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Silurian Pachyporicaes (Coelenterata: Tabulata) from the Gionyama Formation, Miyazaki Prefecture

Shuji Niko[1] and Tomio Adachi[2]

[1]Department of Environmental Studies, Faculty of Integrated Arts and Sciences, Hiroshima University, 1–7–1 Kagamiyama, Higashihiroshima, Hiroshima, 739–8521 Japan
[2]3–2–26 Kadokawa Nishisakae, Higashiusuki, Miyazaki, 889–0622 Japan

Abstract Three new species of tabulate corals, that can be referred to the superfamily Pachyporicae, are described from the Gionyama Formation, Miyazaki Prefecture. The assemblages include the pachyporids *Hillaepora gionensis* sp. nov. from the lower Ludlow G3 Member and *Striatopora sugiyamai* sp. nov. from the upper Wenlock G2 Member and G3 Member, and a parastriatoporid *Parastriatopora hyugaensis* sp. nov. from the G2 Member. *Hillaepora* was not previously known in Japan. Closely related forms with the pachyporicaes are reported from the Siberian Platform, Inner Mongolia, Chinling of China, and the Imose Limestone of Kochi Prefecture.

Key words: Silurian, tabulate corals, Pachyporidae, Parastriatoporidae, Gionyama Formation, Miyazaki

Introduction

Silurian pachyporicaes are described in this paper which is third in a series documenting the tabulate coral fauna in the Gionyama Formation, Miyazaki Prefecture, southern Japan. Three new species, *Hillaepora gionensis*, *Striatopora sugiyamai*, and *Parastriatopora hyugaensis*, are named herein and added to far away to well-known tabulate coral fauna in Japan. See Niko (1998) for information of geologic setting and collecting sites of the present corals. The tabulate coral specimens studied are deposited in the National Science Museum, Tokyo.

Systematic Paleontology

Order Favositida Wedekind, 1937
Suborder Favositina Wedekind, 1937
Superfamily Pachyporicae Gerth, 1921
Family Pachyporidae Gerth, 1921
Genus *Hillaepora* Mironova, 1960

Type species: *Hillaepora spica* Mironova, 1960.

Hillaepora gionensis sp. nov.

Figs. 1-1–5

Holotype: NSM PA14536, from which two thin sections were made.

Other specimens: Four thin sections were studied from the three paratypes, NSM PA14537–14539.

Diagnosis: Species of *Hillaepora* with 7.2 mm in maximum branch diameter, approximately 0.64 mm in corallite diameter, and uniformly corpulent intercorallite walls; calical opening oblique, approximately 60°–70° in angle to branch axis; tabulae very rare.

Description: Coralla may be ramose with subcylindrical branches, and cerioid except for free calical edges; branch diameters attain 7.2 mm in holotype; total corallum diameter and growth form unknown owing to fragile nature. Corallites prismatic, 4–6 sided in cross section, ranging from 0.50 to 0.90 mm with 0.64 mm mean in corallite diameter, whose increase very gradual; each corallite lies at small angles to branch axis in proximal portion, then turns gradually outward to form exceptionally long calical edge that opens obliquely upward, with approximately 60°–70° in angle to branch axis; calices deep, well-preserved calical edges of holotype are cylindrical, attain 0.94 mm in length and 0.65 mm in diameter; tabularia subcircular in cross section; increase of new corallites lateral, rare. Intercorallite walls uniformly corpulent, thick for genus, 0.13–0.21 mm in thickness, composed of thin median dark line and relatively thick stereoplasm with microlamellar structure; mural pores large and elliptical with lateral compression in cross section, 0.19×0.27 mm in diameter, common, forming single row in each corallite face; distinct septal spine not observed; tabulae complete, rectangular to corallite, very rare.

Discussion: *Hillaepora* is a very rare genus characterized by the long, free calical edges, and previously only two records of occurrence of the genus have been known. With the exception of the type species, *Hillaepora spica* Mironova (1960, pl. 11, fig. 2) from the Lower Devonian in Salair, western Siberia, Chi (1976) questionably referred a species (*H.*? sp., pl. 47, fig. 7), that occurs in the Upper Silurian of Inner Mongolia, to the genus. *Hillaepora gionensis* sp. nov. is differentiated from the previously known two species by its narrower corallites (approximately 0.64 mm versus 0.6–1.5 mm in *H. spica* and 0.8–1.5 mm in *H.*? sp.) and its uniformly corpulent intercorallite walls. Thickness of the intercorallite walls in *Hillaepora spica* is somewhat increasing to the branch periphery. *Hillaepora*? sp. has the thin intercorallite walls.

This new species represents the first undoubted Silurian record of *Hillaepora*, and the first occurrence of the genus in Japan.

Etymology: The specific name is derived from Mt. Gion-yama.

Occurrence: Scarce in massive limestone of the lower Ludlow G3 Member at locality 3.

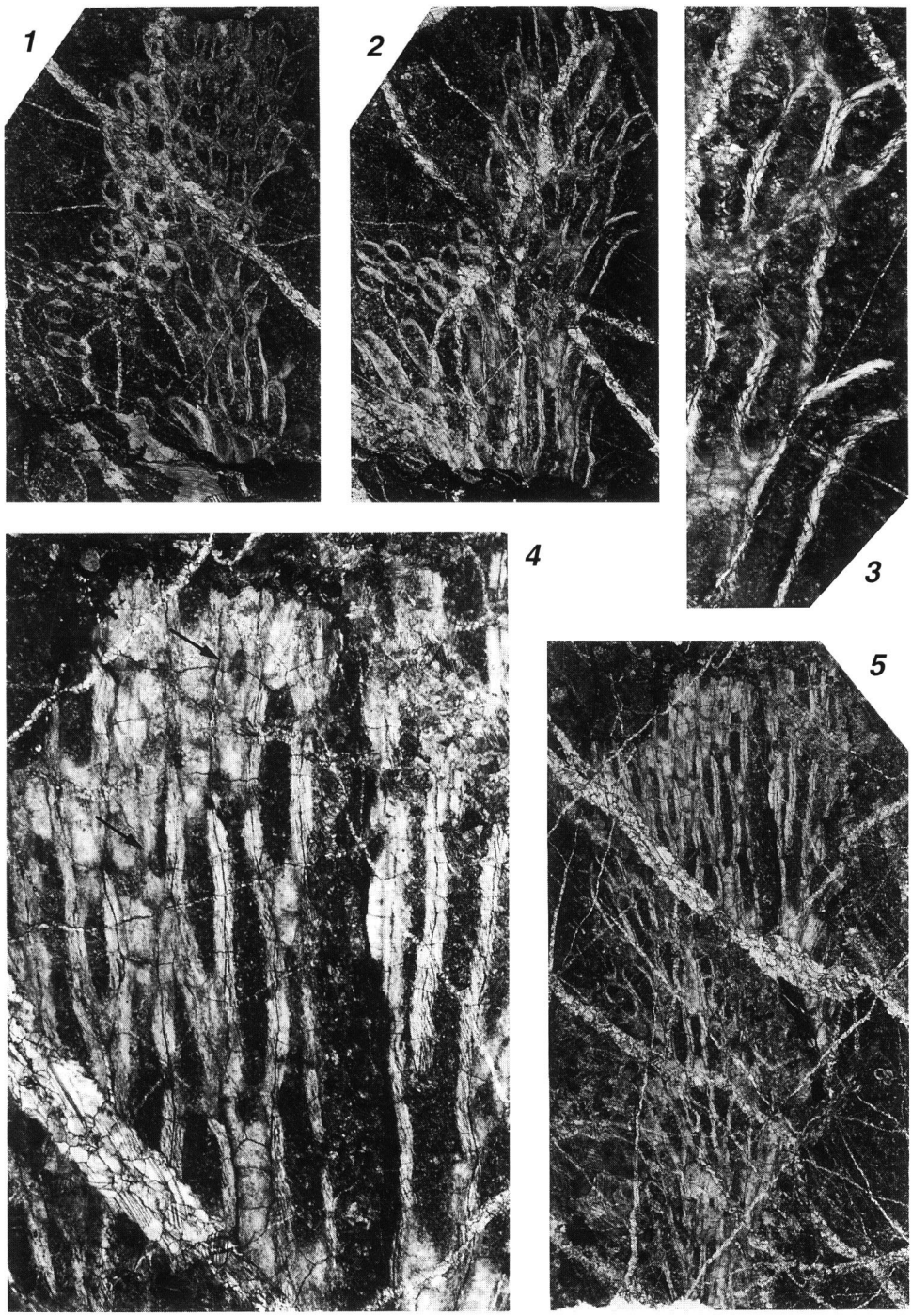

Fig. 1. *Hillaepora gionensis* sp. nov., thin sections. 1–3, holotype, NSM PA14536. 1, oblique to longitudinal section, ×5. 2, longitudinal section, ×5. 3, longitudinal section, showing calical edge, ×14. 4, 5, paratype, NSM PA14537. 4, longitudinal section, arrows indicate mural pores, ×14. 5, longitudinal section, ×5.

Genus *Striatopora* Hall, 1851

Type species: *Striatopora flexuosa* Hall, 1851.

Striatopora sugiyamai sp. nov.

Figs. 2-1–7; 3-1

Striatopora sp., Adachi and Niko, 1996, p. 70, figs. 4-3, 4.

Holotype: NSM PA14540, from which seven thin sections were made.

Other specimens: Two silicone rubber casts from an external mold and thirteen thin sections were studied from the ten paratypes, NSM PA14541–14549, 14551. In addition, four specimens, NSM PA14550, 14552–14554, also examined.

Diagnosis: Species of *Striatopora* with usually 1.6–2.3 mm in branch diameter, stellately arranged axial corallites; number of corallites in cross section of branch 15–21; corallite diameters attain approximately 0.66 mm; calical opening oblique, usually 40°–50° in angle to branch axis.

Description: Coralla ramose with cylindrical branches of 1.1–3.9 mm, usually 1.6–2.3 mm in diameter, cerioid; branching rare, bifurcate; total corallum diameter and growth form unknown owing to fragile nature. Corallites prismatic; 15–21 corallites recognized in cross section of branch; each corallite consists of proximal straight portion, that lies at small angles to branch axis, with 3 sided in cross section, and distal outwardly curving and inflated portion with indistinct 6–8 sided in cross section; most proximal corallites radially arranged, thus axial 7–12 corallites form stellate structure in cross section of branch; corallite diameters range from 0.19 to 0.68 mm, with 0.63–0.68 mm (0.66 mm mean) in most distal portion; calices deep, to open obliquely upward with 37°–67°, usually 40°–50°, in angle to branch axis; apertures elliptical, laterally compressed, approximately 0.37×0.62 mm in diameter; distinct calical edge not developed; increase of new corallites lateral, common, occurs in axial zone of branch; cross section of tabularia polygonal in proximal corallite and circular to elliptical in distal corallite. Intercorallite walls of proximal corallites are relatively thin with 0.06–0.11 mm in thickness, composed of thin median dark line and relatively thin stereoplasm, then walls in distal corallite are abruptly thickening to form wide peripheral stereozone where median dark line disappeared and stereoplasm has distinct growth lamination, attaining approximately 0.65 mm in thickness; mural pores subcircular in cross section, numerous, but small and approximately 0.04 mm in diameter, forming single row in each corallite face; septal spines sporadic, very short, approximately 0.06 mm in length; tabulae complete, outwardly convex, relatively rare.

Discussion: This new species is clearly distinguished from the previously known species of *Striatopora* by its unique axial corallites forming the stellate structure recognized in cross section of the branch.

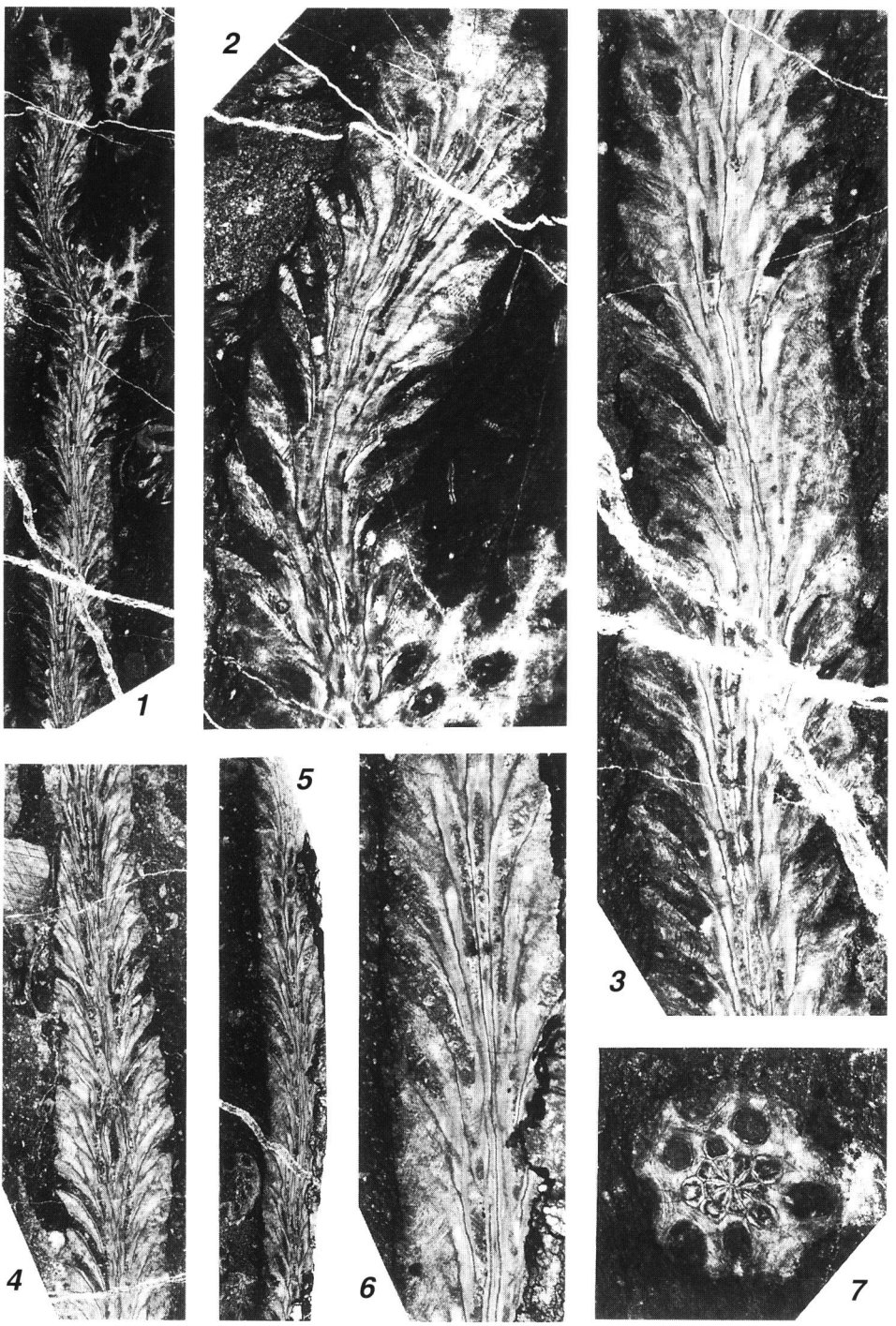

Fig. 2. *Striatopora sugiyamai* sp. nov., thin sections. 1–3, 5–7, holotype, NSM PA14540. 1, longitudinal section, ×5. 2, longitudinal section, ×14. 3, longitudinal section, ×14. 5, longitudinal section, ×5. 6, longitudinal section, ×14. 7, transverse section, note stellately arranged axial corallites, ×14. 4, paratype, NSM PA14544, longitudinal section, ×5.

Sugiyama (1944, pl. 3, figs. 2a, b) reported a cylindrical tabulate coral "*Coenites*" sp. from the middle Silurian Imose Limestone, Kochi Prefecture. This species is referable to the Pachyporicae rather than the Chaetetidae or Coenitidae, and somewhat resembles *Striatopora sugiyamai* sp. nov. Although figured specimens of "*Coenites*" sp. are poorly preserved, the perpendicular opening of the calices in "*C.*" sp. indicates that the Imose's specimens are different at least in specific level from *Striatopora sugiyamai* having oblique calices.

Etymology: The specific name honors the late Dr. Toshio Sugiyama who was a pioneer in the study of the Silurian corals in Japan.

Occurrence: Very abundant in limestone pebbles or boulders (NSM PA14540–14548, 14550, 14554) and scarce in calcareous sandstone (NSM PA14549) in the upper Wenlock G2 Member at locality 1. Scarce in massive limestone in the G3 Member at locality 2 (NSM PA14551) and locality 3 (NSM PA14552, 14553).

Family Parastriatoporidae Chudinova, 1959

Genus *Parastriatopora* Sokolov, 1949

Type species: *Parastriatopora rhizoides* Sokolov, 1949.

Parastriatopora hyugaensis sp. nov.

Figs. 3-2, 3; 4-1–6

Holotype: NSM PA14558, from which four thin sections were made.

Other specimens: Four silicone rubber casts from an external mold and eight thin sections were studied from the seven paratypes, NSM PA14555–14557, 14559–14562. In addition, a single specimen, NSM PA14563, also examined.

Diagnosis: Species of *Parastriatopora* with approximately 5.0 mm in branch diameter; corallite diameters attain approximately 0.74 mm; number of corallites in cross section of branch 84–101; increase of new corallites frequent; calical opening perpendicular to branch axis; mural pores numerous in distal corallite forming 1–3 row(s); septal spines contiguous.

Description: Coralla ramose with cylindrical branches of 4.3–5.6 mm with 5.0 mm mean in diameter, cerioid; branching rare, bifurcate or umbelliferous; total corallum diameter and growth form unknown owing to fragile nature. Corallites prismatic, 4–8 sided; 84–101 corallites recognized in cross section of branch; each corallite consists of narrowly divergent proximal portion and distal nearly straight portion that is perpendicularly oriented to branch axis; turning from proximal to distal portions denotes sharp bend where indicates abrupt inflation of corallites; corallite diameters range from 0.24 to 0.82 mm, with 0.71–0.78 mm (0.74 mm mean) in most distal portion; calices very shallow, to open perpendicular to branch axis and surface; apertures polygonal and usually 6 sided, variable in diameter ranging from 0.30 to

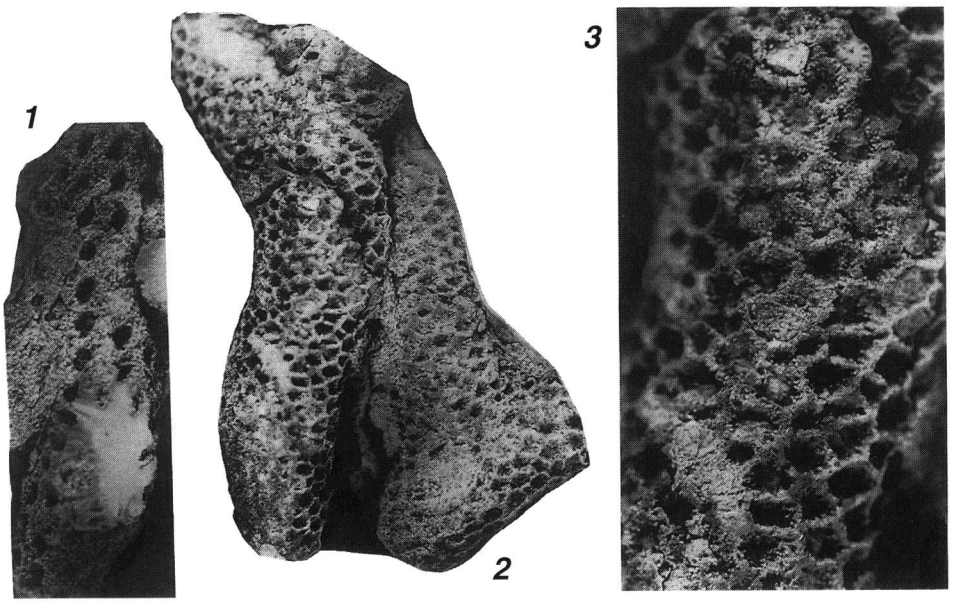

Fig. 3. 1, *Striatopora sugiyamai* sp. nov., paratype, NSM PA14549, external view of silicon rubber cast, ×8. 2, 3, *Parastriatopora hyugaensis* sp. nov., paratype, NSM PA14562, external views of silicone rubber cast. 2, ×3. 3, details of calices, ×8.

0.74 mm, divided by calical edges; increase of new corallites lateral, frequent, occurs in axial zone of branch; cross section of tabularia polygonal in proximal corallites and sub-stellate in distal corallites. Intercorallite walls of proximal corallites are relatively thin with 0.10–0.21 mm in thickness, composed of thin median dark line and relatively thin stereoplasm, then walls in distal corallites abruptly thickening by addition of stereoplasm and contiguous septa, attaining approximately 0.46 mm in thickness, and forming peripheral stereozone; mural pores subcircular in cross section, sporadic in proximal corallites and numerous in distal corallites, approximately 0.13 mm in diameter, forming 1–3 row(s) in each corallite face; septal spines develop in distal corallite, long, attaining 0.27 mm, but contiguous thus only short edges recognized in tabularium, basal septa may form septal laminae; tabulae mostly complete, somewhat variable in form, rectangular or oblique to corallite and flat or outwardly concave, common in proximal corallite and relatively abundant in distal corallite; most distal 7–9 tabulae thickened by outwardly inflation.

Discussion: In many respects this new species appears most similar to *Parastriatopora rhizoides* Sokolov (1949, pl. 8, figs. 6, 7; 1955a, pl. 22, figs. 5, 6; 1955b, pl. 50, figs. 2, 3, 4a, b; Chudinova, 1959, pl. 3, figs. 2a, b, v, 3a, b, 4a, b, 5a, b, pl. 4, figs. 1–3, 4a, b, 5a, b, 6a, b, 7a, b, 8a, b, 9a, b, pl. 5, figs. 1a, b, 2a, b, 3, 4a, b, 5a, b, 6a, b, pl. 6, figs. 1, 2a, b, v, pl. 7, figs. 1, 2, 3a, b) from the lower or middle Silurian of the

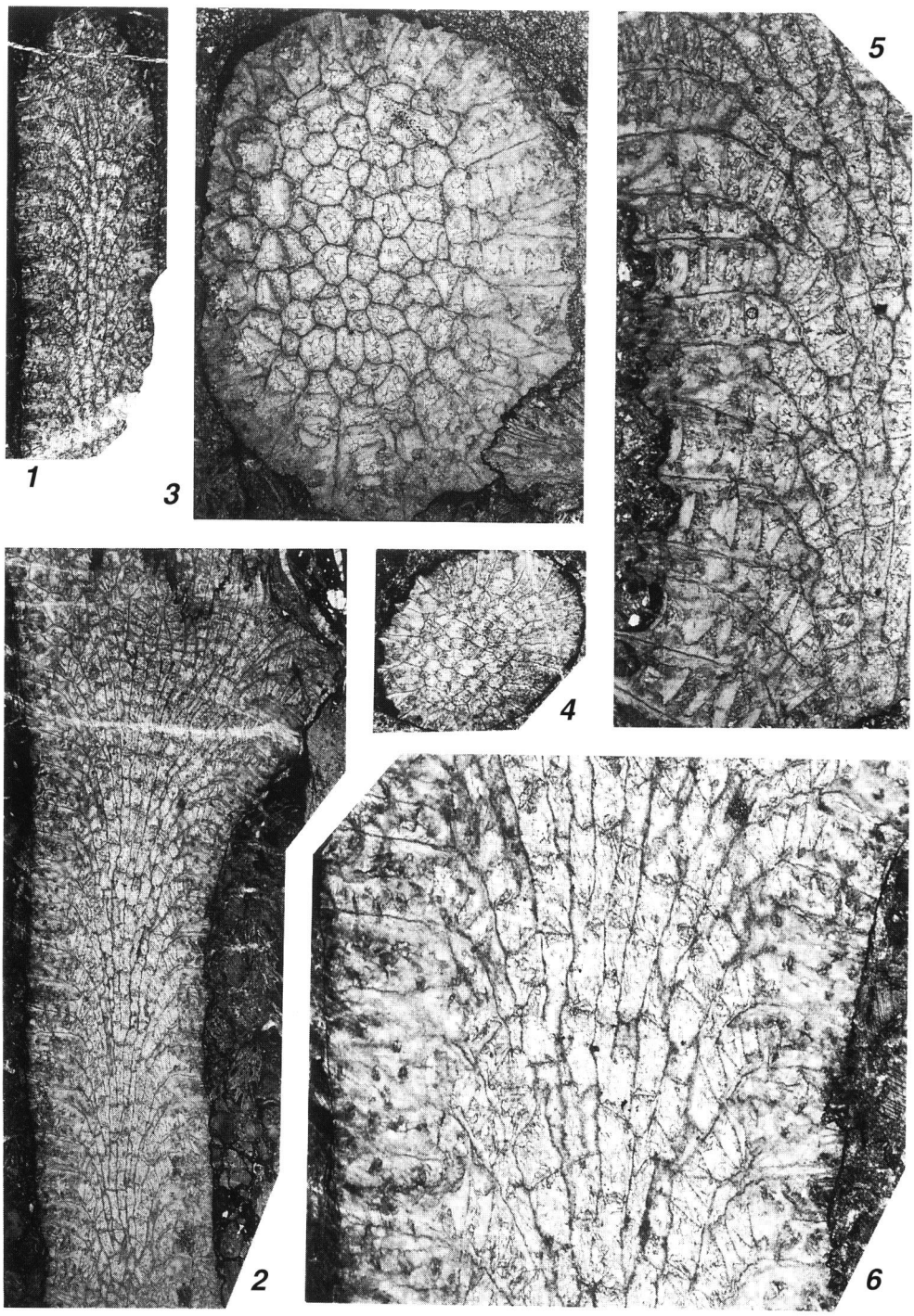

Fig. 4. *Parastriatopora hyugaensis* sp. nov., thin sections. 1, paratype, NSM PA14557, longitudinal section, ×5. 2, 3, 6, holotype, NSM PA14558. 2, longitudinal section, ×5. 3, transverse section, ×14. 6, longitudinal section, ×14. 4, paratype, NSM PA14555, transverse section, ×5. 5, paratype, NSM PA14559, longitudinal section, note thickening of distal tabulae, ×14.

Siberian Platform, *P. gracilis* Lin (1975, pl. 58, figs. 3a, b) from the middle Silurian of Shaanxi in Chinling (Qing Ling), China, and *P. tebenjkovi* (Chernyshev, 1938, figs. 2a, b; Sokolov & Tesakov, 1963, pl. 9, figs. 1–7) from the Wenlock (Lower Silurian) of the Siberian Platform. *Parastriatopora rhizoides* differs from *P. hyugaensis* sp. nov. in its larger diameter of branches (approximately 5.0 mm versus usually 7–9 mm in *P. rhizoides*), its oblique calical opening (40°–80° in angle to branch axis), and its isolated long septal spines. *Parastriatopora gracilis* differs from *P. hyugaensis* in its variable intercorallite diameters caused by very frequent increase of new corallites. The mural pores of *Parastriatopora tebenjkovi* arrange in usually 5 rows in each corallite face as compared with 1–3 row(s) in *P. hyugaensis*, in addition the both species are different in the corallite number in cross section of branch (84–101 versus 30–60 in *P. tebenjkovi*).

Kato (1990) reported "*Parastriatopora*" like favositeds from the Pridoli (Upper Silurian) Hitoegane Formation, Gifu Prefecture, however their morphology is still undescribed. Thus, compression with *Parastriatopora hyugaensis* to this species is impossible at present.

Etymology: The specific name is derived from Hyuga, which is the historic province name of the type locality.

Occurrence: Common in limestone pebbles (NSM PA14555–14561) and scarce in calcareous sandstone (NSM PA14562, 14563) in the G2 Member at locality 1.

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