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Report

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## Middle Permian (Wordian) foraminifers of the Furen Limestone, Oita Prefecture, Japan

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### Abstract

The Furen Limestone exposed in Yatsu-cho, Usuki City, Oita Prefecture is contained as an exotic block in the Jurassic siliciclastic rocks of the Okugawachi Formation in the Southern Chichibu Belt. In addition to the known Early Permian (Asselian) fusulines, Middle Permian (Wordian) foraminifers of eight species of fusulines and seven species of non-fusuline foraminifers were newly found from the limestone. Among them, *Neoschwagerina craticulifera*, *Verbeekina verbeeki*, *Chusenella* cf. *conicocylindrica*, and *Pseudodoliolina* sp. are systematically described.

**Key words:** Middle Permian foraminifers, Furen Limestone, Chichibu Belt

### Introduction

The Furen Limestone exposed at north of Tomari, Yatsu-cho, Usuki City, Oita Prefecture is famous of the germination of an imposing limestone cave locally called as “Furendo” or “Furendokutsu” (Figure 1). The limestone corresponds to the western extension of the Permian Tsukumi Limestone (Kambe and Teraoka, 1968) and is contained as an exotic limestone block in the Jurassic siliciclastic rocks of the Okugawachi Formation (Teraoka et al., 1992; Sakai et al., 1993) in the Southern Chichibu Belt in Kyushu.

Huzimoto (1937) described seven species of Early Permian fusulines from the Furen Limestone. The most important species among them is *Pseudoschwagerina orientale* described as a new species. It is probably referable to *Sphaeroschwagerina fusiformis* (Krotow, 1888), an index species of the lower Asselian (lowest part of the Permian) (Rauzer-Chernousova and Scherbovich, 1958). In addition to these seven species, many other fusulines ranging from Early to Middle Permian are listed in and around the Tsukumi Limestone

(Kambe and Teraoka, 1968). However, paleontologic description of Paleozoic foraminifers is very few in this area and almost confined to that of Huzimoto (1937).



Figure 1. Location of the Furen Limestone.

In the course of the fusuline biostratigraphic work in the Tsukumi Limestone, I visited the Furen Limestone to collect better samples than in the Tsukumi where most fusulines are deformed and not well preserved. Middle Permian fusulines obtained from the Furen Limestone are described and illustrated in the present report. All limestone thin sections of the Furen Limestone are stored in the Museum of Nature and Human Activities, Hyogo, Japan (Fumio Kobayashi Collection, MNHAM).

### Material, Fauna and Age

The Furen Limestone more than 100 m in thickness is distributed in the western part of the Tsukumi Limestone, a huge exotic block in the northern part of the Southern Chichibu Belt in Kyushu. It is massive, cut off by many faults of various scales, and contained in Jurassic argillaceous rocks of the Okugawachi Formation (Teraoka et al., 1992). Most limestones are gray, and partly recrystallized and dolomitized. Four samples were collected at different localities, although stratigraphic relationships among them are uncertain. Sample available for age determination is only one treated herein. It was collected from the gray limestone cropping out at about 250 m north of the entrance of Furendo. The limestone consists of grainstone containing various kinds of algae, foraminifers, crinoids, rugose corals, porifers, and gastropods.

Identified fusuline species are *Neoschwagerina craticulifera* (Schwager, 1883), *Verbeekina verbeeki* (Geinitz, 1876), *Pseudodoliolina* sp., *Chusenella* cf. *conicocylindrica* Chen, 1956, *Dunbarula simplex* (Lange, 1925), *Codonofusiella* sp., *Kahlerina* sp., and *Pseudoendothyra* sp. (Figure 2).

Among them, *Neoschwagerina craticulifera* is dominant, *Verbeekina verbeeki* is common, and other species are rare. Non-fusuline foraminifers are few in comparison with dominant fusulines. They consist of *Abadehella coniformis* Okimura and Ishii in Okimura et al., 1975, *Neoendothyra* sp., *Climacammina* sp., *Neodiscus* sp. A, *Neodiscus* sp. B, *Geinitzina* sp., and *Pachyphloia?* sp. These fusulines represented by *Neoschwagerina craticulifera* undoubtedly indicate the middle Guadalupian (Wordian) age of the limestone sample based on the well-established biostratigraphy and correlation of the Permian fusulines in the Tethyan regions by many workers as Sheng (1963) and Leven (1967).

### Systematic Paleontology

Superfamily Fusulinoidea von Möller, 1878

Family Schwagerinidae Dunbar and Henbest, 1930

Genus *Chusenella* Hsu, 1942

*Chusenella* cf. *conicocylindrica* Chen, 1956

Figures 2-7, 2-8

Cf. *Chusenella conicocylindrica* Chen, 1956, p. 43, 44

*Remarks.*—*Chusenella conicocylindrica* was proposed based on two specimens from the Chingsichung Limestone of Hunan and its close resemblance with *Chusenella deprati* (Ozawa, 1925) was indicated by Chen (1956). He suggested that this species might be diagnostic in having larger test with protruding poles, more whorls, and more strongly folded septa than *C. deprati*. In addition to these features, the Furen specimens are common to *C. conicocylindrica* in their well developed axial filling. On the other hand, septal folding is weaker in the median part of the test in the present ones than in the types of Hunan. Further comparison needs more specimens.

Family Verbeekinidae Staff and Wedekind, 1910

Subfamily Verbeekininae Staff and Wedekind, 1910

Genus *Verbeekina* (Geinitz, 1876)

*Verbeekina verbeeki* (Geinitz, 1876)

Figures 2-13, 2-17, 2-18

*Verbeekina verbeeki* Geinitz, 1876, p. 399, 400.

*Remarks.*—Parachomata in inner and outer whorls in the present specimens are fewer and lesser distinct than in numerous materials referable to *Verbeekina verbeeki* by many workers (e.g., Toriyama, 1958; Sheng, 1963). Other test characters are common between the present specimens and type and subsequent materials. Somewhat different appearance of parachomata in the former is thought to only represent the wide intraspecific variation of *V. verbeeki*.

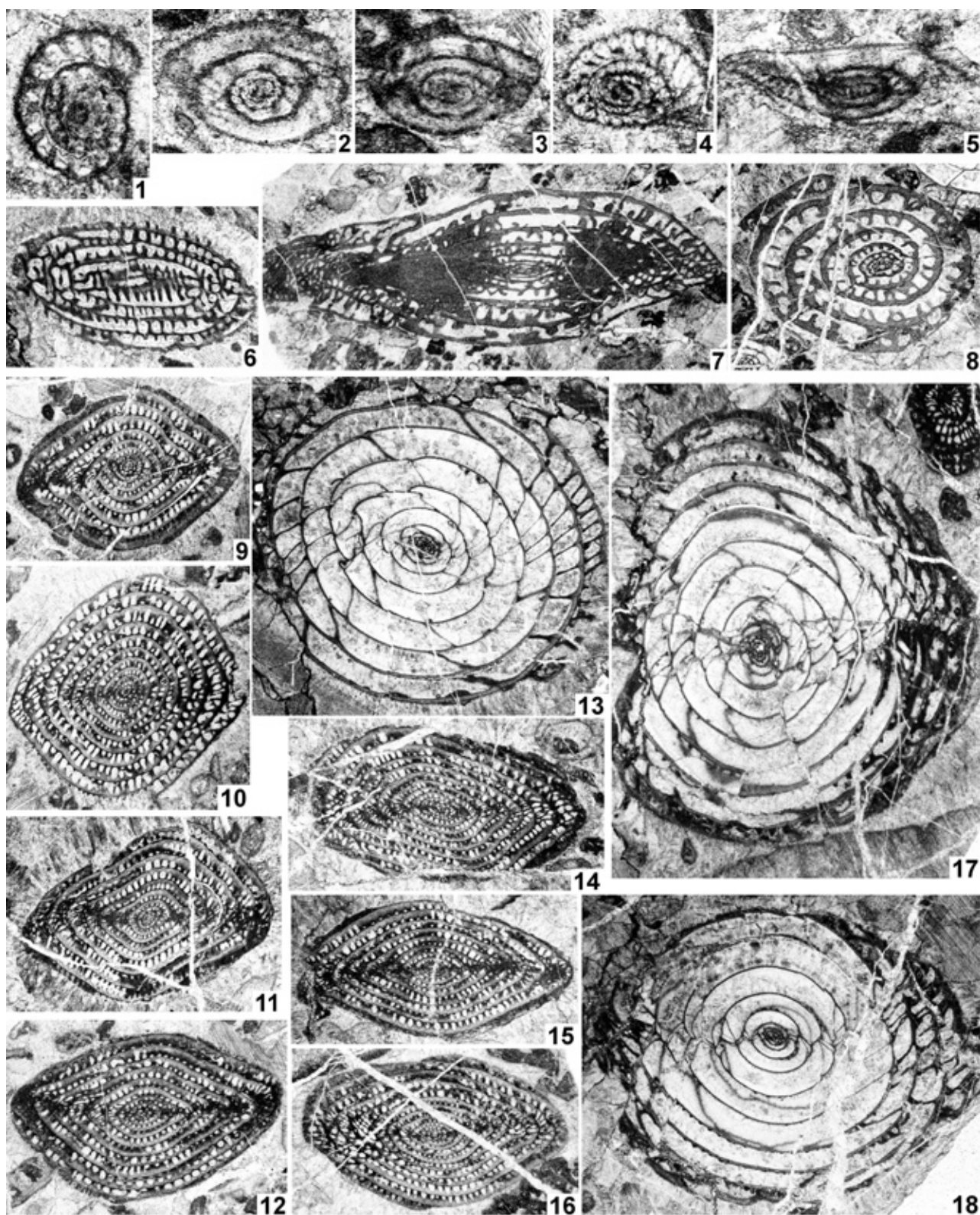
Subfamily Pseudodoliolinae Leven, 1963

Genus *Pseudodoliolina* Yabe and Hanzawa, 1932

*Pseudodoliolina* sp.

Figure 2-6

*Remarks.*—In spite of no axial sections, the present material might be identified with either *Pseudodoliolina ozawai* Yabe and Hanzawa, 1932 or *Pseudodoliolina pseudoleida* (Deprat, 1912). Its



**Figure 2.** 1—3: *Dunbarula simplex* (Lange), 1: D2-051040; ×50, 2: D2-051050; ×40; 3: D2-013434, ×50. 4, 5: *Codonofusiella* sp., 4: D2-013425; 5: D2-051037, both ×40. 6: *Pseudodoliolina* sp., D2-051035, ×15. 7, 8: *Chusenella* cf. *conicocylindrica*, 7: D2-051040; 8: D2-051047, both ×10. 9—12, 14—16: *Neoschwagerina craticulifera*, 9: D2-051046; 10: D2-013432; 11: D2-051038; 12: D2-013427; 14: D2-013433; 15: D2-013434; 16: D2-013431, all ×10. 13, 17, 18: *Verbeekina verbeeki*, 13: D2-013428; 17: D2-013423; 18: D2-013435, all ×10.

assignment to the former species is more probable by its smaller test, more tightly coiled inner whorls, and smaller proloculus.

Family Neoschwagerinidae Dunbar and Condra, 1927  
Subfamily Neoschwagerininae Dunbar and Condra, 1927

Genus *Neoschwagerina* Yabe, 1903

*Neoschwagerina craticulifera* (Schwager, 1883)

Figures 2-9—2-12, 2-14—2-16

*Schwagerina craticulifera* Schwager, 1883, p. 140, pl. 18, figs. 15—25.

*Remarks.*—Various appearance of test morphologies such as form ratio of the test, length and width of the corresponding whorls in the Furen material is apparently due to differences of degree and mode of the test deformation by specimens. All the specimens examined are identified with *Neoschwagerina craticulifera* based on the size and shape of each whorl and outer test, and development of septula.

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## 大分県風連石灰岩産ペルム紀中期有孔虫化石

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兵庫県立人と自然の博物館 自然・環境評価研究部／兵庫県立大学 自然・環境科学研究所 〒669-1546 兵庫県三田市弥生が丘6丁目

大分県臼杵市野津町の風連石灰岩は秩父南帯奥河内層のジュラ紀珪質碎屑岩類に異地性ブロック岩体として含まれている。これまでに知られていたペルム紀前期（アッセリアン）のフズリナ類のほかに、風連石灰岩からペルム紀中期（ワーディアン）の有孔虫類、フズリナ類8種とフズリナ以外の有孔虫類7種が新たに見出された。これらのうち、*Neoschwagerina craticulifera*, *Verbeekina verbeeki*, *Chusenella* cf. *conicocylindrica*, *Pseudodoliolina* sp. のフズリナ類4種を記載した。

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