Monodiexodina from the Permian Oguradani Formation, Hida Gaien Belt, central Japan

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Abstract

A well-known antitropical fusulinoidean genus *Monodiexodina* is reported with illustration of specimen for the first time from calcareous sandstone of the Oguradani Formation in the Ise area, Hida Gaien Belt, central Japan. The present Oguradani specimens are referable to *Monodiexodina* sp., and indicate a middle Middle Permian (Murgabian/Wordian) age. The occurrence of *Monodiexodina* from the Permian Oguradani Formation, together with the overall similarity of Paleozoic stratigrapghy in the two belts, further reinforces the current opinion on the original geologic connection of the Hida Gaien Belt with the South Kitakami Belt of Northeat Japan.

Key words: central Japan, Fusulinoidea, Hida Gaien Belt, Middle Permian, *Monodiexodina*, Oguradani Formation.

Introduction

The Hida Gaien Belt in central Japan is a unique geotectonic domain composed mainly of Ordovician mafic- and ultramafic rocks, about 300-400Ma high-P/T metamorphic rocks, and Paleozoic and Mesozoic non-metamorphosed rocks including Permo-Carboniferous shallow-marine strata, and is narrowly distributed along the margin of the Hida Belt (Tazawa, 1989). The Permian in the Hida Gaien Belt is distributed, from east to west, in the Fukuji, Moribu, and Ise areas (Fujimoto et al., 1962; Igo, 1990). Among them, the Mizuyagadani Formation in the Fukuji area and the Moribu Formation in the Moribu area have been studied stratigraphically and paleontologically in detail, and correlated to the Early Permian (Igo, 1957; Niikawa, 1980; Niko et al., 1987) and the late Early to Middle (and partly Late?) Permian

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(Yamada and Yamano, 1980; Horikoshi et al., 1987; Tazawa et al., 1993; Tazawa, 1996a, 2001), respectively. In contrast with these formations, the Permian of the Ise area in the western part of the Hida Gaien Belt still remains being poor in information on its stratigraphy and fossil contents.

In the Ise area, several stratigraphic units such as the Oguradani, Konogidani, Magatoji, Oboradani, and Otani formations have been proposed for the non-metamorphosed Permian (Ozaki et al., 1954; Yamada et al., 1958; Yamada, 1967). Yamada (1967) once mentioned the occurrence of *Monodiexodina* sp. from calcareous shale of the Oguradani Formation but without illustration of specimen. With respect to this Oguradani *Monodiexodina*, Tazawa et al. (1993) noted, based on personal communication with K. Yamada, that the fusulinoidean specimens of Yamada (1967) have been lost already and, moreover, additional collection of specimens from the same locality would be very difficult due to submergence by the subsequent construction of the Kuzuryu Dam (Kuzuryu Lake). *Monodiexodina* is an important fusulinoidean genus for the discussion on the origin and paleobiogeographic affinity of the Hida Gaien Belt, and thus additional specimens from the Oguradani Formation is eager to be reported and illustrated.

In this paper, we report the mode of occurrence of *Monodiexodina* from the Oguradani Formation and illustrate the specimen, although they are by no means well preserved. We further refer to some geologic implications of the occurrence of *Monodiexodina* from the formation. In the Hida Gaien Belt, this genus has only hitherto been reported by Tazawa et al. (1993) with illustration of specimen from sandstone of the middle part of the Moribu Formation. Therefore, this is the second report of occurrence of *Monodiexodina* with illustration of specimen from the Hida Gaien Belt. Specimens examined in this study are all registered and housed in the paleontological collections of the Department of Geology, Faculty of Science, Niigata University, Niigata, Japan, with prefix NU-F.

Stratigraphy

The Oguradani Formation is mainly distributed as an E-W trending narrow belt from Kuzuryu Lake to Motodo through Shiroki-yama, and is fine clastic-dominated strata with minor intercalations of limestone. It was first introduced by Ozaki et al. (1954) as one of Permian stratigraphic units in the Ise area. Later, Kawai et al. (1957), in the explanatory text of 1:50,000 geologic map "Arashimadake" sheet, regarded it as a member in the Nojiri Formation.

Yamada (1967) summarized the Permian of the Ise area, and recognized two formations in the Nojiri Group, the Oguradani Formation in apparently lower stratigraphic position and the Konogidani Formation in upper stratigraphic position. He noted that the Oguradani Formation in the type section at Oguradani is of sandstone-dominated in the lower one third and of shale-dominated in the upper two-thirds. Recently, Tazawa and Matsumoto (1998) redefined the Oguradani Formation as being composed of the Oguradani and Ashidani formations of Yamada (1967), the latter of which had been treated in Yamada (1967) as a formation of

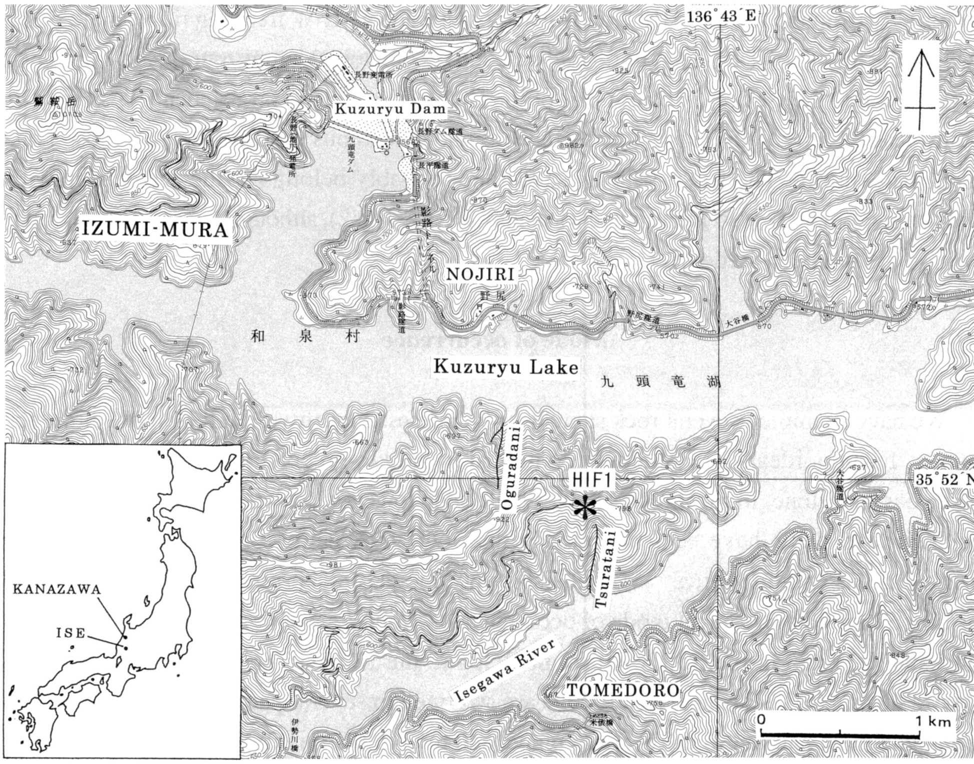

Fig. 1. Map showing fossil locality, HIF1 (asterisk), using topographic map of "Echizen-asahi" scale 1:25,000 published by Geographical Survey Institute of Japan.

unknown age. They noted that the formation, attaining over 750 m in total thickness, is divided lithologically into three members: the lower shale-limestone member of 470 m thick, the middle sandstone member of 110 m thick, and the upper shale member of more than 170 m thick.

Fossils occur rather scarcely in the Oguradani Formation, but such brachiopods and cephalopods as *Lyttonia* (=*Leptodus*), *Camarophoria*, *Productus*, *Paraceltites*, and *Foordiceras* have been reported by Hayasaka and Matsuo (1951) and Hayasaka and Ozaki (1955) from the formation. Recently, Tazawa and Matsumoto (1998) described a Middle Permian brachiopod fauna composed of *Derbyia* cf. *buchi* (d'Orbigny), *Meekella* sp., *Transennatia gratiosa* (Waagen), *Leptodus nobilis* (Waagen), *Stenoscisma margaritovi* (Tschernyschew), and *Hustedia* cf. *grandicosta* (Davidson) from argillaceous impure limestone in the lower part of the Oguradani Formation. They concluded that the Oguradani brachiopod fauna consists of mixed Boreal-, Tethyan-, and bipolar-type genera, and can be correlated with those from the Southern Subzone of the Inner Mongolian-Japanese Transition Zone of Tazawa (1991) in Middle Permian paleobiogeography.

The present fusulinoidea-bearing samples studied herein were collected by the junior author (JT) from the locality HIF1, an isolated outcrop on an E-W trending ridge about 500 m north of the mouth of Tsuratani, north of Tomedoro (Tometoro), Izumi-mura, Ono-gun, Fukui Prefecture, i.e., the Ise area, western part of the Hida Gaien Belt, central Japan (Fig. 1). At the fossil locality, gray to greenish gray tuffaceous and calcareous sandstones are exposed on a small road cutting. The fossil-bearing sandstone probably belongs to the lower part of the Oguradani Formation (see Tazawa and Matsumoto, 1998, fig. 2), although the exact stratigraphic position has not been settled yet.

Mode of occurrence

We have examined several rock samples from the fossil locality described in the precedent chapter. Fusulinoideans are generally contained in gray to greenish gray, medium-grained, calcareous sandstone. In most rock samples collected, however, calcareous materials including fusulinoidean shells have been completely dissolved by weathering. Consequently, these fusulinoideans exhibit typical "Matsubaishi-type" mode of occurrence (Figs. 2A-D), which has been reported as a typical mode of occurrence of *Monodiexodina matsubaishi* (Fujimoto) and its allied form in the South Kitakami Belt and the Hida Gaien Belt (Fujimoto, 1956; Tazawa et al., 1993). Fusulinoidean shells are swarmed in several particular layers (Fig. 2A), arranged almost parallel to the bedding plane, and tend to be roughly oriented (Figs. 2A, 2B, 2D). Their original external shell morphology including shell length and shell width seems to be relatively well preserved as external molds in most specimens on the surfaces almost parallel to the bedding plane even though they may have slight deformation. In contrast, fusulinoidean shells are very much squashed by compaction in sections vertical to the bedding plane (Fig. 2C).

We also collected some rock samples in which calcareous materials including fusulinoidean shell are still preserved, and processed them for thin sections (Figs. 3A-H). In this type of samples, however, fusulinoidean shells are more poorly preserved than those found in the rock samples showing the "Matsubaishi-type" mode of occurrence due to strong abrasion and subsequent diagenetic dissolution of the outer part of shells. Many fusulinoidean shells in this type of samples have irregular shell outlines surrounded by thin, dark residual materials (e.g., Fig. 3H). They always have stylolitic contact with the surrounding sediments, which consist of medium-grained calcareous sandstone (e.g., Fig. 3G). Under the microscope, a large number of angular to sub-angular detrital quartz grains cemented by calcareous matrix are observed among fusulinoidean shells. Besides fusulinoideans, other calcareous particles such as crinoid stems and fragments of bryozoans are found in thin sections. Similarly to the first type of samples, fusulinoidean shells are also very much squashed by compaction in sections perpendicular to the bedding plane.

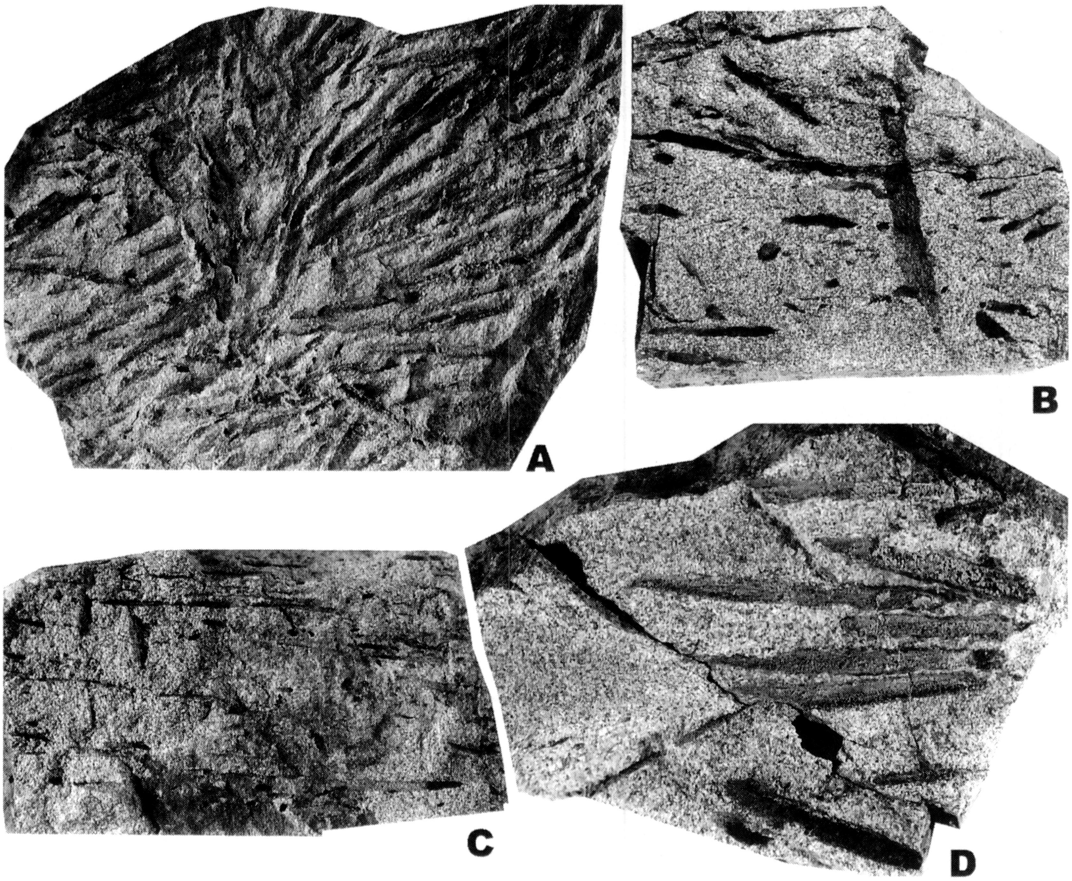

Fig. 2. Photographs of *Monodiexodina*-bearing sandstone. A: *Monodiexodina*-swarmed surface almost parallel to bedding plane. Fusulinoideans (*Monodiexodina* sp.) are completely dissolved and exhibit typical "Matsubaishi-type" mode of occurrence. NU-F41, × 1. B: Surface almost parallel to bedding plane. Molds of shells of *Monodiexodina* sp. are generally preserved in medium-grained sandstone and sometimes filled partly with brown-colored residure. NU-F42, × 1. C: Surface almost perpendicular to bedding plane, showing linear arrangement of highly squashed individuals of *Monodiexodina* sp. Almost vertical to surface of B, × 1. D: Several complete external molds of shells of *Monodiexodina* sp. on surface almost parallel to bedding plane. They have very elongated subcylindrical shells. NU-F43, × 2.

Shell morphology

In this study, we unfortunately could not get any completely oriented (axial and/or sagittal) section, which is generally indispensable for the taxonomic study of fusulinoidean foraminifers. Specimens available for this study are external molds of whole fusulinoidean shells preserved in weathered sandstone (Figs. 2A-H) and a number of randomly oriented fragments in thin

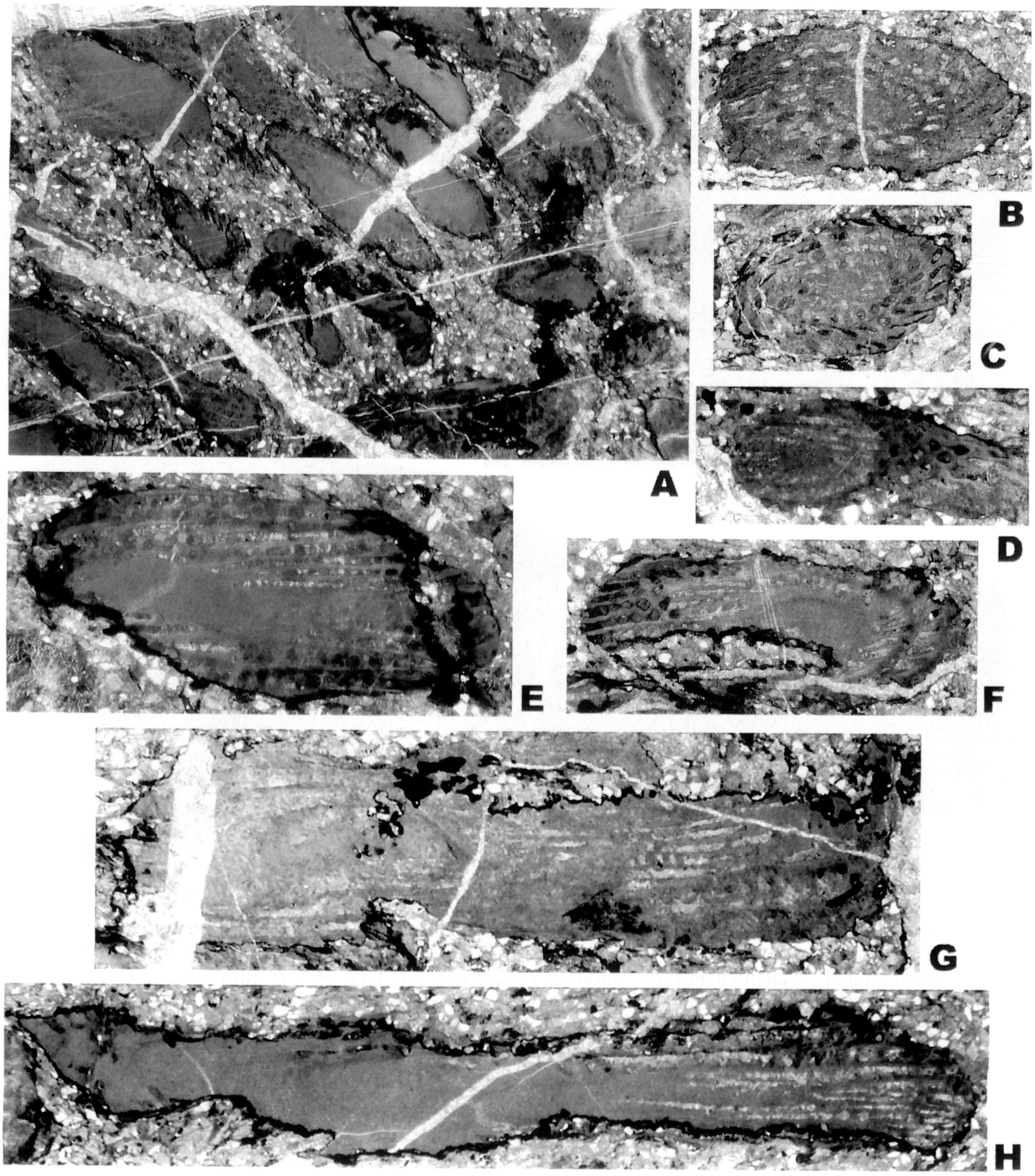

Fig. 3. Photomicrographs of *Monodiexodina*-bearing calcareous sandstone. A: Microfacies of calcareous sandstone (partly sandy limestone) with many, poorly preserved fusulinoidean (*Monodiexodina* sp.) shells. NU-F71, ×5. B-H, Variously fragmented and oriented specimens of *Monodiexodina* sp. B,C: Parallel sections with several volutions, in which a number of septa can be seen in one volution. NU-F60 and NU-F65, both ×10. D-G: Various fragments of tangential and nearly tangential sections, showing an elongated subcylindrical shell, regularly fluted septa, and well-developed axial fillings. NU-F68a, NU-F68b, NU-F51a and NU-F52, all × 10. H: Fragment of tangential section corresponding almost to a half of whole shell. Almost plane septa in central part of shell (right-hand side), regularly arranged septal loops, and heavy axial fillings in axial part are observed. This specimen should have a very elongated subcylindrical shell, attaining more than 25 mm in total shell length. NU-F51b, × 10.

sections of calcareous sandstone (Figs. 3A-H). By joining together the lines of fragmentary information from them, however, we could reconstruct basic morphology of the Oguradani specimens, which enabled us some taxonomic discussion.

The present Oguradani fusulinoideans are about 16 to 21 mm in length and about 2 mm in width in large, molded specimens. Although it is difficult in most cases to measure the exact length and width of shells, their form ratios would attain to around 8.0 to 10.0. They have very elongated subcylindrical shells (Figs. 2D, 3H) with probably 5 to 6 volutions (Figs. 3B, 3C, 3E). Septa are almost plane in the central part of shell but tend to be fluted regularly towards polar regions, forming semicircular septal loops (Figs. 3D-H). Spirotheca is completely altered by diagenesis and looks structureless in most specimens, but obscure vestige of keriothecal structure is partly discernible. Axial fillings are well developed in axial and polar regions as secondary deposits (Figs. 3E, 3H).

All these morphological features observed in the Oguradani specimens, especially the highly elongated shells, together with their typical "Matsubaishi-type" mode of occurrence, strongly suggest that they can be subsumed in the genus *Monodiexodina*. As we have got no well-oriented section available in this study, however, the Oguradani fusulinoideans should be best assigned to *Monodiexodina* sp. in the existing state of affairs. Poor preservation of our materials notwithstanding, their "Matsubaishi-type" mode of occurrence somewhat reminds us of possibility that the present specimens may be referable to *Monodiexodina matsubaishi* (Fujimoto).

Geologic implications

Monodiexodina is well-known as an antitropical fusulinoidean genus, which is mainly distributed in the northern and southern transitional zones in the context of Permian paleobiogeography (e.g., Shi et al., 1995; Ueno, 2003). Recently, Ueno and Tazawa (2003) summarized the geographic and stratigraphic distributions of *Monodiexodina*, and concluded that the genus has a range from the Kubergandian to Midian (namely the entire Middle Permian) in the northern transitional zone, i.e., the Inner Mongolian-Japanese Transition Zone of Tazawa (1991) which corresponds to present-day Northeast China, South Primorye, and several pre-Jurassic terranes in Japan including the Hida Gaien Belt. Furthermore, they noted that it is especially dominated in the Murgabian (middle Middle Permian) in this paleobiogeographic zone.

In Japan, the genus *Monodiexodina* has been reported with illustration of specimen from the lower part of the Kanokura Formation in the South Kitakami Belt (Fujimoto, 1956; Choi, 1973; Tazawa, 1976), the Kozaki Formation in the Kurosegawa Belt (Kanmera, 1963), the Moribu Formation of the Hida Gaien Belt (Tazawa et al., 1993), and the Takagami Conglomerate of the Choshi Peninsula, central Japan (Maeda and Mitsuoka, 1961). Among the *Monodiexodina*-bearing strata in Japan, the Moribu Formation and the Kanokura Formation bear similar brachiopod faunas composed of mixed Boreal-, Tethyan-, and bipolar-type genera to that from the Oguradani Formation (Tazawa and Matsumoto, 1998). It is noteworthy that the Hida Gaien Belt and the South Kitakami Belt also show close similarity in basic stratigraphy and faunal and floral successions throughout the Paleozoic (Tazawa, 2000).

Judging from the facts that the *Monodiexodina* from the Moribu Formation of the Hida Gaien Belt and the Kanokura Formation of the South Kitakami Belt can be considered as the Murgabian in age (Ueno and Tazawa, 2003) along with that the Oguradani species is somewhat similar to *M. matsubaishi* (Fujimoto), the present Oguradani *Monodiexodina* would also be referable to the Murgabian (=Wordian, middle Middle Permian). Available brachiopod dating of the Oguradani Formation (Tazawa and Matsumoto, 1998) is also consistent with this age assignment. Moreover, the present report of *Monodiexodina* from the Oguradani Formation results in further reinforcing the original geologic (both geotectonic and paleobiogeographic) connection of the Hida Gaien Belt with the South Kitakami Belt, which has been insisted by Tazawa (1989, 1996a, 1996b, 2000).

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