*Classification of the Fukuji formation (Silurian) on the basis of FAVOSITES with description of some FAVOSITES (Study on paleozoic rocks of Hida II)**

Tadao KAMEI

(Department of Geology, Faculty of Liberal Arts and Science)

Introduction

The Fukuji formation was named for Silurian rocks exposed in the south-eastern part of Hida mountainland, exactly to say, in the vicinity of Fukuji village, Kamitakara-mura, Yoshiki-gun, Gifu-ken, Central Japan. It consists largely of limestones, tuff and shales. Although it is jamed like a slice between the younger paleozoic rocks (lower Carboniferous to middle Permian) by faults and dike intrusions, it yields numerous, well preserved Silurian fossils which include the corals, stromatoporoids, brachiopods, echinoids, pelecypods, gastropods and nautiloids. But here the author only deal with the *Favosites* corals which are distributed widely within this formation. The stratigraphical work on the paleozoic rocks of this district was reported by the author three years ago (Kamei, 1952). After this, he restudied on the stratigraphy of the Fukuji formation on the basis of faunal succession of *Favosites* corals and he admitted to correct the former work. The result on the stratigraphy and the description of *Favosites* fauna are introduced here.

The writer wishes to express his sincere thanks to Prof. Dr. M. Minato of the Hokkaido Univ., Assist-Prof. K. Kobayashi of the Shinshu Univ., Mr. M. Ōkubo of the Tokyo Univ., Mr. H. Igō of the Tokyo Educational Univ., for their helpful guidance in the field and laboratory. Particular thanks are due to Prof. Dr. H. Fujimoto and the members of the Researching Group for the Geology of the Hida Mountainland, for their encouragement and valuable suggedtion. To Mr. K. Tanaka of the Shinshu Univ., he lent the author many valuable specimens.

* Received November 12, 1955

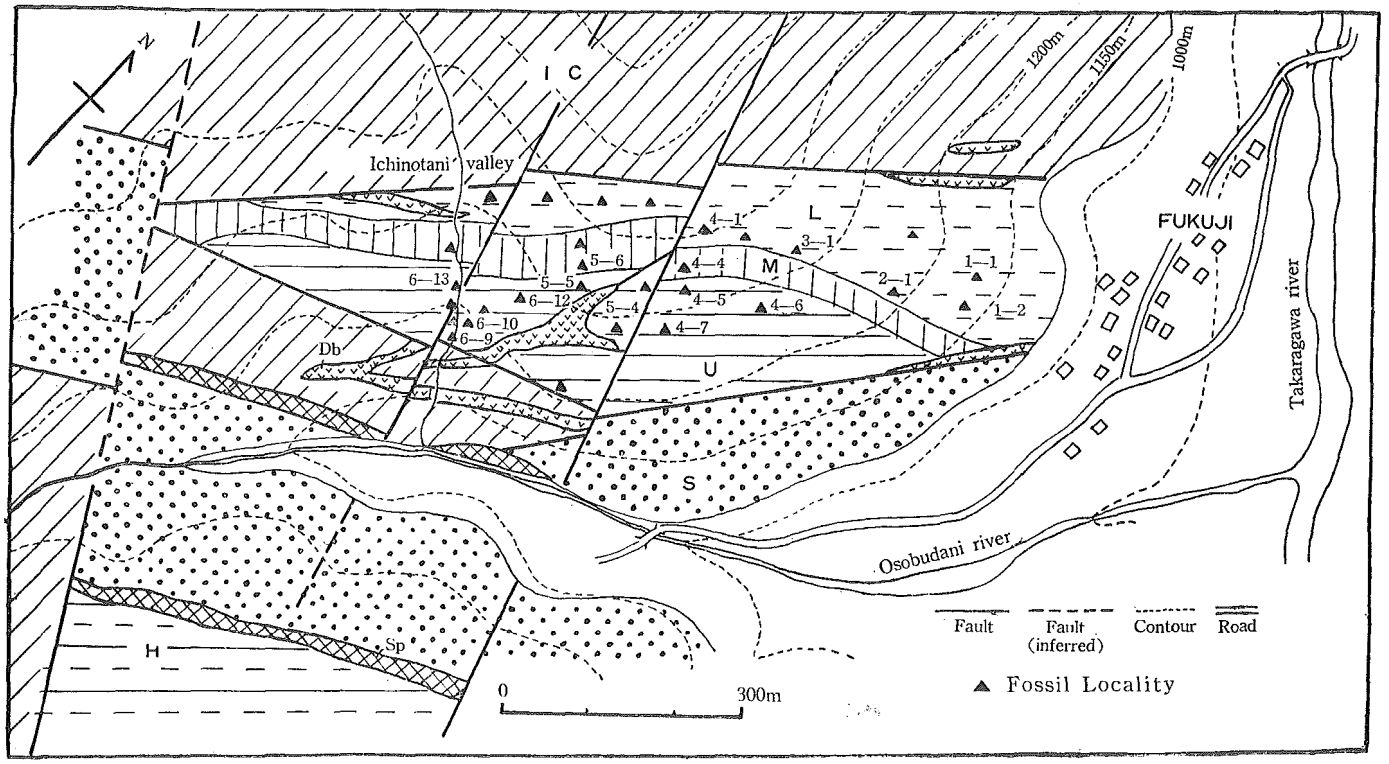
Lithological succession

The Fukuji formation is exposed at the north-facing slope of the Osobudani valley west to Fukuji village and near the junction between the river Takara-gawa and the river Gamata-gawa. However, the latter is largely obscured by debris and only some fossiliferous limestone boulders have been found over there. At the former place there are some exposures of this formation. It is hardly to have a continuous succession owing to blockwise geological structure which is brought about by net-work faults system and dike intrusions, though the middle and lower course of the stream, known as the Ichinotani which pours into the Osobudani valley from north to south, offers a nearly complete section of the fossiliferous part of the formation. Three main lithological units are present. These are the Lower Limestone member, the Middle Acid Vitric Tuff member and the Upper Limestone and Shale member, each of which can be distinguished without difficulty.

The Lower Limestone member, 80 — 100 m. thick, is composed with massive, black to gray limestone, convieniently named as Bed. 1. Numerous exposures of it occur near the ridge of mountain slope, however, they are expossed discontinuously. In the middle part of the Ichinotani stream, the lower part of this limestone is cut by fault, and contact directly with the Lower Carboniferous *Kueichouphyllum* limestone (lower part of Ichinotani group). And also such fault is modified by porphyrite dike intrusion at the limestone cliff, west to Fukuji village. Thus the lower limit of the Lower Limestone member, that is of the Fukuji formation, is unknown. Along the ridge, richly fossiliferous limestone are exposed discontinuously in E—W trends, and these yield numerous stromatoporoids associated with many corals. These fossiliferous limestone beds occupy the top of this member. Below these beds some bituminous or shaly limestone are exposed. From the boulders of this black limestone, some massive *Favosites* corals, brachiopods, nautiloids etc. were found. Further below are fossil barren gray massive limestone beds, which occupy more than half of this member.

The Middle Acid Vitric Tuff member, about 50 m. thick, is exposed in the middle course of the Ichinotani stream and on its west-facing slope. The member is dominantly composed of acid vitric tuff, associated with fine to coarse pyroclastics and impure limestones. This acid vitric tuff is blue to green color and very siliceous. In the valley of Ichinotani following succession were treated, in descending order:

7m. Greenish vitric tuff (Bed 6): small clavate *Favosites* and *Camarotoechia*.



Text-Fig. 1. -Geological Map of Fukuji.

H : the Hirayu group. Permian, S : Sorayama group. Permian. IC : Ichinotani group. Lower Carboniferous to Middle Permian. U : Upper Limestone and Shale member (Fukuji formation). M : Middle Tuff member (〃). L : Lower Limestone member (〃). Db : Diabase, Sp : Serpentine.

12m. Gray limestone with thin tuff (Bed 5) : crinoidal.
20m. Thin alternation of tuff and limestone (Bed 4) : *Camarotoechia* etc.
5m. Black impure limestone (Bed 3) : Gastropoda, Brachiopoda *Amphipora*.
2m. Blue acid vitric tuff (Bed 2) : nonfossils.

The blue acid vitric tuff of the lowest lies upon the dark gray limestone of Bed 1 with marked boundaly conformably, and thin clay film are intercalated between both beds contacted each other with nearly vertical planes. The facies of these acid vitric tuffs vary to thick bedded tuffeceous sandstone or impure limestone laterally. The pyroclastics range from bedded plagioliparite to thick bedded tuffeceous sandstone.

The Upper Limestone and Shale member attains a thickness of about 130 m. in the valley of the Ichinotani and on its west-facing slope. The following succssion of this member was made in descending order:

17m. Gray sandy shale associated with limestone lens, fossiliferous. (Bed 11)
.....Fault.....
15m. Black limy shale, fossiliferous. (Bed 10)
70m. Gray bedded massive limestone, poor in fossils. (Bed 9)
4m. Black limy shale; fossiliferous. (Bed 8)
20m. Gray to dark gray crinoidal limestone, fossiliferous. (Bed 7)

From field observations it is now clear that the lowest crinoidal limestone (Bed 7) overlies on greenish vitric tuff (Bed 6) conformably and has some variegated facies such as calcarenite. It is particularly noticeable that this limestone is often interbedded with thin calcareous shaly layers associated with crinoids and brachiopods fragments. This bed is fairly fossiliferous and yields numerous corals, stromatoporoids, brachiopods and crinoids. Large spherical *Favosites*, *Heliolites* and *Clathrodictyon* are characteristic. Succeedingly above, this bed is overlaine by black limy shale, which is lenticular in form and often tongues out into limestone. Strophomenid and Atripid brachiopoda, and Pelecypods were aboundantly collected from this bed. Above this bed, very thick, gray, beded, massive limestone beds overlie with marked boundary conformably. The upper part of this limestone is thick bedded, while the lower is massive. Throughout this limestone fossils are very poor in number. At the place where this limestone contact with black limy shale overlain, a small waterfall is formed. This black limy shale has three fossil layers in which the lowest near the base is thick and fossiliferous.

The gray sandy shale (Bed 11) is isolated from other beds by faults and dike intrusion, so its stratigraphical position is obscure. But according to lithological and faunal characters, it may be either above or in same horizon

with Bed 10. Faults and dike run between Bed 11 and Bed 10, and also between Bed 11 and Bed 9. The basal part of this bed is fragile sandy shale which weathers to a distinctive brown color, and it yields a number of brachiopods and corals. About 2 m. above this, limestone lenses are interbedded in hard black limy shale. The succeeding 10 m. of shales are thin bedded and barren in fossils.

Fault contact between Bed 11 and younger paleozoic schalstein (Sorayama group, Permian) is inferred. So the upper limit of the Fukuji formation is unknown as well as the lower limit.

Description of species

Family Favositidae Edwards and Haime

Genus *Favosites* Lamarck

Favosites gotlandicus Lamarck

Plate I, Figs. la-ld.

1855 *Favosites gotlandicus*, Edwards and Haime : Brit. Fossil Corals, pt.V, p. 256, P1. XL, Figs.1, la.

1894 *Favosites gotlandicus*, Weissermel : Zeits. deit. geol. Gesell., XLVI, p. 647, Taf. LI, Fig.8.

1899 *Favosites gotlandica*, R. Etheridge : Rec. Geol. Surv. N.S.W. VI, pt.3, p.162.

1902 *Favosites gotlandicus*, Potca : in Barracnde 'Systeme Sil. du Cent. d. l. Bohême.' VIII, Tome I, p.230, P1. LXXVI, Figs.1-12.

1908 *Favosites gotlandica*, Mansuy : Contribution à la Carte Géologique de l'Indochine, Palaeontologique, p.32, P1. LV, Figs.7, 7a; P1.V, Fig.3.

1915 *Favosites gotlandicus*, Yabe and Hayasaka : Jour. Geol. Soc. Tokyo, XXII, p.66

1930 *Favosites gothlandicus* froma *gothlandica*, Smith : Q.J.G.S., LXXXVI, p.317

1933 *Favosites gotlandica*, Tripp : Palaeontographica, LXXIX Abth. A(3-6), pp. 101-108. Pls.11-12; Text-Figs. 28-33.

1936 *Favosites gothlandicus* forma *gotlandica*, O.A. Jones : Ann. & Mag. Nat. Hist. ser.10, No.97, pp.8-9, P1.1, figs, 1-4.

Description.—Although the materials dealt here are unsatisfactory to observe their external form, they have all massive corallum with the width of more than 10 cm. The corallites are prismatic, arranged parallel. They are polygonal in cross section and have hexagonal and pentagonal form of large diameter ranging 2.5-3.0 mm. Their large polygonal form and uniform size of corallites are discriminatory to other species. And also, it is important to say that the walls of contiguous corallites are very thin, about 0.04 mm, without amalgamation. They are straight in cross section, while slightly wrinkled in longitudinal section. The mural pores are circular with

about 0.25 mm. in diameter throughout their mature grouth stages. Then, the ratio of diameters, mural pores to corallites, is nearly 1:10; pores are arranged in one or two rows alternating, on average 0.8 mm. apart on the faces of corallites. No elevated marginal rims around the pores are traceable. The tabulae are thinner than wall, complete and horizontal, spaced distantly 4-5 within 3 mm. Sometimes the tabulae being concave upwardly with slight depression at the central are observed in peripheral region. Septa are normaly absent.

Remarks.—To this worldwide Silurian species, numerous descriptions had been given in various manner. When tried to compare each other will be brought some confusion from adverse opinions. Turning points are, presence or absence of septa, close or distant distribution of the tabulae, equal or unequal arrangement of corallites. Such opposite opinions were synthesized by O. A. Jones (1936). Jones found that "there is a complete gradation from this (which has no septa) to other forms in which septal spines are both numerous and well developed." Jones also proceeded discussion on the arrangement of corallites, and emphasized that there are gradation between *Favosites gothlandicus*, *F. forbesi* and *F. multipora*, accompanied with intermediate forms. In the discussion Jones stated that these gradation might be due to the enviromental effects. Apart from Jones, study on *Favosites* fauna from Gotland had been done by K. Tripp (1933). Tripp had traced phylogeny of *F. asper*, *F. gotlandica* and *F. hisingeri* on the basis of statistic works. According to his opinion, septal number, corallites size, density of tabulae etc. of *F. gotlandica* are variable in phylogenitical development, however, thickness of wall, horizontal septal spines and the ratio of diameters between pores and corallites (1:10) are rather constant.

Judging from above, the specimens studied can be identified right to *F. gotlandicus* in having no septa, large polygonal corallites, thin wall, distantly spaced thin tabulae, remoted pores in one or two rows alternating on the faces of corallites and constant ratio of pores and corallites. *F. gothlandicus* forma *gothlandica*? was found from Kitakami (Sugiyama, 1940). That is slightly differ from the present. The former have small globular corallum and slightly thicker wall, while the latter have large massive corallum and thinner wall. *F.* cfr. *gotlandicus* from Kenniho Conglomerate, Korea (Ozaki, 1936) is differ from the present in having smaller corallites, wrinkled wall and rather thick septal spines. *F.* cf. *gotlandicus* from the Malung limestone of East Yunnan (Grabau, 1926) which have small corallites and numerous tabulae is greatly differ from the writer's materials.

Horizon and Locality.—Silurian, Bed 7 of Fukuji formation; 5-5, 6-12 in the vally of the Ichinotani.

Reg. No. G. I. S. U. L. 30101 (Slide, 30102.)

Favosites asper d'Orbigny

Plate I, Figs. 2a-2b.

1839 *Favosites alveolaris* (Goldfuss), Lonsdale : in R. I. Murchison, 'The Silurian System.' p. 681, Pl. XV. bis. Figs. 1, 1a-b, 2, 2a.

1850 *Favosites aspera*, d'Orbigny : Produme de Palaeontologie, I, p. 41; in O. A. Jones (1936)

1855 *Favosites aspera*, Edwards and Haima : Brit. Fossil Corals, pt. v. p. 257. Pl. LX, Figs. 3, 3a.

1894 *Favosites asper*, Weissermel : Zeits. deut. Gesell., Bd. XLVI, p. 648, Taf. LI, Fig. 9.

1902 *Favosites asper*, Pocta : in Barrande, 'System Sil. du Cent. d. 1. Bohême.' VIII, Tome II, p. 230, Pl. LXXXII, Figs. 1-11; Pl. LXXXIV, Figs. 1-24.

1914 *Palaeofavosites asper*, Twenhofel : Geol. Surv. Canada, Mus. Bull. no. 3, (Geol. ser. no. 19), p. 39, pt. 1

1933 *Favosites asper*, Tripp : Palaeontographica, Bd. LXXIX, Abth. A(3-6), pp. 90-101, Taf. VIII—X; Text-figs. 20-26.

1934 *Palaeofavosites aspera*, Ozaki : Jour. Shanghai Sci. Inst. separate print no. 6. sect. II, vol. I, pp. 73-74, PI1 XIV, Figs. 8, 9; Pl. XV, Fig. 1.

1936 *Favosites asper* O. A. Jones : Ann. & Mag. Nat. Hist. ser. 10, no. 97, pp. 15-17, Pl. II, Figs. 1-3.

1940 *Favosites asper* Sugiyama : Sci. Rep. Tohoku Imp. Univ. second ser., XXI, no. 2., pp. 126-127, Pl. XIX (VII), Fig. 11; Pl. XX (VIII), Figs. 2-4; Pl. XXI (IX), Figs. 9-11

Description.—A few specimens referable to this species were collected. Those are entirely embedded in limestone matrix, but it is possible to observe the mural pores located at or near the angles of the corallites, small corallites and thin walls.

The corallum is massive, and hemispherical to cylindrical. The prismatic small coralltes fan out from the basal restricted portion. In cross section, they are polygonal, usually hexagonal of rather equal diameter (1.4 to 1.6 mm.). The walls are thin (about 0.05 mm) and straight, both in cross and longitudinal section, without amalgamation. the mural pores of medium diameter (c. a. 0.2 mm.) are circular, located at or near the angles of the corallites in two rows alternating. Sometimes they are on the faces in one rows. The tabulae are thin, as thick as walls. They are complete and horizontal, closely set 15-17 in a space of 5 mm. The short septal spines are

irregularly distributed in the corallites, pointing upwards in longitudinal sections.

Remarks.—*Favosites asper* is characterized by its small corallites with thin walls, by often having the pores in the angles of corallites, and by irregularly distributed feeble septal spines which point upwards. All of them can be observed in the present specimens. K. Tripp (1933) stated the following description based upon statistical study "Der gotländische *Asper*-Formen Komplex ist sehr variabel. Stabil bleiben während der Formen umwandlung in Verlauf der Generationen nur die Anordnung der Poren in der Winkeln der Zellröhren und die aufwärtsgerichtete Lage der Stacheln. Alle andern (inneren und ausseren) Bau elemente verändern sich gesetzmässing." And he divided '*Favosites asper*-Formen Komplex' of Gotland into eight groups. The present speciments are closely related with those of 'Gruppe II' found from Visby Mergel.

Favosites asper found from Kitakami (Sugiyama, 1940) is similar to the present, though the tabulae are more distantly spaced than the latter. *Favosites asper* var. *aokii* Sugiyama (1940), which mural pores are located not in the angles but on the faces, may be separable from *F. asper*.

Horizon and Locality.—Silurian. upper part of Bed 1 of Fukuji formation ; 1-1, west of Fukuji village.

Reg. No. G. I. S. U. L. 30103, Slide 30104.

Favosites baculoides Barrande

Plate I, Figs. 4a, 4b.

1902 *Favosites baculoides*, Pocta : in Barrande, 'System Sil. du Cent. d. 1. Bohême', VIII, Tome II, pp. 242-243, Pl. 81, Figs. 13-17; Pl. 86, Figs. 1-10; Pl. 89, Figs. 17-18

1940 *Favosites* cf. *baculoides*, Sugiyama : Sci. Rep. Tohoku Imp. Univ. second ser., XXI, no. 2, pp. 125-126, Pl. XIX (VII), Figs. 1-10; Pl. XX (VIII), Fig. 1

Description.—The corallum is cylindrical, about 5 cm. wide and about 7 cm. high. The corallites fan outwards from central 'imaginary axis', or sometimes from the basal part, approaching to the lateral surface at an low angle. Those are polygonal and variable in size and form. There are gradual change between the larger octagonal of 2.5 mm. in diameter and the smaller penta-, hexagonal of 1.5 mm. Sometimes very small trigonal ones are seen near the corner of the larger. The walls are thin, about 0.07mm. in average thickness, though not so uniform in thickness. They are slightly sinuous without septal projections. The mural pores are moderate, of 0.20 mm.

broad. They are usually found in two rows alternating on the faces of the corallites, but sometimes near the angles. The tabulae are thinner than walls, horizontal or somewhat concave upwards and closely spaced 9—12 within 5 mm. They are thichened by secondary calcification, but primordial thin tabulae are clearly seen.

Remarks.—Although the tabulae of *F. baculoides* from Bohemia is more distantly spaced than those of the present specimens, but other features are hardly distinguishable. *F.* cf. *baculoides* from Kitakami (Sugiyama, 1940) is quite agree with the present, however, the former has smaller mural pores. For comparison, *F. baculoides* from Kitakami (Slide G. IS. U. L. 30105) is shown in Pl. I, Figs. 5a, 5b.

Horizon and Locality.—Silurian. upper part of Bed 1 of Fukuji formation; 1-1, 1-2, 2-1

Reg. No. G, I, S. U. L. 30106, Slide 30107.

***Favosites flexuosus* n. sp.**

Plate III, Figs. 2a-2c.

Diagnosis.—This species is characterized by having thin, strongly wrinkled walls. The corallum is clavate to pyriform. The polygonal corallites open out on all parts of the corallum except for its restricted base. Form and size of corallites are very variable. The largest ones are rather subrounded and have diameter of about 3.0 mm. No septal spines are traceable. The mural pores are large and circular, and are distributed distantly in one row longitudinally in the middle of corallites faces. The tabulae spaced distantly are very thin and slightly concave or convex upwardly.

Description.—The corallum is clavate to pyriform, and has the breadth of about 2 cm. and the height of about 4 cm. The corallites diverge from the middle part of corallum, but have no tendency to form a dendritic corallum. They open out on all parts of the corallum except for its restricted base. The corallites are subrounded in weathered surface, and vary their size and form continuously from the smaller trigonal ones (0.4 mm. in diam.) to the larger octagonal ones (3.0 mm in diam.). The walls are thin (0.1 mm. in average) and strongly wrinkled. They are composed of fibroid materials and are variable in thickness. No septal spines are observable. The mural pores are large (0.3 to 0.4 mm. in diam.) and circular, arranged distantly in one row longitudinally on the faces of corallites. The tabulae are very thin, slightly concave or convex upwardly, and spaced about 8 within 5 mm.

Remarks.—*F. forbesi occidentalis* (Hall, 1879) has thicker and less wrinkled wall. *F. clavatulus* (Amsden, 1949) differs from *F. flexuosus* in having much smaller corallites. *F.* cfr. *gotlandicus* (Ozaki, 1934) has distinct wrinkled walls, but differs from the present greatly in other features. *F. baculoides* has less wrinkled walls and is different in form of corallum.

Horizon and Locality.—Silurian. Bed 10 of Fukuji formation; 6-9, downstream side of small waterfall in the lower part of the Ichinotani valley.

Reg. No. G.I.S.U.L. 30108 (Holotype, Slide), 30109 Slide, 30110 Slide, 30111.

***Favosites ichinotanensis* n. sp.**

Plate III, Figs. 1a-1c.

Diagnosis.—The corallum is hemispherical. The corallites are prismatic, variable in size and form. The larger one attains its diameter to 3 mm. The walls are thin and usually, slightly wrinkled. The arrangement of mural pores is characteristic. On the faces of corallites opposite pores are arranged being 0.6 mm. apart, in two or three rows, sometimes alternating one and two opposite pores. They are medium to large, circular. The tabular are thick, horizontal and spaced rather distantly. The septal spines are feeble and irregularly distributed.

Description.—The corallum is usually hemispherical, but sometimes pyriform to globular. The maximum diameter of corallum attains to 10 cm., however, those of about 5 cm. are common. The basal epitheca can not be observed. The corallites radiate from the basal portion, but not diverge. They are continuous from small trigonal (less than 1 mm. in diam.) to the larger octagonal of 3 mm. Amongst them, octagonal and hexagonal ones are common. The walls are thin (0.1 mm.) and slightly wrinkled. The mural pores are circular and medium (ranging from 0.15 to 0.20 mm. in diam.). The arrangement of pores is very variable even in one corallum. They are usually distributed in two and three rows, being in the same line horizontally to pores of neighbouring rows. Sometimes one row and alternating one and two opposite pores are observable. On the average they lie 0.6 mm. apart. The tabulae are thick, horizontal and spaced moderately, 5-8 in a space of 5 mm. The septal spines are normaly absent, but a few feeble spines are often seen.

Remarks.—*F. forbesi* (Edwards and Haime, 1855; O. A. Jones, 1936) differs from the present species in having thicker wall accompanied 'central dark line' and opposite or subopposite larger pores in two rows. *F. gotlandicus* described above has fairly uniform corallites. *F. baculoides* has characteristic

cylindrical corallum and alternate pores in two rows. *F. flexuosus* is distinguishable from *F. ichinotanensis* by its strongly wrinkled walls and by simple pores in one row.

Horizon and Locality.—Silurian. Bed 11 of Fukuji formation; 5-4.

Reg. No. G.I.S.U.L. 30112 (Holotype), 30113 (Paratype, Slide).

***Favosites forbesi* Edwards and Haime var. *sugiyamai* n. var.**

Plate II, Figs. 1a-1f, ; Plate IV, Figs. 1,2.

Diagnosis.—The corallum is typically spherical, but has often various forms. The corallites are prismatic and large (2.5 to 3.0 mm. in diam.). Their size and form are variable. The walls are thick without any uniformity in thickness, but on average 0.2 mm. The blunt septal spines produced from fibers of wall are distributed irregularly. They are projected upwardly from the wall. The mural pores are arranged in two or three rows opposite or subopposite on the faces of the corallites. They lie 0.5 mm. apart. The tabulae are closely spaced, rather thick and horizontal.

Description.—The corallum is variable; spherical, hemispherical, globular, clavate and cylindrical, however, spherical form being commom. The diameter of the corallum is usually less than 10 cm. Concentrically wrinkled epitheca and central point of attachment are observed at the central basal portion. The prismatic corallites radiate from the restricted basal portion, and they open their calices nearly entire surface. Their size and form usually change gradually from the larger hexagonal to octagonal ones (2.5 to 3.0 in diam.), to the smaller trigonal to pentagonal ones (0.8 to 2.0 mm. in diam.). Continuous variation is also traceable from mature to immature. The walls are thick, especially on the corner of the corallites. Their thickness is not constant, but on average 0.2 mm. together with the 'central dark line'. The blunt septal spines formed by elongation of fibers in the wall, are irregularly distributed. They show wedge form in cross section and hook form pointing upwards in longitudinal section. The mural pores are circular and mediun, with a diameter of 0.13-0.2 mm. They are arranged in one, usually two, but sometimes three longitudinal rows on each sides of the corallites. Those of one row often observed in immature corallites are large in size, while those of two and three rows in mature are small. Sometimes the pores are observed near the angles of the corallites in later stage. The pores are regularly spaced lying 0.5 mm. apart. The pores are arranged opposite or subopposite with those of neighbouring rows. The tabulae are moderately thick, complete, horizontal and irregularly spaced, being 11-15 within 5 mm. They

are arranged opposite or subopposite with those of neighbouring corallites. In peripheral region, they are often cystose or oblique.

Remarks.—O. A. Jones (1936) distinguished *F. forbesi* Edwards and Haime (as *F. gothlandicus* forma *forbesi*) from *F. gothlandicus* forma *gothlandica* by the presence of septa, by thicker wall and by more closely tabulae. Main charactsr of *F. forbesi* described by many authors, are summarized followingly; 1. large corallites which are unequal. 2. moderately thicker walls with prominet central dark line. 3. blunt septal spines pointing upwardly weakly which are not very numerous. 4. thin tabulae rather closely set. 5. large mural pores, circular or oval, lying far apart usually in two rows which are opposite or subopposite.

The specimens here studied are approximately identical with *F. forbesi*, but differ from the latter in having relative thicker wall and closely set pores. In those respects this variety may be rather referable to some of Devonian form, like as *F. goldfussi* (Edwards and Haime, 1855; O. A. Jones, 1936) and *F. polymorpha* (Hall, 1852), but its fundamental properties are allied to *F. forbesi*. *F. forbesi* and its new variety *F. forbesi muralis* from Yunnan (Yang, 1949) have much smaller corallites and few septal spines.

Horizon and Locality.—Silurian. Bed 7 of Fukuji formation; 4-5, 5-5, 6-12, 6-13.

Reg. No. G. I. S. U. L. 30114 (Cotype, Slide), 30115.

***Favosites forbesi* Edwards and Haime var. *takarensis* n. var.**

Plate II, Figs. 3a-c, 4a-b, 5a-b; Plate IV, Figs. 4, 5, 6.

Diagnosis.—The corallum varies in form; cylindrical, clavate and irregularly shaped coralla. The corallites radiate from the basal restricted portion and present unequal size and form of small. The walls are moderately thick and are not constant in thickness. They are fibrous, but without or with a few septal spines. The mural pores are large, circular or elliptical. They are arranged in one row longitudinally on the faces of the corallites, but sometimes in two rows alternating near the angles. The pores normaly lie 0.5 mm. apart. The tabulae are thin, horizontal and closely spaced.

Description.—The present specimens are classified into three types depending on the forms of corallum. Namely, type A, type B and Type C are distingushable each other. The dimension of them are shown in Table 1.

Type. A (Plate II, Figs 3a-c; Plate IV, Fig.4); The corallum is cup-shaped, 3 cm. in diam. and 4 cm. in height. The corallites radiate from the restricted basal portion upwardly and gradual divergence is observed in the middle.

Table 1

	Corallum	Corallites	Thickness of Wall	Tabulae	Mural pores
A	cup-shape D : 30 mm. H : 40 mm.	L : 1.4 - 1.6 S : 0.4 - 1.2 in mm.	0.12 - 0.18mm.	8 - 10 in 5mm.	elliptical 0.25 × 0.30 in diameter
B	clavate D : 15 mm. H : 40 mm.	L : 1.4 - 1.7 S : 0.6 - 1.0	0.12 - 0.18	8 - 14 in 5 mm.	0.26 mm.
C	cylindrical D : 30 mm. H : 50 mm.	L : 1.4 - 1.6 S : 0.8 - 1.0	0.11 - 0.18	8 - 10 in 5 mm.	0.25 mm

D : diameter of corallum, H : height of corallum
L : larger ones, S : smaller ones

Those are hexagonal to pentagonal; variable in diameter from 1.2 to 1.6 mm.. Sometimes smaller trigonal to tetragonal ones (0.4 to 1.0 mm. in diam.) are interpolated among the larger. The walls are moderately thick and have variable thickness ranging from 0.12-0.18 mm. The straight 'central dark line' is visible. The septal spines are normaly absent, but sometimes very short ridge-like blunt septal spines extend from the fibers of wall. The mural pores are large and eliptical, extending its long axis longitudinally. The long axis is 0.30 mm. and the short is 0.25 mm. The pores are arranged usually in one row on the faces of the corallites, lying 0.5 mm. apart, but those of two rows near the angles suboppositing are observed in peripheral region. The tabulae are very thin, horizontal and spaced 8-10 within 5 mm. They are arranged subopposite with those of adjacent corallites.

Type B (Plate II, Figs. 4a-b; Plate IV, Figs. 5.6); The corallum is clavate, but sometimes globular and pyriform. They have small diameter (1.0-2.0 cm.) and height of less than 4.0 cm. The corallites grow from the basal attachment upwardly, and diverge gradually to lateral. The corallites are subpolygonal with a diameter of 1.4-1.6 mm. These larger ones are distributed sparsely in smaller trigonal and tetragonal ones (0.6 - 1.0 mm. in diam.). The walls are moderately thick and have variable thickness ranging 0.12-0.18 mm.. The septal spines are normally absent, but feeble blunt septal spines like those of Type A are present. The mural pores are large and circular (0.26 mm. broad). The pores are arranged in one row on the faces

of the corallites and lie 0.4 mm. apart. The tabulae are very thin, horizontal and spaced 8–12 within 5 mm. They are arranged opposite or subopposite with those of the adjacent.

Type C (Plate II, Figs 5a-b); The corallum is cylindrical, 3 cm. in diameter and 5 cm. in height. The corallites are polygonal, contrasting with subpolyg onal in Type A and B. These prismatic ones radiate upwardly. The larger (1.4–1.6 mm. in diam.) ones are hexagonal to octagonal, while the smaller (0.8–1.0 mm. in diam.) ones are trigonal and pentagonal. The walls are moderately thick and vary their thickness from 0.15 mm. to 0.18 mm. Fibrous structure and 'central dark line' are visible. The septal spines are absent. The mural pores are large (0.25 mm. broad), and are distributed in one longitudinal row on each side of the corallites. The tabulae are very thin, horizontal and spaced regularly 8-10 within 5 mm.

Remarks.—This variety has smaller corallites, undeveloped septal spines and simple pores, comparing to *F. forbesi sugiyamai*. But, one may notice the similarities of the wall pattern. Furthermore, immature stage of the latter is hardly distinguishable to the presnt. This may suggest that *F. forbesi takarensis* is the ancestal form of *F. forbesi sugiyamai*. *F. subforbesi.* (Yang, 1947) is very near to the present, but the former differs from the latter in having convex thick tabulae. *F. ellipticopora* from Carboniferous of Yun-Nan (Mansuy, 1912) has elliptical mural pores like Type A of the present, but is distinguishable strictly to the latter in all other features.

Horizon and Locality.—Silurian. upper part of Bed 1; 1-1, 1-2, 2-1, 4-2

Reg. No. G.I.S.U.L. 30116 (Cotype, Slide).

Favosites aff. *minor* Ozaki

Plate III, Figs. 3a–c.

1934 *Favosites minor*, Ozaki; Jour. Shanghai Sci. Inst. sep. print, no.6, sect. II, vol.I. p.73, Pl. XIV, Figs.5–7.

Description.—All of the specimens referable to this species, have a very small globular corallum, about 1.0 cm. in diameter. The corallites are small and subrounded in cross section, varying the diameter from 0.7 mm. to 1.5 mm. The walls are moderately thick (0.15 mm.) and smooth without septa. The mural pores, 0.18 mm, broad, are located near the angles of the corallites. The tabulae are thin, horizontal or concave upwardly, spaced closely 12–18 within 5 mm. They are arranged oppositing with those of adjacent corallites.

Remarks.—As the specimens studied are entirely embedded in limestone

matrix, detail observation is impossible. *F.* aff. *minor* differs from *F. minor* from Kenniho Conglomerate, Korea, by the absence of septal spines and less number of tabulae. But, generally speaking, difference between them is very slight.

Horizon and Locality.—Silurian. upper part of Fukuji formation; 1-2, 2-1, 3-1, 4-1.

Reg. No. G.I.S.U.L. 30117 (Slide), 30118.

***Favosites hidensis* n. sp.**

Plate III, Figs 4a-c; Plate IV, Fig. 7.

Diagnosis.—The corallum is small, pyriform to clavate. The corallites are small (less than 1 mm. in diam.). Their polygonal calices are regularly distributed on nearly of all surface. The walls are very thick, especially in peripheral region. The tabulae are thick and closely spaced. The mural pores are large and circular, located near the angles of corallites in two rows alternating. No septa are traceable.

Description.—The corallum is small, pyriform to clavate, but sometimes globular. The size of corallum is about 1 cm. in width and 3 cm. in length. There are no epithecal wall. The corallites radiate gradually from the basal attachment, approaching to the surface at a high angle. They are closely packed each other in central portion, but loosely in peripheral margin. The polygonal corallites open on nearly of all surface, and regularly distributed. They are small (0.8-1.0 mm. in diam.) and tetragonal, pentagonal and hexagonal in form. The walls are thick, composed of fibrous structure. Near the peripheal, the thickness on the walls is about 0.3 mm., while in the central it decrease to half of the former. The mural pores are large (0.13 mm. broad) and circular, arranged in two rows alternating near the angles of each corallites. The tabulae are thick, horizontal or oblique and spaced 16 within 5 mm. No septa are traceable.

Remarks.—Edwards and Haime (1855) proposed *F. cristatus* to dendritic *Favosites* with small corallites. They did not show any detail, but cited the presence of thick walls. *F. hidensis* differs from *F. cristatus* in that the former has pyriform to clavate corallum while the latter has dendritic and branching ones. *F. hidensis* is distinguished from *F.* aff. *minor* by its thicker wall and polygonal corallites.

Horizon and Locality.—Silurian. Bed 6 (4-5, 5-6), Bed 7 (6-12, 5-5) and Bed 11 (5-4), or Fukuji formation.

Reg. No. G.I. S.U.L. 30119 (Holotype), 30120 (Paratype, Slide), 30121,

30122.

***Favosites uniformis* Yang var. *igoi* n. var.**

Plate I, Figs. 3a-d; Plate IV, Fig. 3.

Diagnosis.—The corallum is massive, and usually spherical or hemispherical. The corallites are of small diameter (1 to 1.4 mm.) and fairly uniform in size and form. They are polygonal in cross section; hexagonal and pentagonal ones are common. The walls are moderately thick, straight and constant in thickness. The mural pores are medium and circular, arrnged in one longitudinal row on each sides of the corallites, lying 1.2 mm. apart. The tabulae are slightly thinner than wall, concave upwards and spaced distantly. No septal spines are traceable.

Description.—The corallum is massive; usually spherical or hemisperical; but cylindrical coralla is also common. It attains about 20 cm. in diameter and 10-18 cm. in height. The distal surface is developed into knobs and pits and no epitheca is observed. The corallites radiate upwardly from the basal restricted portion and open their calices on the upper surface. The corallites are of small diameter (1.0 to 1.4 mm.) and fairly uniform in size and form. They are polygonal, usually hexagonal and pentagonal, but sometimes smaller trigonal and tetragonal ones are interpolated amongst them. The walls are moderately thick (about 0.1 mm.) and fairly uniform in thickness. They are straight and smooth. The 'central dark line' is visible, though it is calcified. The mural pores are medium (0.15 mm. broad) and circular. The pores are arranged in one longitudinal row in the middle of the each faces, and regularly and distantly spaced 1.2 mm. apart. The tabulae are a little thinner than walls concave upwards and counted 5-7 in a space of 5 mm. They are arranged opposite with those of adjacent corallites. Calcification often thicken the tabulae. The septal spines are normally absent, but rarely a few are visible.

Remarks.—*F. uniformis. igoi* differs from *F. uniformis* (Yang, 1948) in that the former has spherical corallum while the latter has discoidal corallum. Furthermore, the tabulae are distantly spaced in *F. uniformis igoi*, while closely set in *F. uniformis*. But other features are hardly distinguishable with each other.

Horizon and Locality.—Silurian. aboundant in Bed 7 (5-5, 6-12) and poor in Bed 9 (6-10) of Fukuji formation.

Reg. No. G.I.S.U.L. 30123 (Cotype), 30124 (slide), 30125.

Genus *Parafavosites* Orlov

***Parafavosites fukujensis* n. sp.**

Plate I, Fig. 6; Plate III, Figs. 5a–c

Diagnosis.—The characteristic cylindrical tubes which are hollow of small diameter (0.20 to 0.25 mm.), are irregularly distributed at the corner or in the middle of the walls. They have contorted form in longitudinally. The corallum is large massive with hemispherical distal surface. The corallites are polygonal and medium in size of small diameter (ca. 2.0 mm.). The walls are thin, but feeble 'central dark line' is visible. The septal spines are numerous. They point upwards and turn to downwards on their extremities. The mural pores are large and circular. The pores are usually arranged in one row on the each faces of the corallites, but sometimes in two rows opposite with those of neighbouring row. They lie with close intervals. The tabulae are thin, horizontal or oblique, spaced moderately.

Description.—The corallum is large massive, attaining 8–14 cm. in breadth and 10 cm. in height. The distal surface is hemispherical without any epithecal walls, while the top is uneven. The corallites are prismatic, radiating from the restricted basal attachment. There is gradual variation between the octagonal larger ones (1.8–2.0 mm. in diam.) and hexagonal or pentagonal of the smaller (1.4–1.8 mm. in diam.). The walls are straight and thin (0.06 mm. in thickness), and have feeble 'central dark line', The septal spines are numerous and irregularly distributed about 2–8 in one corallite. They point upwards in the first and turn to downwards on their extremities. They are long, extending about one third of the radii of the corallites, but rudimentary in immature stage. The mural pores are circular and of large diameter (0.3 mm.). The pores are arranged in one row or two rows oppositing, on the faces of the corallites. In the latter case, they are of small diameter (0.1 mm.) The tabulae are thinner than walls, and horizontal or oblique. They are evenly spaced (6–7 within 5 mm.) in mature stage, but more closely (11 within 5 mm.) in immature stage. The tubes which are hollow and cylindrical of small diameter (0.2 to 0.25 mm.) are intermingled irregularly in the prismatic corallites. They are small and circular, located at the corner and in the middle of the walls in cross section. They show characteristic contorted form in longitudinal section.

*Remarks.** Orlov (1930) established two new species from Ferghana of

* Formerly Dr. R. S. Bassler of U.S. National Museum pointed out the presence of *Parefavosites* from Fukuji limestone in his letter to Prof. Dr. T. Kobayashi of the Tokyo Univ.

Turkestan, in which *P. ferganensis* is genotype. Bassler (1944) described three species of this genus from Khatanga of Siberia and one from Ellesmerland of Arctic America. About twenty years ago, Ozaki (1933) reported several *Favosites* and its allies from kenniho Conglomerate, Korea. Some of them, *F. kennihoensis regularis*, *F. shimizui* and *Sapporipora favositoides* have small hollow cylindrical tubes which characterize *Parafavosites*. Thus, all of those *Parafavosites* were found from Silurian strata of Turkestan, Siberia, Korea and Arctic America. Comparing the present specimens with others, *P. fukujensis* differs from them in having some contorted tubes, though, in other features, the present is near to *P. mana* (Bassler, 1944) and *Favosites shimizui* (Ozaki, 1933). In writer's collection, *P. fukujensis* is also found from Oisedani limestone, Kamiise, Kamianama-mura, Ono-gun, Fukui-ken.

Horizon and Locality.—Silurian. only three specimens were collected from upper part of Bed 1 (1-1).

Reg. No. G. I. S. U. L. 30126 (Holotype, Slide) 30127.

Faunal succession of the Fukuji formation

As preceedingly described, there are eleven species and varieties of *Favosites* in Fukuji formation. By means of the *Favosites* it is possible to establish the existence of the zones (biozone) F1 and F2, and some of the species and species group present enable the subzones within the latter to be subdivided into four, F2a, F2b, F2c and F2d. The followings are the description of each zone and subzone.

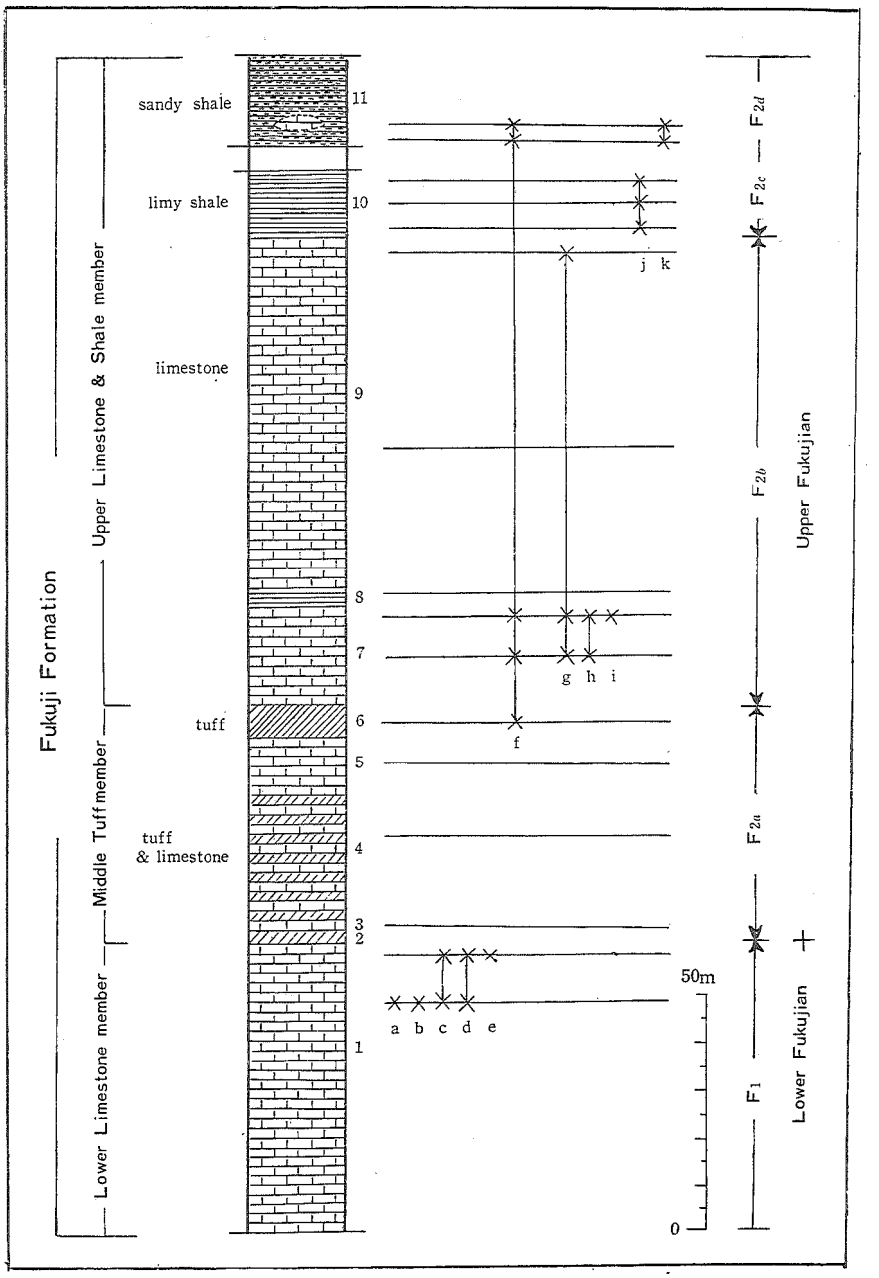
Lower Fukujian, F1

This zone is characterized by ***F. baculoides***. The upper beds of the Lower Limestone member yield numerous fossis, while the lower beds are barren in fossils. From the black limestone of the top, the following fossils were found.

Stromatoporoids : *Clathrodictyon tenuilaminatum*, *Clavidictyon columnare*, *Actinostroma vesiculosum*, *Amphipora cylindrica*, Corals : ***Favosites baculoides***, ***F. forbesi takarensis***, ***F. aff. minor***. *Tryplasma hayasakai*, *T. ozakii*, *Cyathophyllum* sp,. *Coenites triangularis*, *Pachypora* spp., Crinoid.

The black shaly limestone imediately below yields also numerous fossils. Those are ;

Corals : ***Favosites baculoides***, ***F. asper***, ***F. forbesi takarensis***, ***Parafavosites fukujensis***, *Entelophyllum* sp., *Pachypora* sp., *Aulopora* sp., *Conites triangularis*, *Chaetetes* sp., *Heliolites decipens*, *H. bohemicus*,. Brachiopods : *Leptaena* cf. *rhomboidalis*, *Atrypa* sp., Nautiloids : Actinoceratid, Orthoceratid, Gastropoda gen. et. sp. indet. Crinoid.



Text-Fig. 2. -Vertical Section of The Fukuji formation.

This section was made from the succession in the valley of the Ichinotani.
a : Parafavosites fukujensis, b : Fav. asper, c : Fav. baculoides
d : Fav. forbesi takarensis, e : Fav. aff. minor, f : Fav. hidensis
g : Fav. uniformis igoi, h : Fav. forbesi sugiyamai i : Fav. gotlandicus
j : Fav. flexuosus k : Fav. ichinotanensis

As the lower part of the Lower Limestone member is quite barren in fossils, the lower limit of the F1 is indeterminable.

Upper Fukujian, F2

Small clavate ***F. hidensis*** occur from the top of the Middle member to the top of the Upper member throughout, and so from the Middle member, at least from the top, to the top of the Upper member may be included in the F2, ***F. hidensis*** zone. This zone is still able to be subdivided into four subzones, F2a, F2b, F2c and F2d.

F2a ; The first appearence of ***F. hidensis*** was recognized from Bed 6, which was the top of the Middle member. Associated with this, *Camarotoechia* sp., and numerous crinoid fragments were found from Bed 6. The lower 40 m. or so below this bed, vitric tuff and impure limestone were alternated and poor in fossils except *Camarotoechia* sp., *Coenites triangularis, Amphipora cylindrica.* From the impure limestone near the base *Horomotoma* sp., and *Holopea* ? sp. were found. *Amphipora* and *Coenites* were continuous from the F1, however, *F. hidensis, Hormotoma* and *Holopea* were new form. Lithological boundary between the Lower member and the Middle member could be lined at the base of Bed 2 of the base of the Middle member, and also faunal dissimilarlities would be made along this boundary. The evidence above described indicates that the base of the F2a may be lowered to the base of the Middle member, though *F. hidensis* have been firstly known from the top of this member.

F2b ; This zone is characterized by ***F. uniformis igoi.*** On the east-side slope in the middle part of the Ichinotani valley, there are some gray fossiliferous limestone exposures yielding *F. uniformis igoi* aboundantly. These (Bed 7) overlie conformably the vitric tuff (bed 6). From this limestone beds the following numerous fossils were found;

Corals : ***F. uniformis igoi, F. forbesi sugiyamai, F. gotlandicus, F. hidensis,*** *Heliolites fukujensis* n.sp., *Syringopora* sp., *Cystiphyllum japonicum* n.sp. *Entelophyllum dilatoseptatum* n.sp., *Coenites triangularis.* Stromatoporoids : *Clathrodictyon* sp. *Actinostroma* sp. *Anphipora* sp., Brachiopods : *Fukujiella pingius* Gen. and sp. nov., Crinoid.

Lenticular black limy shale bed (Bed 8) overlie succeedingly above this limestone, and yields many brachiopods and corals;

Brachiopods : *Strophonella oblonga* n. sp., *S. expansa* n. sp., *Amphistrophia* cf. *euglypha, Fardenia* sp. *Idioglyptus stigmatus, Leptaena* sp. *Fukujiella pinguis* Gen. and sp. nov., *Atrypa reticularis, Pentamerus* sp., Corals : *Entelophyllum dilatoseptatum* n.sp. ***Favosites*** sp., *Pelecypods* : *Pterinea* sp., *Ctenodonta* sp., *Modiomorpha* sp., Crinoids.

Amongst them, *Strophnella* and *Atrypa* is most aboundant. This bed often tongues out into limestone, and sometimes overlying massive limestone contact directly with underlying fossiliferous limestone without this shale bed. The upper thick beded masive limestone (Bed 9) is fossil barren in spite of its large thickness. Only *Heliolites fukujensis* n. sp. in the middle and ***F. uniformis igoi*** at the top, were found from this limestone. Thus, the F2b ranges from the base of Bed 7 to the top of Bed 9.

F2c ; Thick bedded limestone of Bed 9 passes gradually into succeeding above black limy shale at the small waterfall in the lower course of the Ichinotani valley. Here in the shale (Bed 10), the thick fossil layer of about 1 m. thick is found. This layer is composed of closely packed corals, like a fagot of *Entelophyllum*. From this the following fossils were found;

Corals : *Entelophyllum dilatoseptatum* n. sp., ***Favosites flexuosus***, *Striatopora* sp., *Heliolites* cf. *decipens*, *H.* sp., Brachiopods : *Dalmanella* sp., *Parmorthis* sp., *Pentamerus* sp., Trilobita : *Cheirurus* sp. n.sp.

Lateral extension of this layer is capable to trace about fifty meter, then the most aboundant fossils is *Entelophyllum dilatoseptatum*. Associated with this *F. flexuosus* is common, thus, this subzone is characterized by ***F. flexuosus***.

F2d ; On the south-facing mountain slope of the lower part of the Ichinotani valey, there are some exposures of sandy shale, which are isolated from other beds by faults and dike intrusions. The lower part of this bed (Bed 11), though it is apparent, consists of fragile sandy shale and yields numerous fossils. These are;

Brachiopods : *Rhipidomella* sp., *Rhynchotreta* sp., *Parmorthis* sp.n.sp., *Camarotoechia* sp., *Delthyris* sp., *Cyrtia* sp., *Dolerorthis* sp. n. sp., *Dalmanella* sp., *Idioglyptus stigmatus*. *Leptaena rhomboidalis*., *Fardenia attenuata*, *Pentamerus* sp., *Chonetis* sp. *Atrypa reticularis*, *A.* cf. *tenesseensis*, Corals : ***Favosites ichinotanensis***, ***F. hidensis***. *Entelophyllum* sp., *Amplexus* sp., *Coenites* sp., Trilobita : *Cheirurus* sp. n. sp.

Immediately above, hard limy shale intercalated with limestone lenses was exposed, and this limestone lenses yielded *Favosites* and solitary corals. The next 10 m. is beded sandy shale without any fossils. Eastwards extensions of this bed are exposed in some places but no fossils have been found. It is difficult to determine the accurate stratigraphical position of this bed, owing its isolated occurences from other beds, but faunal assemblage above described show some relations to the F 2c and F 2b in having some characteristic common fossils. But it must be remembered to notice the appearence of new forms. So this bed may be regardced as new zone, F 2d ***F. ichinotanensis*** zone, higher than the F 2c.

Correlation with other area

The fauna of the F 1 indicates strong similarities to those of the Kawauti series, Kitakami, which have been considered as the Middle Silurian to correlate with the Wenlock limestone of England, the Louisville limestone of North America and the Lojaping series of Middle China (Sugiyama, 1941). All of the Silurian rocks of Japan, distributed at Shikoku, Kyushu, Hida, Echizen and Kii, were usually correlated with the Kawauti series. Common fossils of them are *Favosites baculoides*, *F. asper*, *Heliolites decipens*, *Tryplasma hayasakai*, *Halysites* and *Encrinurus*. Such association is also referable to those of the F 1, though the latter dose not include *Halysites* and *Encrinurus*.

In Kitakami the Takainari series rests conformably on the Kawauti series and it follows gradually the Ōno series upwards (Sugiyama, 1940). According to recent critical investigation of those series, upper two series mainly composed with pale greenish vitric tuffs with subordinate limestones are undivisible lithologically (Ōkubo, 1950). Sugiyama discovered *Favosites styriacea*, *Thamnopora cristata*, *Lindstromia* sp., *Actinostroma* sp., from a limestone lens near the base of the Ōne series, and he considered that these indicate the Lower Devonian age. Then he also stated that the Takainari series lain between the Middle Silurian Kawauti series and the Lower Devonian Ōne series could be inferred as the Upper Silurian age. Although the Takainari series mainly composed of vitric tuff is baren in megafossils, it is referable lithologically with the Middle Acid Vitric Tuff member of the Fukuji formation which is characterized by *F. hidensis*. On the other hand, *Thamnopora cristata*, though Sugiyama left no description of it, found from the base of the Ōno series is synonymous to *Favosites cristatus*, which is dominantly recorded from Silurian rocks of Europe and North America. This *Favosites cristatus* is closely resemble in form to *F. hidensis*, so the inferrence that the F 2a is equivalent to together with the Takainari series and the lower part of the Ōno series may be possible. And also, it is noticeable that the acid vitric tuff have been recorded from Shikoku and Kyushu associated with the Silurian limestone.

Further examination whether the faunas of the F 2 may indicate the Upper Silurian age or not must be done, for *F. hidensis* occurs throughout the F 2. As the Upper Silurian succession have never been established in Japan, correlation with foreign land may be admitted. When examined the faunas of F 2a, F2b, F2c and F2d, are recognized in them some Upper Silu-

rian forms of Europe, North America and South China, though they are not important guide fossils but subordinate ones. Moreover, the dominant fossils of them are occupied by Middle Silurian forms; those from Wenlock shale to Aymestry limestone of England. Accordingly, there is no evidence that F 2 indicates right to Upper Silurian age, but, in Japan, the F 2 will be treated as Upper Silurian if Kawauti series or F 1 represent Middle Silurian.

Summary

1. The Fukuji formation is divided lithologically into three member; Upper Limestone and Shale member, Middle Acid Vitric Tuff member, Lower Limestone member.
2. In Fukuji formation following five zones (biozone) and subzones (biozone) are recognized by means of *Favosites*, ascendingly.
   Lower Fukujian, F1 *Favosites baculoides* Zone
   Upper Fukujian, F2 *Favosites hidensis* Zone
   F2a *Favosites hidensis* subzone
   F2b *Favosites uniformis igoi* subzone
   F2c *Favosites flexuosus* subzone
   F2d *Favosites ichinotanensis* subzone
3. Amongst them, the F 1 is equivalent to Kawauti series of Kitakami and represent the Middle Silurian, and the F 1 may be considered to indicate the Upper Silurian of Japan.
4. This classification is proposed as hypothesis to Silurian stratigraphy of Japan, for "Zone" treated here means "Biozone" and "Teil Zone", not "Faunen Zone".

Bibliography

AMSDEN, T.W., 1949. Stratigraphy and Paleontology of the Brownsport Formation Silurian) of Western Tennessee. Bull. Peabody Museum Nat. Hist., Yale Univ.

BASSLER, R.S., 1944. Parafavosites and Similar Tabulate. Corals. Journ. Paleont. vol. 18. no.1

EDWARDS, H.M., & HAIME, J., 1850. A Monograph of the British Fossil Corals., Part 1., Introduction., Mon. Palaeont. Soc. London.
& 1855. Ibid. Part V, Corals from the Silurian Formation.

GIRTY, G.H, 1895. Development of the Corallum in Favosites Forbesi var. occidentalis. Amer. Geologist. vol xv.

GRABAU, A.W., 1926. Silurian Faunas of Eastern Yunnan. Palaeontologia Sinica, ser. B., vol. 3. fas. 2.

HALL, J. 1876. Illustrations of Devonnan fossil corals. Geol. Surv. New York, Palaeont

——. 1879. The fauna of the Niagaran group, 28th Rept. New York State Mus. Nat. Hist.

JONES, O.A., 1936. The Controlling effect of enviroment upon the corallum in Favosites, with a revision of some massive species on this basis. Ann. Mag. Nat. Hist., ser. 10. vol. 17

KAMEI, T., 1952. The stratigraphy of the palaeozoic rocks of the Fukuji district, southern part of Hida mountainland. Journ. Shinshu Univ. vol. 2.

LONSDALE, W., 1839. "Corals", in R.I. Murchison, 'The Silurian System'

MANSUY, H., 1912. Etude geologique du Yunnan oriental, IIe partie, Paléontologie, Mém. Serv. Géol. 1, Indochine.

——. 1908. Contribution á la Carte géologique de l' Indochine, Paleontologique.

ŌKUBO, M., 1950. On the Gotlandian and Devonian deposits of Hikoroichi, Kesen-District, Iwate-Prefecture. Journ. Geol Soc. Japan., vol. 56. no. 657 (in Japanese with English abstruct)

ORLOV, J.A., 1931 Uber einige neue obersilurische Favositen aus Ferghana, Central. Bl. f. Min. u.s.w. Abth. B.

OZAKI, K., 1934. In "Gotlandian deposits of Northeast Korea,", Journ. Shanghai Sci. Inst. sect. II, vol. 1.

POCTA, P., 1902. Anthozoaires et Alcyonaires, in Barrande, System. Sil. du Cent. d. 1. Bohême, vol. 8. tom. 2.

SMITH. S., 1930. Some Valentian corals from Shropshire and Montgomeryshire with a note on a new stromatporoid. Q.J.G.S. vol. 86.

SUGIYAMA. T., 1940. Stratigraphical and palaeontolngical studies of the Gotlandian deposits of Kitakami mountainland. Sci. Rep. Tohoku Imp. Univ. ser. 2. vol. xxi. no. 2.

——. 1941. Correlation of the Gotlandian deposits of. Japan and China. Journ. Geol. Soc. Japan. vol. xliix, no. 568. (in Japanese)

TRIP K., 1933. Die Favositen Gotlands, Palaeontographica, Bd. lxxix, Abth. B.

WEISSERMEL, W., 1894. Die Korallen der Silurgeschiebe Ost Preussens und die östlichen Westpreussens. Zeit. Geol. Gesell.,

YABE, H., & HAYASAKA I., 1915. Palaeozoic corals from Japan, Korea and China. Journ. Geol. Soc. Tokyo. vol. xxii.

YANG, C., 1948. The Silurian Waseh formation of Western Yunnan and its Favosites Faunas. Fiftieth anniversary papers of the National Peking Univ. Geological series.

Explanation of plates

PLATE I.

Figs. 1a—d. *Favosites gotlandicus* Lamarck,; 1a, cross section, 1b, longitudinal section, 1c. ibid. showing mural pores. (X7.5) 1d. showing structure of wall (X 22.5)

Figs. 2a—b. *Favosites asper* d'Orbigny, : 2a, cross section, 2b, longitudinal section, (X 7.5)

Figs. 3a—d. *Favossites uniformis* var. *igoi* nov., : 3a, cross section, 3b, longitudinal section. (X 7.5); cross section (X 22.5); 3d, weathered surface showing mural pores. (X 3.)

Figs. 4a—b. *Favosites bacoloides* Barrande, : 4a, cross section, 4b. longitudinal section. (X 7.5)

Figs. 5a—b. *Favosites baculoides* Barrande, materials from Kitakami : 5a, cross section. 5b, longitudinal section (X 7.5)

Figs. 6. *Parafavosites fukujensis* nov, showing cylindrical tube in cross section (X 22.5)

PLATE II.

Figs. 1a —f. *Favosites forbesis* var. *sugiyamai* nov. : 1a, cross section, (1b, 1d) longitudinal section (X 7.5); 1c, structure of wall (X 22.5); 1e, septal spine in longitudinal section (X 22.5), 1f, mural pores (X 22.5)

Figs. 2a—b. *Favosites forbesi* var *sugiyamai* nov., cross and longitudinal section of its younger stage. (X 7.5)

Figs. 3a—c. *Favosites forbesi* var. *takarensis* nov. : 3a, 3b. cross and longitudinal section of type A. (X 7.5); 3c. Structure of wall (X 22.5)

Figs. 4a—b. *Favosites forbesi* var. *takarensis* nov., cross and longitudinal section of type B. (X 22.5)

Figs. 5a—b. *Favosites forbesi* var, *takarensis* nov. cross and longitudinal section of type C. (X 7.5)

PLATE III.

Figs. 1a —c. *Favosites ichinotanensis* nov. : 1a, 1b, cross and longitudinal section (X 7.5); 1c, weathered surface showing mural pores. (X 22.5)

Figs. 2a—c. *Favosites flexuosus* nov. : 2a, 2b, cross and loangitudinl section (X7.5), 2a, structure of wall (X 22.5)

Figs. 3a—c. *Favosites* aff. *minor* Ozaki, : 3a, 3b. cross and longitudinal section (X 7.5), 3c, structure of Wall (X 22.5)

Figs. 4a—c. *Favosites hidensis* nov. ; 4a, 4b, cross and longitudinal section, (X 7.5), 4c, struture of wall (X 7.5)

Figs. 5a—c. *Parafavosites fukujensis* nov.; cross and longitudinal section (X 7.5), 5b showing cylindrical tube.

PLATE IV.

Figs 1—2. *Favosites forbesi* var. nov. (X 1.)

Fig. 3 *Favosites uniformis sugiyamai* var. *igoi* nov. (X 1.)

Figs 4, 5, 6. *Favosites forbesi* var. *takarensis* nov. (X 2/3)

Fig. 7 *Favosites hidensis* nov. (X 3.75)

Plate I

Fig.1 a

Fig.1 b

Fig.1 c

Fig.2 a

Fig.2 b

Fig.1 d

Fig.3 a

Fig.3 b

Fig.3 c

Fig.4 a

Fig.4 b

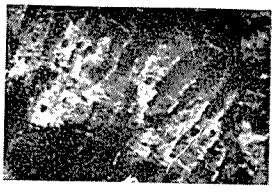


Fig.3 d

Fig.5 a

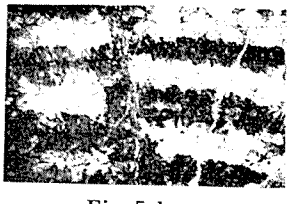


Fig.5 b

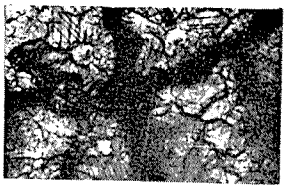


Fig.6

Plate II

Fig.1 a

Fig.1 b

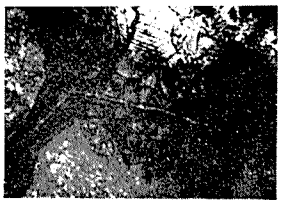


Fig.1 c

Fig.2 a

Fig.2 b

Fig.1 d

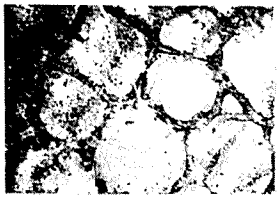


Fig.3 a

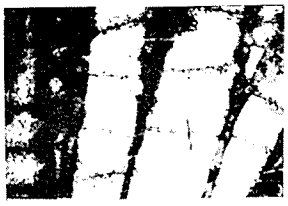


Fig.3 b

Fig.3 c

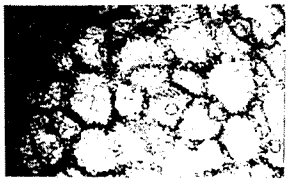


Fig.4 a

Fig.4 b

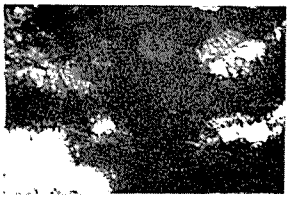


Fig.1 e

Fig.5 a

Fig.5 b

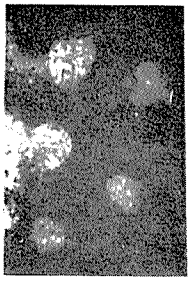


Fig.1 f

Plate III

Fig.1 a

Fig.1 b

Fig.1 c

Fig.2 a

Fig.2 b

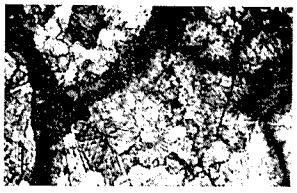


Fig.2 c

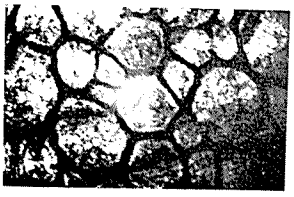


Fig.3 a

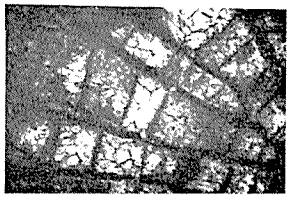


Fig.3 b

Fig.3 c

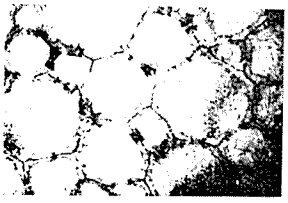


Fig.4 a

Fig.4 b

Fig.4 c

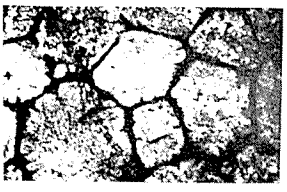


Fig.5 a

Fig.5 b

Fig.5 c

Plate IV

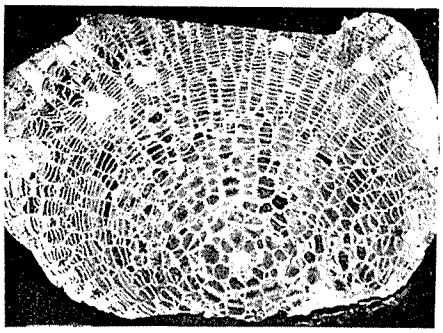


Fig. 1

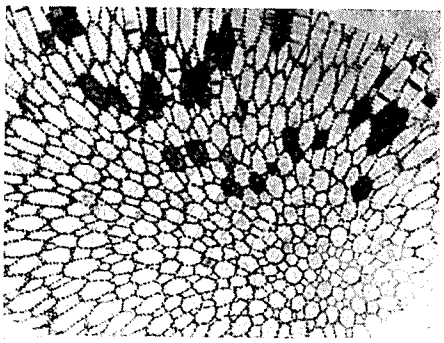


Fig. 2

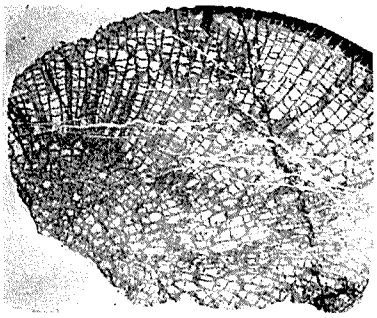


Fig. 3

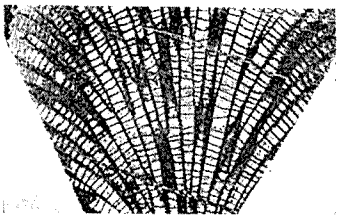


Fig. 4

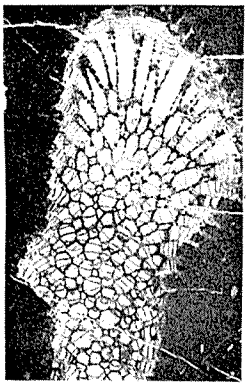


Fig. 5

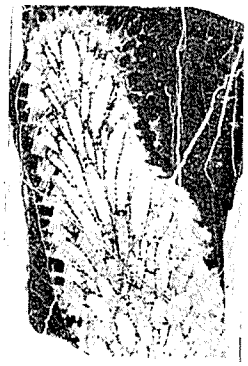


Fig. 6

Fig. 7