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Halysitid Tabulate Corals from the Silurian Fukami Formation, Kumamoto Prefecture, Japan

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Abstract Five Wenlock to Ludlow (late Early to early Late Silurian) species of halysitid tabulate corals are recorded from limestones of the Fukami Formation in Kumamoto Prefecture, southern Japan. They are *Halysites catenularius* (Linnaeus, 1767), *H. bellulus* Hamada, 1958, *H. miyazakiensis* Niko and Adachi, 2014, *Falsicatenipora shikokuensis* Noda and Hamada *in* Hamada, 1958, and *Schedohalysites kitakamiensis* (Sugiyama, 1940). *Halysites bellulus* and *H. miyazakiensis* represent the first occurrences in the formation. The specific diagnosis of *S. kitakamiensis* is emended based on a newly discovered specimen as the possession of the dendritic corallum.

Key words: Wenlock to Ludlow (late Early to early Late Silurian), *Halysites*, *Falsicatenipora*, *Schedohalysites*, Halysitida

Introduction

The first reference to Silurian rocks from Kumamoto Prefecture, southern Japan was made by Kanmera and Matsumoto (1948), who discovered *Halysites*-bearing limestone and associated tuffaceous shale in the Fukami area. Subsequently, Matsumoto and Kanmera (1949) provided the geological map of this area, and Matsumoto and Kanmera (1964) designated these rocks as the Fukami Formation. Paleontological investigations of the formation were began to start by T. Hamada. His results were published in 1956 and 1958 (halysitid tabulate corals) and 1962 (brachiopods).

The present paper documents the occurrences of five species of halysitid tabulate corals in the Fukami Formation, and reexamines previously known species. This is a part of my long-term study to reveal species composition of the Fukami fauna. Used abbreviations herein indicating repositories of examined specimens are NMNS (National Science Museum of Nature and Sciences, Tokyo) and UMUT (University Museum, the University of Tokyo).

Geologic Setting and Locality

The Fukami Formation crops out as the disconnected lenticular bodies along the northern margin of the serpentinite zone in the Kurosegawa Belt. These bodies are small (up to ca. 30–40 m width and 150 m length) and surrounded by high-angled faults. Constituents of these bodies are limestone, tuffaceous shale, and acidic pyroclastic rocks (Matsumoto and Kanmera, 1964). Murata (1992) correlated the former two strata with the Wenlock to Ludlow (upper Lower to lower Upper Silurian) G2 to G3 Members of the Gionyama Formation, Miyazaki Prefecture in southern Japan, and suggested similarity between remaining pyroclastic rocks and the Upper Silurian to Lower Devonian G4 Member of the same formation. Limestones of the formation are more or less recrystallized. Bioclastic wackestone is predominant in their lithology with subordinate amounts of calclithite and coral biolithite. Although moderately diverse megafossils occur in limestones and tuffaceous shales; they are traversed by calcite veins and poorly preserved.

The geographic positions of these fossil localities are shown in Fig. 1. Except for material of

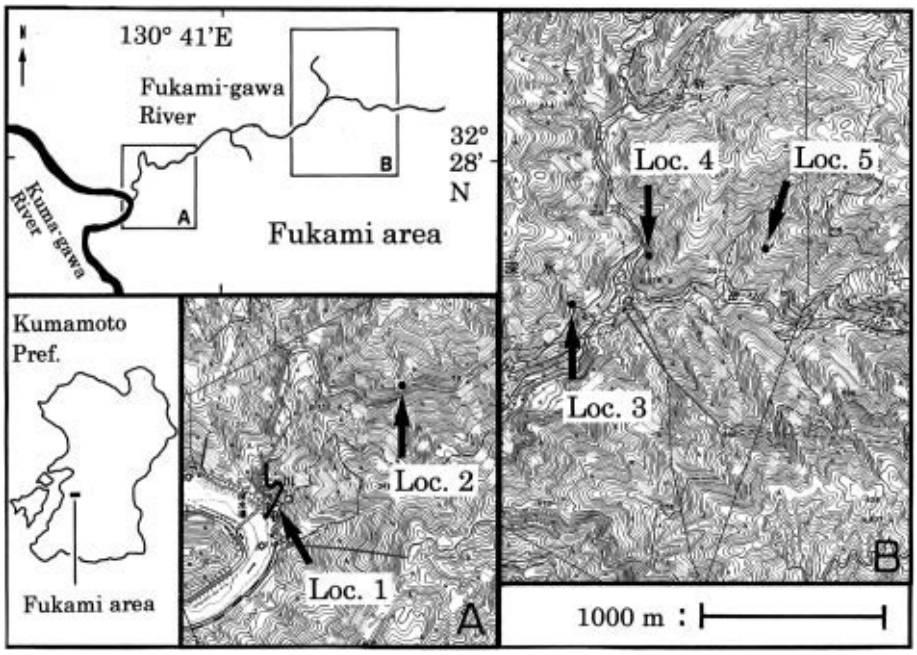

Fig. 1. Index maps showing fossil localities in the Fukami area, Kumamoto Prefecture, on the topographic map of "Sakamoto" scale 1:25,000 published by the Geographical Survey Institute.

locality 1 that was recovered from float blocks in riverbeds of the Fukami-gawa River, all specimens were collected from taluses near the outcrops.

Systematic Paleontology

Subclass Tabulata Milne-Edwards and Haime, 1850

Order Halysitida Sokolov, 1947

Family Halysitidae Milne-Edwards and Haime, 1849

Subfamily Halysitinae Milne-Edwards and Haime, 1849

Genus ***Halysites*** Fischer von Waldheim, 1828

Type species: *Tubipora catenularia* Linnaeus, 1767.

Halysites catenularius (Linnaeus, 1767)

(Figs. 2-1, 2)

Halysites catenularius (Linnaeus); Niko and Adachi, 2013, p. 17, 20, figs. 1-1–5, 2-1–6 [with earlier synonymy]; Adachi and Niko, 2015, p. 75, 77, figs. 1-A–E.

Material examined: NMNS PA18306, 18316–18320, 18327.

Occurrence: Common in gray limestones at localities 1 (NMNS PA18306) and 2 (NMNS PA18316–18320, 18327).

Discussion: Revisions of *Halysites catenularius* are given by Laub (1979), Young and Noble (1987), and Mõtus and Klaamann (1999). This species somewhat resembles an associated species, *H. bellulus*, however its well inflated corallites with larger diameters than those of *H. bellulus* are diagnostic, if fragmented such as the present case. The stratigraphic rang of *H. catenularius* in Japan is upper Wenlock to lower Ludlow (Niko and Adachi, 2013).

A single corallum (UMUT PC7271) from the Fukami Formation was referred to *Halysites cratus* Etheridge, 1904 by Hamada (1958). Because there are no significant differences between the emended specific diagnosis of *H. catenularius* and characters of the Fukami specimens including Hamada's one, it is better to exclude from the faunal list of the formation.

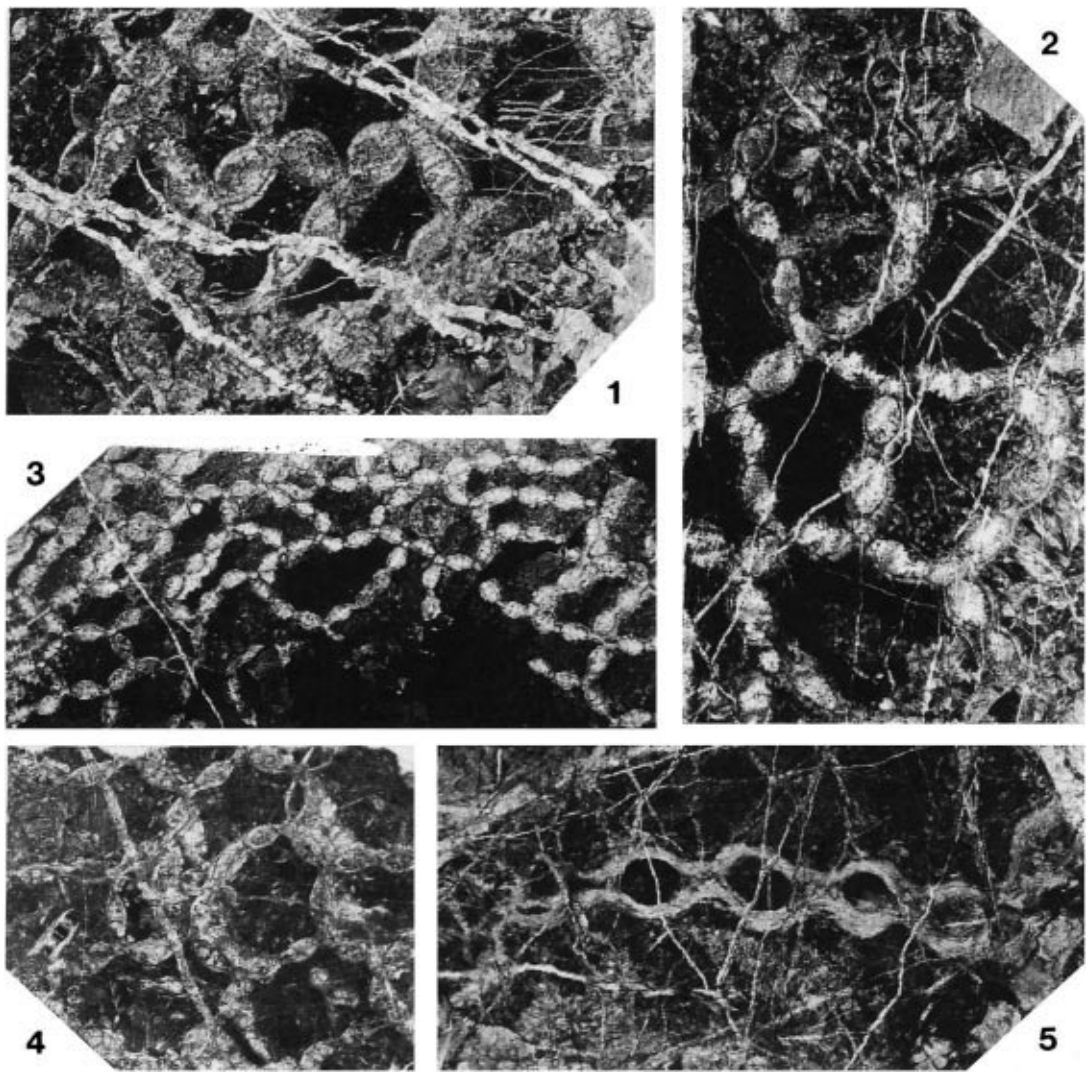

Fig. 2. **1**, **2**, *Halysites catenularius* (Linnaeus, 1767), thin transverse sections of corallites. **1**, NMNS PA18318, ×5. **2**, NMNS PA18327, ×5. **3**, **4**, *Halysites bellulus* Hamada, 1958, thin transverse sections of corallites. **3**, NMNS PA18324, ×5. **4**, NMNS PA18325, ×5. **5**, *Halysites miyazakiensis* Niko and Adachi, 2014, thin transverse sections of corallites, NMNS PA18333, ×5.

Halysites bellulus Hamada, 1958

(Figs. 2-3, 4)

Halysites bellulus Hamada; Niko and Adachi, 2013, p. 20, 22, figs. 3-1–6 [with earlier synonymy]; Adachi and Niko, 2015, p. 77, figs. 2-A–C.

Material examined: NMNS PA18323–18326, 18330.

Occurrence: Rare in gray to reddish gray limestones at Localities 2 (NMNS PA18323–18326) and 3 (NMNS PA18330).

Discussion: The holotype (UMUT PC7276) of *Halysites bellulus* from the G3 Member of the Gionyama Formation was accurately redescribed and illustrated by Niko and Adachi (2013). Morphologies of the examined specimens herein are consistent with those of the holotype. This is the first record of this species except for the type locality in the Kuraoka area, Miyazaki Prefecture.

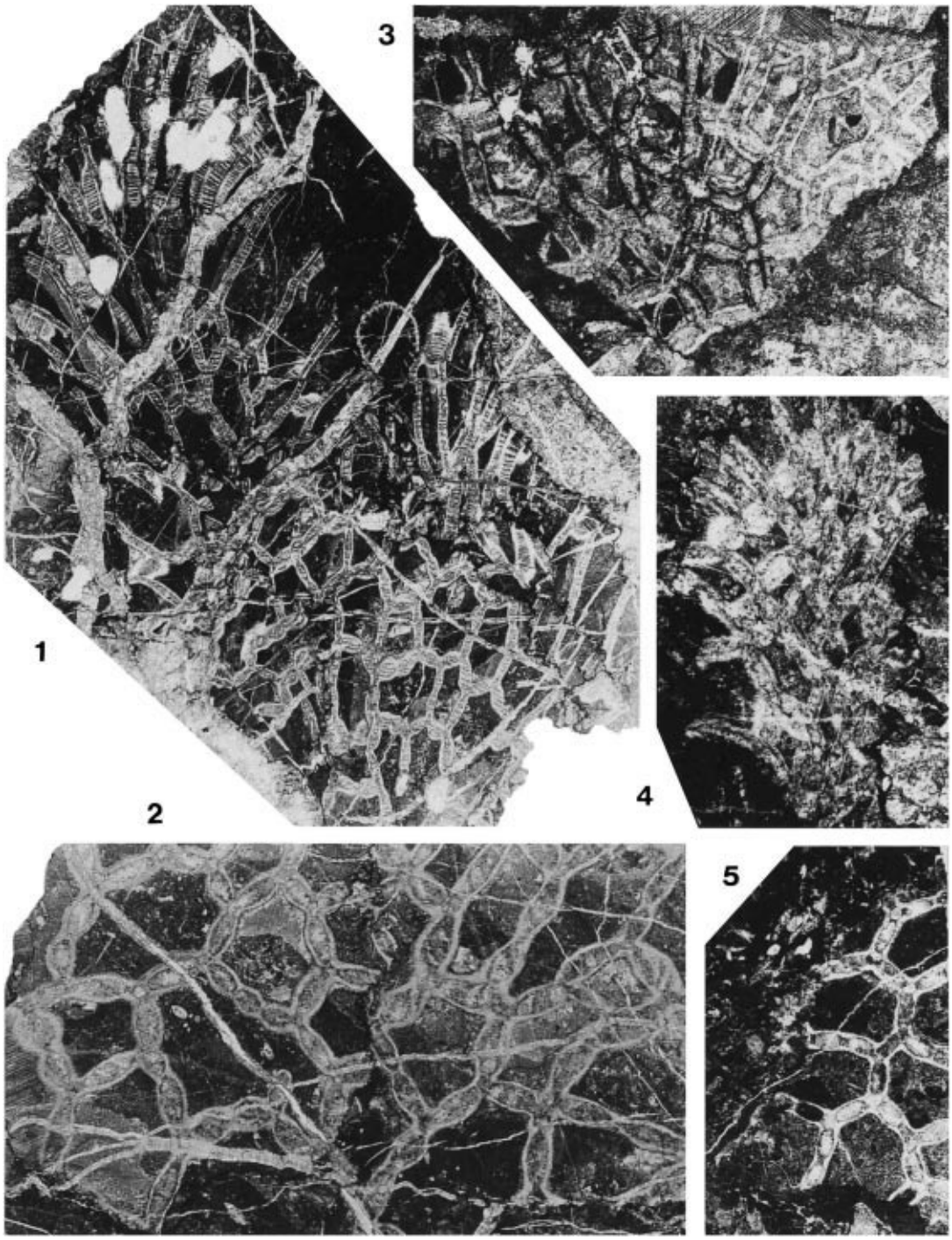

Fig. 3. **1**, **2**, **5**, *Schedohalysites kitakamiensis* (Sugiyama, 1940), thin sections. **1**, **2**, NMNS PA18328; **1**, oblique sections of branches, note branching, ×2; **2**, transverse sections of corallites, ×5. **5**, NMNS PA18331, transverse sections of corallites, ×5. **3**, **4**, *Falsicatenipora shikokuensis* Noda and Hamada *in* Hamada, 1958, thin sections. **3**, NMNS PA18322, transverse section of branch, ×5. **4**, NMNS PA18334, longitudinal section of branch, ×5.

Halysites miyazakiensis Niko and Adachi, 2014

(Fig. 2-5)

Halysites miyazakiensis Niko and Adachi, 2014, p. 11–13, figs. 1-1–5.

Material examined: NMNS PA18333.

Occurrence: Very rare in gray limestone at locality 3.

Discussion: *Halysites miyazakiensis* was previously represented by a single corallum from the G3 Member of the Gionyama Formation (Niko and Adachi, 2014). The present fragmentary specimen indicates large diameters of corallites with strongly inflated profiles and very thick corallite walls, whose characters warrant its specific placement and clearly distinguish this species from all others in the Fukami fauna.

Genus ***Falsicatenipora*** Hamada, 1958

Type species: *Halysites japonica* Sugiyama, 1940.

Falsicatenipora shikokuensis Noda and Hamada *in* Hamada, 1958

(Figs. 3-3, 4)

Falsicatenipora shikokuensis Noda and Hamada; Niko and Adachi, 2013, p. 30, 33, figs. 9-1–6 [with earlier synonymy]; Kawamura *et al.*, in Kawamura *et al.*, 2013, figs. 4.9B, 4.10A; Adachi and Niko, 2015, p. 81, figs. 6-A–D.

Material examined: NMNS PA18321, 18322, 18334.

Occurrence: Rare in gray limestones at localities 2 (NMNS PA18321, 18322) and 3 (NMNS PA18334).

Discussion: Although fragmentary, preserved characters, such as corallite shape and arrangements of the examined Fukami specimens match with those of *Falsicatenipora shikokuensis.* This species is the most common halysitid coral in the Kurosegawa and South Kitakami Belts, and a relaiable index-fossil of late Wenlock age.

Matsumoto and Kanmera (1964) documented Cf. *Falsicatenipora shikokuensis* without any description and illustration. This discovery from the Fukami Formation conforms to their documentation.

Genus ***Schedohalysites*** Hamada, 1957

Type species: *Halysites orthopteroides* Etheridge, 1904.

Discussion: Growth forms of the colonies in *Schedohalysites kitakamiensis* (see below) and *Falsicatenipora shikokuensis* (see Niko and Adachi, 2013) are quite different in comparing with the massive ones in usual species of *Halysites*. There is a possibility that genera of the subfamily Halysitinae can separate into two groups on the basis of this criterion.

Schedohalysites kitakamiensis (Sugiyama, 1940)

(Figs. 3-1, 2, 5)

Schedohalysites kitakamiensis (Sugiyama); Niko and Adachi, 2013, p. 30, 33, figs. 9-1–6 [with earlier synonymy]; Adachi and Niko, 2015, p. 81, 86, figs. 7-A–E.

Material examined: NMNS PA18304, 18305, 18307–18315, 18328, 18329, 18331, 18332, 18335, 18336.

Emended diagnosis: Coralla dendritic consisting of thick branches. For other diagnostic characters see previous workers, including Sugiyama (1940), Hamada (1956, 1957, 1958), Nakai (1981), and Niko and Adachi (2013).

Description of coralla: Large more than 14 cm in diameter and dendritic with subcylindrical branches; branching bifurcate; diameters of branches are thick, usually 18–60 mm.

Occurrence: Abundant in gray to reddish gray limestones at localities 1 (NMNS PA18304, 18305, 18307–18309), 2 (NMNS PA18310–18315), 3 (NMNS PA18328, 18329, 18331, 18332), and 5 (NMNS PA18335, 18336).

Discussion: Detailed morphologies of corallites, lacunae, coenenchymal tubule, and internal structures of *Schedohalysites kitakamiensis* are given in Niko and Adachi (2013). Because of no additional information from the Fukami speci-

mens except for morphologies of corallum, they are not repeated herein. Corallum growth form of the species has been misidentified as “massive”, “bun-shaped”, “trochoidal”, “irregular” or “cylindrical” in previous workers owing to its large and fragile natures. However, a newly discovered large fragment of a corallum (NMNS PA18328) provides the above-mentioned emendations.

Schedohalysites kitakamiensis widely occurs in the Ludlow limestones in the South Kitakami and Kurosegawa Belts in Japan. In addition, this species also detected from the Wenlock G2 Member of the Gionyama Formation (Niko and Adachi, 2013).

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