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## Original article

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# Middle Permian foraminifers of Kametsubo, Fukusaki, Hyogo —Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan, Part 1—

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### Abstract

Late Paleozoic and Early Mesozoic foraminifers have been reported from more than 50 localities in Hyogo. For the purpose of the examination of the original data by many workers and further advance of data bank project in the Museum of Nature and Human Activities, Hyogo, the Late Paleozoic and Early Mesozoic foraminifers of Hyogo are considered on the basis of the serial descriptive works. This paper deals with Middle Permian foraminifers of Kametsubo, Fukusaki, north of Himeji, for the first of this serial works. *Colania douvillei* (Ozawa) and *Gifuella* sp. are described and discussed in comparison with other materials of Japan and former works performed at Kametsubo.

**Key words:** Foraminifers, Middle Permian, Kametsubo, Hyogo, Serial descriptive works.

### Introduction

Pre-Cretaceous basement rocks of Hyogo, Southwest Japan are tectonically divided into seven terranes (belts) from north to south, Akiyoshi (Permian accretionary complexes); Sangun (high P/T metamorphic complexes); Maizuru (Permian and Triassic formations and the Yakuno ophiolitic complexes); Ultra-Tamba (Permian accretionary complexes); Tamba (Jurassic accretionary complexes); Ryoke (low P/T metamorphic complexes); and Sambagawa (high P/T metamorphic complexes) (Figures 1, 2). The occurrence of limestone is restricted in the complexes and formations of the Maizuru, Ultra-Tamba, and Tamba terranes. Limestones are all exotic in origin, and occur as blocks and breccias within argillaceous and tuffaceous matrix, or as lithic clasts within conglomerate. Those contained in accretionary complexes were derived from the Panthalassan seamount, and those in the Maizuru Terrane were originated from both the Akiyoshi seamount and the

eastern continental margin of South China (Kobayashi, 2003). These limestones yield Late Paleozoic to Early Mesozoic foraminifers, along with various kinds of other fossils.

Our museum has collected and examined many sorts of data on the natural history and environmental sciences of Hyogo. As a part of this data bank project in our museum, geologic data of Hyogo were compiled systematically on the basis of original data by many workers until the beginning of the 1990's (Kobayashi, 1995). Among them, the fossil locality of Late Paleozoic and Early Mesozoic foraminifers amounts to 53 (Kobayashi et al., 1995). Close examination of fossil identification in each of the original data, however, is nearly difficult, because most fossils were neither described nor illustrated, and are unknown in their repositories.

For the purpose of the test of these original data and further advance of data bank project in the Division of Earth Sciences, the Late Paleozoic and Early Mesozoic foraminifers of Hyogo are examined on the basis of the original samples collected by

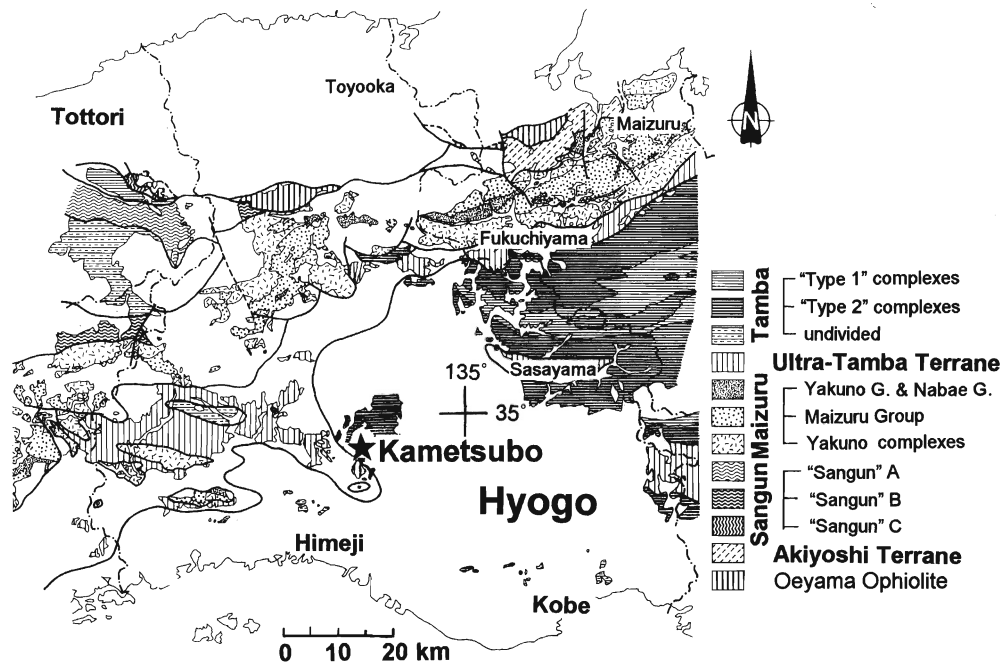


Figure 1. Pre-Cretaceous basement rocks and their tectonic division in Hyogo (After Kobayashi, 1997)

ourselves, hoping to provide available basic data for systematics, paleobiogeography, tectonics, and their related sciences. Their results will be published through the serial descriptive works under the

common title of "Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan". As the first of the serial work, this paper describes and discusses Middle Permian foraminifers from

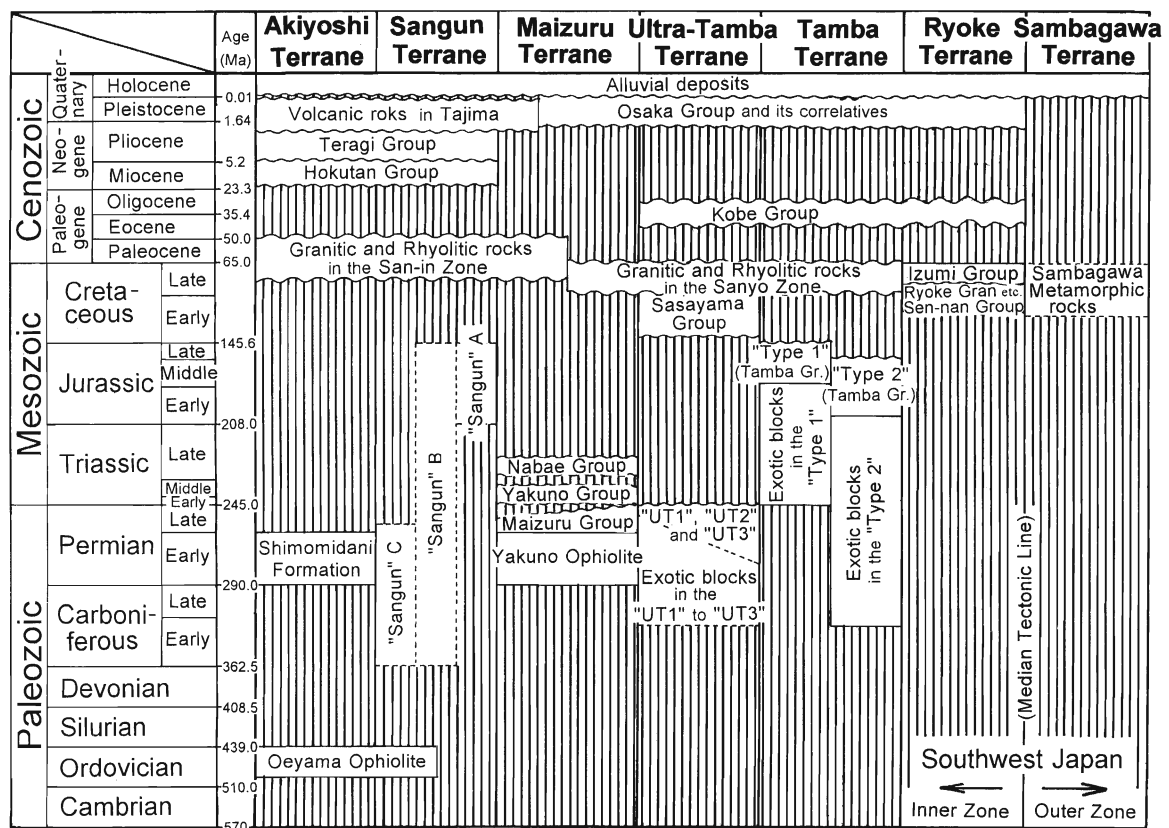


Figure 2. Chronologic distribution of rocks and formations in seven terranes of Hyogo (After Kobayashi, 1995).

Limestones are included in the Maizuru and Yakuno groups of the Maizuru Terrane, and in the Ultra-Tamba and Tamba Terrane as exotic blocks.

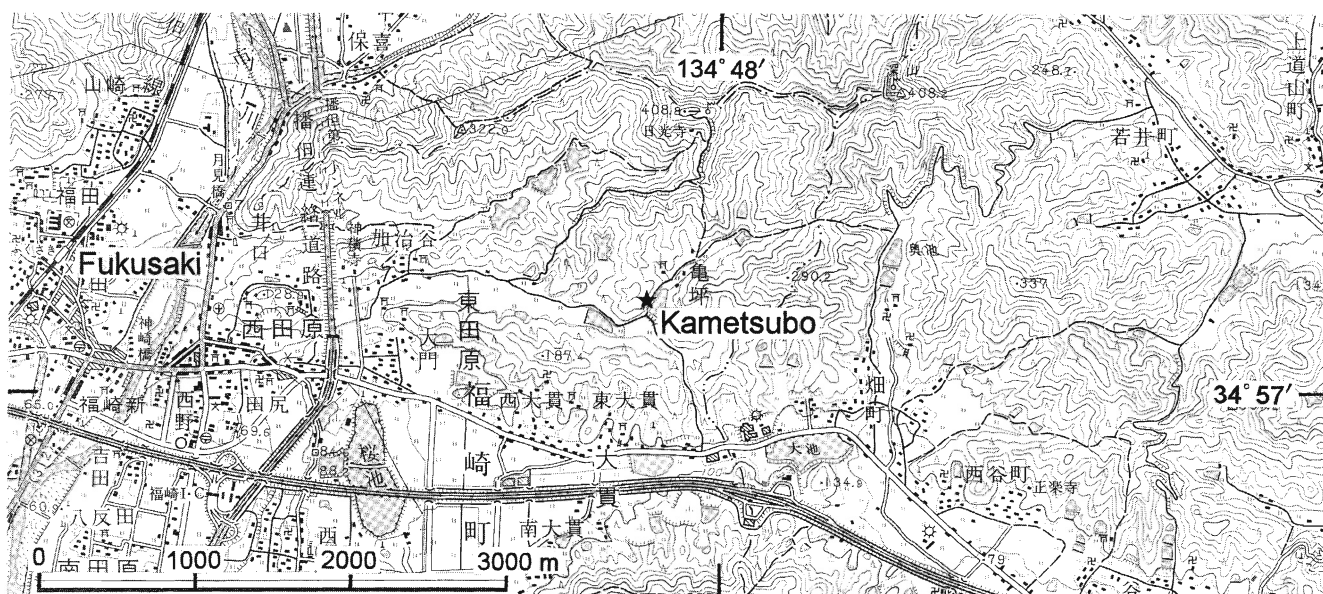


Figure 3. Fossil locality of Kametsubo. Topographic map is from 1 : 50,000 map "Hojo" of Geographical Survey Institute of Japan.

Kametsubo, Fukusaki, comparing with other materials of Japan and previous works reported from Kametsubo.

All the specimens used in this paper are stored in the collection of the Division of Earth Sciences, Museum of Nature and Human Activities, Hyogo (Fumio Kobayashi Collection), with prefix D2.

### Material studied and note on foraminiferal fossils

Small limestone blocks are scattered near Kametsubo, Fukusaki-cho, Kanzaki-gun, 18 km NNE of Himeji (Figures 1, 3). They are contained in the Wakai Complexes of the Tamba-Mino Terrane (Ozaki et al., 1995). Some of limestone near Kametsubo, including the fossiliferous one treated herein, had been completely mined for a production of slaked lime possibly by the 1960's, as well as many of others in Hyogo. Therefore, clenched fist-size limestone is only scattered at an abandoned small quarry.

Huzimoto (1938) reported Permian foraminifers, *Endothyra* sp., *Staffella*? sp., *Schwagerina* (*Pseudofusulina*) sp., *Verbeekina* cf. *verbeeki*, *Neoschwagerina craticulifera* var. *tenuis*, *Yabeina* cf. *globosa* from one of these localities in Kametsubo, though its exact locality was not shown. This brief report is the first note on the occurrence of Paleozoic foraminifers in Hyogo. Subsequently, Shimizu (1961) listed *Yabeina globosa*, *Y. packardii*

*shimensis*, *Neoschwagerina craticulifera*, *N.* cf. *margaritae*, *N.* sp., *Verbeekina* cf. *verbeeki*, and *Schwagerina* sp.

Two limestones, Sample A and B, collected at the abandoned quarry at the southwest end of Kametsubo (Figure 3), consist of fossiliferous packstone/wackestone. They include foraminifers, green algae, cyanobacteria, crinoids, brachiopods (?), and many bioclasts of unknown affinities. Fusulinaceans are mostly fragmental and abraded in their outer test, and partly coated by the film of cyanobacteria. Eighteen species assignable to 16 genera are distinguished in these two samples (Table 1).

*Gifuella* sp. and *Colania douvillei* are most dominant in them. *Gifuella*, proposed by Honjo (1959) from the Akasaka Limestone, was regarded to be synonymous with *Neoschwagerina* (Morikawa and Suzuki, 1961; Win, 1999) or *Colania* (T. Ozawa, 1970a, 1970b; Kobayashi, 1986). However, it is thought to be taxonomically independent by its diagnostic test morphologies, as discussed below. The stratigraphic occurrence of *Gifuella* is restricted to the upper part of the *Neoschwagerina craticulifera* Zone to the basal part of the *Yabeina globosa* Zone in the Akasaka Limestone (Honjo, 1959; Ozawa and Nishiwaki, 1992; Win, 1999), and is characteristic in the Jurassic terranes of Japan. *Colania douvillei* in the Sample B is abundant in the Permian Akiyoshi Terrane, and the index species of

the named zone in the Akiyoshi Limestone (Toriyama, 1958; Ozawa and Kobayashi, 1990). It is also reported from the southern Kanto Mountains (Huzimoto, 1936) and northern Kitakami Mountains (Choi, 1972).

The limestone samples A and B are correlated to the *Neoschwagerina margaritae* Zone of the Jurassic terranes of Japan and *Colania douvillei* Zone of the Permian ones, respectively, and both samples are late Wordian (late Murgabian) in age. Because, neither *Yabeina globosa*, index species of the Capitanian (Midian), nor *Neoschwagerina craticulifera*, diagnostic in the middle Wordian, are associated with them. An occurrence of *Kahlerina* sp. A, *K.* sp. B, and *Dagmarita* sp. in the Sample A is concordant with this age assignment.

Other limestone at the abandoned quarry of Kametsubo also contains fusulinaceans assignable to Neoschwagerinidae and Schwagerinidae. Their generic and specific identification is impossible due to insufficient state of preservation. *Yabeina globosa*, reported by Huzimoto (1938) and Shimizu (1961) are not found from any limestone examined. Further discussion and comparison of fusulinaceans listed by Huzimoto (1938) and Shimizu (1961) are postponed until their original materials are reexamined.

Systematic paleontology

- Order Foraminiferida Eichwald, 1830
- Suborder Fusulinina Wedekind, 1937
- Superfamily Fusulinacea von Möller, 1879
- Family Neoschwagerinidae Dunbar and Condra, 1927
- Subfamily Lepidolininae A. D. Miklukho-Maklay, 1958
- Genus *Colania* Lee, 1934
- Colania douvillei* (Ozawa, 1922)
- Plate 2, Figures 1a, 1b

*Neoschwagerina douvillei* Ozawa, 1922, p. 368-372, not illustrated.

*Material studied.*—Illustrated oblique, and other tangential, parallel and oblique sections.

*Discussion.*—Some neoschwagerinids from South East Asia, which had been named “*Neoschwagerina globosa*” by Douvillé (1906) and Deprat (1912), are quite different from the original material of “*Neoschwagerina globosa*” by Yabe (1906) and its junior synonymous “*Neoschwagerina (Yabeina) inouyei*” by Deprat (1914) in many important test characters. Y. Ozawa (1922) proposed “*Neoschwagerina douvillei*” for “*Neoschwagerina globosa*” from South East Asia to clearly distinguish them from the Japanese ones. Y. Ozawa (1925) showed the occurrence of “*Neoschwagerina douvillei*” from the Permian Akiyoshi Terrane. Specific diagnosis and taxonomic position of this species were made clear by T. Ozawa (1970a, 1970b).

The present materials are not well preserved, and well-oriented axial sections are not obtained. However, they are marked by relatively large test about 4.5 mm in width, large proloculus of 0.25 to 0.30 mm in diameter, thin wall, slender primary transverse septula and parachomata, less well-developed secondary transverse septula. From these characters, they are probably identical with *Colania douvillei*. Compared with the typical forms of this species from the Permian terrane of Japan (e.g., Toriyama, 1958; Kobayashi, 1988), South China (Sheng, 1963), and Thailand (T. Ozawa, 1970b), the present specimens have smaller proloculus, thinner wall, and slenderer transverse septula.

*Occurrence.*—Common in the Sample B collected at an abandoned quarry, southwest end of Kametsubo.

- Genus *Gifuella* Honjo, 1959
- Gifuella* sp.

Table 1. Middle Permian foraminifers discriminated at Kametsubo.

	Sample A	Sample B
<i>Tolypammina</i> sp.	X	
<i>Glomospira</i> sp. A	X	X
<i>Glomospira</i> sp. B	X	
<i>Tuberitina</i> sp.	X	
<i>Lunucammina?</i> sp.		X
<i>Pachyphloia?</i> sp.	X	
<i>Palaeotextularia?</i> sp.	X	
<i>Globivalvulina</i> sp.	X	X
<i>Dagmarita</i> sp.	X	
<i>Postendothyra?</i> sp.	X	X
<i>Dunbarula?</i> sp.	X	
<i>Chusenella</i> sp.	X	
<i>Neoschwagerina</i> sp.		X
<i>Gifuella</i> sp.	X	
<i>Colania douvillei</i> (Ozawa)		X
<i>Kahlerina</i> sp. A	X	X
<i>Kahlerina</i> sp. B	X	
<i>Agathammina?</i> sp.		X



## Plate 1, Figures 1–15

*Material studied.*—Six axial, three sagittal, two transverse, two parallel, and two oblique sections, all illustrated.

*Description.*—Test inflated fusiform, with rounded poles and straight axis of coiling. Mature specimens attain more than 15 whorls, more than 6 mm in length and more than 4 mm in median width. Form ratio about 1.5 : 1. Proloculus spherical to subspherical, and 60 to 170 microns in their longer diameter. Inner one to two whorls variable in shape, succeeding ones fusiform with bluntly pointed poles, slowly expanding outwards, outer ones inflated fusiform with rounded poles.

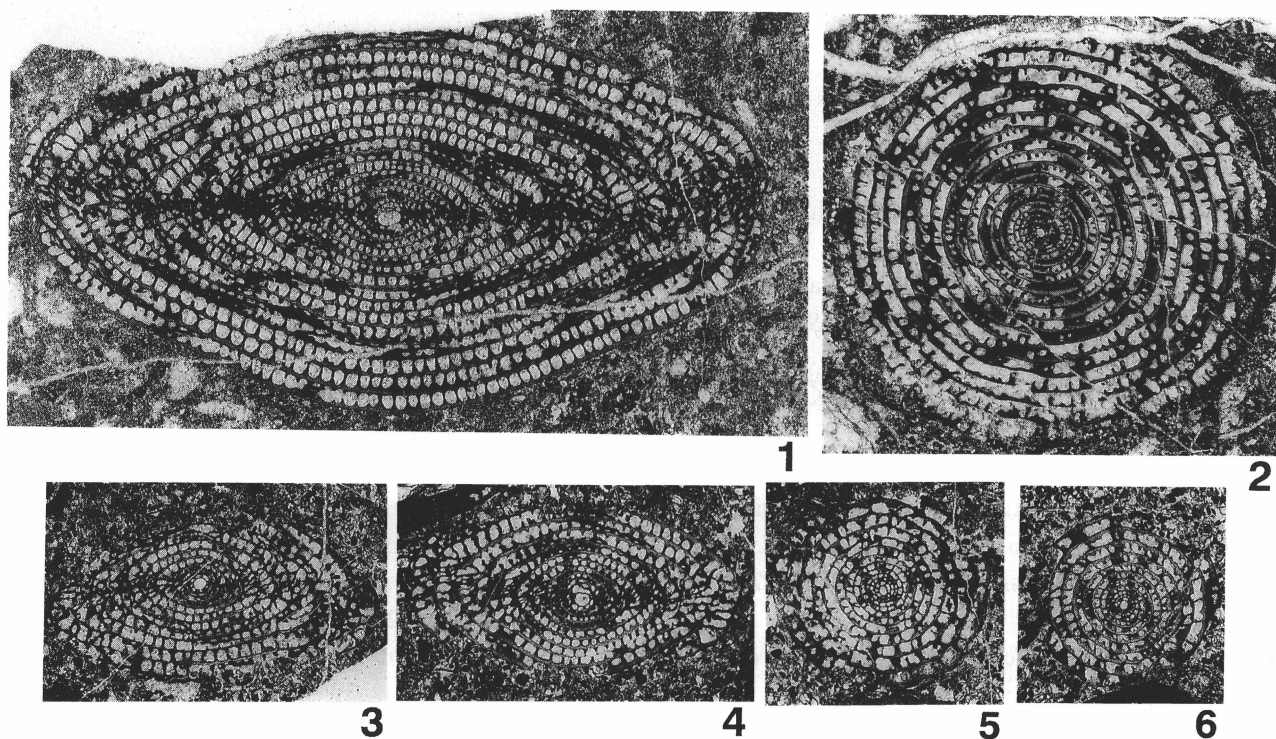
Wall thin, in comparison with chamber height, composed of tectum and very fine alveolar keriotheca. Septa slender and widely spaced. Adjacent septa are inserted vertically by transverse septula and laterally by axial septula, producing regularly arranged mesh-work structure.

Transverse septula slender, numerous, well-developed, and mostly connected with slender parachomata. Axial septula slender, uneasily distinguished from septa, and not counted exactly throughout whorls.

*Discussion.*—*Gifuella* was proposed by Honjo (1959) based on small transverse septula and highly

elongate test. Most diagnostic characters of *Gifuella*, however, are nearly complete lack of transverse septula even in large specimens of the type species more than 1 cm in axial length (Figure 4-1). It is easily distinguished from *Neoschwagerina* by larger proloculus and slenderer septula of *Gifuella* (Figure 4), and from *Colania* by smaller proloculus, lack of secondary transverse septula, and uneasily distinguishable microspheric forms in *Gifuella*. *Gifuella* is considered to be independent and taxonomically valid by these characters. *Gifuella* was regarded to be a junior synonym with *Neoschwagerina* by Thompson (1964) and with *Colania* by T. Ozawa (1970a). The taxonomic treatment by them is thought to be related to insufficient description and illustration by Honjo (1959).

Although most of the present specimens are abraded in outer whorls, they have diagnostic characters to *Gifuella*, mentioned above. Some (Plate 1, Figures. 3, 10) have smaller proloculus and distinct juvenile whorl. However, they can not be distinguished from others by other test characters. No forms surely referable to *Neoschwagerina* can be found in the Sample A. Difference of proloculus size is, accordingly, thought to represent the morphologic variation of this unnamed species, as



**Figure 4.** Two species of *Gifuella* from the Akasaka Limestone. 1, 2. *Gifuella gifuensis* Honjo. 3-6. *Gifuella amacula* Honjo. 1:D2-029056, 2:D2-0290601, 3:D2-028967, 4:D2-028965, 5:D2-028959, 6:D2-028996. All X 10.

well as other morphologic characters such as test form in inner and outer whorls, and development of septula and parachomata.

*Gifuella* sp. differs from *Gifuella amacula* Honjyo by its slenderer and more number of septula, thinner wall, and larger test, and from *Gifuella gifuensis* Honjo by its slenderer septula, thinner wall, smaller proloculus, and smaller test.

**Occurrence.**—Abundant in the Sample A collected at an abandoned quarry, southwest end of Kametsubo, in association with *Kahlerina* sp. A, *K.* sp. B, *Dagmarita* sp., and others.

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**Plate 1.** Middle Permian foraminifers at Kametsubo (1)

**Figs. 1-15.** *Gifuella* sp. 1:D2-028666, 2:D2-028661a, 3:D2-028654, 4:D2-028659, 5:D2-028656, 6:D2-028645, 7:D2-028663, 8:D2-028668, 9:D2-028649, 10:D2-028662, 11:D2-028644, 12:D2-028642, 13:D2-028657a, 14: D2-028653, 15: D2-028652.

All contained in the Sample A. All X 10 except for 1a, 2a, 3a: X 20.

**Plate 2.** Middle Permian foraminifers at Kametsubo (2)

**Fig. 1.** *Colania douvillei* (Ozawa). D2-029341, 1a:X 20, 1b:X 10.

**Fig. 2.** *Neoschwagerina* sp. X 10.

**Figs. 3-7.** *Chusenella* sp. 3:D2-028660a, 4:D2-028670, 5:D2-028642, 6:D2-028646, 7:D2-028651.  
All X 10.

**Fig. 8.** *Kahlerina* sp. B. D2-028658, X 30.

**Figs. 9-11.** *Kahlerina* sp. A. 9: D2-028649, X 30; 10:D2-028660b, X 30; 11:D2-028657b, X 50.

**Fig. 12.** *Dagmarita* sp. D2-028651b, X 50.

**Fig. 13.** *Globivalvulina* sp. D2-028657b, X 50.

**Fig. 14.** *Glomospira* sp. A. D2-028661b, X 50.

**Fig. 15:** *Glomospira* sp. B. D2-028651c, X 50.

All specimens are obtained in the Sample A except for 1 and 3 in the Sample B.

## Plate 1

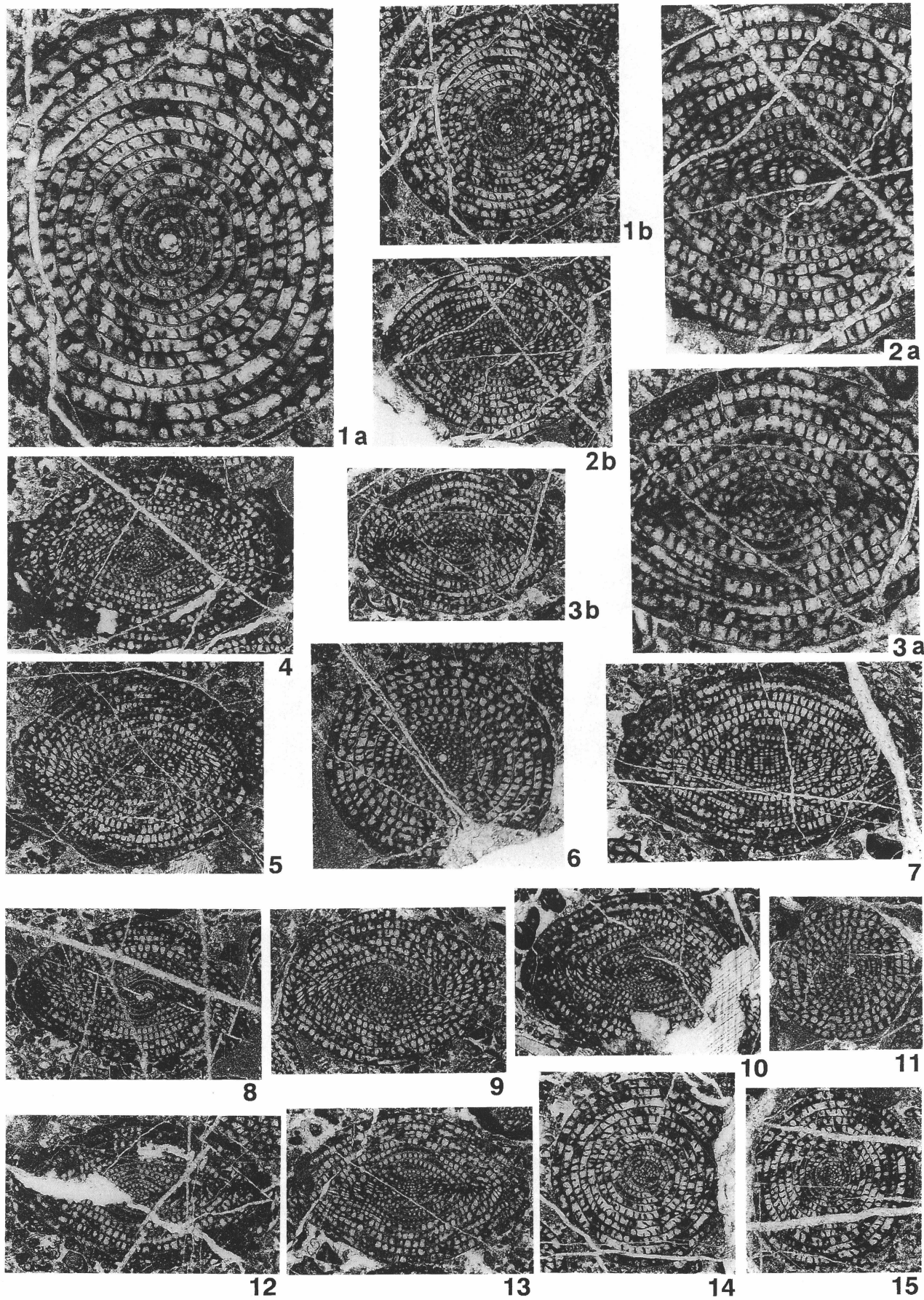




Plate 2

