

Auloporid Tabulate Corals from the Lower Permian Ryozensan Limestone, Shiga Prefecture

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Abstract The tabulate coral fauna from the Lower Permian Ryozensan Limestone Formation, Mino Terrane in Shiga Prefecture consists of two auloporid species, i.e. the aulocystid *Pseudoromingeria onishii* sp. nov. and the sinoporid *Sinopora ryozensanensis* sp. nov. and is of Sakmarian age. This discovery of *Pseudoromingeria onishii* leads to the following emendations: a revised generic diagnosis is presented, and the stratigraphic range of the genus is extended from the Capitanian (Late Permian). The comparable forms with the present Ryozensan tabulate corals are known from the Akasaka Limestone, Gifu Prefecture, and Yunnan and Guizhou of South China. This paper represents the first reliable documentation of tabulate corals in the formation.

Key words: Sakmarian (Early Permian), tabulate corals, Aulocystidae, *Pseudoromingeria*, Sinoporidae, *Sinopora*, Ryozensan Limestone Formation, Shiga.

Introduction

The first reliable tabulate corals to be described from the Lower Permian Ryozensan Limestone Formation (Takimoto, 1936; redefined by Miyamura, 1973), Mino Terrane based on material found and donated to the National Science Museum, Tokyo, by Mr. Tetsuro Onishi. Two auloporid species, *Pseudoromingeria onishii* sp. nov. and *Sinopora ryozensanensis* sp. nov., are identified in the present specimens whose localities are in the Gongen-dani Valley of Inukami-gun, Shiga Prefecture, Central Japan (Fig. 1). Previous studies considered Ryozensan corals as exclusively Rugosa, including *Amandophyllum* sp. nov. (Yamagiwa and Oyagi, 1989) and unnamed rugose corals (Oyagi, 1991, 1994, 2000). The presence of corals in this formation has been also noted by Miyamura (1973), Miyamura *et al.* (1976), and Tamura *et al.* (1979).

The Mino Terrane is an accreted tectonostratigraphic unit consisting mainly of Permian greenstone-limestone complex, Permian to Triassic chert, and Jurassic terrigenous sediments (e.g., Mizutani, 1990). The juxtaposed Akasaka, Ibukiyama, Ryozensan and Fujiwaradake Limestones of this greenstone-limestone complex were situated in a warm-water condition of Panthalassa (Ross and Ross, 1985; Ozawa,

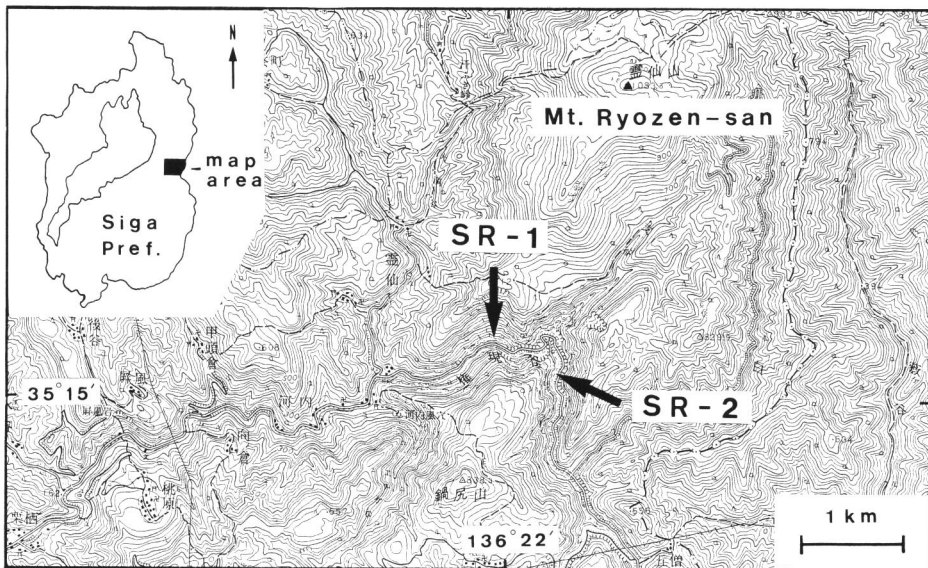


Fig. 1. Index map of the present coral localities (SR-1, 2) in the Gongen-dani Valley, Shiga Prefecture using 1:50,000 map of “Hikonetobu” published by the Geographical Survey Institution.

1987; Zaw Win, 2000) during Permian time. Among them, the Ryozensan Limestone Formation forms the principal axis of the northern Suzuka Mountains as the remnants of nappe on the Early to Middle Jurassic (Okimura *et al.*, 1986) Ikuridani Group. This formation is divided into two distinct members, basic volcanic rocks (150 m thick) below and coral-bearing limestone (450 m thick) above. The types of *Pseudoromingeria onishii* came from light gray bioclastic packstone at locality SR-2. *Sinopora ryozensanensis* was collected in float blocks of black wackestone/packstone in talus at locality SR-1. The fusulinids *Pseudofusulina vulgaris* (Schellwien) and *Paraschwagerina* sp. co-occur with the both tabulate coral localities and indicate the Sakmarian (Early Permian) age.

Systematic Paleontology

Order Auloporida Sokolov, 1947

Superfamily Auloporicae Milne-Edwards and Haime, 1851

Family Aulocystidae Sokolov, 1950

Genus *Pseudoromingeria* Yabe and Sugiyama, 1941

Type species: Romingeria? kotoi Yabe and Hayasaka, 1915.

Emended diagnosis: Subramose coralla consisting of lax mass with slender

corallites in clusters, phacelo-ceriod; prostrate in early stages; increase lateral; without connecting tubule; walls thick with numerous septal spines; mural pores rare, restrict near branch periphery; tabulae infundibuliform and dissepiment-like; stereoplasm consists of rect-radiate fibers.

Pseudoromingeria onishii sp. nov.

Figs. 2-1-3; 3-1-3; 4-1-4

Holotype: NSM PA14634, from which six thin sections were made.

Other specimens: Nine thin sections were studied from the two paratypes, NSM PA14635, 14636.

Diagnosis: Species of *Pseudoromingeria* consisting mostly of cerioid branches and very narrow phaceloid portion; corallite diameters usually 1.1–1.6 mm; intercorallite walls usually very thick, attain 0.80 mm; tabulae well-developed, forming indistinct axial syrxinx.

Description: Coralla subramose with mostly cerioid branches, but distal corallites partly separated and phaceloid; some branches lack phaceloid portion; early growth stages are prostrate and *Cladochonus*-like; growth form of corallum may domical; maximum observed size of holotype approximately 80 mm in height. Branch shape is somewhat irregular, nearly cylindrical with usually 5–9 mm in diameter to blade-like; branching frequent, may bifurcate; length of each cerioid branch at least 19.5 mm; phaceloid portion very narrow in comparing type species, maximum 2.8 mm in length. Corallites are somewhat variable in shape, usually prismatic with indistinct 4–8 sided in cross section, but cylindropismatic with semicircular to fan-shaped cross sections in prostrate portion and peripheral branch, or cylindrical forms in phaceloid portion also recognized; corallite diameters range from 0.6 to 1.8 mm usually 1.1–1.6 mm with 1.3 mm mean, and attain 2.0×1.3 mm in semicircular form; there are 9–52+ corallites in cross section of cerioid branch; increase of new corallites lateral, common; tabularia narrow, usually subcircular in cross section, shifting deep calical pits, but their transition point is indistinct; calical opening obliquely upward with approximately 40° in angle to branch axis in sides. Intercorallite and corallite walls variable in thickness, but usually very thick, range from 0.10 to 0.80 mm with 0.55 mm mean in cerioid portion, composed of median dark line and stereoplasm of rect-radiate fibers; mural pores rare, restrict near corallum periphery, and occur at corallite faces; cross section of mural pores circular with approximately 0.08 mm in diameter; septal spines numerous, 0.13–0.27 mm in length; tabulae well-developed, incomplete, mostly infundibuliform, somewhat irregular in space and distribution; there are 0–4 tabulae in 2.5 mm of corallite length; crowded tabulae form indistinct axial syrxinx.

Discussion: Until now *Pseudoromingeria* was the monotypic genus and repre-

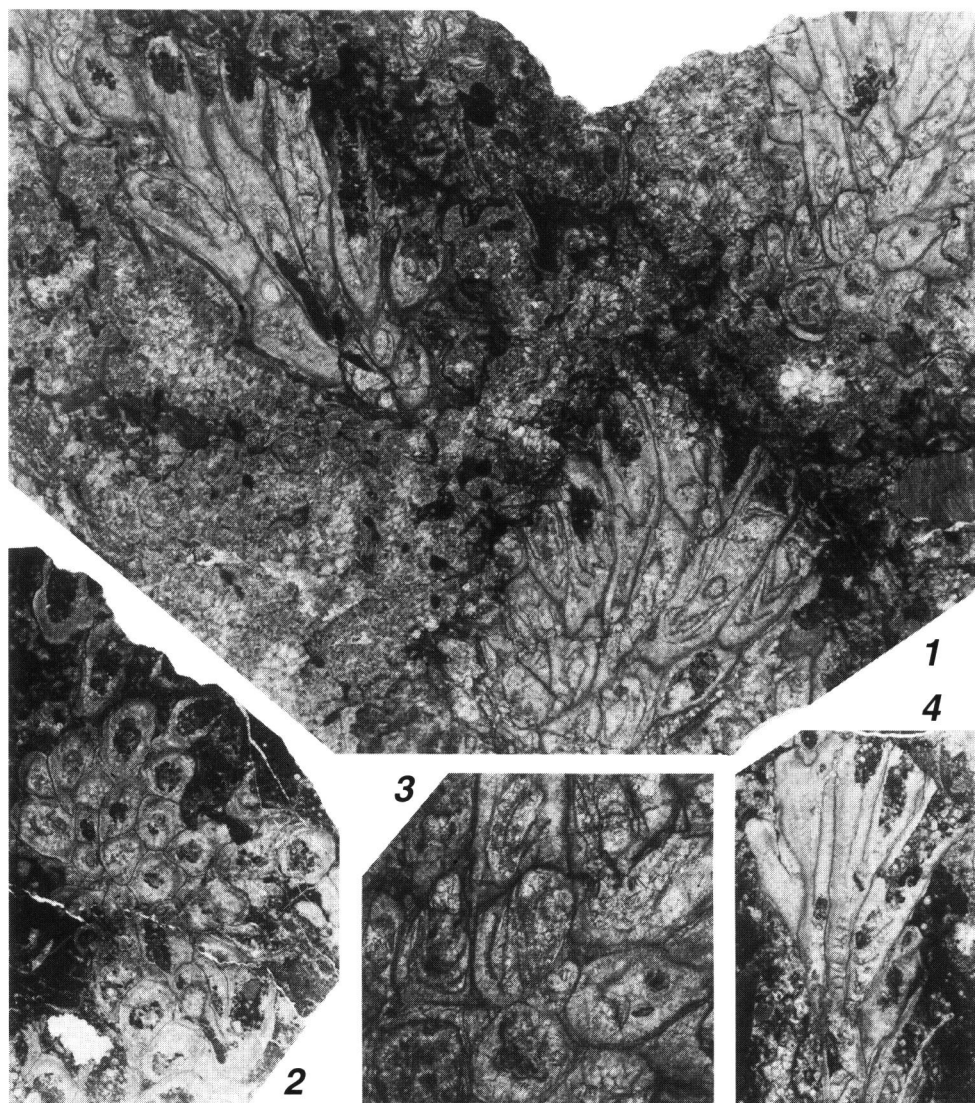


Fig. 2. *Pseudoromingeria onishii* sp. nov., thin sections. 1, 3, 4, holotype, NSM PA14634. 1, transverse to oblique sections of branches, $\times 5$. 3, cross sections of corallites, $\times 10$. 4, longitudinal section of branch, $\times 5$. 2, paratype, NSM PA14635, cross section of branch, $\times 5$.

sented by the Capitanian (Late Permian) species *P. kotoi* (Yabe and Hayasaka, 1915; Yabe and Sugiyama, 1941, figs. 1–3) from the Akasaka Limestone, Gifu Prefecture. *Pseudoromingeria onishii* sp. nov. is distinctive in terms of the narrower phaceloid portion, the thicker corallite walls (maximum 0.80 mm versus 0.5 mm in *P. kotoi*),

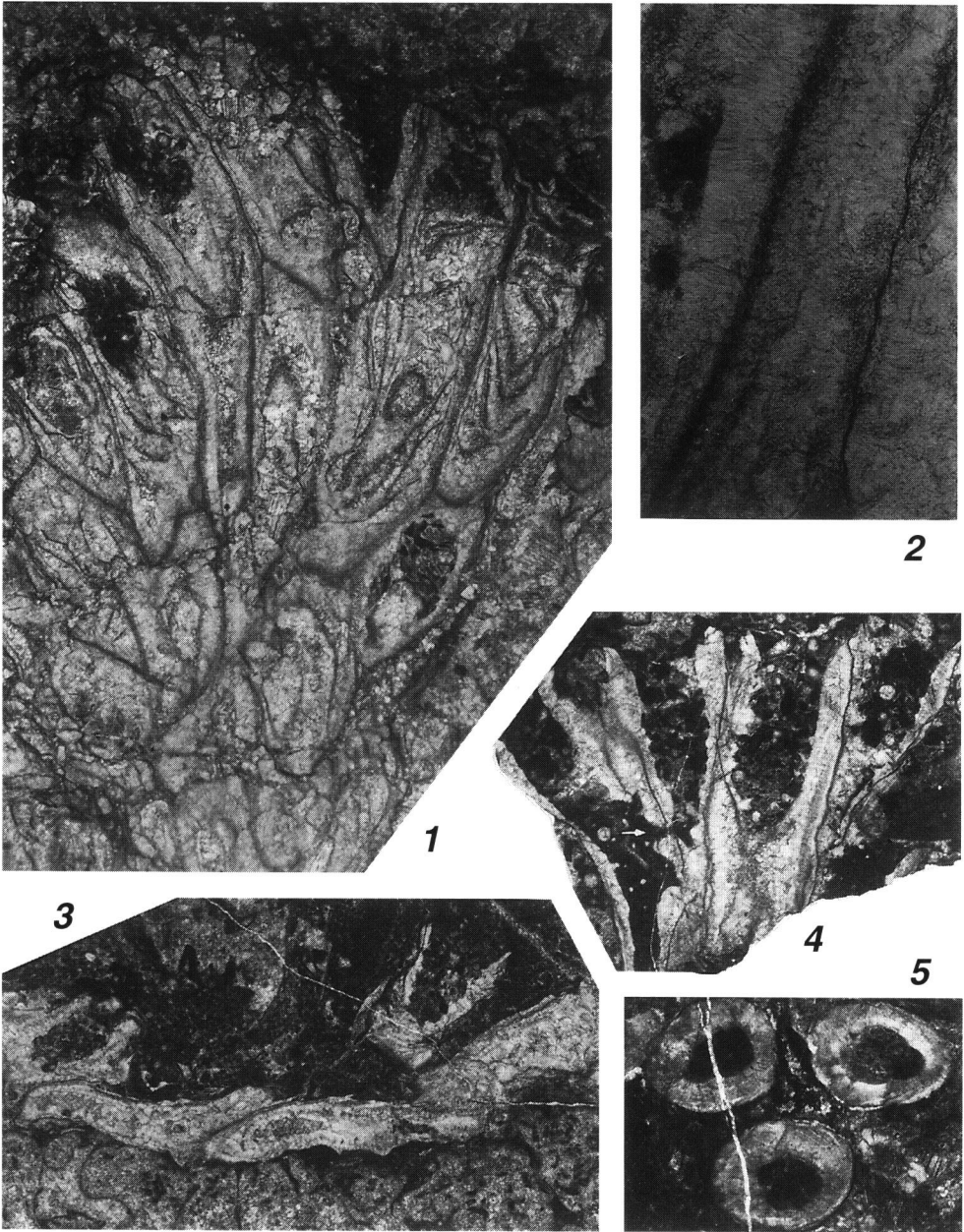


Fig. 3. 1–4, *Pseudoromingeria onishii* sp. nov., thin sections. 1, 2, holotype, NSM PA14634. 1, longitudinal sections of corallites, note infundiburiform tabulae, $\times 10$. 2, partial enlargement to show intercorallite wall structure, $\times 50$. 3, 4, paratype, NSM PA14635. 3, longitudinal sections of corallites, showing prostrate early growth stages, $\times 10$. 4, longitudinal sections of corallites, arrow indicates mural pore, $\times 10$. 5, *Sinopora ryozensanensis* sp. nov., holotype, NSM PA14641, thin transverse section, $\times 10$.

and well-developed tabulae. The generic diagnosis, summarized by Hill (1981), is emended to include new data of *Pseudoromingeria onishii*, notably the confirmation of the early growth form and the presence of the mural pores. In addition, this Sakmarian new species downwards extends the stratigraphic range of the genus.

Etymology: The specific name honors Mr. Tetsuro Onishi, who discovered this coral.

Family Sinoporidae Sokolov, 1955

Genus *Sinopora* Sokolov, 1955

Type species: *Monilopora dendroidea* Yoh in Yoh and Huang, 1932.

***Sinopora ryozensanensis* sp. nov.**

Figs. 3-3; 4-1-6

rugose coral; Oyagi, 1991, pl. 10, figs. 1-3.

compound rugose coral; Oyagi, 2000, p. 157.

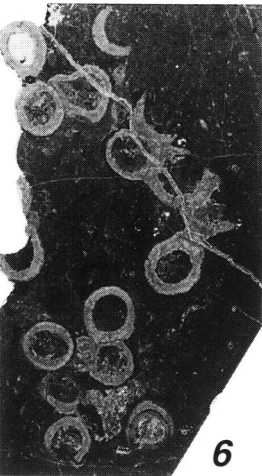
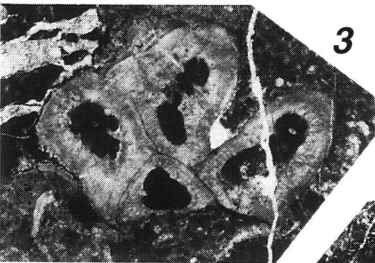
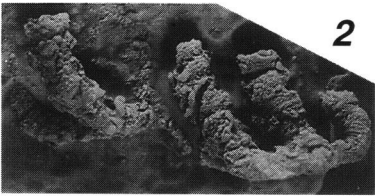
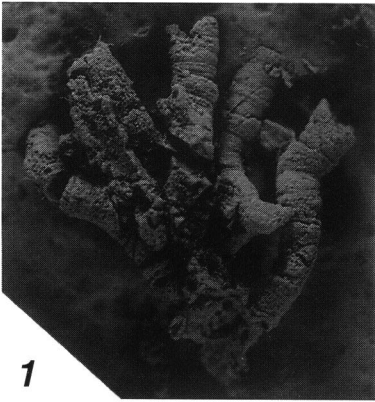
Holotype: NSM PA14641, from which five thin sections were made.

Other specimens: Twenty-two thin sections and two etched corallum fragments were studied from the eight paratypes, NSM PA14637, 14639, 14643, 14644, 14653-14656. In addition, eleven specimens, NSM PA14638, 14640, 14642, 14645-14652, were also examined.

Diagnosis: Species of *Sinopora* with partial corallite adhesion forming cerioid-like portion; corallites usually 1.3-1.7 mm in diameter; septal spines well-developed, attaining 0.29 mm in length.

Description: Coralla domical of maximum observed size 25 mm in diameter and 16 mm in height (holotype), composed of phaceloid portion with closely spaced and dendritic branches and less frequent cerioid-like portion consisting of partial adhesion with up to 10 corallites; connecting tubule absent; early growth stages prostrate and *Cladochonus*-like. Corallites cylindrical in phaceloid portion with growth wrinklins on surface, range from 0.5 to 1.9 mm, usually 1.3-1.7 mm with 1.5 mm mean, in diameter; calices deep, lacking calical modification; lumina usually subcircular in cross section, shift deep calical pits without distinct transition point; increase of new corallites lateral, frequent with bifurcate branching. Corallite walls variable in thick-

→Fig. 4. *Sinopora ryozensanensis* sp. nov. 1, paratype, NSM PA 14656, etched corallum fragment, $\times 4$. 2, paratype, NSM PA14644, etched corallum fragment, showing *Cladochonus*-like early growth stages, $\times 4$. 3-5, holotype, NSM PA14641, thin sections. 3, cross section of cerioid-like portion, $\times 10$. 4, longitudinal to cross sections of dendritic corallites, note well-developed septal spines, $\times 10$. 5, longitudinal section, $\times 5$. 6, paratype, NSM PA14639, thin cross section, $\times 5$.



ness, but usually thick, range from 0.08 to 0.54 mm with 0.39 mm mean, consist of epitheca and stereoplasm with microstructure of rect-radiate fibers; banded structure, that parallel to epitheca, also recognized in stereoplasm; no mural pore detected even in cerioid portion; septal spines well-developed for genus, conical in profile and slightly upturned, attaining 0.29 mm in length, somewhat irregular in spacing; apparent tabula not detected.

Discussion: *Sinopora ryozensanensis* sp. nov. most resembles *S. maxima*, which was established by King (1974; not seen by the author, its specific diagnosis and geologic setting come from citation by Lin *et al.*, 1988, p. 382) on the basis of specimens collected from the Lower to Middle Permian Chihhsia Formation, Yunnan, South China. This species was also described from Middle Permian Maokou Formation in Guizhou, South China (Yang, 1978). The well-developed septal spines and the partial corallite adhesion of *Sinopora ryozensanensis* agree with diagnosis of *S. maxima*, but the corallite diameters are somewhat smaller (usually 1.3–1.7 mm) than those of *S. maxima*, whose corallites range from 1.4 to 2.2 mm, usually 1.8–2 mm in corallite diameter.

Oyagi (1991, 2000) illustrated several corals from the Ryozensan Limestone Formation and referred all specimens to Rugosa. The synonymy given above includes the three coralla in his illustrations.

Etymology: The specific name is derived from the type stratum.

Acknowledgments

The author is indebted to Mr. Tetsuro Onishi, who bring the Ryozensan corals to my attention and provided assistance in the field. He also provided access to his personal collection.

References

- Hill, D., 1981. Part F, Coelenterata, Supplement 1. Rugosa and Tabulata. In R. C. Moore *et al.* (eds.), Treatise on Invertebrate Paleontology, pp. F1–F762. The Geological Society of America, INC. & The University of Kansas, Boulder, Colorado & Lawrence, Kansas.
- King, G., 1974. Tabulata. In, Atlas of Paleontology of Yunnan, p. 244. Yunnan People's Publishing House, Kunming. (In Chinese, not seen.)
- Lin, B. Y., Y. Y. Tchi, C. T. Jin, Y. X. Li & Y. Y. Yan, 1988. Monograph of Palaeozoic corals, Tabulatomorphic corals. Vol. 2, 493 pp. Geological Publishing House, Beijing. (In Chinese.)
- Miyamura, M., 1973. Geologic structure of the Permian formations in the Suzuka Mountains, Central Japan. *Rept. Geol. Surv. Japan*, (24): 495–511.
- Miyamura, M., K. Mimura & T. Yokoyama, 1976. Geology of the Hikonetobu district. With Geological Sheet Map at 1:50,000, Geol. Surv. Japan, 55 pp., pls. 1, 2. (In Japanese with English abstract.)
- Mizutani, S., 1990. Mino Terrane. In K. Ichikawa *et al.* (eds.), Pre-Cretaceous Terranes of Japan, pp. 121–135. Publication of IGCP Project No. 224, Osaka.
- Okimura, Y., S. Suzuki, H. Fujita & Y. Yoshida, 1986. A preliminary report on the Mesozoic radioralians

- from the Kurakake-toge Formation and the Ikuridani Group of the Suzuka Mountains. *News of Osaka Micropaleontologists*, Special Volume, (7): 181–185. (In Japanese with English abstract.)
- Oyagi, K., 1991. The Permian fossils in northern part of the Suzuka Mountains. *In*, Landscape and Environment of Shiga, pp. 309–385. The Foundation of Nature Conservation in Shiga Prefecture, Shiga. (In Japanese with English abstract.)
- Oyagi, K., 1994. Field Trips for Fossil Collection All Over the Japanese Country. 166 pp. Tukiji Shokan, Tokyo. (In Japanese.)
- Oyagi, K., 2000. Selection of 800 Fossils in Japan with Locality Divisions. 298 pp. Tukiji Shokan, Tokyo. (In Japanese.)
- Ross, C. A. & J. R. Ross, 1985. Carboniferous and Early Permian biogeography. *Geology*, **13**: 27–30.
- Ozawa, T., 1987. Permian fusulinacean biogeographic provinces in Asia and their tectonic implications. *In* A. Taira & M. Tashiro (eds.), Historical Biogeography and Plate Tectonic Evolution of Japan and Eastern Asia, pp. 45–63. Terra Scientific Publisher, Tokyo.
- Sokolov, B. S., 1955. Paleozoic Tabulata of the European parts of the USSR: Introduction to the general study of the systematics and development of the tabulates. *Tr. Vses. Neft. Nauchno-issled. Geol.-Razved. Inst. (VNIGRI), N.S.*, **85**: 1–527. (In Russian.)
- Takimoto, K., 1936. Geological structure in the vicinity of Mt. Ryozenzan, Inugami-gun, Shiga Prefecture. *Chikyu*, **26**: 1–11, pl. 1. (In Japanese.)
- Tamura, M., S. Matsushita, K. Ito & S. Sakai, 1979. Paleozoic and Mesozoic strata in Shiga Prefecture, Central Japan. *In*, Land and Life in Shiga. Separate Volume for Geomorphology and Geology and Geologic Map of Shiga Prefecture 1 : 100,00 in Scale, pp. 133–159. Institute of Shiga Natural Environment, Kouga-gun, Shiga. (In Japanese.)
- Yabe, H. & I. Hayasaka, 1915. Palaeozoic corals from Japan, Korea and China. II, *Halysites*, *Syringopora*, *Romingeria*, *Striatopora*, *Tetrapora* and *Sylindropora*. *Jour. Geol. Soc. Tokyo*, **22**: 79–92.
- Yabe, H. & T. Sugiyama, 1941. *Pseudoromingeria*, a new genus auloporoids from Japan. *Proc. Imp. Acad. Japan*, **17**: 379–382.
- Yamagiwa, N. & K. Oyagi, 1989. On a new species of rugose coral fossil from the Ryozenzan Limestone Formation, Shiga Prefecture. *Abstracts of the 1989 Annual Meeting of the Palaeontological Society of Japan*, p. 78. (In Japanese.)
- Yang, S. W., 1978. Tabulata. *In*, Atlas of the Palaeontology of the Southwestern Regions of China. Fascicle Guizhou (Kweichow), vol. 2, Carboniferous–Quaternary, pp. 189–229, pls. 62–84. Beijing, Geological Publishing House. (In Chinese.)
- Yoh, S. S. & T. K. Huang, 1932. The coral fauna of the Chihhsia Limestone of the Lower Yangtze Valley. *Palaeont. Sinica*, Ser. B, **8**: 1–72.
- Zaw Win, 2000. Paleoenvironmental and paleogeographical consideration on the Akasaka Limestone, Gifu Prefecture, Japan. *Bull. Kitakyushu Mus. Nat. Hist.*, **19**: 9–23.

