinner. There are about 56 septa in a corallite of 4 mm by 5 to 5.5 mm, 62 in that of 4.2 mm by 5 mm, and 70 in that of 4 mm by 6 mm in diameter. In another measuring way there are usually 6 to 7, rarely 5, septa in a distance of 1 mm at the periphery of the corallites.

Due to poor preservation of the material, the succession of the septal cycles is not clearly discriminated, but the septa of probably the first two cycles are almost equal in length and reach the central part of the corallite. The septa of probably the third cycle are slightly shorter and those of the following cycle are two-thirds to a half of the radius of the corallite. The shortest septa are one-third as long as the radius to rudimentary.

The septa appear to be sparsely granulated on their lateral surfaces, and there are not a few bars or rods connecting the surfaces of the neighbouring septa. They are too thick to be regarded as intercepts of dissepiments and may probably be synapticulae.

No columella is present. Very faint vestiges of intercepts of dissepiments can be recognized, but nothing more in detail can be given on their structure.

Comparison.—Due to poor preservation and insufficiency of the material, its

generic identification is doubtful. However, the thin and long, granulated septa and the general features suggest that it may belong to the genus *Procyclolites*. This species is somewhat similar to *P. dichotoma* KLIPSTEIN described by VOLZ (1896, p. 78, pl. 9, figs. 16-24; text-fig. 39) from the Upper Ladinian Cassian beds of Southern Tyrol, but differs in that the granulation and synapticulae of the septa of this species are not so strong as those of the latter. So far as the septal granulation is concerned, this species approaches the group of *P. badiotica* LORETZ described by VOLZ (1896, pl. 9, fig. 9; text-figs. 39, 41), but differs in many other structures such as the shape of the corallite, the number of the septa, etc.

Genus *Conophyllia* ORBIGNY, 1849

Type-species.—*Montlivaltia granulosa* MÜNSTER, 1841

Conophyllia? sp.
Pl. 17, fig. 8; pl. 18, figs. 3-6

Material.—GK. F345, 346 and 347, from loc. Ko. 278. The structures of these specimens have been largely obliterated due to recrystallization, so that only brief accounts can be given.

Description.—Corallum phaceloid, with corallites arranged irregularly and in subparallel. Corallites circular to subcircular in cross-section, ranging in diameter from 5 to 7.5 mm.

Epitheca well developed, very thin, almost encircling the corallite. Septa not exsert, fairly numerous. So far as is measured, there are approximately 50 to 60 septa in the corallites of 5 to 7 mm in diameter as shown in the following table.

Diameter (mm)	Number of septa
3 × 5	38
5 5	50
4 5.5	54
4 6	56
5 7	60

In the largest corallite with a diameter of 5 mm by 7.5 mm (slightly diagonal section) there are 40 septa, including short septa of the fifth cycle, in a half circle of the corallite.

The septa, at least the longer ones, have distinct lateral granulations, and a pair of spinose ridges occur on the opposite sides of the adjacent septa, although they seem to be not always regularly opposed to each other. The septa may probably be perforated only in their distal parts near and at the calical end, but they seem to be continuous in other parts.

Many of the septa of the first two cycles reach the center of the corallite and are joined with a columella. The septa of the third cycle are nearly equal in

thickness to those of the earlier cycles, and extend close to the columella. Those of the fourth cycle are thinner and are two-thirds to a half of the radius of the corallite. The fifth cycle septa are short and many of them are rudimentary. The septa of the later cycles are sometimes leaned to the earlier septa at their distal ends. A styliform columella is prominent in most of the corallites, oval in cross-section, usually 0.5 mm by 1 mm in diameter.

Dissepiments are relatively large, consisting of elongate to subglobular vesicles, and are rather steeply inclined at an angle slightly less than 45 degrees.

Comparison.—In the irregularly branching phaceloid habit, the size of the corallites, the spinose septa, the prominent columella with which the longer septa are joined, and in general features, this species is most close to the species described by VOLZ (1896, p. 70, pl. 8, figs. 18-26; not fig. 17, LAUBE's original specimen) under the name of *Omphalophyllia recondita* LAUBE. However this species has more numerous septa and less regular septal granulations. In the original figure by LAUBE (1865, pl. 4, fig. 36) the septa of the third order in length are joined with those of the second order at their proximal ends. However this type of septal arrangement is uncommon in the figure (pl. 8, fig. 24, a, b) of the sections which were obtained from one of LAUBE's syntypes. Furthermore the former has much more numerous septa (about twice) than the latter. Thus, so far as is seen in the figures, VOLZ's specimens appear to be not conspecific with *"Omphalophyllia" recondita* LAUBE.

Family Thamnasteriidae VAUGHAN and WELLS, 1943
Genus *Thamnasteria* LESAUVAGE, 1823

Type-species.—*Thamnasteria lamourouxi* LESAUVAGE, 1823

Thamnasteria (*Thamnasteria*) sp.
Pl. 13, figs. 6-9

Material.—Two small, probably immature, colonies; GK. F335 A, B; loc. Ko. 278. Their internal structures are largely obliterated by secondary replacement.

Description.—Corallum of small thamnasterioid, 12 mm broad and about 10 mm thick; laterally lobed; its surface structures cannot be known.

Corallum made of fifteen corallites in the largest part, which are rather variable in size and circular in cross-section. Corallite centers usually 1.5 to 2 mm distant.

Septa very thin, confluent with those of the adjacent corallites, straight or geniculate, or gently flexuous. The number of the septa is very variable according to the size of the corallite. The small corallites of 1 to 1.5 mm broad have 15 or fewer septa. The larger corallites have usually 25 to 35 septa. The largest corallite attaining 2 mm by 2.5 mm in diameter has about 35 septa, of which about 12 septa reach close to a columella and some of them may join with it.

Septal microstructures cannot be known due to the recrystallization, but

diagonal sections of the corallites show that the septa are minutely and sparsely perforated. The same sections also show that granulations or probably discontinuous ridges are well developed and not a few of them are connected with those of the opposed faces of adjacent septa, forming synapticulae. That the septa are seen as smooth plates in transverse sections indicates that the synapticulae are disposed horizontally or very gently inclined.

Styliform columella well developed, elliptical to subcircular in cross-section, ranging 0.1 to 0.3 mm in the shorter diameter.

Comparison.—Because of insufficiency and poor preservation of the material, the satisfactory comparison with the known species cannot be made. This species is closer to *Thamnasteria* (*Thamnasteria*) *loretzi* VOLZ (1896, p. 59-60, pl. 6, figs. 12, 12a-c) from the Cassian beds of Southern Tyrol than to any other known species of the genus in the size of the corallites and the number, thickness and arrangement of the septa. However, the present species has smaller corallites, that is, its corallite centers are disposed as distant as 1.5 to 2 mm, whereas in *Th. loretzi* they are 2 to 3 mm, rarely 4 mm apart. Another difference is seen in that the septa are not connected with the columella so frequently as in *Th. loretzi*. These differences may be sufficient to distinguish them as a distinct species from each other.

This species is also similar in general features to *Th.* (*Th.*) *rectilamellosa minor* FRECH (1890, p. 62, pl. 7, fig. 12) from the Zlambach beds and *Th. smithi* SQUIRES (1956, p. 13-14, figs. 25-28) [=*Th. rectilamellosa* var. *minor*, SMITH (1927, p. 131, pl. 116, fig. 3; pl. 118, figs. 5, 6)] from the Carno-Norian beds of Idaho, California, British Columbia and Alaska. It differs, however, in having smaller corallites and much more numerous septa.

Thamnasteria (s.l.) *furukawai*, sp. nov.
Pl. 19, figs. 1-7

Material.—Holotype, GK. F350; paratype, GK. F351; from loc. Ko. 278. They have been largely recrystallized except for the distal ends where the macrostructures have been examined fairly well.

Description.—Coralla massive, with a wide base; 70 to 80 mm wide, 20 to 30 mm high. Although the surfaces of the coralla cannot be seen, they appear to be meandroid, and longitudinal and transverse sections show that relatively acute collines and deep valleys which contain series of corallite centers are arranged in parallel or subparallel, slightly flexuous lines which traverse the most parts of the coralla.

Collines or valleys are usually 4 to 5 mm, rarely 2 to 3 mm, distanct. In the latter case, that is, the neighbouring calices are disposed relatively closely, the collines become indistinct and the coralla approach a thamnasterioid form in which the corallite centers are still arranged in linear series. In the circumference area the corallite centers are not disposed in linear series, but assume a common thamnasterioid habit.

In the meandroid part each valley contains only a single series of corallite centers, which are disposed usually 2 to 2.5 mm, rarely 3 or 1.5 mm, distant in the series. The septa pass without any interruption from one series into another, but in their midway the septa are often, but not always, thickened and laterally fused with the adjacent ones to make a wall which forms a crest of a colline.

Septa rather thick; most of them on the lateral sides extend in a completely or nearly straight line from the fossula of one calice to that of the neighbouring one. Especially in the colline area they are disposed in parallel to one another and are almost equal in thickness. The septa in the bordering areas between the neighbouring corallites of the same series are strongly bent at their distal ends towards the columella, and those connecting adjacent calices are usually thicker than others and are coalesced with the septa inserted from the lateral sides.

The septa greatly vary in number according to diameters of the corallites; there are usually 22 to 26, rarely up to 31, septa in the corallites of the meandroid part, but usually 25 to 29, sometimes even to 34, septa in the thamnasterioid corallites. In most corallites 15 to 18 septa extend to the central area and some are connected with the columella.

The septa of the first two cycles are almost equal in development, and those of the third are shorter and slightly thinner in the valley area, and are incomplete in development.

The septa appear to be delicately crenated on their lateral sides. So far as is seen in transverse sections of the septa very short spines project inwardly, but most of the septa have been smothered by secondary recrystallization.

Columella prominent, styliform, usually subcircular to elliptical, rarely thick lamellar in cross-section, but its microstructures cannot be known.

Comparison.—This species is characteristic in its growth habit with a linear arrangement of corallite centers and collines, and its prominent styliform columella. In these structures this species is somewhat similar to *Thamnasteria settsassi* VOLZ (1896, p. 60, pl. 6, figs. 11, 11a-b) from the Cassian beds in Southern Tyrol. It differs, however, in its more regular alignment of corallites and more prominent columella, more regularly parallel arrangement of the septa, and thickening and fusing of the septa so as to form collines.

This species is dedicated to Mr. H. FURUKAWA who collaborated with me in a part of the field work on the Konosé Group and in finding of fossils.

Faunal Affinity

The Upper Triassic Norian and/or Rhaetian coral faunas came first to our knowledge owing to the excellent work by FRECH (1890) on the material from the Zlambach, Hallstatt and Hauptdolomite beds of Austrian Alps. Since then the coral faunas of the same age with the assemblage of analogous or similar species have been known from the areas shown with an asterisk (*) in Fig. 1.*

There are some other records of the existence of the Upper Triassic coral

beds in Spiti and Rapshu (HAYDEN, 1904; DIENER, 1908), and the occurrence of some corals from Northwest Himalaya (GERTH, 1938), Yunnan (REED, 1927), Thaungyin of Burma (GREGORY, 1930), and Lampang and Maesot of Thailand (BURAVAS, 1961). No descriptions have been, however, published for the corals from Spiti and Rapshu, and Thailand. From Yunnan *Thecosmilia* aff. *clathrata* EMMRICH, *Th.* aff. *weberi* VINASSA, and *Th.*? sp. have been recorded respectively from different localities but their stratigraphic positions are uncertain.

Thus, for a great extent northeastward from Timor or eastward from Persia to Alaska no reliable information on the Upper Triassic coral fauna has been hitherto given. The Kuma massif of Kyushu, from which came the corals described above, lies midway between these regions.

Apart from the three new species, some of the corals from Konosé have been compared but not precisely identified with the known species and others are indeterminable, because of unfavorable preservation and insufficiency of the material. Nevertheless, it cannot be denied that many of the species closely resemble the Upper Triassic species of the above mentioned areas, particularly to those of Timor and Austrian Alps, and that others show also a Triassic aspect. In the present state of our knowledge it would be desirable to inspect the species assemblages from locality to locality comparing each of them with the known faunas or faunules.

1) *Species assemblage from loc. Ko. 278.*—One species each of *Montlivaltia* and *Procyclolites* are comparable to, if no identical with, *M. norica* FRECH and *P. triadicus* FRECH, respectively, both of which have been known from the Zlambach beds (FRECH, 1890) and the Upper to Uppermost Triassic of Pualaca, Timor (VINASSA, 1915). The former species is also known from the Carno-Norian of Idaho, Oregon, and Alaska. Specific similarities to the Timorian corals are also exemplified by *Procyclolites* cf. *timoricus* (VINASSA) and *M.* cf. *stylophylloides* VINASSA. *P. timoricus* is associated with *P. triadicus* and *M. norica* at Pualaca, Timor. *Thecosmilia eguchii*, sp. nov., is similar to, though clearly distinguished from, *Th. norica* FRECH which has been known from the Zlambach beds and Pualaca, Timor.**

On the other hand, two species of *Thamnasteria* are closer to the species from the Upper Ladinian Cassian beds than to any of the species from the Zlambach beds and also other Upper Triassic beds. However, they are specifically distinguishable from those Ladinian species.

To sum up, the assemblage of the species from loc. Ko. 278 is most intimately allied to the Upper Triassic or the Carno-Norian coral faunas of the Tethys-Indonesian province and the northwest coastal region of North America.

2) *Species assemblage from loc. Ko. 352.*—From this locality *Thecosmilia konosensis*, sp. nov., and *Montlivaltia* cf. *timorica* VINASSA were obtained. The former

* Comparable coral faunas have been listed from Hungary, the Karpathen, the Dinariden and Greece, but unfortunately papers on them are not accessible to me at present.

** *Thecosmilia norica* FRECH described by SMITH (1927, p. 128, pl. 111, figs. 1-4) differs from FRECH's as already pointed out by SQUIRES (1956, p. 23)

is closely allied to *Th. subdichotoma* MÜNSTER which is one of the diagnostic species of the Upper Ladinian Cassian beds of Southern Tyrol. VINASSA (1915) identified the latter species from Oëtoeloe, Timor, but since it was based on a single incomplete specimen and its exact stratigraphic position has not been determined, whether it ranges up to the Upper Triassic or not is uncertain. The latter species is similar to, though not identical with, *M. timorica* which occurred in association with a Norian coral *M. norica* FRECH and a Norian and Rhaetian calcisponge *Lovcenipora vinassai* GIATTINI, in Bonleo, Timor (VINASSA, 1915). The species in question is also allied to *M. verae* VOLZ from the Upper Ladinian Cassian beds which belongs to the same species-group as *M. timorica.*

The species from this locality are incomplete for age determination, but taking their stratigraphic positions into consideration, I am inclined to regard them as being probably of the Upper Ladinian age.

3) *Species from loc. Ko. 232*

Only one unnamed species of *Thecosmilia* came from this locality. It is too poorly preserved for specific identification, but is more closely similar to, but not identical with, the species described by SMITH (1927) as *Stylophyllopsis zitteli* FRECH (p. 127, pl. 111, figs. 7-9) than to any other known species. As has already been mentioned in the systematic part, the specimens of SMITH's *Thecosmilia norica* and *Stylophyllopsis zitteli* should be referred to one and the same species (SQUIRES, 1956, p. 19, 23). These specimens came from the Upper Carnian of the Blue Mountains, Oregon.

Thus, the age of the species from loc. Ko. 232 cannot be definitely determined, but it could be Upper Triassic.

4) *Species from loc. Ko. 724.*—The specimens obtained from this locality is too incomplete for specific as well as generic identification, but it is similar to *Oppelismilia polyactis* (FRECH) from the Zlambach beds of Austria, showing a Triassic aspect.

The four localities discussed above are separated from one another and the first two and the last two localities are respectively in different tectonic zones, between which there is a thrust. The definite stratigraphic relationship between these two groups of the coral beds remains undecided at the present moment owing to the insufficient evidence and remarkable facies-changes. But a tentative correlation on various kinds of evidence may be shown in Fig. 4.

As is described in p. 144, some calcareous algae, sponges and stromatoporoids are associated with the corals in question, but none of them gives us confident conclusion on their ages due to poor preservation of the material. Additional evidence which indicates the Triassic ages of the main part of the Konosé Group are the occurrence of ammonoids, *Balatonites*? sp. from a limestone at about 600 m below the coral bed at loc. Ko. 232 and *Cycloceltites*? sp. from about 100 m below the same bed. If the generic assignment were correct, the former would indicate Anisian and the latter Carnian to Norian.

Concluding remarks.—Mesozoic corals in Japan have been studied by NEUMAYR (1890), YABE (1931), YABE and SUGIYAMA (1932, 1934), YABE and EGUCHI

(1933, 1936), EGUCHI (1934, 1936, 1951), MURATA (1960) and MORI (1963), but they are mostly of the Jurassic and Lower Cretaceous ages. The Triassic corals hitherto known in Japan are only one undescribed species each of *Thecosmilia* and *Montlivaltia* known from the Carnian Sambosan Limestone of southern Shikoku (EGUCHI, 1951).

The coral faunas from the Konosé Group consist of three new species, five species which are comparable with the known species and other indefinite ones. Since our knowledge on the stratigraphic ranges of and phylogenetic relations of early Mesozoic corals are still incomplete, the greatest care must be taken for the age determination of the fauna by the method relying solely on the morphological similarity of a species. However, as outlined above, it should not be overlooked that none of the Konosé corals show an alliance to the Jurassic and younger species of any parts of the world and that all of them show Triassic aspects. As far as the species-assemblage is concerned, that of the Konosé Group is similar to that of the Zlambach beds of Austria and the Upper Triassic of Timor.

All the available data suggest that the age of the coral-bearing beds in the Konosé Group is probably Triassic and not older than the Middle Triassic.

Appendix

Notes on Stratigraphy

By

Kametoshi KANMERA and Hiroyasu FURUKAWA

It is not the purpose of this paper to describe details of stratigraphy, lithology and facies relationship to other formations of equivalent ages, but brief accounts on the generalized stratigraphic succession of the Konosé Group and some essential lithologic features of the constituents are given here.

I. Geologic setting

The Konosé Group occupies a belt crossing the middle course of the Kuma river and its tributaries in the Kuma massif, southern Kyushu. This belt occupies the southern part of the Chichibu Terrain in the western extremity of the Outer Zone of Southwest Japan. It is 2.5 to 4 km wide, extending in the NEE-SWW direction, and is bordered on the south by the Butsuzo line against the Shimatogawa Group of Mesozoic rocks of uncertain ages with some Tertiary formations, and on the north by another fault against the middle Upper Carboniferous rocks. This belt corresponds in its geologic setting to what is called the Sambosan belt in Shikoku.

II. Stratigraphic succession

The Konosé Group consists of a thick series of dominantly basic pyroclastic rocks associated with many bodies of limestone, thin bedded chert of various thicknesses and intertongues of slate with some beds of sandstone and conglomerate. It is a conformable series ranging in age from the upper part of the Permian (*Yabeina* zone) to the Upper Triassic, so far as is known, but it could

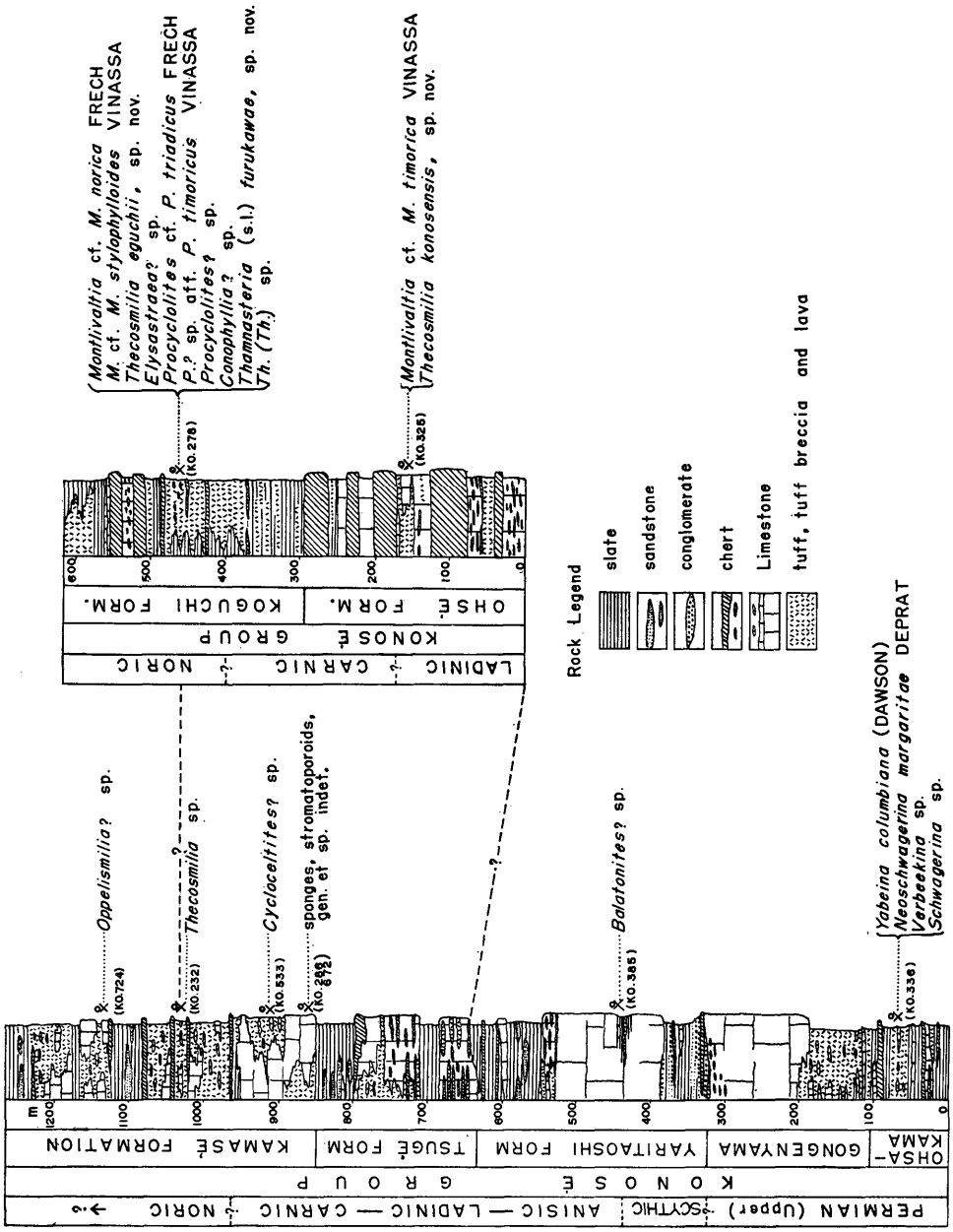

Fig. 4. Generalized stratigraphic section of the Konosé Group
(Of the specific names tabulated above, read *Thamnasteria* (s.l.) *furukawai*, sp. nov. for *Thamnasteria* (s.l.) *furukawae*, sp. nov.)

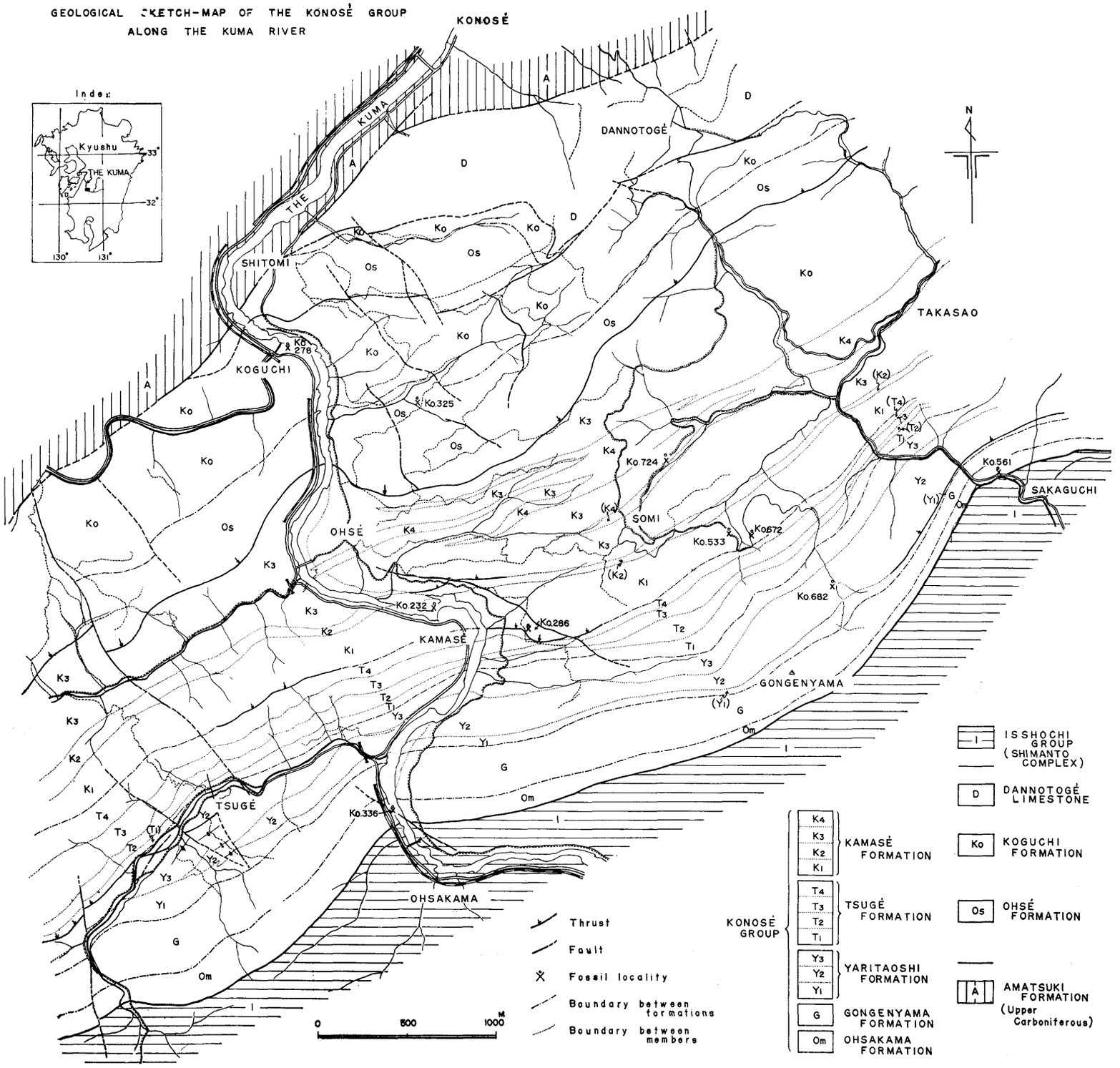

Fig. 5. Geological shetch-map of the Konosé Group along the Kuma river.

range up to the Jurassic. It is at least 1300 m thick, and its basal and upper limit cannot be known owing to faulting.

The Konosé belt is divided by a thrust into two minor belts, the southern and the northern. The succession is more typically shown in the southern belt than in the northern.

A. Southern belt.—The general succession, in ascending order, of the Konosé Group in the southern belt is as follows (see Figs. 4 and 5):

1) *Ohsakama formation* (80-150 m): Black slate, chert and basic tuff associated with lenticles of limestone. The limestone in the middle part contains *Yabeina columbiana* (DAWSON), *Neoschwagerina margaritae* DEPRAT, *Verbeekina* sp. and *Schwagerina* sp. Thus this formation is the upper part of the Permian.

2) *Gongenyama formation* (80-200 m): Green tuff with small bodies of limestone in the lower (0-80 m), and white, thick, massive limestone in the upper (80-150 m).

3) *Yaritaoshi formation* (230-300 m): Lower member (Y_1; 20-60 m) mainly of black slate with a few beds of conglomerate at the basal part, sandstone, chert and limestone. Middle member (Y_2; 80-170 m) consisting of dark grey to black, thick, massive limestone partly with thin bands of slate and chert in the middle and with chert nodules or ribbons in the upper. *Balatonites*? sp. occurs in a thin bedded black limestone (1 m) in the middle part. Upper member (Y_3; 60-90 m) mainly of black slate with some lenticles or beds of limestone and chert.

4) *Tsugé formation* (200-300 m): Four members of two assemblages of sediments in alternation; the first (T_1) and third (T_3) members consist of reddish or greenish purple tuff and tuff-breccia associated with limestone which contains in part many thin bands, ribbons or nodules of chert. The second (T_2) and the fourth (T_4) are black slate with intertongues of sandstone and some lenses of limestone.

5) *Kamasé formation* (400-500 m): Consisting of four members, lower, middle, upper and uppermost. Lower member (K_1; 200-300 m): Green or red tuff and tuff-breccia intercalated with many bodies of limestone of various thicknesses and extents, and with some intertongues of slate and chert. The lowest limestone beds contain fragmental remains of some stromatoporoids, sponges and calcareous algae. An ammonite species was obtained from a small, black, carbonaceous limestone in the middle part. It is provisionally referable to *Cycloceltites*. From the upper part of this member *Thecosmilia* sp. and some undetermined sponges were obtained. Middle member (K_2; 40-100 m): Black slate with some lenticles of sandstone.

Upper member (K_3; 80-150 m): Green or reddish purple tuff, tuff-breccia and lava, with many lenticular bodies of limestone and some thin beds of chert. *Oppelismilia*? sp. was obtained from a dolomitic limestone in its lower part. Uppermost member (K_4; 50-70 m): Black slate with some lenticles of coarse- and medium-grained sandstone.

B. Northern belt.—The Konosé Group in the northern belt shows an intensely complicated structure and a remarkable facies-change. The following

succession, in ascending order, may be tentative.

1) *Ohsé formation* (200-300 m): Composed of at least five thick beds of chert alternating with limestone, which is often accompanied with bands, ribbons and nodules of chert, and with some beds of reddish or greenish tuff and tuff-breccia. *Montlivaltia* cf. *timorica* VINASSA and *Thecosmilia konosensis*, sp. nov., occurred from a limestone in the middle part.

2) *Koguchi formation* (200-320 m): Lower member consisting of greenish grey tuffaceous slate and slate with some thin bands of tuff and conglomerate made up of granules of chert.

Middle member of greenish or reddish purple tuff, tuff-breccia and lava with some chert and tuffaceous chert. Upper member of slate, chert, limestone with chert bands and nodules, and tuff and tuff-breccia. The pyroclastic rocks of this formation pass laterally into slate through tuffaceous slate. As is described in detail in page 144-145, the limestone debris embedded in a green tuffite bed of the middle member contain a fairly large number of corals as listed in Fig. 4, and also abundant remains of calcareous algae and some sponges.

The Konosé Group of the northern belt is quite similar to that of the southern belt in the lithologic assemblage and facies, but it includes more numerous and much thicker chert beds in its lower part.

The warrantable correlation between the formations of the two belts cannot be made at present because of lack of reliable guide fossils or key beds common to both of them. However the similarity in the general stratigraphic successions and lithology, and the occurrence of corals which show Upper Triassic aspects suggest that the formations of the northern belt are probably correlated with the upper part of the typical section of the group in the southern belt.

III. General lithologic features and facies

A. *Pyroclastic rocks and lava.*—The Konosé Group contains many beds and intertongues of basic volcanic ejecta at many horizons, in particular abundantly in its upper part. The volcanic ejecta consist of dark reddish or greenish purple agglomerate, volcanic breccia, tuff-breccia, tuff, tuffite, and lava flow of augite basalt in composition. They are characteristically calcareous and often contain a great number of lenticles, nodulous bodies or bands of limestone of various sizes. Amygdales in lava are filled with calcite. These pyroclastics and lava are the products of a submarine volcanism.

B. *Chert.*—Chert is of various thicknesses ranging from less than 1 m to 50 m. It is thin beded in commonly 2 to 5 cm thickness, variegated in colour, and occasionally contains radiolarians. It is made up of microcrystalline mosaic quartz. Many of the chert beds occur at the boundary between a pyroclastic member and a slate member, and the remaining others are in pyroclastic rocks and interchange with them through tuffaceous chert.

C. *Limestone.*—The limestone bodies, including two massive, thick and extensive ones, of the Gongenyama and Yaritaoshi formations consist of homogeneous microcrystalline calcite mudstone or micrite (FOLK, 1959) which is

considered to have been originally lime ooze. Fossils are extremely rare in them, and only a small number of radiolarians and smaller foraminifers of a pelagic type are found. A layer of laminated, highly carbonaceous, sooty black limestone, about 1 m thick, is intercalated at two horizons in the middle part of the Gongenyama. It contains exclusively ammonites within layers of a few centimeter thickness. These facts suggest that these limestones are pelagic deep sea deposits.

In other formations of the group occur a great number of lenticular bodies of white grey limestone which are intimately related to pyroclastic rocks. Fairly large number of bodies of limestone which laterally interchange with tuff and tuff-breccia are also associated with many thin alternating bands, less than 20 cm thick, or irregular ribbons and nodules of chert. This intimate association of limestone, tuff and nodulous or ribbon-shaped chert is the most characteristic lithologic assemblage of the Konosé Group, exemplified at many horizons, especially well in the Ohsakama, Tsugé and Ohsé formations. The limestone of this kind is almost barren of fossils except for radiolarians, and is made up of microcrystalline calcite mud, although not a small portion of them have been recrystallized to coarser-grained mosaic calcite.

The limestone in the Kamasé and Koguchi formations sometimes contains, together with the corals described in this paper, fragmental remains of calcareous algae, stromatoporoids, calcisponges, and crinoid stems and plates. The occurrence of these organic remains demonstrates that the limestone in question is the deposits in much shallower water conditions than those of the Gongenyama and Yaritaoshi formations. It is interesting to note that the limestone showing a reef facies in constituents and texture sometimes occurs as subangular blocks of various sizes scattered in a layer of tuffite (see page 144). The limestone containing bioclastic fragments which shows evidence of more or less being sorted has a matrix of sparry calcite. In general, the lesser the contained bioclastic fragments are, the finer and wider the matrix of the limestone becomes.

Thus, more than one lithologic type of limestone are recognized in the Konosé Group, but it should be noted that the limestones are as a whole very small in bioclastic constituents, especially of molluscas.

D. *Clastic rocks.*—Contrary to the great abundance of pyroclastic rocks, limestone and chert, the terrigeneous materials are comparatively less important in the group. They are represented by rather episodic thin intercalations of black, occasionally pyrite-bearing, slate with some lenticular bodies of medium- to fine-grained sandstone. The sandstone is poorly sorted, and is made up of grains of chert in the lower part and is arkosic in the upper part. Also a few thin beds of conglomerate may occur, containing angular pebbles and cobbles of chert and limestone with interstices of calcite. The constituents of the conglomerate are considered to be detritus produced by contemporaneous erosion within the sedimentary area of the Konosé Group.

E. *Concluding remarks.*—As is understood from the above description, the Konosé Group shows a nature of sediments in and near the submarine volcanic

belt from late Permian to probably late Triassic times.

It has been known that products of volcanic activity are almost lacking throughout the whole series of the Triassic sediments of the Inner Zone of and the main part of the Chichibu Terrain of the Outer Zone of Southwest Japan. The Triassic formations of the Inner Zone are of a shallow sea faices in part with deltaic and limnic ones, consisting of conglomerate, sandstone and shale in the lower series, and of a thick sediments dominantly of terrigeneous materials of light-coloured sandstone·and conglomerate of a so-called molasse faices in the upper. Those of the main part of the Chichibu Terrain show a shallow marine facies, being composed of grey to dark grey sandstone and shale with dark grey fossiliferous, mostly molluscan, limestone in the Skythian, and grey sandstone and shale with some conglomerate in the upper series. Exceptionally the Carnian Tanoura formation in western Kyushu contains small lenticular bodies of dark grey argillaceous or arenaceous limestone.

In contrast to these the Konosé belt occupying the southern margin of the Chichibu Terrain was the scene of the extensive volcanic outbursts during the same times. In a close genetical association with this submarine volcanic activity, a number of limestone and chert beds, which are mainly chemical sediments with bioclasts of lesser amount, were deposited interfingering and interchanging laterally with pyroclastic rocks in the area surrounding volcanic centers or in the downstream sides of the prevailing ocean currents in the sedimentary basin for some distances. The proportion of clastics to pyroclastics and their associates is the smallest in the Upper Triassic formations, so far as the sedimentary area of the Konosé Group is concerned.

IV. Descriptions of collecting localities

The obtained materials came from the following four localities.

1) *Loc. Ko. 278 at Koguchi, Ashikita-cho, Ashikita-gun, Kumamoto Prefecture.*

Here is exposed a tuffite containing the fossiliferous limestone blocks. It is about 10 m wide and 30 m long, and the bed is intercalated in a series of volcanic breccia, tuff and tuffite with basaltic lava flows and some thin bands of chert (see Fig. 4). A majority of the described species came from this locality. Many subangular blocks of fossiliferous limestone from sand to boulder sizes are scatteringly embedded in light green, coarse-grained calcareous tuffite with some volcanic breccias. These blocks are sharply separated from the surrounding tuffite matrix, and are grey to light grey in colour and lithologically resemble reef limestone.

The limestone occurring as blocks in the tuffite is richly fossiliferous, comprising calcareous algae including encrusting stromatolites and coralline algae, subordinately corals, spongiomorphoids, stromatoporoids, vesicular calcisponges, and some bryozoas and crinoid oscicles. It is not uncommon that the larger or entire part of smaller blocks consists exclusively of a single organic remains, that is, often a single colony of calcareous alga, coral, etc. The interstices of these skeletal structures are filled with an unsorted mixture of algal debris and

fine-grained organic fragments of other undiscriminated kinds. Furthermore, in a considerable part between and within the frame-builders there are void filling clear calcites. No terrigenous materials are contained and none of the blocks show clear sorting or stratification.

Thus the texture and constituents of the blocks themselves are quite similar to those of reef limestone, and their occurrence suggests that they may probably be reef debris derived from a reef mass which probably grew up on a submarine volcanic mound or on a slope of a volcanic island, although neither actual reef mass nor limestone of any other types has been exposed near this locality.

2) *Ko. 325, in a small stream between Shitomi and Osé, Kuma-mura, Kuma-gun, Kumamoto Prefecture.* Here is a massive, white grey limestone of about 30 to 70 m thick between thick beds of chert. The limestone passes laterally into dark green or reddish purple basic tuff. It is unfossiliferous for the most part, consisting of fine-grained mosaic calcite which was probably microcrystalline calcite mud in origin.

One of two new species of *Thecosmilia* and a species of *Montlivaltia* came from this locality. The corals were obtained from a grey limestone band in a tuff bed which was intercalated in the host limestone. This band contains, besides the obtained corals, Solenoporacean algae, stromatoporoids, crinoid stem joints, calcisponges and some small brachiopod shells. The matrix is microcrystalline calcite mud, and some void fillings are seen in part.

3) *Ko. 232, inlying strand in the Kuma river, 200 m north of Kamasé, Ashikita-cho, Ashikita-gun, Kumamoto Prefecture.* At this locality a species of *Thecosmilia* was obtained from a white semi-crystalline limestone with many, thin and irregular laminae, bands or ribbons of reddish-purple tuff. The limestone is fairly fossiliferous and contains calcisponges, calcareous algae, stromatoporoids, a few gastropods, etc., but their structures have been largely obliterated due to secondary recrystallization. Therefore it is hardly possible to identify their specific names, and little can be known of the original lithology of the host rock.

At this horizon the limestone interchanges laterally with reddish purple tuff containing small lenticular or nodulous limestone.

4) *Ko. 724, 400 m northeast of Somi, Kuma-mura, Kuma-gun, Kumamoto Prefecture.* This localtiy is at a horizon about 100 m above that of loc. Ko. 232. The limestone, from which an undetermined species of *Oppelismilia* came, is intercalated in reddish purple tuff and contains irregularly disseminated clots and veinlets of dolomite. It is white, semi-crystalline and commonly contains fragments of crinoid stems and plates, small brachiopod shells, Solenoporacean and Codiacean algae, and also small foraminiferas, but its main constituents are small, black pellets and clots mostly of aphanitic texture. The martix is very fine-grained mosaic calcite which must have been originally microcrystalline calcite.

The location and stratigraphic position of these fossil beds are shown in Figs. 4 and 5.

References

BRINKMANN, R. (1960): *Geologic evolution of Europe.* Hafner Pub. Co., New York. 161 p., 46 figs., 19 pls., 18 correl. charts.

BURAVAS, S. (1961): Stratigraphy of Thailand. *Proc. 9th Pacific Sci. Congress.* 12, *Geology and Ggeophisics*, 301-305.

DIENER, C. (1907): The fauna of the Himalayan Muschelkalk. *Palaeontologia Indica*, [15] *Himalayan fossils*, **5**, (2), 1-140, pls. 1-17.

——— (1908): Ladinic, Carnic and Noric faunae of Spiti. Ibid., **5**, (3), 1-157, pls. 1-24.

——— (1921): Cnidaria triadica. *Fossilium Catalogus, Animalia*, pt. 13, 1-46.

DOUGLAS, J. A. (1929): A marine Triassic fauna from eastern Persia. *Quart. Jour. Geol. Soc. London*, **85**, (4), 624-650, pls. 42-46.

DUNBAR, C. O. (1932): *Neoschwagerina* in the Permian faunas of British Columbia. *Trans. Roy. Soc. Canada*, [3], **26**, (4), 45-49, pl. 1.

EGUCHI, M. (1951): Mesozoic Hexacorals from Japan. *Sci. Rep. Tohoku Univ.*, [2], **24**, 1-96, pls. 1-28.

FLÜGEL, E. (1960): Untersuchungen im obertriadischen Riff des Gosaukammes (Dachsteingebiet, Oberösterreich). II. Untersuchungen über die Fauna und Flora des Dachsteinriffkalkes der Donnerkogel-Gruppe. *Verh. Geol. Bundesanstalt*, Jg. 1960, 241-252.

FLÜGEL, E. and RAMOVS, A. (1961): Fossilinhalt und Mikrofazies des Dachsteinkalkes (Ober-Trias) in Begunjscica-Gebirge, S-Karawanken (NW-Slovenien, Jugoslavien). *Neues Jahrb. f. Geol. u. Pälaont. Monats.*, Jg. 1961, 287-294.

FOLK, R. L. (1959): Practical petrographic classification of limestome. Bull. Amer. Assoc. Petr. Geol., **43**, (1), 1-38.

FRECH, F. (1890-1891): Die Korallen der juvavischen Triasprovinz. *Palaeontographica*, [A], **37**, 1-113, pl. 1-21.

GERTH, H. (1938): Permkorallen aus dem Ostlichen Karakorum und Triaskorallen aus dem nordwestlichen Himalaya. Ibid., **88**, 230-237, pl. 15.

GREGORY, J. W. (1930): Upper Triassic fossils from the Burmo-Siamese frontier. The Thaungyin Trias and description of the corals. *Geol. Survey India, Rec.*, **63**, 155-166, 2 pls.

HAYDEN, H. H. (1904): The geology of Spiti, with parts of Bashahr and Rapshu. *Mem. Geol. Survey India*, **36**, (1), 1—129+vi, pls. 1-17.

KAMBE, N. (1963): On the boundary between the Permian and Triassic Systems in Japan, with the description of the Permo-Triassic formations at Takachiho-cho, Miyazaki Prefecture in Kyushu and the Skytic fossils contained. *Geol. Survey of Japan, Rep.* **198**, 1-66, pls. 1-19.

KAMBE, N. and TOKUYAMA, A. (1963): The Triassic, in *Geology of Japan*, edited by F. TAKAI, T. MATSUMOTO and R. TORIYAMA. Univ. Tokyo Press, 59-78.

KOBAYASHI, T. (1931): Notes on a new occurrence of Ladino-Carnic Limestone at Samposan, Tosa Province, Japan. *Japan. Jour. Geol. Geogr.*, **8**, (4), 251-258, pl. 25.

——— (1941): The Sakawa Orogenic cycle and its bearing on the origin of the Japanese Islands. *Jour. Fac. Sci., Univ. Tokyo*, [2], **5**, (7), 219-578, pls. 1-4.

——— (1957, a): *Regional geology of Japan. General Statement.* xv+363 p., pls. 1-4. Asakura Pub. Co., Tokyo.

——— (1957, b): *Regional Geology of Japan. Shikoku Region.* xii+271 p., Asakura Pub. Co., Tokyo.

KOLOSVARY, G. (1958): Corals from the Upper Anisian of Hungary. *Jour. Pal.* **32**, (3), 636,

KRUMBECK, L. (1913): Obere Trias von Buru und Misol. *Palaeontographica*, Suppl. **4**.

——— (1914): Obere Trias von Sumatra. Ibid., **4**, (2),

LAUBE, G. C. (1865): Die fauna der Schichten von St. Cassian. (Ein Beitrage zur Paläontologie der Alpenen Trias). I Abth. Spongitarium, Corallen, Echiniden und Crinoiden. *Denkschr. Kaiserl. Akad. Wissensch. Math.-Naturwiss. Wien*, **24**, 223-296, pls. 1-10.

MCKEE, E. D., ORIEL, S. O., KETNER, K. B., MACLACHLAN, M. E., GOLDSMITH, J. W.,

MACLACHLAN, J. C. and MUDGE, M. R. (1959): *Paleotectonic maps of the Triassic System*. Dept. of the Interior U. S. Geol. Survey, 1-32, 9 pls.

MCLEARN, F. H. (1953): Correlation of the Triassic formations of Canada. *Geol. Soc. Amer., Bull.*, **64**, 1205-1288.

MILNE-EDWARDS, H. and HAIME, J. (1850-1854): A monograph of the British fossil corals. *Palaeontogr. Soc.*, i-lxxxv, 1-322, pls. 1-72.

MOJSISOVICS, E. (1893): Die Cephalopoden der Hallstätterkalke. *Abh. d. K. K. Geol. Reichs* [4], **2**, 1-835, pls. 1-200.

MULLER, S. W. (1936): Triassic coral reefs in Nevada. *Amer. Jour. Sci.*, **31**, 202-208.

REED, F. R. COWPER (1927): Palaeozoic and Mesozoic fossils from Yunnan. *Palaeontologia Indica*, n.s., **10**, (1), 1-291, pls. 1-20.

REESIDE, J. B. (Jr.) (Chairman) (1957): Correlation of the Triassic formations of North America exclusive of Canada. The Triassic subcommittee on stratigraphy of the National Reserach Council. *Geol. Soc. America, Bull.*, **68**, 1451-1514.

REUSS, A. E. (1854): Beitrage zur Characteristik der Kreideschichten in den Ostalpen. *Denkschr. Kaiserl. Akad. Wissensch. Math.-Naturwiss., Wien*, **7**, 1-156, pls. 1-30.

SMITH, J. P. (1912): On the Occurrence of coral reefs in the Triassic of North America. *Amer. Jour. Sci.*, [4], **33**, (11), 92-96.

——— (1914): The middle Triassic marine invertebrate faunas of North America. *U. S. Geol. Survey, Prof. Paper*, **83**, 1-148, pls. 1-49.

——— (1927): Upper Triassic marine invertebrate fauna of North America. Ibid., 141, 1-135, pls. 1-121.

SQUIRES, D. F. (1956): A new Triassic coral fauna from Idaho. *Amer. Museum Novitates*, No. 1797, 1-27.

VINASSA de REGNY, P. (1915): Triadische Algen, Spongien, Anthozoen und Bryozoen aus Timor. *Palaeont. von Timor*, **4**, (8), 75-118, pls. 63-72.

VOLZ, W. (1896): Die Korallen der Schichten von St. Cassian in Süd-Tirol. *Palaeontographica* **43**, 1-123, pls. 1-11.

WELLS, J. W. (1956): Scleractinia, in *Treatise on Invertebrate Paleontology*. Part F, Coelenterata, F 328-444.

SILBERLING, N. J. (1959): Pre-Tertiary stratigraphy and Upper Triassic paleontology of the Union district, Shoshone Mountains, Nevada. *U. S. Geol. Survey, Prof. Paper*, **322**, 1-63, pls. 1-9.

VAUGHAN, T. W. (1905): A critical review of the literature on the simple genera of the Madreporaria Fungida, with a tentative classification. *Proc. U. S. National Museum.* **28**, (1401), 371-424.

VAUGHAN, T. W. and WELLS, J. W. (1943): Revision of the suborders, families, and genera of the Scleractinia. *Geol. Soc. Amer., Special paper*, **44**, xv+363, 51 pls., 39 text-figs.

WILCKENS, O. (1927): Contributions to the palaeontology of the New Zealand Trias. *New Zealand Dept. of Sci. and Indust. Research Geol. Survey Branch, Palaeont. Bull.*, **12**, 1-65, pls. 1-10.

YABE, H. and SUGIYAMA, T. (1932): Upper Triassic spongiomorphoid coral from Samposan, Province of Tosa, Japan. *Japan. Jour. Geol. Geogr.*, **10**, (1-2), 5-9.

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Triassic Coral Faunas from the Konosé Group

Plates 12–19

Plate 12

Explanation of Plate 12

(All figures ×3, unless otherwise stated)

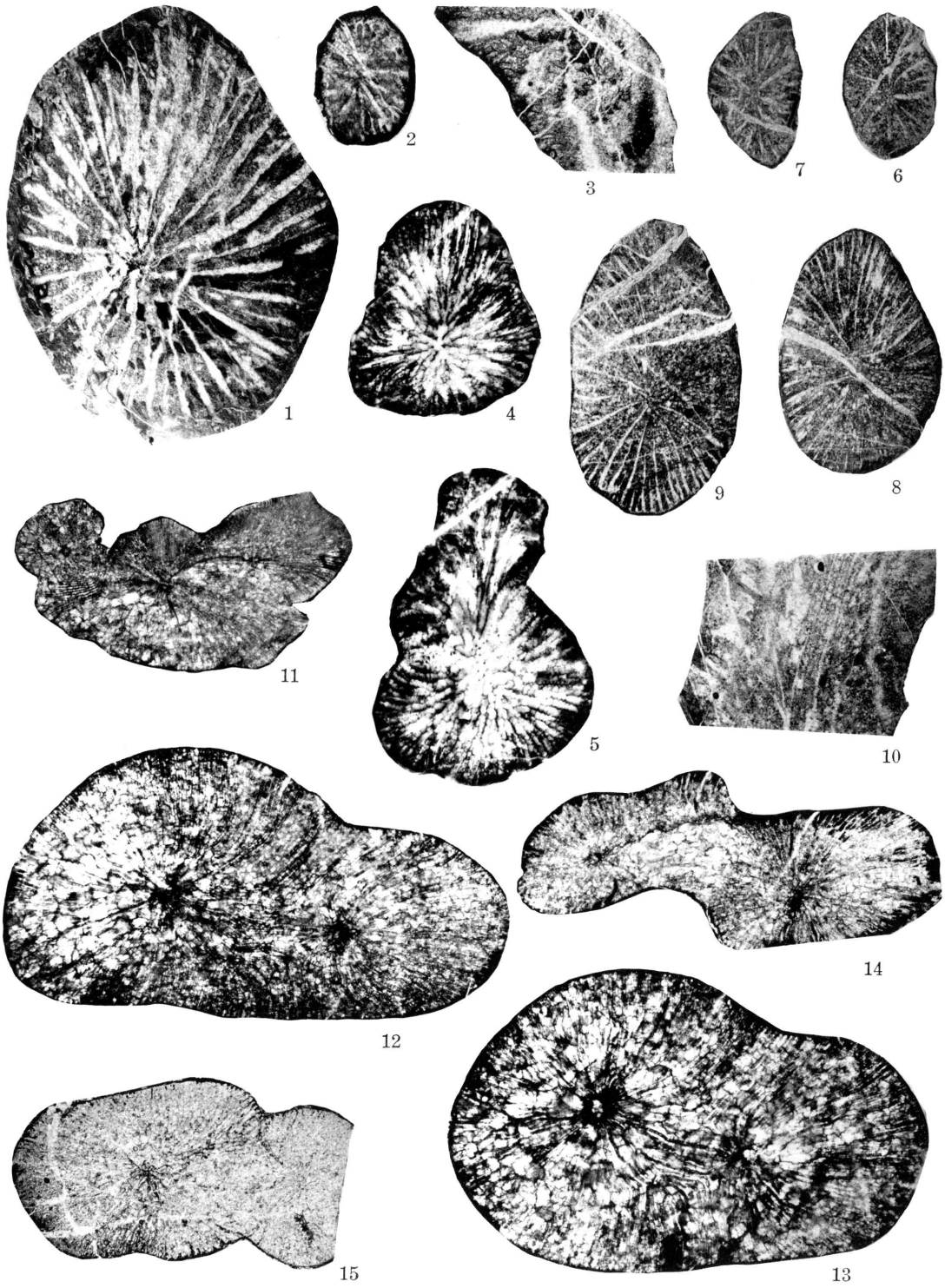
Figs. 1–3. *Montlivaltia* sp. cf. *M. stylophylloides* VINASSA .....Page 123
1. Transverse section of a mature specimen, GK. F337.
2. Transverse section of an immature part of the same specimen.
3. Longitudinal section of the same specimen. Loc. Ko. 278.

Figs. 4, 5. *Montlivaltia* sp. cf. *M. timorica* VINASSA .....Page 121
Serial transverse sections of a specimen, GK. F330. Loc. Ko. 325.

Figs. 6–10. *Montlivaltia* sp. cf. *M. norica* FRECH.....Page 120
6–9. Serial transverse sections of a specimen, GK. F331.
10. Longitudinal section of the same specimen. Loc. Ko. 278.

Figs. 11–15. *Procyclolites* sp. cf. *P. triadicus* FRECH.....Page 129
11. Transverse section of a specimen, GK. F332, ×1.
12, 13. Serial transverse sections of a specimen, GK. F333.
14. Transverse section of a specimen, GK. F334.
15. Transverse section of a specimen, GK. F352. All from loc. Ko. 278.

Photos by K. KANMERA



K. KANMERA: Triassic Coral Faunas from the Konosé Group

Plate 13

Explanation of Plate 13

Figs. 1–5. *Procyclolites*? sp. aff. *P. timoricus* (VINASSA) ..... Page 131
1–4. Serial transverse sections of a specimen, GK. F355, ×3.
5. Longitudinal section of the same specimen, ×3. Loc. Ko. 278.

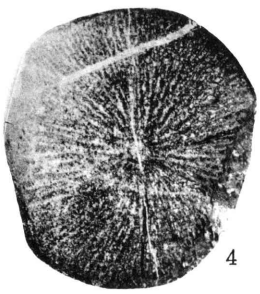
Figs. 6–9. *Thamnasteria* (*Thamnasteria*) sp. ..... Page 134
6–8. Serial transverse sections of a specimen, GK. F335A, ×5.
9. Enlarged part of the same section illustrated as fig. 8, showing septal structures, ×8. Loc. Ko. 278

Fig. 10. *Oppelismilia*? sp. ..... Page 119
Transverse section of a specimen, GK. F358, ×3. Loc. Ko. 724.

Fig. 11. *Elysastraea*? sp. ..... Page 129
Transverse section of a specimen, GK. F357, ×3. Loc. Ko. 278.

Fig. 12. *Thecosmilia* sp. (see also Plate 14) ..... Page 125
Transverse section of a specimen, GK. F356, ×3. Loc. Ko. 232.

Photos by K. KANMERA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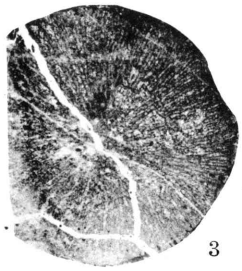
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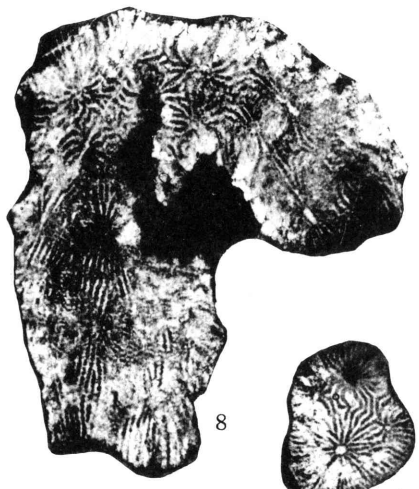
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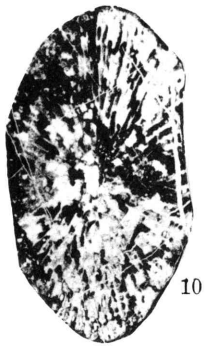
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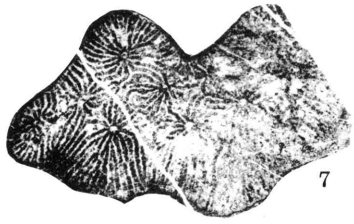
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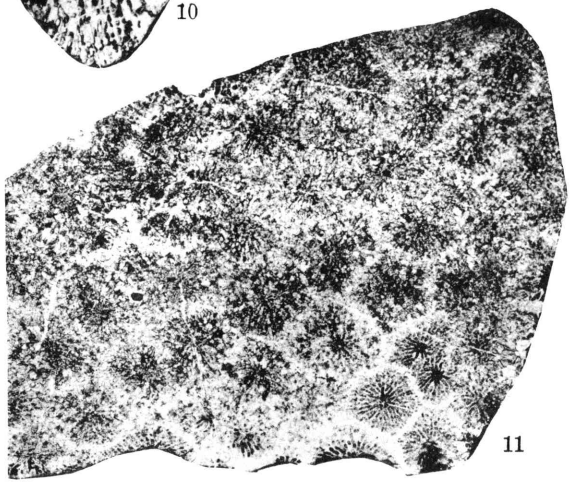
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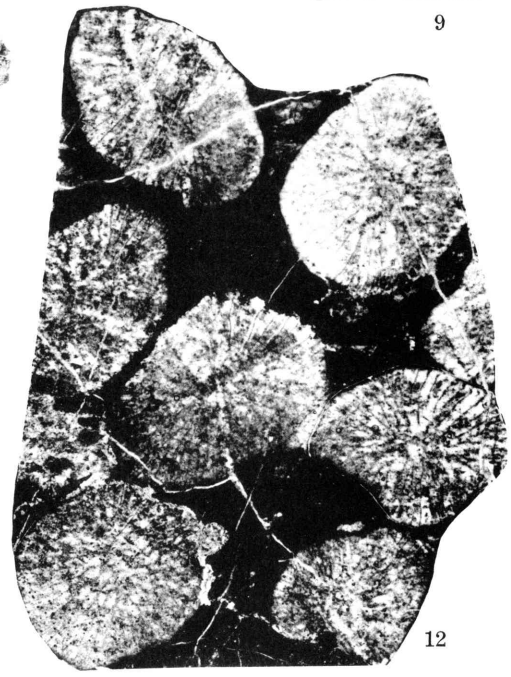
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K. KANMERA: Triassic Coral Faunas from the Konosé Group

Plate 14

Explanation of Plate 14

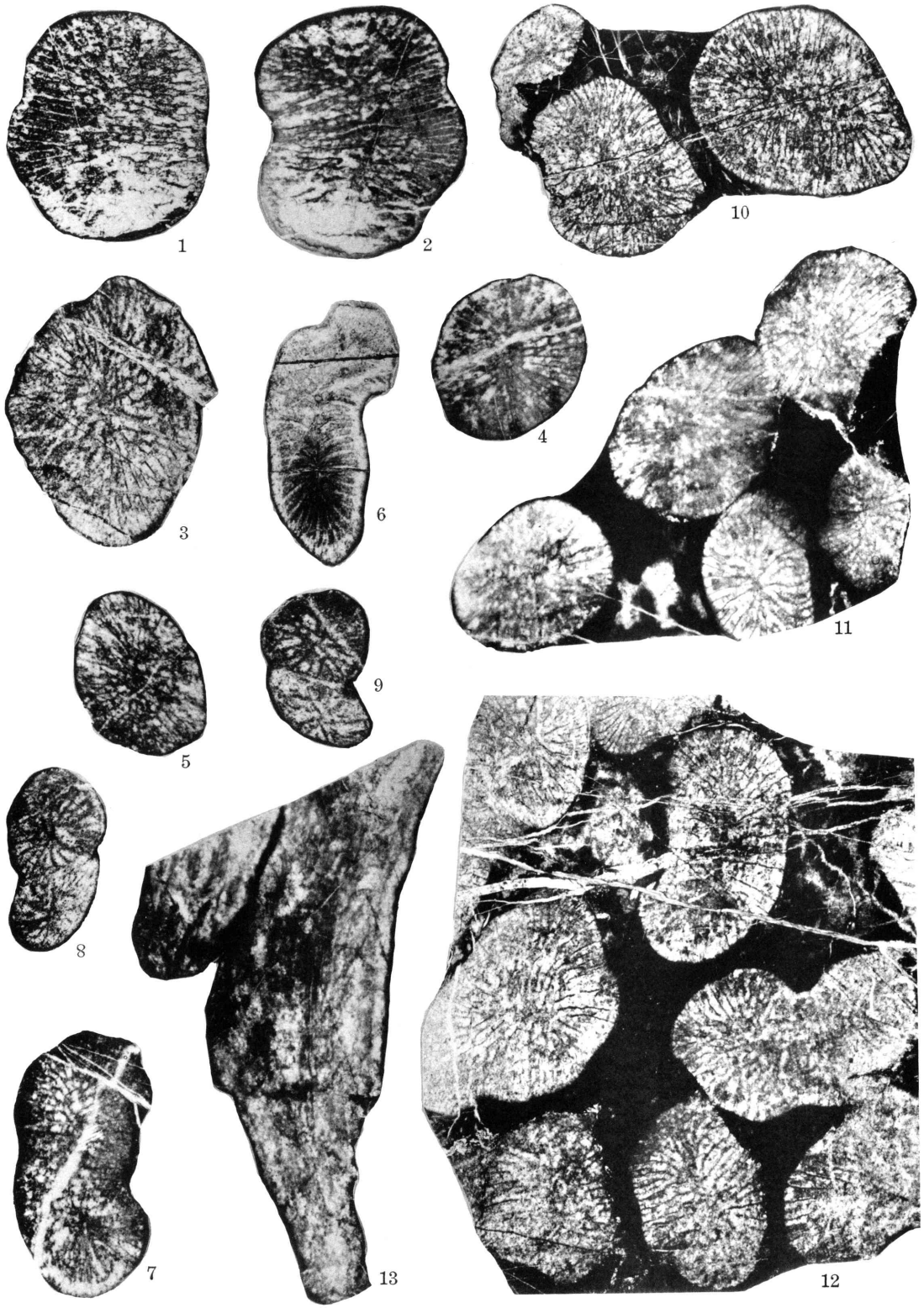
(All figures ×3)

Figs. 1–13. *Thecosmilia* sp. (see also Plate 13) ..... Page 125

1–12. Transverse sections of a specimen, GK. F356. 1, 2, serial transverse sections of a mature corallite; 3, 11, 12, transverse sections of mature corallites; 4, 5, transverse sections of early mature corallites; 6, 7, transverse sections showing a distmodaeal budding; 8, 9, transverse sections of young corallites; 10, transverse sections of two mature corallites and one very young corallite. Loc. Ko. 232.

13. Longitudinal section of a corallite, GK. F356, Loc. Ko. 232.

Photos by K. KANMERA



K. KANMERA: Triassic Coral Faunas from the Konosé Group

Plate 15

Explanation of Plate 15

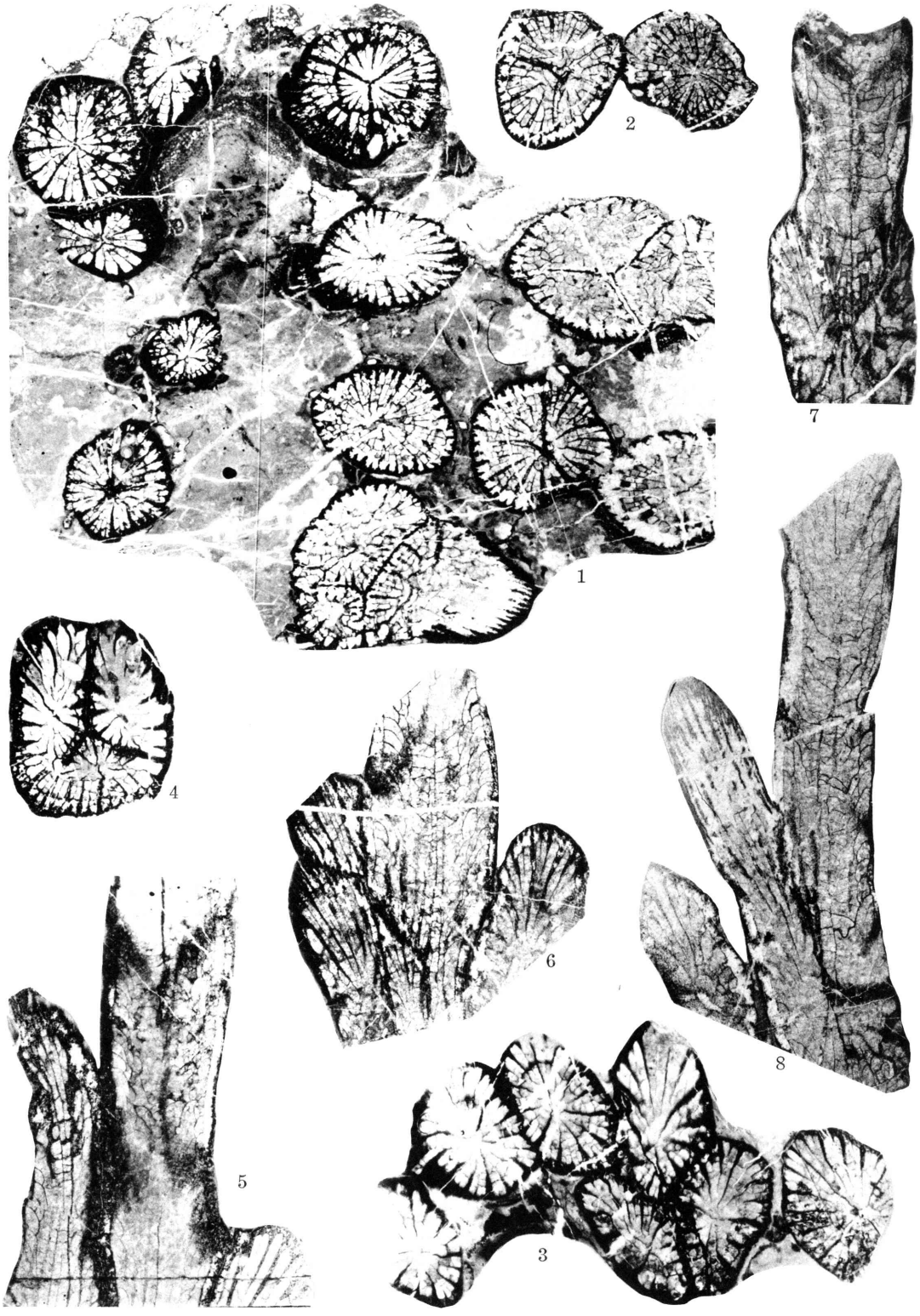
(All figures ×3)

Figs. 1–8. *Thecosmilia konosensis*, sp. nov. (see also Plate 16) ..... Page 127

1–4. Transverse sections of the holotype, GK. F348. 1–3, transverse sections of mature or early mature corallites; 4, transverse section with three young corallites produced by budding.

5–8. Longitudinal sections of the holotype, GK. F348. Loc. Ko. 325.

Photos by K. KANMERA



K. KANMERA: Triassic Coral Faunas from the Konosé Group

Plate 16

Explanation of Plate 16

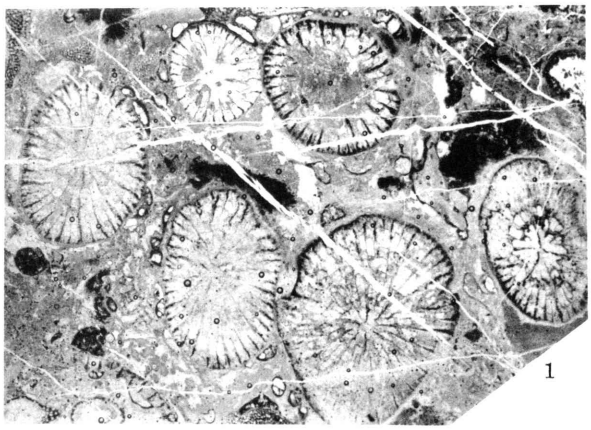
(All figures ×3)

Figs. 1–9. *Thecosmilia konosensis*, sp. nov. (see also Plate 15) .....Page 127

1–8. Transverse sections of the holotype, GK. F348. 1–4, transverse sections of mature or early mature corallites; 5–8, transverse sections of young corallites showing the mode of budding.

9. Transverse section of the holotype, GK. F348. Loc. Ko. 325.

Photos by K. KANMERA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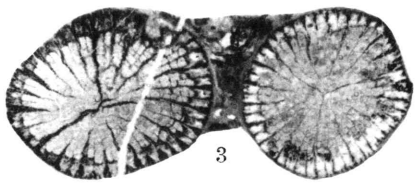
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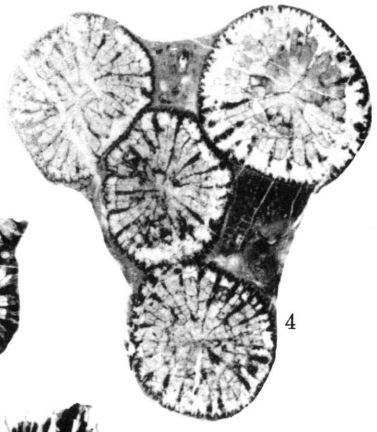
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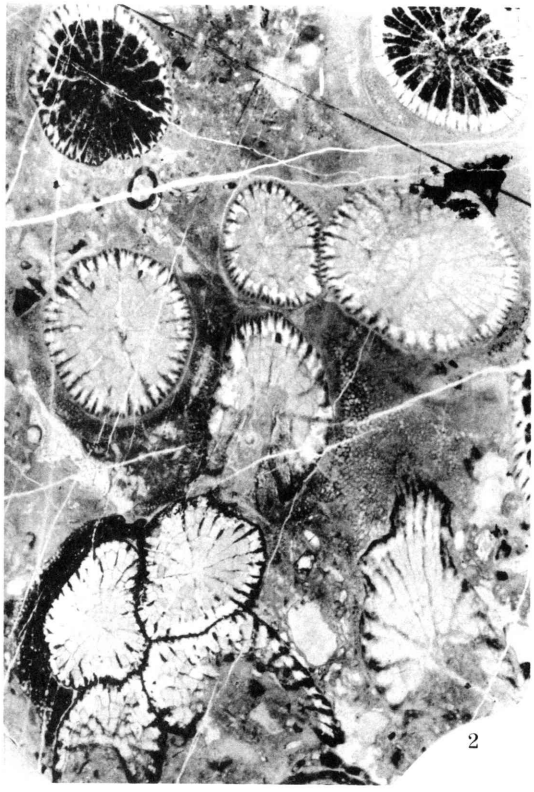
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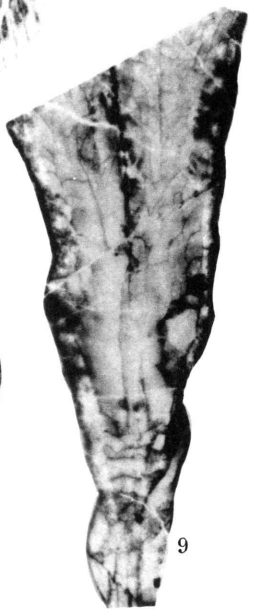
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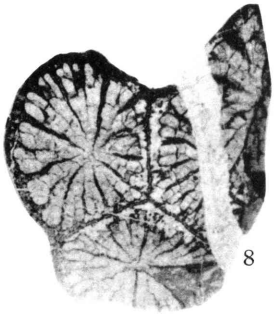
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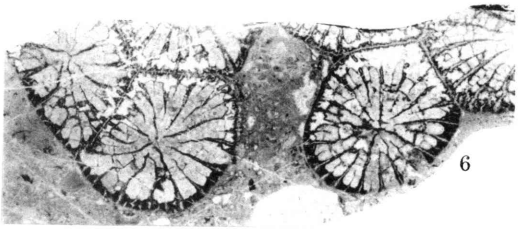
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K. KANMERA: Triassic Coral Faunas from the Konosé Group

Plate 17

Explanation of Plate 17

(All figures ×3, unless otherwise stated)

Figs. 1–7. *Thecosmilia eguchii*, sp. nov. (see also Plate 18) .....Page 124

1. Transverse sections of the holotype, GK. F341.
2. Transverse section of a paratype, GK. F342.

3–6. Longitudinal sections of the holotype.

7. The same section as fig. 2, ×1. Loc. Ko. 278.

Fig. 8. *Conophyllia*? sp. (see also Plate 18) .....Page 133

Transverse section of a specimen, GK. F346. Loc. Ko. 278.

Photos by K. KANMERA

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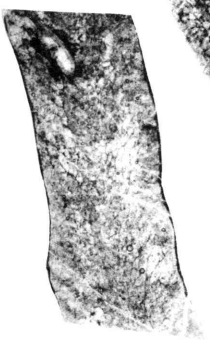

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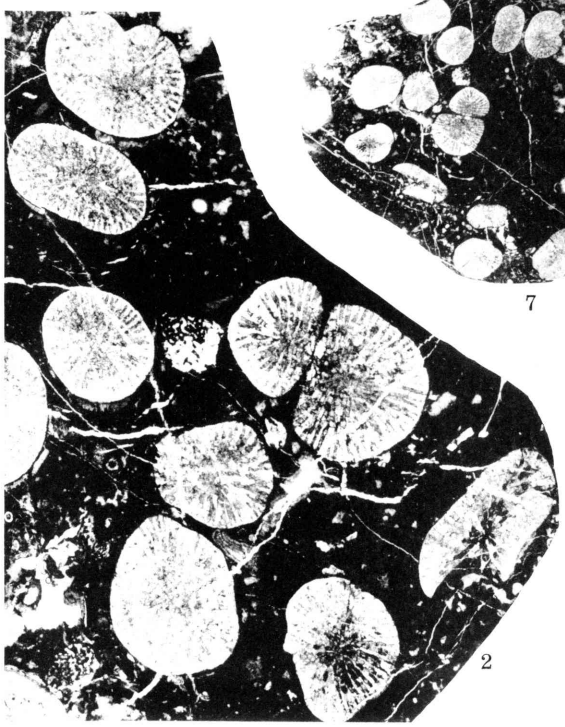

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K. KANMERA: Triassic Coral Faunas from the Konosé Group

Plate 18

Explanation of Plate 18

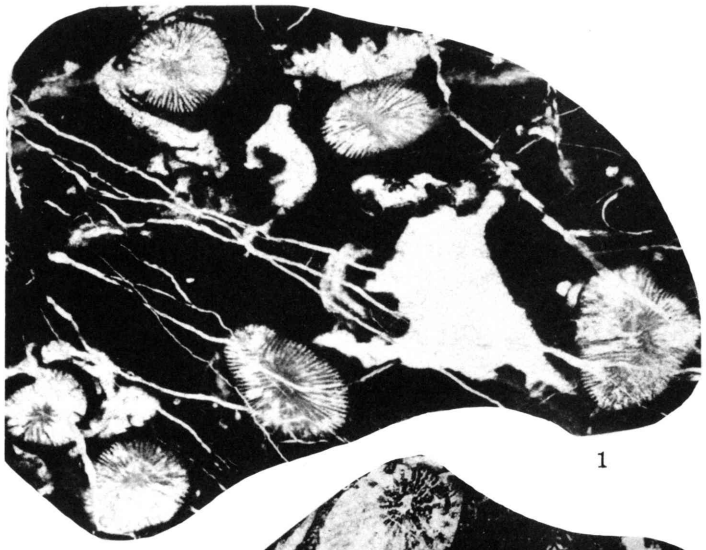
(All figures ×3)

Figs. 1, 2. *Procyclolites*? sp. ..... Page 132
Transverse sections of a specimen, GK. F353. Loc. Ko. 278.

Figs. 3–6. *Conophyllia*? sp. (see also Plate 17) ..... Page 133
3. Transverse section of a specimen, GK. F345.
4, 5. Transverse sections of a specimen, GK. F346.
6. Transverse section of a specimen, GK. F347. Loc. Ko. 278.

Fig. 7. *Thecosmilia eguchii*, sp. nov. (see also Plate 17) ..... Page 124
Transverse section of the holotype, GK. F341. Loc. Ko. 278.

Photos by K. KANMERA



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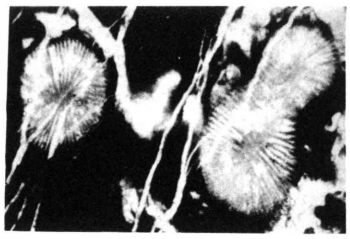

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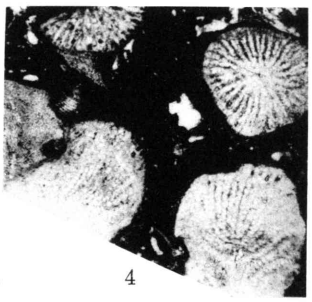

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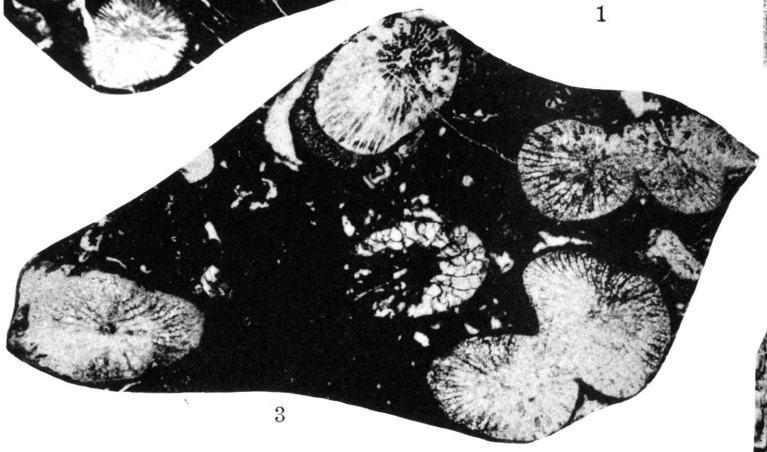

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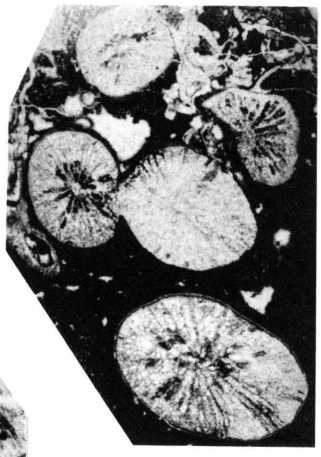

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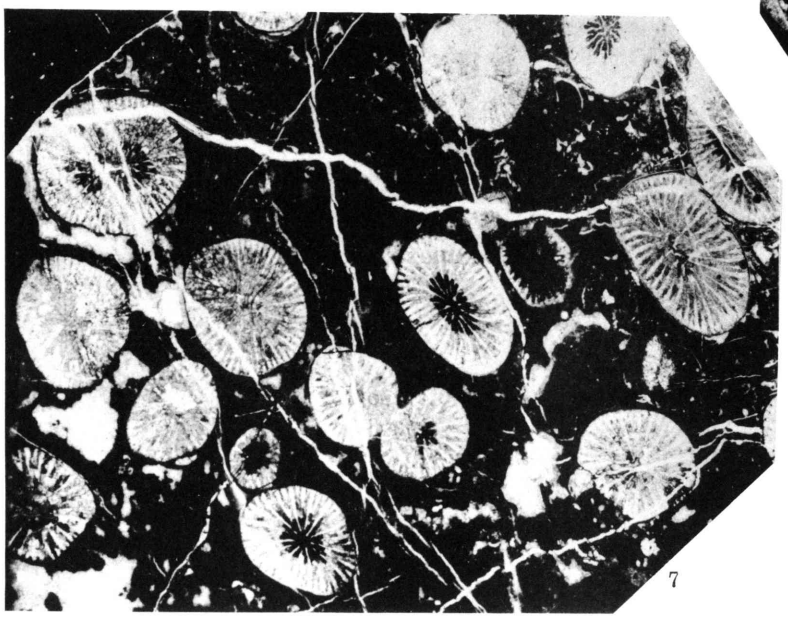

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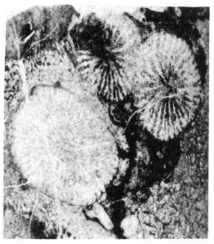

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K. KANMERA: Triassic Coral Faunas from the Konosé Group

Plate 19

Explanation of Plate 19

(All figures ×3)

Figs. 1–7. *Thamnasteria* (s.l.) *furukawai*, sp. nov. .....Page 135

1–5. Transverse sections of the holotype, GK. F350.

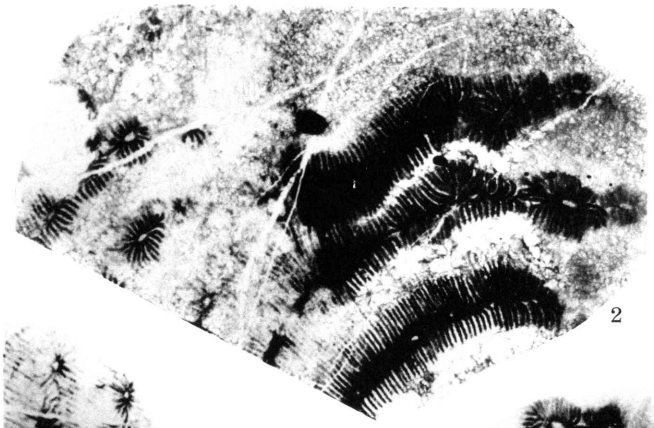
6. Longitudinal section of the same specimen.

7. Transverse section of a paratype, GK. F351. Loc. Ko. 278.

Photos by K. KANMERA


1


3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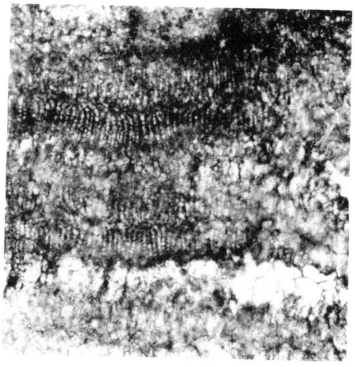
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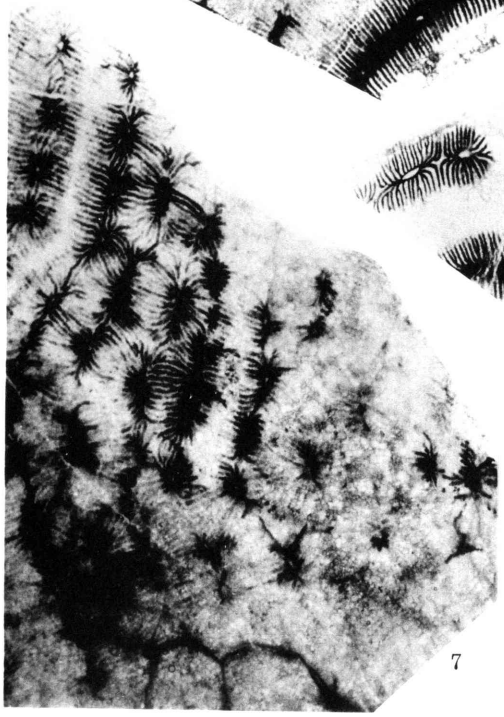
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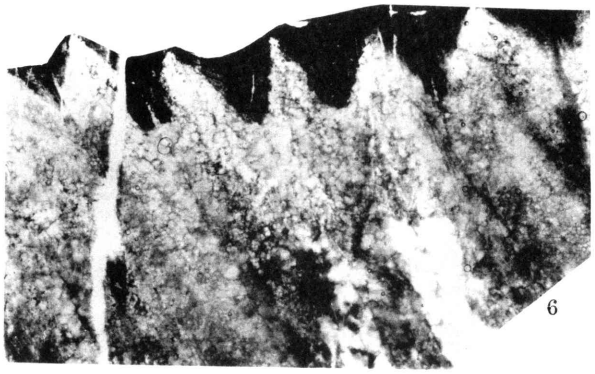
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K. KANMERA : Triassic Coral Faunas from the Konosé Group