Carboniferous tabulate corals from the *Eostaffella-Millerella* Zone of the Omi Limestone, Niigata Prefecture, central Japan

Shuji NIKO[*], Yousuke IBARAKI[**] and Jun-ichi TAZAWA[***]

Abstract

In a serial paper documenting the tabulate coral fauna of the Omi Limestone, Niigata Prefecture, central Japan, this installment focuses favositid and auloporid species from the *Eostaffella-Millerella* Zone (late Visean to Bashkirian, Carboniferous). They include *Pseudofavosites hinaensis* Niko, 1999, *Michelinia japonica* Niko, 2002, *Donetzites* sp. cf. *D. kibiensis* Niko, 1999, and *Cladochonus ozawai* Niko and Haikawa, 2007. The new specimen of *P. hinaensis* permits a more detailed description than the holotype, and provides emendations of the specific concept. Apparent faunal similarity between tabulate corals of the Omi Limestone and those of the reef complexes in southwest Japan is recognizable.

Key words: Bashkirian, *Cladochonus, Donetzites, Michelinia,* Omi Limestone, *Pseudofavosites,* Serpukhovian, tabulate corals, Visean.

Introduction

Following previous papers (Niko and Hasegawa, 2000; Niko et al., 2009, 2010), the present study represents the fourth installment in a series documenting the tabulate coral fauna of the Omi Limestone in the Omi area, Itoigawa, Niigata Prefecture, central Japan. Specimens used herein were collected from the *Eostaffella-Millerella* Zone at three localities including

* Department of Environmental Studies, Faculty of Integrated Arts and Sciences, Hiroshima University, Hiroshima 739-8521, Japan
** Fossa Magna Museum, Ichinomiya, Itoigawa 941-0056, Japan
*** Hamaura-cho 1-260-1, Chuo-ku, Niigata 951-8151, Japan
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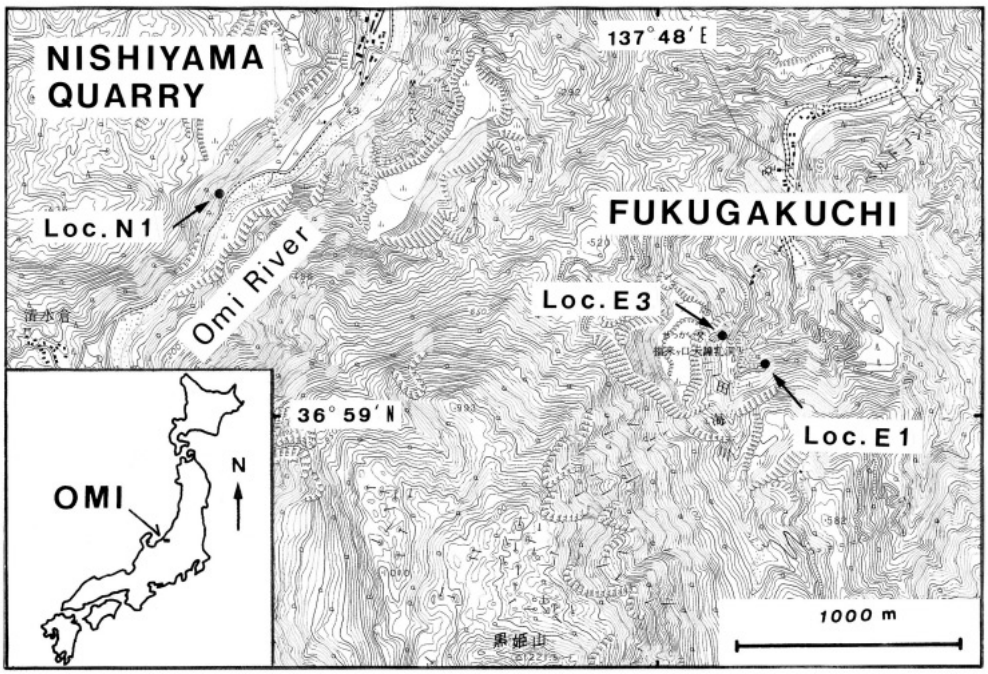


Fig. 1. Index map showing the fossil localities in the Omi area, on the topographical map of "Kotaki" scale 1:25,000 published by the Geospatial Information Authority of Japan.

locality N1 (36˚59’31” N, 137˚46’40” E) in the Nishiyama quarry and localities E1 (36˚ 59’08” N, 137˚48’19” E) and E3 (36˚ 59’13” N, 137˚48’11” E) at Fukugakuchi (Fig. 1). Although its detailed collecting site is unclear, a specimen, derived from the same fusulinacean zone and has kept in the Fossa Magna Museum (prefixed FMM), was also examined.

The *Eostaffella-Millerella* Zone was defined by Hasegawa et al. (1969) and is typically recognizable along banks of the Omi River, where the total thickness is 200–250 m. It can be also recognized in the vicinities of Fukugakuchi, Uta and Kotaki. Lithologically, the Carboniferous limestones ascribing to this zone are divided into two units, namely the lower unit consisting mostly of bioclastic grainstone, and the upper one characterized by the predominance of biolithite with a micrite matrix (Hasegawa et al., 1982; Hasegawa and Goto, 1990; Tazawa et al., 2002). The paleontological evidence including conodonts (Igo and Koike, 1964), foraminifers (Hasegawa et al, 1982) and corals (Yoshida and Okimura, 1992) indicates the late Visean to Bashkirian in age for the zone.

The newly collected material is also deposited in the paleontological collection of the Fossa Magna Museum, Itoigawa.

Systematic Paleontology

Order Favositida Wedekind, 1937
Suborder Favositina Wedekind, 1937
Superfamily Favositoidea Dana, 1846
Family Pseudofavositidae Sokolov, 1950
Genus *Pseudofavosites* Gerth, 1921

Type species.—*Pseudofavosites stylifer* Gerth, 1921.

Pseudofavosites hinaensis Niko, 1999
Figs. 2-1–6

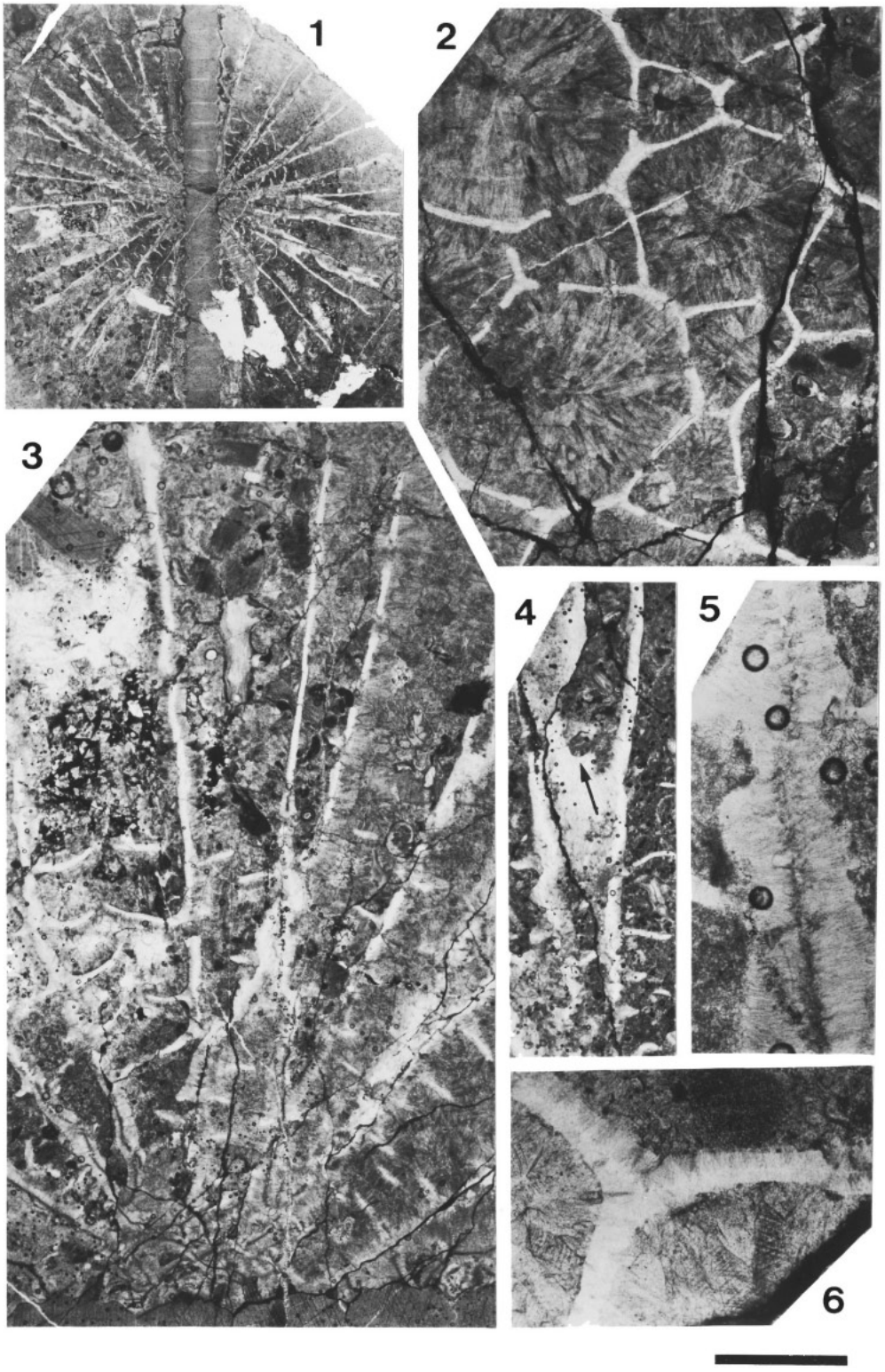
Pseudofavosites hinaensis Niko, 1999, p. 31, 33, figs. 2-1–4; 9-2.

Material, occurrence and age.—FMM1999. Its detailed collecting site is unclear. The specimen occurs from right gray limestone (bioclastic grainstone). Associated foraminifers, such as *Eostaffella* (?) sp., *Haplophragmella* sp., *Monotaxinoides* sp., *Planoendothyra* sp. and *Tetrataxis* sp., indicate the limestone belongs to the lower *Eostaffella-Millerella* Zone, whose age is the late Visean to Serpukhovian, Carboniferous.

In addition, a single specimen, FMM2000, collected from right gray limestone (bioclastic grainstone) at locality N1, is questionably assigned to *Pseudofavosites hinaensis* Niko, 1999. Foraminifers, such as "*Endothyra*" spp., *Eostaffella* (?) sp., *Globivalvulina* sp. and *Tetrataxis* sp., indicate the limestone also belongs to the lower *Eostaffella-Millerella* Zone.

Emended diagnosis.—Species of *Pseudofavosite*s with subspherical corallum, approximately 3.6 mm in adult corallite diameter, and prismatic lumina; intercorallite walls relatively thin, 0.05-0.27 mm; fewer mural pores than type species; in addition to abundant mid-wall pores, angle pores commonly developed; squamulae well-developed in central zone of corallum, but rare to almost absent in more outer zone, very long and wide, attaining 1.15 mm in length.

Description.—Corallum moderate in size for the family and genus, subspherical with approximate size of 31 mm in diameter and 25 mm in height, cerioid, and encircling crinoid stem. Corallites and lumina prismatic, radial in arrangement; transverse sections of corallites have 3-5 sides in early growth stages then shift to indistinct 8-10 sides in adult ones; diameters of corallites are variable in peripheral zone of corallum, range from 0.4 to 4.1 mm, with 3.6 mm mean in adult portions; calices perpendicularly oriented to corallum surface, very deep; increase of new corallites is lateral, frequently occurs. Intercorallite walls relatively thin for the genus, 0.05-0.27 mm, and differentiated into median dark line and stereoplasm, the latter of which consists of rect-radiate fibers in microstructure; mural pores abundant on corallite faces as mid-wall pores and common at corallite angles as angle pores, but not so numerous in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comparing with the type species; they form 1-2 longitudinal row(s); profiles of mural pores are circular to laterally compressed, 0.25-0.31 mm in diameter; squamulae very long and wide, attain 1.15 mm in length, and have concave to nearly flat, or rarely convex profiles, whose directions are usually rectangular to corallites, but weakly to strongly upturned squamulae are uncommonly developed; mode of occurrence of squamulae is well-developed in central zone (approximately 15 mm in diameter) of corallum, where there are 5-7 squamulae in 2.5 mm of corallite length, but rare to almost absent in more outer zone; some squamulae indicate a regularity in arrangement with alternate manner; structural differentiation is not recognized in squamulae; septal elements including ridges and spines are replaced by squamulae; tabula absent.

Discussion.—*Pseudofavosites hinaensis* was established by Niko (1999) on the basis of a single corallum (holotype, specimen repository of National Science Museum, Tokyo, NSM PA14522) from the late Visean stratum of the Hina Limestone, Okayama Prefecture, southwest Japan. The Omi specimen described here provides the opportunity to give a more complete description of this species. In particular, the nature of the corallum shape, angle pores and squamulae is added to the emended diagnosis.

Family Micheliniidae Waagen and Wentzel, 1886
Subfamily Micheliniinae Waagen and Wentzel, 1886
Genus *Michelinia* de Koninck, 1841

Type species.—*Calamopora tenuiseptata* Phillips, 1836.

Michelinia japonica Niko, 2002
Figs. 3-1, 2

Michelinia japonica Niko, 2002, p. 26, 30, figs. 1-4, 5; 2-1–3; 3-1–6; Niko and Haikawa, 2009, p. 3, pl. 2, figs. 1-5.

Material, occurrence and age.—FMM2001, 2002. The both specimens were collected from a block of white limestone (bioclastic grainstone) at locality E3. Associated foraminifers, such as *Asteroarchaediscus* sp., *Palaeotextularia* sp. and *Planoendothyra* (?) sp., indicate that the specimens of *Michelinia japonica* were derived from the upper *Eostaffella-Millerella*

⬅ **Fig. 2.** *Pseudofavosites hinaensis* Niko, 1999, FMM1999, thin sections. **1:** longitudinal section of corallum, note encircling on crinoid stem. **2:** transverse sections of distal corallites. **3:** longitudinal sections of corallites. **4:** longitudinal sections of corallites, arrow indicates mural pore. **5:** partial enlargement to show intercorallite wall structure in proximal corallites, longitudinal section. **6:** partial enlargement to show intercorallite wall structure in distal corallites, transverse section. Scale bar equals 2 mm, except Fig. 2-1 where scale bar represents 10 mm and Figs. 2-5, 6 where scale bar represents 0.4 mm.

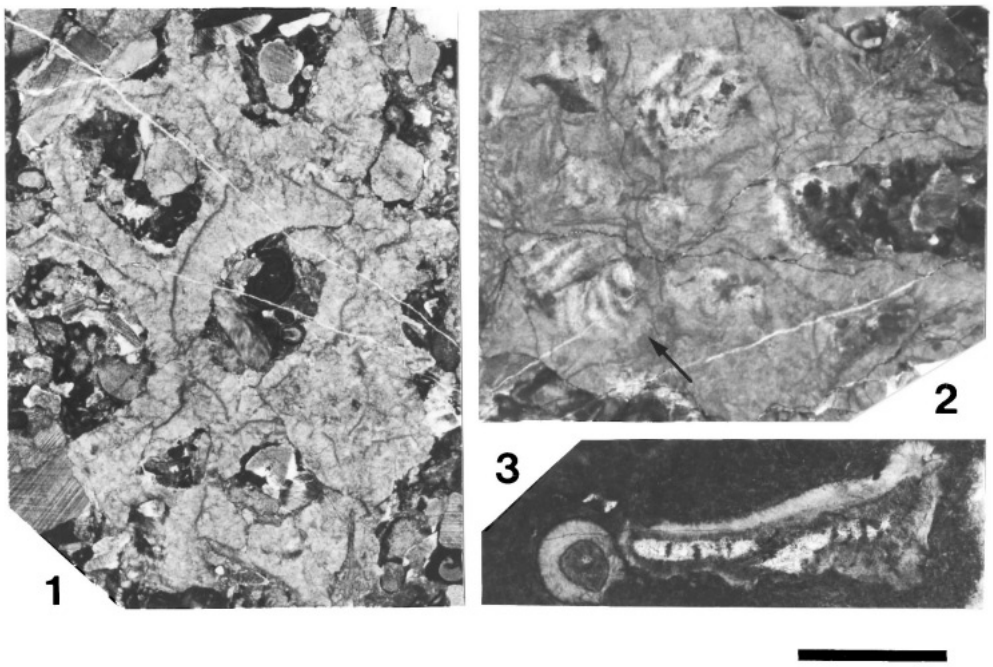

Fig. 3. 1, 2: *Michelinia japonica* Niko, 2002, FMM2001, transverse to oblique thin sections of corallites, arrow indicates incomplete tabulae. **3:** *Cladochonus ozawai* Niko and Haikawa, 2007, FMM2005, longitudinal and transverse thin sections of corallites. Scale bar equals 2 mm.

Zone, whose age is Serpukhovian to Bashkirian, Carboniferous.

Remarks.—There is no doubt that the new specimens from the Omi Limestone belong to *Michelinia japonica*, which has been recorded from the allochthonous reef complexes in southwest Japan, such as the upper Visean to Serpukhovian (or lower Bashkirian) sediments of the Hina Limestone (Niko, 2002), and the reef deposits correlatable with the *Millerella yowarensis* Zone (late Serpukhovian) of the Akiyoshi Limestone Group, Yamaguchi Prefecture (Niko and Haikawa, 2009). The specific description of *M. japonica* by Niko (2002) is adequate, thus it is not repeated here.

Family Cleistoporidae Easton, 1944

Genus *Donetzites* Dampel, 1940

Type species.—*Donetzites milleporoides* Dampel, 1940.

Donetzites sp. cf. *D. kibiensis* Niko, 1999

Figs. 4-1–3

Compare with:

Donetzites kibiensis Niko, 1999, p. 33, 35, figs. 3-1–3; 4-1, 2; Niko and Haikawa, 2010, p. 18, pl. 1, figs. 1-6.

Material, occurrence and age.—FMM2003, 2004. The specimens were collected from gray limestones (coral biolithite) at locality E1. Specific constituent of foraminifers in the limestones is quite identical and characterized by diverse fusulinaceans, including *Eostaffella ikensis*, *E. postmosquensis*, *E.* sp., *Mediocris breviscula*, *Millerella* sp., *Plectostaffella* (?) sp. and *Pseudoendothyra* sp. The present assemblage is assigned to the upper *Eostaffella-Millerella* Zone of the Serpukhovian to Bashkirian age.

Description.—Coralla encrusting, discoid to tabular, cerioid; holotheca absent. Corallites subcylindrical; each corallite consists of proximal prostrate and distal erect portions; calices shallow, nearly perpendicular to corallum surface; diameters of corallites are approximately 2 mm. Intercorallite walls cribriform, very thick, attaining approximately 0.9 mm, whose inner surface possesses septal spine- or ridge-like projections; mural pores represented by numerous and frequently anastomosed tunnels; tabulae complete, concave proximally, relatively close in spacing; there are 4-6 tabulae in 2.5 mm of corallite length.

Discussion.—The referred specimens bear closest resemblance to *Donetzites kibiensis*, though nevertheless clearly distinct in the nature of intercorallite walls and tabulae. The thin and non-perforate portions, that are partially recognized in the intercorallite walls of the types (holotype, NSM PA14516; paratype, NSM PA14519), are not developed in the present material. The spacing of the tabulae is closer than that of the types.

Occurrences of *Donetzites kibiensis* have been reported from the upper Visean to Serpukhovian (or lower Bashkirian) sediments of the Hina Limestone (Niko, 1999) and the *Millerella yowarensis* Zone of the Akiyoshi Limestone Group (Niko and Haikawa, 2010).

Order Auloporida Sokolov, 1947
Superfamily Auloporoidea Milne-Edwards and Haime, 1851
Family Pyrgiidae de Fromentel, 1861
Genus *Cladochonus* M'Coy, 1847

Type species.—*Cladochonus tenuicollis* M'Coy, 1847.

Cladochonus ozawai Niko and Haikawa, 2007
Fig. 3-3

Cladochonus ozawai Niko and Haikawa, 2007, p. 6, 7, pl. 2, figs. 1-8.

Material, occurrence and age.—Two specimens, FMM2005 from an identical block with

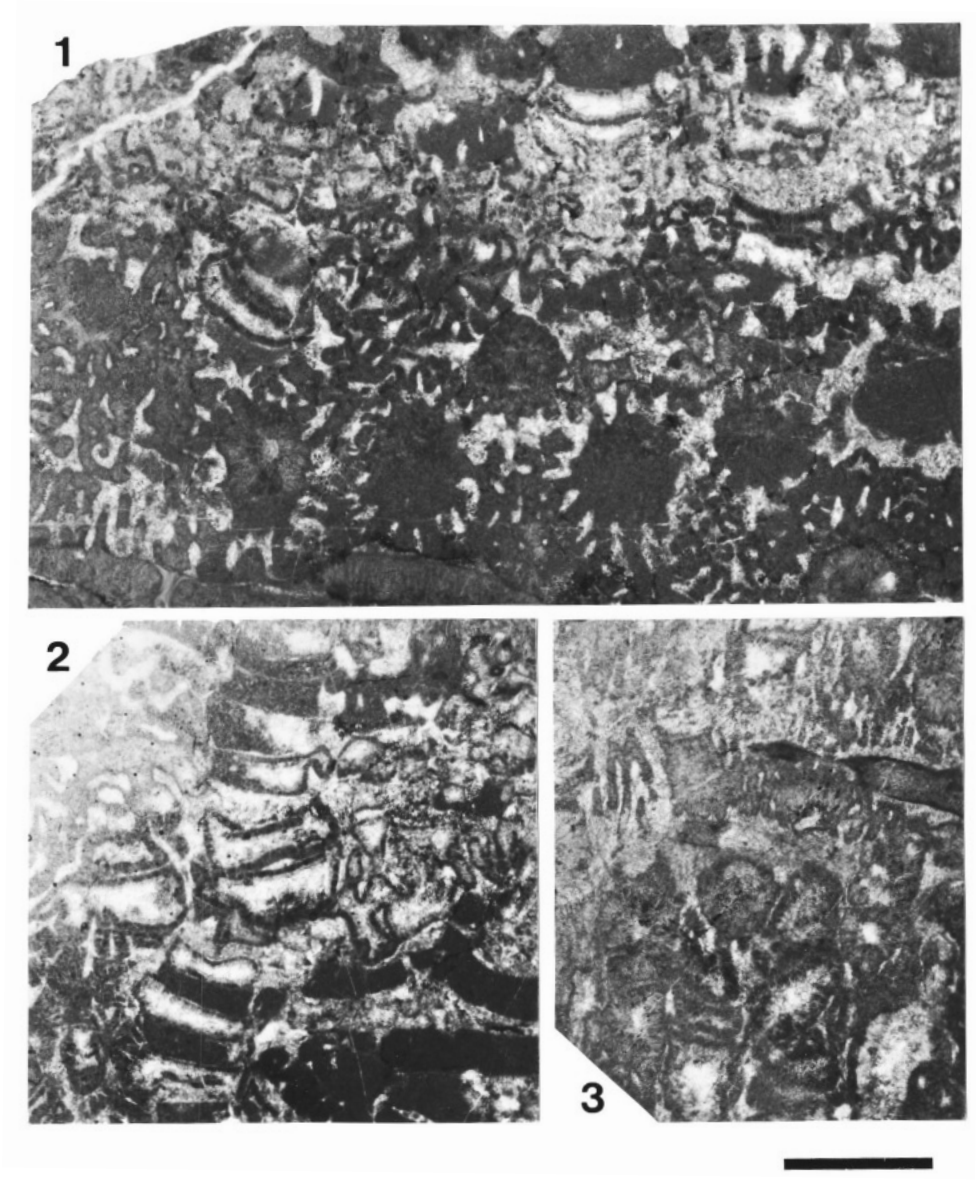

Fig. 4. *Donetzites* sp. cf. *D. kibiensis* Niko, 1999, thin sections. **1, 2:** FMM2004. **1,** transverse to slightly oblique sections of corallites, **2,** longitudinal sections of corallites. **3:** FMM2003, oblique to longitudinal sections of corallites. Scale bar equals 2 mm.

FMM2004 (*Donetzites* sp. cf. *D. kibiensis*; the upper *Eostaffella-Millerella* Zone; Serpukhovian to Bashkirian age) and FMM2006 from an identical block with FMM2001, 2002 (*Michelinia japonica*; the upper *Eostaffella-Millerella* Zone).

Remarks.—The new specimens from the Omi Limestone probably belong to *Cladochonus ozawai*, although they indicate slightly smaller corallites than those of the holotype described

from the *Millerella yowarensis* Zone of the Akiyoshi Limestone Group. The corallite diameter of the present material ranges from 0.7 to 1.5 mm, whereas the type specimens (holotype, specimen repository of Akiyoshi-dai Museum Natural History, Mine, ASM19020; paratypes, ASM19022, 19024, 19026) have approximately 1.6 mm in diameter. In other aspects, however, the Omi specimens are essentially identical with the types. The full description of this species is referable in Niko and Haikawa (2007).

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