135. *Saccamminopsis Limestone.*

By Hisakatsu YABE, M.I.A.

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A few months ago, Mr. I. Saga, geologist of the Hitati Mines, called our attention to a dark coloured limestone, interbedded in a Lower Carboniferous coralline limestone that is exposed on the hill-slope on the northern side of the valley of the Miyata-gawa, midway between the city of Hitati and the Hitati Mines, Ibaraki prefecture. This dark limestone is crowded with small round bodies, 2-3.5 mm in diameter, frequently prominent on its weathered surface, which is earthy with black carbonaceous material. Owing to poor preservation, even the microscope failed to reveal the true nature of the round bodies contained in the thin slices that were cut from the sample of the limestone received by our Institute of Geology and Palaeontology, Tôhoku Imperial University. On the kind invitation of Mr. Saga, Mr. T. Sugiyama and the writer personally visited the locality of the limestone, but were not successful in their search for more suitable material for examination.

In the meantime, a fresh hand specimen of the same limestone was found in a collection of rocks made by a student of our Institute, Mr. Toneo Tanzawa, deceased last year, who was engaged in a geological study of this district prior to his untimely death. Unfortunately, however, the precise locality of this sample is not given, beyond a simple note that it is from Loc. No. 4, although it is very probable, in fact almost certain, that the locality is only a short distance away from the valley above-mentioned, on a southern prolongation of the strike of the limestone that is exposed on the northern side of the valley.

Thin sections prepared of Tanzawa's material, under the microscope showed the round bodies to be in excellent preservation, and indistinguishable from *Saccamminopsis carteri* (Brady), originally referred by Brady to *Saccamina*, from the Lower Carboniferous of England.

Saccamminopsis Sollas, 1921.

Carteria Brady, 1869. Report British Association, Exeter Meeting, p. 372 (after Brady)—Non *Carteria* Diesing, 1865 (1866) which belongs to *Mastigophora*.

Saccamminopsis W. J. Sollas, 1921. On *Saccamina carteri* Brady, and the Minute Structure of the Foraminiferal Shell. Quart. Jour. Geol. Soc. London, Vol. LXXVII, pp. 193-211, Pl. VII, Figs. 8-14. J. A. Cushman: Foraminifera, 2nd ed., 1933, p. 74. J. J. Galloway: A Manual of Foraminifera, 1933, p. 166, Pl. XV, Figs. 3, 4.

"Test free, consisting of globular, pyriform or fusiform chambers, occurring separately or loosely joined end to end, wall calcareous, thin, finely granular, frequently replaced by quartz, beekite or chalcedony; pores in the walls unknown; aperture simple. round, produced, length of each chamber 2-5 mm.—Shallow water limestones—Mississippian of England, Scotland, Ireland and Belgium." (Galloway)

Galloway placed this genus in Nodosinellidae, while Cushman doubted its foraminifera-nature.

Genotype: *Saccamina carteri* Brady. Monotypic.

Saccamminopsis carteri (Brady).

Figs. 1-3.

Saccamina carteri Brady, in Ann. Mag. Nat. Hist., Ser. 4, Vol. VII, 1871, p. 177. Pl. XII.

Saccamina carteri Brady, in Pal. Soc. Monog., 1876, p. 56, Pl. I, Figs. 1-7; Pl. XII, Fig. 6.

Saccamminopsis carteri (Brady) Sollas: O. c.

Chambers subspherical to pyriform, 2 to 3.5 mm in shorter diameter, produced to neck at one end, which is some 1 mm long and 0.4 mm broad in well preserved examples. Aperture simple, open at tip of neck. Rarely two or three chambers arranged linearly, joined end to end, as in *Nodosaria*. Wall very thin, of uniform thickness, being 0.05 mm., calcareous apparently imperforate, but in reality perforate; outer and inner surface smooth.

Remarks: The thin wall is always distinctly bordered on the external side by the dark matrix of the limestone in which the organic remains are embedded, and internally by an aggregate of relatively large xenomorphic crystals of calcite, the latter boundary being frequently marked by a layer of very minute dark granules, presumably of carbonaceous material. Not infrequently, a common mosaic of calcite occupy the interior of the chamber, also replacing the wall itself.

Although, with low magnification, the wall appears to be homogeneous in microstructure, with high magnification, it usually resolves to an aggregate of calcite grains, appearing granular, and very rarely to be radial fibrils of the same mineral. Often there are dog-tooth crystals standing perpendicular to the external boundary plane of the wall and within it, while their interspaces are filled by granular calcite of later growth; where the dog-tooth crystals are slender and crowded, they look under low magnification, as if the wall were finely perforated. Further, we find another case of pseudo-perforation of the wall, in which the outward edges of very fine twin-lamellae of calcite exhibit a zigzag outline along the boundary between the wall and the matrix.

The aspect presented in Fig. 3, however, seems indisputable evidence for the primary perforation of the wall, seeing that they are not due to either of the two causes cited above, and moreover, in this particular instance, the wall is not radially fibrous, it being, on the contrary, together with the interior of the chamber, altered to a relatively coarse mosaic of calcite; the calcite crystals that form the very part of the wall are lamellarly twinned in directions quite out of harmony with the delicate irregularity of the outer surface of the wall.

Although in dealing with the English material of *Saccamminopsis* Brady was convinced of its arenaceous test, Sollas, after discussing in detail, later, the structure of foraminiferal shells and the state of their preservation in fossils of different geological ages and conditions, held

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Fig. 1. Weathered surface of *Saccamminopsis* limestone, crowded with the foraminifer. Nat. size.

Fig. 2. *Saccamminopsis* limestone in thin section. $\times 4$.

Fig. 3. A part of the chamber wall of *Saccamminopsis* highly enlarged in order to show its primary perforation. $\times 140$.

to the Calcareo-, instead of the Agglutinantia-nature of the foraminifer, without deciding whether or not it was originally perforated. On the evidence mentioned above, I am now inclined to believe that the wall was originally perforated in *Saccamminopsis*, although in most cases, its primary structure is no longer retained. The pores of the wall in Fig. 3 are measured $0.007 \pm$ mm broad.

In the size and form of separate chambers, the present fossil is similar to and liable to be confounded with *Mizzia*¹⁾ from the Permian of Dalmatia and Japan on one side and *Margaritina*²⁾ from the Permian of India and South China on the other; but the latter two differ from the former by having chamber wall which is thick and polygonally partitioned, instead of being thin and simple.

Our fossil agrees well with *Saccamminopsis carteri* (Brady) from the Lower Carboniferous of England not only in the size, form, and structure of the chambers, but also in the state of preservation and in its being a limestone-builder. It is noteworthy that the Lower Carboniferous of the British Isles and Japan, widely separated from each other, have in common such peculiar fossils as *Saccamminopsis* among the Foraminifera, and *Hexaphyllia* and *Heterophyllia*³⁾ among the Tetracoralla, all of rather rare occurrence in the contemporaneous deposits of the world, so far as our present knowledge goes.

Locality: Hitati, Ibaraki prefecture. *Tetrataxis* and a few other minute, generically indeterminable forms of foraminifera rarely found in association. Type specimen stored in the Institute of the Geology and Palaeontology, Tôhoku Imperial University; Reg. No. 65035. Lower Carboniferous, on the coral fauna of the coralline limestone in which the *Saccamminopsis* limestone is interbedded.

Foreign occurrences: Lower Carboniferous of England, Scotland, Ireland, and Belgium.

Finally I wish to express my hearty thanks to Mr. Saga of the Hitati Mines, to whose active interest on Palaeontology, I owe the chance personally to examine the outcrops of the fossiliferous limestone.

1) R. J. Schubert: Zur Geologie des oesterreichischen Velebit. Jahrb. k. k. Geol. Reichsanst., Vol. LVIII, 1908, p. 382. A. Karpinsky: Einige problematischen Fossilien aus Japan. Verh. k. Russ. Mineralog. Gesell., Vol. XLVI, 1910, p. 257. H. Yabe: Palaeozoic Formations of the Japanese Islands. Proc. Sixth Pac. Sci. Congr., 1939, p. 377.

2) C. Schwager: Productus Limestone Fossils, Protozoa. Pal. Indica, Ser. XIII, I, 6, 1886, p. 992, Pl. CXXVIII, Figs. 12-15. H. Yabe and I. Hayasaka: Palaeontology of Southern China, Geogr. Research in China, 1911-1916, Atlas of Fossils, Pl. XVII, Fig. 1.

3) H. Yabe and T. Sugiyama: Discovery of *Hexaphyllia* in the Lower Carboniferous of Japan. Jour. Geol. Soc. Japan, Vol. XLVI (Trans. Pal. Soc. Japan, No. 91), 1939, p. 499. H. Yabe and T. Sugiyama: Notes on *Heterophyllia* and *Hexaphyllia*. Jour. Geol. Soc. Japan, Vol. XLVII (Trans. Pal. Soc. Japan, No. 99), 1940, p. 81.