Nature and Human Activities **12**, 17-35, 2007

Original article

Late Early Carboniferous and Early Permian foraminifers contained in limestone fragments of conglomerate of the Lower Cretaceous Sasayama Group, Hyogo －Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Part 9－

Fumio Kobayashi* and Kiyoshi Adachi**

** Division of Earth Sciences, Institute of Natural and Environmental Sciences, University of Hyogo / Division of Natural History, Museum of Nature and Human Activities, Hyogo, Yayoigaoka 6, Sanda, Hyogo, 669-1546, Japan*
*** Minami-tada 751-5, Kaibara-cho, Tamba, Hyogo, 669-3301, Japan*

Abstract

Late Paleozoic foraminifers of 38 species assignable to 25 genera are discriminated in limestone fragments of conglomerate which is intercalated in the lower formation of the Lower Cretaceous Sasayama Group. Limestone fragments of determined age are divided largely into two different groups. Older one contains non-fusulinoidean genera such as *Endothyranopsis, Bradyina, Archaediscus*, and *Endothyra* suggesting possibly late Early Carboniferous Serpukhovian age. Younger one is Early Permian Cisuralian, and contains many fusulinoideans of *Biwaella omiensis, Schubertella kingi, Schubertella melonica,* "*Triticites*" *ellipsoidailis, Schwagerina densa*, and others. Two Serpukhovian non-fusulinoidean foraminifers and fifteen Cisuralian fusulinoideans are systematically described and discussed.

These age-determined limestone fragments are thought to have been derived from the Akiyoshi Terrane. Most of others of unknown age including the broken limestone are also presumably of the Akiyoshi Terrane in their origin. In addition, the Sangun and Maizuru Terranes are highly probable as their provenance for lithic clasts of crystalline schist, gabbroic rocks, and most of basaltic rocks.

Surface geology in Early Cretaceous time in and around Hyogo was largely different from in the present day, and exotic blocks of seamount limestone and high P/T type metamorphosed accretionary complexes, all of which are now distributed far from the Sasayama area, should have exposed in the 130 Ma river basin of the area.

Key words: Late Paleozoic foraminifers, conglomerate, Lower Cretaceous Sasayama Group, provenance of lithic fragments

Introduction

The Lower Cretaceous Kanmon Group, to which the Sasayama Group herein described is correlated, consists of non-marine to brackish sedimentary rocks, and unconformably rests on the Permian to Jurassic accretionary complexes and the overlying Triassic and Jurassic sedimentary cover in the Inner Zone of Southwest Japan (e.g., Hase, 1960). Familiar, classical usage of the "Kenseki Group" or "Kenseki Series" for the Kanmon Group is originated from the Japanese ink stone processed from dark argillaceous rocks intercalated within the group. The Kanmon Group is typically developed in both sides of the Kanmon Strait (eastern part of Fukuoka prefecture and western part of Yamaguchi prefecture), and extends eastward to Hyogo prefecture where it is locally called as the Sasayama Group.

Presence of two fusulinoidean genera, *Neoschwagerina* and *Fusulinella* is briefly reported by Sakaguchi (1961) from the limestone pebble of conglomerate, intercalated within the lower part of the Sasayama Group near Shimotaki, Tamba City, Hyogo Prefecrure. Subsequently, Sotsuka (1975) and Ueno et al. (1994) described fusulinoideans from the conglomerate from the Kanmon

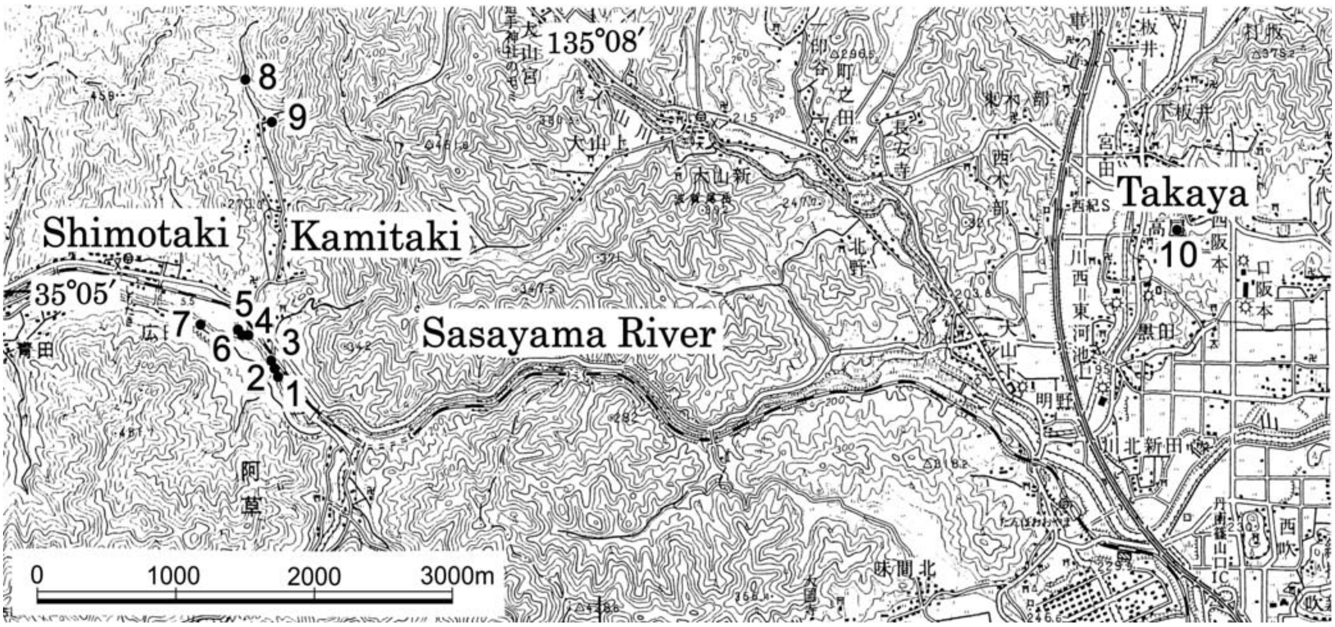

Figure 1. Sample locations of limestone fragments of the Sasayama Group in the Kamitaki-Shimotaki area (1 to 9) and Takaya in the western part of the Sasayama Basin (10).

Group in Kita-Kyushu City, and its correlative rock unit in Kamiyuno, western part of Okayama Prefecture, respectively. These foraminifers and related geologic information are available for determination of provenance of limestone fragments, as discussed by Sotsuka (1975) and Ueno et al. (1994). They are also presumable for surface geology of the present-day' Inner Zone of Southwest Japan in Early Cretaceous time.

We have found many foraminifers of possibly late Early Carboniferous (Serpukhovian) and Early Permian (Cisuralian) ages after the microscopic observation of 224 thin sections of limestone fragments of conglomerate in the lower formation of the Sasayama Group. In this paper, these foraminifers are systematically described, and provenance and tectonic implications of limestone fragments are discussed along with other lithic clasts. This paper is the ninth of the serial descriptive work under the title of Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan.

This study was done under the Co-operative Research and Lifelong Study Supporting Program of Tamba 2007 ("Tamba Caravan 2007") in the Museum of Nature and Human Activities, Hyogo, Japan. All limestone thin sections used in this paper are stored in the museum (Fumio Kobayashi Collection, MNHAH).

Geologic setting

The Sasayama Group consists of Lower Cretaceous sedimentary rocks of terrestrial (fluvial to lacustrine) origin and is divided into the lower formation of 1,300 m thick and the upper formation of 250 m thick. It is distributed isolatedly in the Sasayama Basin and its westward Kamitaki-Shimotaki area (Kurimoto et al., 1993).

The lower formation is composed mainly of conglomerate, sandstone, and mudstone, intercalating with several rhyolite tuff beds. It unconformably rests on the Permian accretionary complexes and Jurassic formations referable to the Ultra-Tamba Terrane. Two zircon fission track ages were dated as 139 and 136 Ma in the rhyolite tuff in the basal part of the lower formation (Kurimoto et al. 1993). Very recently, well-preserved dinosaur fossils were discovered from reddish mudstone on the river floor of the Sasayama River in the Kamitaki-Shimotaki area (Saegusa et al., 2007).

The upper formation is made up of hornblende andesite lapilli tuff, tuff breccia, fine-grained tuff, tuffaceous sandstone, conglomerate, and mudstone, and is overlain by the Upper Cretaceous Arima Group. Two hornblende K-Ar ages of the andesite and andesite lapilli tuff are dated as 100 and 109 Ma (Kurimoto et al. 1993).

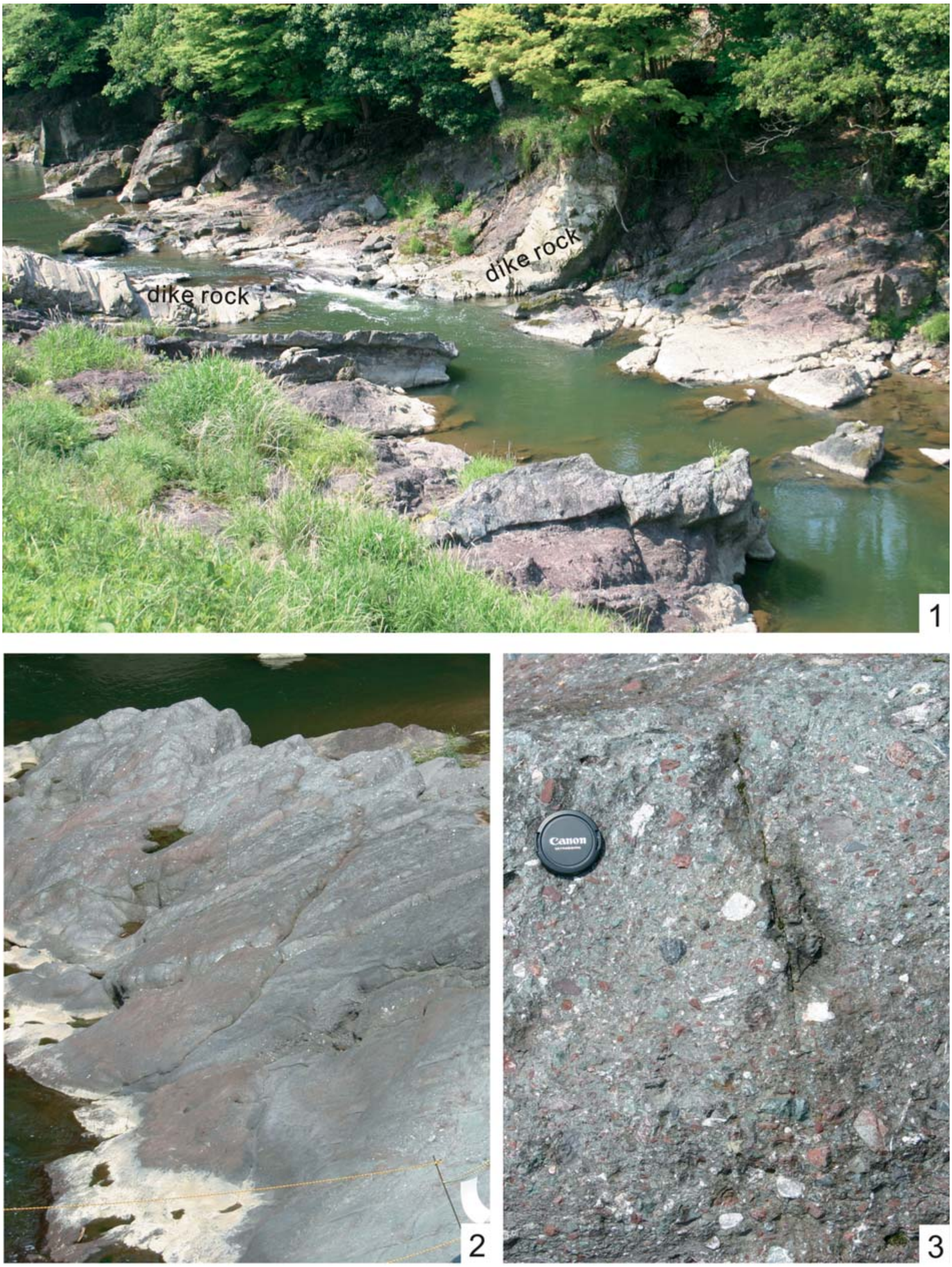

Figure 2.

1. The lower formation of the Sasayama Group gently dipping southward, well cropping out on the river floor of the Sasayama River in the Kamitaki-Shimotaki area. Dike rock in this figure corresponds to that shown at the top of the columnar section of Figure 3.
2. Conglomerate bed exposed at Loc. 2, from which limestone fragments of the Sample 2 were collected.
3. Close-up view of the conglomerate bed at Loc. 2. Light colored granules and pebbles are of limestone. Many small fragments of reddish and greenish color are mostly of syn-depositional lithic clasts of mudstone.

Terrestrial estherides, bivalves, gastropods, and plant fossils occur in black mudstone at a few localities (Sakaguchi, 1961).

The Sasayama Group unconformably overlying the formations of the Ultra-Tamba Terrane suggests that the fundamental geologic structure of pile-nappe structure of pre-Cretaceous basement rocks was formed until the deposition of the Sayamama Group (Kurimoto et al, 1993). The separated distribution of the group in the eastern block of Sasayama Basin and the western block of Kamitaki-Shimotaki area is due to: (1) the relative elevation of the eastern block resulting more than 150 m height gap between eastern and western blocks, and (2) higher elevation of the western part than the eastern part of the eastern block after the deposition of the group, regardless of the deposition in the same sedimentary basin.

Samples

Conglomerates with limestone fragments are well-exposed on the river floor along the Sasayama River in the Kamitaki-Shimotaki area, but the exposure of them is poor in the Sasayama Basin. Limestone fragments are mostly of granule- to pebble-size, and range locally into cobble-size. More than one hundred samples of limestone fragments were collected at nine localities in the Kamitaki-Shimotaki area and one locality (Takaya) in the western part of the Sasayama Basin (Figure 1). Two-hundred and twenty-four thin sections of limestone fragments were made from these samples. All the conglomerates with limestone fragments are certainly assigned into the lower formation of the Sasayama Group, but their stratigraphic levels from the base of the lower formation are unknown exactly.

Notes on the conglomerate of the lower formation

The lower formation of the Sasayama Group in the Kamitaki-Shimotaki area is generally trending east to west and dipping both north and south by gentle folds with angles of 10 to 30 degrees (Figure 2-1). It is composed of reddish, thinly to thickly bedded mudstone, sandstone, and conglomerate, which are intruded in places by porphyritic and andesitic dike rocks of centimeters to five meters width (Figures 2-1, 3). Centimeter- to a few tens centimeter-order upward fining sedimentary cycle is observed in coarse-grained facies of sandstone and granule conglomerate beds.

Conglomerate beds are variable from several tens centimeter to several meters in thickness, rarely up to

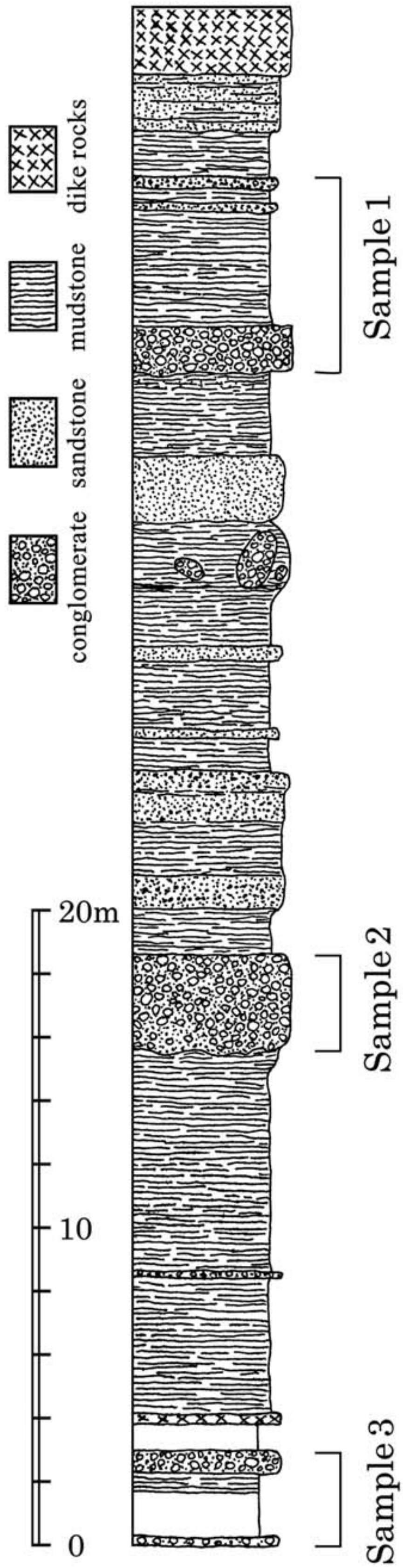

Figure 3. Columnar section of the lower formation of the Sasapyama Group along the route from Loc. 1 to 3 in Figure 1, showing the stratigraphic levels of the Sample 1, 2, and 3 collected from granules to cobbles of the conglomerate beds.

Species	Locality										Plate (Figure)
	1	2	3	4	5	6	7	8	9	10	
Pseudoammodiscus sp.						×					1 (16, 17)
Archaediscus sp.						×					1 (5)
Nodosinelloides sp.										×	1 (24, 25)
Palaeotextularia sp. A			×		×						1 (1, 2)
Palaeotextularia spp.				×	×	×					1 (3, 4, 6, 7)
Palaeotextulariidae indet.		×		×	×	×			×		1 (10)
Globivalvulina spp.		×		×	×	×		×	×	×	1 (11-15)
Endothyra sp. A						×					1 (20, 22, 31)
Endothyra sp. B						×					1 (21)
Endothyra sp. C		×	×								1 (30)
Endothyranopsis sp.						×					1 (19)
Bradyina sp.						×					1 (18)
Tetrataxis conica	×	×	×				×				1 (8, 9)
Schubertella australis						×		×	×	×	3 (10)
Schubertella kingi	×	×	×		×	×	×		×		1 (36-40, 42)
Schubertella melonica		×	×	×	×	×			×		2 (13-22)
Mesoschubertella sakagamii			×		×	×				?	2 (1-4)
Biwaella omiensis	×	×	×	×	×	×	×		×		2 (23-36)
Triticites pseudosimplex		×				×	×			×	3 (22-24)
"Triticites" ellipsoidalis	×	×	×		×	×			?	×	2 (5-12)
"Triticites" subashiensis		×	×			×					3 (6-9)
Schwagerina densa	×	×	×		×	×	×			×	2 (37-40)
Chusenella cervicula	×										1 (43)
Chalaroschwagerina kueichiensis			×		×					×	3 (17-21)
Pseudofusulina stabilis	×				×	×					3 (1-5)
Pseudofusulina spp.			×		×		×	×		×	3 (11-16)
Paraschwagerina cf. *akiyoshiensis*			×			×					1 (41, 46)
Paraschwagerina? sp.					×						1 (44)
Schwagerinidae indet.				×			×	×	×		1 (45)
Palaeoreichelina? sp.						×					1 (35)
Pseudoendothyra sp. A						×					1 (27, 28)
Pseudoendothyra sp. B						×					1 (34)
Nankinella sp.						×					1 (32, 33)
Staffella sp.					×						1 (29)
Staffellidae indet.						×		×	×		
Hemigordius sp.					×						1 (23)
Calcivertella? sp.							×				
Protonodosaria sp.					×						1 (26)

Table 1. Late Paleozoic foraminifers contained in limestone fragments from the Kamitaki-Shimotaki area (Sample 1 to 9) and Takaya in the western part of the Sasayama Basin (Sample 10).

10 m. The conglomerate block of syndepositional deformation is found in mudstone and fine-grained sandstone by horizons (Figure 3). Conglomerate beds are composed of ill-sorted, subangular to subrounded granules to cobbles, densely packed within ill-sorted, reddish siliciclastic matrices (Figures 2-2, 2-3). The base of some conglomerate beds digs down the underlying mudstone and sandstone with shallow trough-like depressions, showing their channel-fill deposit.

Lithic fragments of the conglomerate are diverse and variable. They are characterized by those brought from pre-Cretaceous basement rocks such as chert, limestone, granitic rocks (granite, granodiorite), diorite, gabbroic rocks, basaltic rocks, and crystalline schist (greenschist, pelitic schist, siliceous schist), in addition to more dominant pre-Cretaceous and syndepositional lithic clasts of mudstone and sandstone. Minor amounts of serpentinite and quartzite are also contained.

Foraminiferal fauna and age

Thirty-eight species assignable to 25 genera of Late

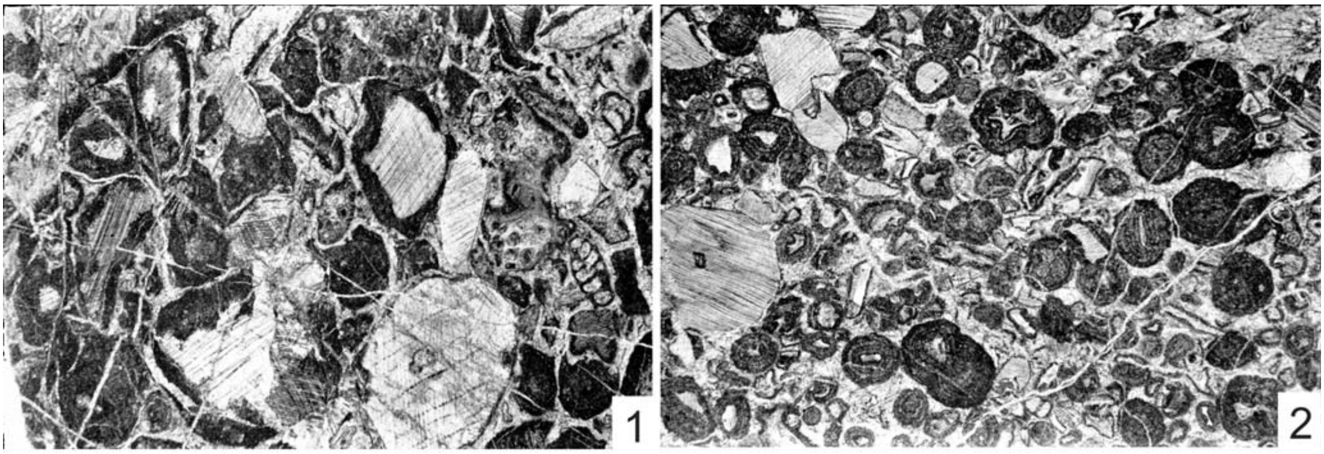

Figure 4. Limestone pebbles of crinoidal bioclastic grainstone (1) and ooid grainstone (2) of possibly Serpkhovian in age.

Paleozoic foraminifers were identified in limestone fragments of the Sasayama Group (Table 1). Fragments of determined age in the Kamitaki-Shimotaki area are divided into two different groups based on many biostratigraphic works of Late Paleozoic foraminifers of Southwest Japan (e.g., Toriyama, 1958; T. Ozawa and Kobayashi, 1990).

The older one contains unidentified species of non-fusulinoidean foraminifers such as *Endothyranopsis, Bradyina, Archaediscus, Endothyra*, and others, and a rugose coral of *Echigophyllum* sp. These fossils are recognized at Loc. 6 from only two pebbles of crinoidal bioclastic grainstone and ooid grainstone (Figure 4). No fusulinoideans are contained in them. Although this pebble is thought to be certainly Carboniferous from these fossils, its definite age determination is not easy. *Endothyranopsis* is widespresd in the Visean and Serpukhovian in the world (Mamet and Skipp, 1970; Mamet, 1974) and the Serpukhovian in the Moscow and Donetz Basins (Aisenberg et al., 1979). In Japan, the genus is reported from the basal part (unit 1) of the Ichinotani Formation (Adachi, 1985), and Visean limestones of the Akiyoshi Limestone (Matsusue, 1986; Ozawa and Kobayashi, 1990) and Omi Limestone (Ueno and Nakazawa, 1993). *Bradyina* is known from the upper Visean to Lower Permian, but most abundant in Bashkirian and Moscovian. *Bradyina* sp. in this paper has a smaller test and more primitive characters than the post-Bashkirian ones. *Echigophyllum* is widespread in the Lower Carboniferous in the Akiyoshi Limestone (Sugiyama and Haikawa, 1993) and its equivalents. Therefore, the Serpukhovian age rather than other ages might be appropriate in these Carboniferous limestone pebbles.

Other more than 30 limestone fragments with definite ages are all Early Permian, as mentioned below. Most of them consist of light gray to gray, bioclastic packstone and bioclastic grainstone. They are highly fossiliferous in general, and contain many foraminifers, especially of fusulinoideans. Non-fusulinoidean foraminifers of these fragments have closer faunal affinity to Late Carboniferous ones than Middle Permian ones. They are dominated by unidentified forms belonging to Palaeotextulariidae. Those with porcelaneous wall are very rare. Non-fusulinoidean genera common in the Middle Permian such as *Pachyphloia* and *Neodiscus* were not recognized in them.

Although the dominance is more or less variable among about 30 samples, most dominant species are *Biwaella omiensis* Morikawa and Isomi, 1960, *Schubertella kingi* Dunbar and Skinner, 1937, and *S. melonica* Dunbar and Skinner, 1937. *"Triticites" ellipsoidailis* Toriyama, 1958 and *Schwagerina densa* (Toriyama, 1958) are also found in most samples. On the contrary, relatively larger-sized schwagerinids such as *Chalaroschwagerina kueichiensis* (Chen, 1934) and the larger form of *Pseudofusulina* are not so common as the mentioned five species.

Early Permian age of the Permian foraminifers is undoubted on account of these and other species known from many Lower Permian limestones of East and Southeast Asia. However, in the Sasayama fauna, there are no genera and species available for biostratigraphic subdivision of the Lower Permian, such as *Sphaeroschwagerina, Pseudoschwagerina, Robustoschwagerina, Pamirina, Chalaroschwagerina vulgaris* (Schellwien, 1909), *C. globosa* (Schellwien, 1909), and *Pseudofusulina kraffti* (Schellwien, 1909). Most of these genera and species are common and characteristic in strata from the Asselian to Artinskian of Japan and Tethyan regions.

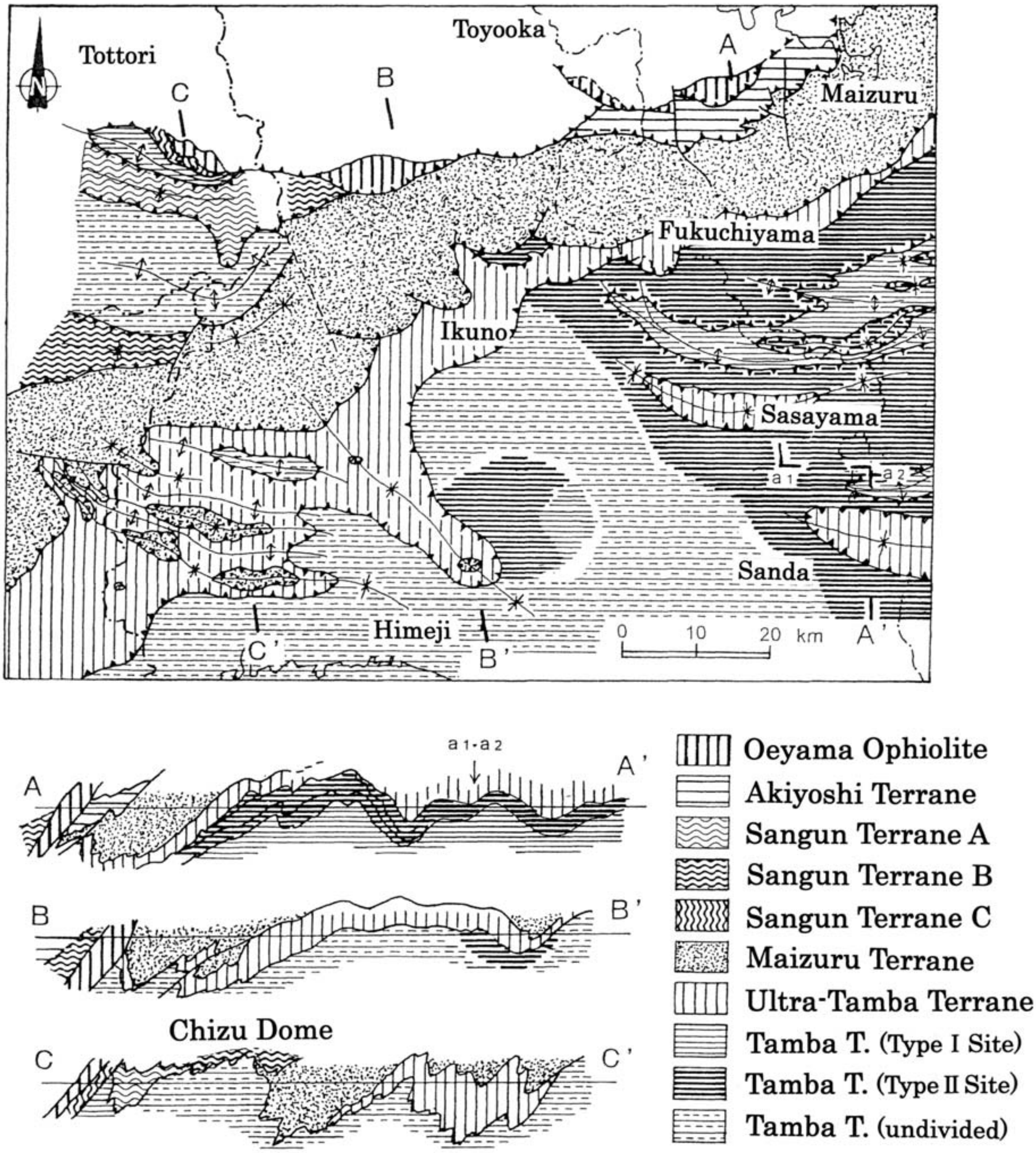

Figure 5. Tectonic map and geologic sections showing major geologic structure in and around Hyogo prefecture (after Kobayashi, 1997).

Age of the Permian limestone fragments of the Sasayama Group having these many fusulinoideans is better to assign an Early Permian (Cisuralian) age. Two genera of Moscovian and Murgabian fusulinoideans reported by Sakaguchi (1961) were not found in our limestone samples.

Provenance and tectonic implications

Pre-Cretaceous basement rocks in and around Hyogo are divisible into eight tectonic units forming a pile-nappe (thrust sheets) from north to south: Oeyama Ophiolite, Akiyoshi Terrane, Sangun Terrane, Maizuru Terrane, Ultra-Tamba Terrane, Tamba Terrane, Ryoke Terrane, and Sambagawa Terrane. The enveloping surface of the thrust sheets is nearly horizontal or gently sloping in various

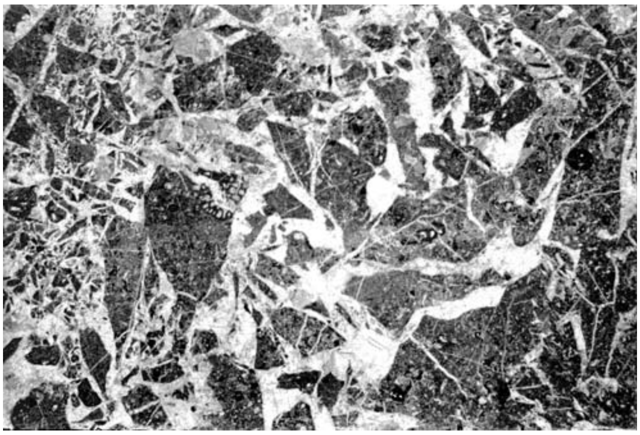

Figure 6. Broken limestone consisting of limestone breccias of different lithologies injected by many veinlets.

directions (Figure 5; Kobayashi, 1997).

Relatively large blocks of limestone are distributed only in the Ultra-Tamba Terrane in the Kozuki area (southwestern marginal part of the prefecture). The limestone with similar lithofacies and fossil contents to those of limestone fragments of the Sasayama Group is not exposed in and around Hyogo. Although the fundamental pile-nappe structure had been formed by the deposition of the Sasayama Group, the surface geology of Hyogo in Early Cretaceous time, accordingly, should be largely different from in the present-day.

Two limestone pebbles of possibly Serpukhovian in age are most reasonably explained to have been derived from the Akiyoshi Terrane based on chronologic distribution of limestone, fossils, and lithofacies of the pre-Cretaceous terranes of Japan. The limestone in the Akiyoshi Terrane nearest from the Sasayama area is exposed in the western part of Okayama prefecture, about 150 km west apart from the area.

Early Permian limestone blocks are thought to have been also brought from the Akiyoshi Terrane. Because, many identified fusulinoidean species are common in those of the limestone blocks of the Akiyoshi Terrane especially of the Akiyoshi Limestone (e.g., Toriyama, 1958; T. Ozawa and Kobayashi, 1990) in addition to lithologic similarities of limestone. Derivation of them from the Maizuru Terrane or Ultra-Tamba Terrane might be less possible than from the Akiyoshi Terrane taking age distribution of limestones in these three terranes into account. Nearly impossible is the Tamba Terrane as a provenance of limestone fragments examined in this study, because the terrane should not have been exposed at the time of deposition of the Sasayama Group.

In addition to the age-determined limestone fragments, there are many limestones of unknown age. Some of them are referable to the broken limestones. They consist of limestone breccias of different lithologies and possibly different ages injected by many veinlets (Figure 6). These broken limestones are thought to have been formed at the time of subduction-related collapse events of the seamount. They are reported from the Akiyoshi Limestone (Sano and Kanmera, 1991) and the limestone fragments, which are originated in the Akiyoshi Seamount, from the Maizuru Terrane (Kobayashi, 2003) in the Inner Zone of Southwest Japan. Broken limestone fragments recognized in the Sasayama Group also suggest that they were derived from the Akiyoshi Terrane.

Thus, almost all limestone fragments of the determined age are thought to have been derived from the Akiyoshi Terrane. Others of unknown ages are also of presumably the Akiyoshi Terrane in origin. On the other hand, there are many other rock fragments probably transported from the Sangun Terrane and Maizuru Terrane. They are fragments of crystalline schist, gabbroic rocks, and most of basaltic rocks.

In conclusion, surface geology in Early Cretaceous time in and around Hyogo was largely different from in the present day. Exotic blocks of seamount limestone, high P/T type metamorphosed accretionary complexes, and others, all of which are now distributed far from the Sasayama area, should have exposed in the 130 Ma river basin of the area.

Systematic paleontology

Order FORAMINIFERIDA Eichwald, 1830
Suborder Fusulinina Wedekind, 1937
Superfamily Enothyroidea Brady, 1884
Family Endothyridae Brady, 1884
Genus ***Endothyranopsis*** Cummings, 1955
Endothyranopsis sp.
Plate 1, Figure 19

Material. ― One excentered transverse section illustrated and others.

Discussion.―The present material is characterized by planispiral coiling, subquadrate chambers, straight septa slightly inclined, and calcareous thick wall with finely granular perforate structure. These characters strongly suggest its assignment into *Endothyranopsis*. Specific identification, however, is impossible due to axial sections.

Family Bradynidae Reytlinger, 1950

Genus ***Bradyina*** von Möller, 1878

Bradyina sp.

Plate 1, Figure 18

Material.—One axial section illustrated and others.

Discussion.—Distinct features of the present material are a nautiloid test with broadly rounded periphery, involute and planispirally coiled three whorls, and calcareous wall consisting of an outer microgranular layer and inner coarsely perforate thicker layer. From these characters specimens examined are assigned to the genus *Bradyina*. They have a smaller test, thinner wall, and smaller number of whorls in comparison with many forms of *Bradyina* reported from the Middle and Upper Carboniferous of Japan (e.g., Adachi, 1985).

Superfamily Fusulinoidea von Möller, 1879

Family Schubertellidae Skinner, 1931

Genus ***Schubertella*** Staff and Wedekind, 1910

Schubertella kingi Dunbar and Skinner, 1937

Plate 1, Figures 36-40, 42

Schubertella kingi Dunbar and Skinner, 1937, p. 610, 611, pl. 45, figs. 10-15.

Material. — Four axial and two sagittal sections illustrated, and others.

Discussion.—The present materials are closely similar to and identical with the original ones by Dunbar and Skinner (1937) from the basal bed of the Permian of the Hueco Mountains and the Sierra Diablo Plateau. The original materials have more elongate fusiform test than the present ones.

Schubertella melonica Dunbar and Skinner, 1937

Plate 2, Figures 13-22

Schubertella melonica Dunbar and Skinner, 1937, p. 611-613, pl. 57, figs. 10-14.

Material. — Seven axial and three sagittal sections illustrated, and others.

Discussion. — Dunbar and Skinner (1937) distinguished this species from *Schubertella kingi* by having an inflated fusiform test and thicker wall. *S. melonica* is also different from *S. kingi* in having larger test. Stratigraphic relationship of the two species and the intrapopulational variation of them are uncertain in our materials from limestone fragments. These two species were tentatively distinguished by more inflated fusiform and larger test of the former. However, the strict discrimination of the two species is not easy in our materials.

Genus ***Mesoschubertella*** Kanuma and Sakagami, 1957

Mesoschubertella sakagamii Ueno, 1996

Plate 2, Figures 1-4

Mesochubertella sakagamii Ueno, 1996, p. 26, 27, pl.6, figs. 1-17.

Material. — Two axial, one sagittal, and one parallel sections illustrated, and others.

Discussion. — *Mesoschubertella sakagamii* was proposed by Ueno (1996) from the upper Bolorian (uppermost Cisuralian) of the Akiyoshi Limestone based on having a smaller test and thinner wall than those of other species of the genus. The Sasayama specimens are the closest to *M. sakagamii* among the described species, but have thicker wall than the types.

Family Schwagerinidae Dunbar and Henbest, 1930

Genus ***Biwaella*** Morikawa and Isomi, 1960

Biwaella omiensis Morikawa and Isomi, 1960

Plate 2, Figures 23-36

Biwaella omiensis Morikawa and Isomi, 1960, p. 302-304, pl. 54, figs. 1-5.

Material.-Seven axial, six sagittal, and one tangential sections illustrated, and others.

Discussion. — Diagnostic characters of the genus *Biwaella* are uneasily understood from both the original and the subsequent description by Morikawa and Isomi (1960, 1961). However, the later materials based on well-oriented sections (Skinner and Wilde, 1965b; Kobayashi, 1993, 2005) revealed that the genus is very characteristic in having *Schubertella*-like, inner tightly coiled whorls and thicker wall with finely alveolar keriotheca in outer whorls, resulting remarkable morphologic contrast between inner and outer whorls. Shorter and fewer septa in comparison with other schubertellid genera are also characteristic to this genus. By these characters *Biwaella* is distinguished from other genera.

On the other hand, wide intraspecific and intrapopulationa variations of *Biwaella omiensis*, with which our materials are identified, are recognized especially in expansion of a test, development of chomata, and tunnel angle. Because of these more or less different characters by specimens and similar appearance to some genera such as *Toriyamaia* and *Schubertella* in not well-oriented sections, several new species of *Biwaella* were proposed by previous authors, and some of them were erroneously included into other genera, as indicated by Kobayashi (1993, 2005).

Genus ***Triticites*** Girty, 1904

Triticites pseudosimplex Chen, 1934

Plate 3, Figures 22-24

Triticites pseudosimplex Chen, 1934, p. 25, 26, pl. 1, figs. 19, 20.

Material. ― Two axial and one sagittal sections illustrated, and others.

Discussion. ― The Sasayama specimens are identical with the original ones by Chen (1934) from the Lower Permian of Jiangsu, South China from many common characters between the two. Axis of coiling of a test is not always straight in the former. Though having a larger test, *Triticites sonobensis* Sakaguchi, 1963 from the limestone block of the Tamba Terrane is thought to be intimately related to this species and may be synonymous with this species.

"Triticites" ellipsoidalis Toriyama, 1958

Plate 2, Figures 5-12

Schellwienia lepida (Deprat, 1914): Y. Ozawa, 1925, p. 46, pl. 3, fig. 1a.

Triticites ellipsoidalis Toriyama, 1958, p. 115-118, pl. 12, figs. 13-34.

Nagatoella ikenoensis Morikawa and Isomi, 1961, p. 22, 23, pl. 20, figs. 6-13.

"Triticites" langsonensis (Saurin, 1950): T. Ozawa and Kobayashi, 1990, pl. 6, figs. 7, 8.

Darvasites ikenoensis (Morikawa and Isomi, 1961): Kobayashi, 2005, p. 19, pl. 3, figs. 1-3

? Triticites langsonensis Saurin, 1950: Sakaguchi, 1963, p. 93, 94, pl. 2, figs. 4-10.

Material. ― Six axial and two sagittal sections illustrated, and others.

Discussion. ― The present materials are marked by an ellipsoidal test, small proloculus followed by tightly coiled inner whorls, nearly plane and short septa in the central part, weakly to moderately fluted septa in polar regions, distinct chomata and tunnel, thin to very thin wall except for outer one or two whorls with finely perforate layer comparable to alveolar keriotheca. These characters of the present materials well agree with and are common to those of the original and subsequent ones referable to *Triticites ellipsoidalis* and those named as *Nagatoella ikenoensis* reported from many Lower Permian limestones of Japan.

Forms listed above have these diagnostic and common characters, and are thought to be conspecific each other. Slight differences pointed out by authors are thought to represent the intraspecific variation of this species. One illustration named *Schellwienia lepida* by Y. Ozawa (1925) from the Akiyoshi Limestone is probably identical with this species.

Original and subsequent descriptions of *ellipsoidalis* and *ikenoensis* are largely different from those of the type species of *Triticites secalicus* (Say in James, 1823) and *Nagatoella orientis* (Y. Ozawa, 1925), respectively. Type specimens of *T. ellipsoidalis* and *N. ikenoensis* appear to be more reasonably assigned to *Eoparafusulina* instead of *Triticites*, and *Nagatoella* or *Darvasites*, respectively. However, assignment of them to *Eoparafusulina* is difficult, because cuniculi are not recognized in any tangential sections of them.

Specimens described and illustrated by Sakaguchi (1963) as *Triticites langsonensis* Saurin, 1950 from the limestone block of the Tamba Terrane have common characters mentioned above in spite of more elongate test than that of others from Japan. The Tamba specimens are treated herein as conspecific with "*Triticites*" *ellipsoidalis.* They are different from the original materials by Saurin (1950) from near Lanson, 200 km northeast of Hanoi in their smaller test, thinner wall, and more irregularly fluted septa. The original description and illustrated specimens of *Triticites langsonensis* by Saurin (1950) are also largely different from those of the type species of the genus *Triticites*.

"Triticites" subashiensis Chang, 1963

Plate 3, Figures 6-9

Triticites subashiensis Chang, 1963, p. 53, 63, pl. 3, fig. 8.

Material. ― Three axial and one sagittal sections illustrated, and others.

Discussion. ― The present materials resemble *"Triticites" ellipsoidalis* in many respects, but have a larger test, more strongly folded septa, and thicker outer whorls. They seem to be the closest to the monotypic specimen by Chang (1963) from the Sakmarian of Xinjiang Tienshan. Although morphologic variation of Chinese material is uncertain, both specimens appear to be more closely related to *Eoparafusulina* rather than *Triticies.* However, cuniculi were not observed in all tangential sections examined as well as in those of *"Triticites" ellipsoidalis.*

This species differs from *"Triticites" langsonensis* in having a shorter ellipsoidal test, larger proloculus, less tightly coiled inner whorls, and more irregularly fluted septa. *"Triticites" subashiensis* is distinguished from the types of *Triticites pusillus* (Schellwien, 1898) described from many Tethyan regions since the proposal from the Carnic Alps in its more whorls, more tightly coiled inner whorls, and thinner wall.

Genus ***Schwagerina*** von Möller, 1877

Schwagerina densa (Toriyama, 1958)

Plate 2, Figures 37-40

Dunbarinella densa Toriyama, 1958, p. 123-125, pl. 13, figs. 12-20.

Material. — Three axial and one sagittal sections illustrated, and others.

Discussion. — *Dunbarinella* was proposed by Thompson (1942) based on such characters as sharply pointed poles, small proloculus, heavy axial filling completely filling most chambers except for inner few and final whorls. It is similar to and uneasily distinguished from *Chusenella* except for having a smaller test and an occurrence in older strata (Upper Carboniferous and Lower Permian). *Dunbarinella* also resembles smaller forms of *Schwagerina* with small proloculus.

Generic reference to *Dunbarinella* of the species *densa* proposed by Toriyama (1958) from the Lower Permian of the Akiyoshi Limestone appears to be based on its morphologic similarities to North American ones. Development of axial filling is different between the Akiyoshi and type materials of *Dunbarinella*. The Akiyoshi ones are thought to be probably assignable to *Schwagerina* instead of *Dunbarinella*. Compared with type specimens by Toriyama (1958), the Sasayama specimens have smaller test and less developed chomata.

Compared with other identified schwagerinid species from limestone fragments of Sasayama, *Schwagerina densa* is different from *Pseudofusulina stabilis* (Rauser-Chernousova, 1938), illustrated in pl. 3, figs. 1-5, in poor development of axial filling, and from *Chusenella cervicalis* (Lee, 1927), illustrated in pl. 1, fig. 43, in more loosely coiled inner whorls and thicker wall.

Genus ***Chalaroschwagerina*** Skinner and Wilde, 1965

Chalaroschwagerina kueichiensis (Chen, 1934)

Plate 3, Figures 17-21

Triticites kueichihensis Chen, 1934, p. 42, 43, pl. 5, figs. 16, 17.

Material. — Three axial and two sagittal sections illustrated, and others.

Discussion. — The Sasayama specimens are probably identical with the original ones by Chen (1934) from the Lower Permian Chihsia Limestone of Kueichih, Anhui and later ones compared by Toriyama (1958) from the Akiyoshi Limestone. They are similar each other in their mode of septal folds and test expansion, thick wall, and weak axial filling. Appearance of larger test and more whorls in the present specimens than Chinese and Akiyoshi ones is thought to be due to the illustrations of the latter two represented by incomplete sections lacking outer or outermost whorls.

Although generic reference of this species was questionably transferred to *Schwagerina* by Toriyama (1958), its assignment to *Chalaroschwagerina* seems to be more possible from larger heights of outer whorls, thicker wall, and prenotheca partly present in sections. This species resembles *C. vulgaris* (Schellwien, 1909) in their general appearance. The former, however, has smaller proloculus, and smaller heights and thinner wall in inner whorls.

Genus ***Pseudofusulin*a** Dunbar and Skinner, 1931

Pseudofusulina spp.

Plate 3, Figures 11-16

Material. — Four axial, one sagittal, and one tangential sections illustrated, and others.

Discussion. — Many specimens referable to *Pseudofusulina* were obtained. They may be classified into two or more forms by differences of test expansion, septal folding, and presence or absence of axial filling. Although some (e.g. pl. 3, figs. 15, 16) are alike to the known species e.g., *Pseudofusulina fusiformis* (Schellwien, 1909), their specific identification and distinction from similar forms of *Pseudofusulin*a are avoided in our incomplete materials all obtained from separated limestone fragments.

Genus ***Paraschwagerina*** Dunbar and Skinner, 1936

Paraschwagerina cf. akiyoshiensis Toriyama, 1958

Paraschwagerina (Paraschwagerina) akiyoshiensis Toriyama, 1958, p. 155-158 pl. 18, figs. 1-14

Plate 1, Figures 41, 46

Material. — Two oblique sections illustrated and others.

Discussion. — Specimens assigned to *Paraschwagerina* are rarely found from a few limestone fragments. They were compared with *P. akiyoshiensis* from their many morphologic similarities to the types by Toriyama (1958) except for thicker wall in outer whorls. Further comparison is not easy because of no well-oriented sections in our material.

Paraschwagerina ? sp.

Plate 1, Figure 44

Material. — One incomplete tangential section.

Discussion. — One individual apparently different from *Paraschwagerina* cf. *akiyoshiensis* was recognized. Although its generic assignment to *Acervoschwagerina* is left unresolved, it is questionably belonged to *Paraschwagerina* from its septal folding not so intense and complicated as that of *Acervoschwagerina.*

Family Staffellidae Miklukho-Maklay, 1949

Genus ***Palaeoreichelina*** Liêm, 1974

Palaeoreichelina ? sp.

Plate 1, Figure 35

Material.—One parallel section illustrated and others.

Discussion. — A few excentered specimens with uncoiled outer portion of a test were obtained in association with *Biwaella omiensis, Schwagerina densa,* and others. Weakly recrystallized test consists of coiled early stage and uncoiled and rectilinearly arranged final stage. Septa gently curved posteriorly, unfluted, and relatively thick for test size. Among the known genera, these features seem to be the closest to those of *Palaeoreichelina* proposed by Liêm (1974) from the Moscovian of Vietnam. This unnamed species is questionably belonged to *Palaeoreichelina* with reservation.

Genus ***Pseudoendothyra*** Mikhailov, 1939

Pseudoendothyra sp. A

Plate 1, Figures 27, 28

Material. — One axial and one tangential sections illustrated, and others.

Discussion. — Small lenticular forms are commonly found in well-washed bioclastic grainstone. They are different from the associated staffellids of unknown generic reference in wall structure and general appearance, and most reasonably assigned to *Pseudoendothyra* among the known genera.

Wall of the present unidentified species consists of a tectum and a protheca of variable thickness and more or less recrystallized by specimens. This wall structure is apparently different from thin wall of a tectum and tectoria of lenticular forms included into Ozawainellidae. Although taxonomic reference of *Pseudoendothyra* to Staffellidae or Ozawainellidae is different among authors, the former seems to be more probable on the basis of the wall structure mentioned above.

Pseudoendothyra sp. B

Plate 1, Figure 34

Material.—One axial section illustrated and others.

Discussion. — The present unidentified form is also assigned to *Pseudoendothyra* based on the wall structure. It is distinguished from *Pseudoendothyra* sp. A by its more umbilicated test in polar regions and larger height in outer whorls. They are not easily discriminated each other by the degree of recrystallization of a test.

References

Adachi, S. (1985) Smaller foraminifers of the Ichinotani Formation(Carboniferous-Permian), Hida Massif, central Japan. *Sci. Rept., Inst. Geosci., Univ. Tsukuba,* **6**: 59-139.

Aisenberg, D. E., Brazhnikova, N. E., Vassilyuk, N. P., Reitlinger, E. A., Fomina, E. V. and Einor, O. L. (1979) The Serpukhovian Stage of the Lower Carboniferous of the USSR, p. 43-59. In, R. H. Wagner, A. C. Higgins, and S. V. Meyen (eds.) The *Carboniferous of the USSR*, Yorkshire Geol. Soc. Occas. Publ., no. 4.

Chang, L. H. (1963) Upper Carboniferous fusulinids of the Kelpin and adjacent districts of Xinjiang (1). *Acta Palaeont. Sinica,* 11: 36-70. (in Chinese and Russian)

Chen, S. (1934) Fusulinidae of South China, Part 1. *Palaeontol. Sinica,* Ser. B, **4**: 1-185.

Cummings, R. H. (1955) New genera of foraminifera from the British Carboniferous. *Jour. Washington Acad. Sci.,* **45**: 1-8.

Deprat, J. (1914) Ėtude des fusulinidės du Japon, de Chine et d'Indochine. Ėtude comparative des Fusulinidės d'Akasaka (Japon) et des fusulinidės de Chine et d'Indochine. *Mėm. Serv. Gėol. l'Indochine,* **3**: 1-45.

Dunbar, C. O. and Skinner, J. W. (1931) New fusulinid genera from the Permian of west Texas. *Amer. Jour. Sci.,* Ser. 5, **22**: 252-268.

Dunbar, C. O. and Skinner, J. W. (1936) *Schwagerina* versus *Pseudoschwagerina* and *Paraschwagerina*. *Jour. Paleont.,* **10**: 83-98.

Dunbar, C. O. and Skinner, J. W. (1937) Permian fusulinidae of Texas. In, Geology of Texas, Vol. 3, Part 2, *Bull. Univ. Texas Bureau Econ. Geol. Technol.,* no. 3701, 517-825.

Girty, G. H. (1904) *Triticites,* a new genus of Carboniferous foraminifera. *Amer. Jour. Sci.,* Ser. 4, **17**: 234-240.

Hase, A. (1960) The Late Mesozoic formations and their molluscan fossils in west Chugoku and north Kyushu, Japan. *Jour. Sci., Hiroshima Univ.,* ser. C, **3**: 281-342.

James, E. (1823) *Account of an expedition from Pittsburg to the Rocky Mountains,* vol. 1. Carey and Lea, Philadelphia, pp. 146-152.

Kanuma, M. and Sakagami, S. (1957) *Mesoschubertella,* a new Permian fusulinid genus from Japan. *Trans. Proc. Palaeont. Soc. Japan*, n. ser., no. 26: 41-46.

Kobayashi, F. (1993) Fusulinaceans contained in the intraformational conglomerate of the Kanyo Formation, north of Itsukaichi, southern Kwanto Mountains, Japan.

Humans and Nature, no. 2: 125-137.

Kobayashi, F. (1997) Pre-Cretaceous basement rocks and major geologic structure in and around Hyogo, Southwest Japan. *Humans and Nature* no. 8: 19-39. (in Japanese with English abstract)

Kobayashi, F. (2003) Paleogeographic constraints on the tectonic evolution of the Maizuru Terrane of Southwest Japan to the eastern continental margin of South China during the Permian and Triassic. *Palaeogeogr. Palaeoclim. Palaeoecol.,* **195**: 299-317.

Kobayashi, F. (2005) Early Permian fusulinaceans in the Hanagiri-Shimokuzu area, eastern part of the Kanto Mountains, Japan. *Nature and Human Activities,* no. 9: 11-31.

Kurimoto, C., Matsuura, H. and Yoshioka, T. (1993) *Geology of the Sasayama district.* With Geological Sheet Map at 1: 50,000, Geol. Surv. Japan, 93 p. (in Japanese with English abstract 5 p.)

Lee, J. S. (1927) Fusulinidae of North China, Part 1. *Palaeontol. Sinica*, Ser. B, **4**: 1-172.

Liêm, N. V. (1974) On uncoiled and rectilinear fusulinids. *Voprosy Mikropaleont.,* **17**: 22-26. (in Russian with English abstract)

Mamet, B. L. (1974) Une zonation par foraminifès du Carbonifè res Infè rieur de la Tė thys Occidentale. *Compte Rendu Septième Congr. Intern. Srtat. Gėol. Carbonifère, Krefeld*, 1971. **3**: 391-408.

Mamet, B. L. and Skipp, B. (1970) Lower Carboniferous calcareous foraminifera: Preliminary zonation and stratigraphic implications for the Mississippian of North America *Compte Rendu Sixième Congr.* Intern. Srtat. Gėol. Carbonifère, Sheffield, 1967. **3**: 1129-1146.

Matsusue, K. (1986) Foraminiferal biostratigraphy of the lower part of the Akiyoshi Limestone Group. *Sci. Repts., Dept. Geol., Kyushu Univ.,* **14**:163-185. (in Japanese with English abstract)

Mikhailov, A. V. (1939) On characteristic genera of Lower Carboniferous foraminifera in territories of the USSR. *Sbornik Leningrad. Geol. Upravel, Glavnoe Geol. Upravel.,* **3**: 47-62. (in Russian)

Möller, V. von (1877) Ueber Fusulininen und ähnliche Foraminiferen-Formen des russischen Kohlenkalkes. *Neues Jahrb. Mineral. Geol. Paläont.,* **1877**: 139-146.

Möller, V. von(1878) Die spiral-gewunden Foraminiferen des russischen Kohlenkalkes. *Mėm. l'Acad. Impėr. Sci. St. Pėtersbourg,* sėr.7, **25**: 1-147.

Morikawa, R. and Isomi, H. (1960) A new genus, *Biwaella, Schwagerina*-like *Schubertella. Sci. Repts., Saitama Univ.,* Ser. B, **3**: 301-305.

Morikawa, R. and Isomi, H. (1961) Studies of Permian fusulinids in the east of Lake Biwa, central Japan. *Rep. Geol. Surv. Japan*, no. 191: 1-29.

Ozawa, T. and Kobayashi, F. (1990) Carboniferous to Permian Akiyoshi Limestone Group, p. E1-E31. In, *Guidebook for Field Trip No. 4, Akiyoshi.* The 4th Intern. Symp. Benthic Foram., Sendai, Japan.

Ozawa, Y. (1925) Paleontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato, Pt. 2, Paleontology. *Jour. Coll. Sci., Imp. Univ. Tokyo,* **45**, art. 6: 1-90.

Rauser-Chernousova, D. M. (1938) Upper Paleozoic foraminifera of the Samara Bend and the Trans-Volga region. *Trudy Geol. Inst. Akad. Nauk* **SSSR, 7**: 69-160. (in Russian)

Saegusa, H., Tanaka, S., Matsubara, T., Kato, S., Kobayashi, F., Sakiyama, T., Sato, H., Handa, K., Furutani, H., Mikami, T. and Watabe, M. (2007) The first discovery of well-preserved Titanosaurian associated bones (Dinosauria, Sauropoda) from Tamba City, Hyogo Prefecture, p. 14. In, *Abst., 2007 Ann. Meet., Palaeont. Soc. Japan,* Osaka. (in Japanese)

Sakaguchi, S. (1961) Ⅱ.3.3. Sasayama Group, p. 54-56. In, *Explanatory text of geological and underground resource map of Hyogo prefecture,* Hyogo-ken. (in Japanese)

Sakaguchi, S. (1963) Stratigraphy and palaeontology of south Tamba district Part 2 Palaeontology. *Mem. Osaka Univ. Liber. Arts and Educ., Nat. Sci.,* no. 12: 89-118.

Sano, H. and Kanmera, K. (1991) Collapse of ancient oceanic reef complex-What happened during collision of Akiyoshi reef complex?- Sequence of collisional collapse and generation of collapse products. *Jour. Geol. Soc. Japan,* **97:** 631-644.

Saurin, E. (1950) Les fusulinidės des calcaires de Ky-Lua, Langson (Tonkin). *Bull. Serv. Gėol. l'Indochine,* **29**: 1-32.

Schellwien, E. (1898) Die Fauna des Karnischen Fusulinenkalks. Theil Ⅱ, Foraminifera. *Palaeontographica,* **44**: 237-268.

Schellwien, E. (1909) Monographie der Fusulinen, Teil Ⅱ, Die Fusulinen des Russisch-Arktischen Meeres-gebietes (nach dem Tode des Verfassers herausgegeben und fortgesetzt von Günter Dyhrenfurth und Has von Staff). *Palaeontographica,* **55:** 137-175.

Skinner, J. W. and Wilde, G. L. (1965a) Permian biostratigraphy and fusulinid faunas of the Shasta Lake area, northern California. *Paleont. Contr. Univ. Kansas, Protozoa,* Art. 6: 1-98.

Skinner, J. W. and Wilde, G. L. (1965b) Lower Permian (Wolfcampian) fusulinids from the Big Hatchet

Mountains, southwestern New Mexico. *Contrib. Cushman Found. Foram. Res.,* **16:** 95-104.

Sotsuka, T. (1975) Fusuline fossils from the River Murasaki area, Fukuoka prefecture, with a comparison with the fusulines of the Akiyoshi Limestone Group. *Bull. Akiyoshi-dai Mus. Nat. Hist.,* no. 11: 13-23 (in Japanese with English abstract)

Staff, H. von and Wedekind, R. (1910) Der Oberkarbon Foraminiferensapro-Pelit Spitzbergens. *Bull. Geol. Inst. Univ. Upsala,* **10:** 81-123.

Sugiyama, T. and Haikawa, T. (1993) Checklist of Late Paleozoic corals and chaetetids described and/or illustrated from the Akiyoshi Limestone area, Southwest Japan. *Bull. Akiyoshi-dai Mus. Nat. Hist.,* no. 28: 59-78

Thompson, M. L. (1942) New genera of Pennsylvanian fusulinids. *Amer. Jour. Sci.* **240**: 403-420.

Toriyama, R. (1958) Geology of Akiyoshi Part 3. Fusulinids of Akiyoshi. *Mem. Fac. Sci., Kyushu Univ.,* Ser. D, **7**: 1-264.

Ueno, K. (1996) *Mesoschubertella* (Permian Fusulinacea) from the Akiyoshi Limestone Group, southwest Japan. *Bull. Akiyoshi-dai Mus. Nat. Hist*., no. 31: 21-31.

Ueno, K., Maruyama, T., Hisada, K. and Igo, H. (1994) Carboniferous fossils from limestone pebbles in a conglomerate of the Early Cretaceous Yuno Formation, Okayama prefecture, southwest Japan. *Jour. Geol. Soc. Japan,* **100:** 181-184.

Ueno, K. and Nakazawa, T. (1993) Carboniferous foraminifers from the lowermost part of the Omi Limestone Group, Niigata prefecture, central Japan. *Sci. Rept., Inst. Geosci., Univ. Tsukuba,* Sec. B, **14:** 1-51.

Plate 1.

Figs. 1, 2. *Palaeotextularia* sp. A.
1: D2-037315, Loc. 5; 2: D2-037652, Loc. 3; both ×20.

Figs. 3, 4, 6, 7. *Palaeotextularia* spp.
3: D2-037342, Loc. 5; 4: D2-037392, Loc. 6; 6: D2-037392, Loc. 6; 7: D2-037299, Loc. 4; 3, 4, 6: ×20; 7: ×30.

Fig. 5. *Archaediscus* sp.
D2-037357, Loc. 6, ×50.

Figs. 8, 9. *Tetrataxis conica* Ehrenberg.
8: D2-037247, Loc. 1, ×30; 9: D2-037646, Loc. 3, ×40.

Fig. 10. Palaeotextulariidae gen. et sp. indet.
D2-037346, Loc. 5, ×20.

Figs. 11-15. *Globivalvulina* spp.
11: D2-037401; 12: D2-037404; 13: D2-037401; 14: D2-037238; 15: D2-035579, 11-13, 15: Loc. 6; 14: Loc. 10, all ×40.

Figs. 16, 17. *Pseudoammodiscus* sp.16: D2-037378, ×40; 17: D2-037358, ×50; both Loc.6.

Fig. 18. *Bradyina* sp.
D2-037362, Loc. 6, ×20.

Fig. 19. *Endothyranopsis* sp.
D2-037361, Loc. 6, ×40.

Figs. 20, 22, 31. *Endothyra* sp. A.
20: D2-037373; 22: D2-037366; 31: D2-037359, all Loc. 6, ×50.

Fig. 21. *Endothyra* sp. B.
D2-037377, Loc. 6, ×40.

Fig. 23. *Hemigordius* sp.
D2-037311, Loc. 5, ×40.

Figs. 24, 25. *Nodosinelloides* sp.
Both D2-037234, Loc. 10, ×40.

Fig. 26. *Protonodosaria* sp.
D2-037308, Loc. 5, ×50.

Figs. 27, 28. *Pseudoendothyra* sp. A.
27: D2-037404, ×40; 28: D2-037380, ×30; both Loc.6.
Fig. 29. *Staffella* sp.
D2-037319, Loc. 5, ×30.
Fig. 30. *Endothyra* sp. C.
D2-037289, Loc. 2, ×50.
Figs. 32, 33. *Nankinella* sp.
32: D2-037396; 33: D2-037389, both Loc. 6, ×20.
Fig. 34. *Pseudoendothyra* sp. B.
27: D2-037402, Loc. 6, ×40.
Fig. 35. *Palaeoreichelina*? sp.
D2-037385, Loc. 6, ×30.
Figs. 36-40, 42. *Schubertella kingi* Dunbar and Skinner.
36: D2-037402; 37: D2-037274; 38: D2-037346; 39: D2-037263; 40: D2-037278; 42: D2-037402; 36, 37, 42: Loc. 6; 38: Loc. 5; 39: Loc. 1; 40: Loc. 2; 36, 38, 40, 42:×40; 37, 39:×30.
Figs. 41, 46. *Paraschwagerina* cf. *akiyoshiensis* Toriyama.
41: D2-037651, Loc. 3; 46: D2-037397, Loc. 6, both ×10.
Fig. 43. *Chusenella cervicula* (Lee).
D2-037256, Loc. 1, ×10.
Fig. 44. *Paraschwagerina*? sp.
D2-037325, Loc. 5, ×10.
Fig. 45. Schwagerinidae gen. et sp. indet.
D2-037299, Loc. 4, ×15.

Plate 2.

Figs. 1-4. *Mesoschubertella sakagamii* Ueno.
1: D2-037404; 2: D2-037317; 3: D2-037401; 4: D2-037634; 1, 3: Loc. 6; 2: Loc. 5; 4: Loc. 3; 1, 2:×30; 3, 4:×40.
Figs. 5-12. *"Triticites" ellipsoidalis* Toriyama.
5: D2-037390; 6, 7: D2-037650; 8: D2-037634; 9: D2-037642; 10: D2-037646; 11: D2-037636; 12: D2-037345; 5: Loc. 6; 6-11: Loc. 3; 12: Loc. 5; 5, 8, 9:×20; 6, 7, 11, 12a:×15; 10:×10; 12b:×40.
Figs. 13-22. *Schubertella melonica* Dunbar and Skinner.
13: D2-037333; 14: D2-037259; 15: D2-037403; 16, 18, 22: D2-037287; 17: D2-037652; 19: D2-037400; 20: D2-037397; 21: D2-037300; 13: Loc. 5; 14: Loc. 1; 15, 17, 19, 20: Loc. 6; 16, 18, 22: Loc. 2; 21: Loc. 4 ,14: ×30; others: ×40.
Figs. 23-36. *Biwaella omiensis* Morikawa and Isomi.
23: D2-037384; 24: D2-037399; 25: D2-037635; 26: D2-037651; 27: D2-037643; 28: D2-037288; 29: D2-037634; 30: D2-037392; 31: D2-037404; 32: D2-037263; 33: D2-037394; 34: D2-037300; 35: D2-037339; 36: D2-037299; 23, 24, 30, 31, 33: Loc. 6; 25-27, 29: Loc. 3; 28: Loc. 2; 32: Loc. 1; 34, 36: Loc. 4; 35: Loc. 5; 23, 24, 28, 30-33: ×30; 25-27, 29, 34-36:×20.
Figs. 37-40. *Schwagerina densa* (Toriyama).
37: D2-037258; 38: D2-037295; 39: D2-037260; 40: D2-037634; 37, 39: Loc. 1; 38: Loc. 2; 40: Loc. 3, all×10.

Plate 3.

Figs. 1-5. *Pseudofusulina stabilis* Rauser-Chernousova.
1: D2-037360, Loc. 6; 2: D2-037388, Loc. 6; 3: D2-037251, Loc. 1; 4; D2-037344, Loc. 5; 5: D2-037387, Loc. 6; all ×10.
Figs. 6-9. *"Triticites" subashiensis* Chang
6: D2-037384, Loc. 10; 7: D2-037296, Loc. 2; 8: D2-037639, Loc. 3; 9: D2-037640, Loc. 3; all×10
Fig. 10. *Schubertella australis* Thompson and Miller.
D2-037234, Loc. 10, ×40.
Figs. 11-16. *Pseudofusulina* spp.
11: D2-037635, Loc. 3; 12; D2-037328, Loc. 5; 13: D2-037405, Loc. 7; 14: D2-037305, Loc. 5; 15: D2-037647, Loc. 3; 16: D2-037318, Loc. 5; all×10.
Figs. 17-21. *Chalaroschwagerina kueichiensis* (Chen).
17: D2-037311; 18: D2-037318; 19: D2-037312; 20: D2-037645; 21: D2-037333; 17, 19, 21: Loc. 5; 18, 20: Loc. 3; all×10.
Figs. 22-24. *Triticites pseudosimplex* Chen.
22: D2-037381; Loc. 6; 23: D2-037287, Loc. 2; 24: D2-037245, Loc. 10; all×10.

Plate 1

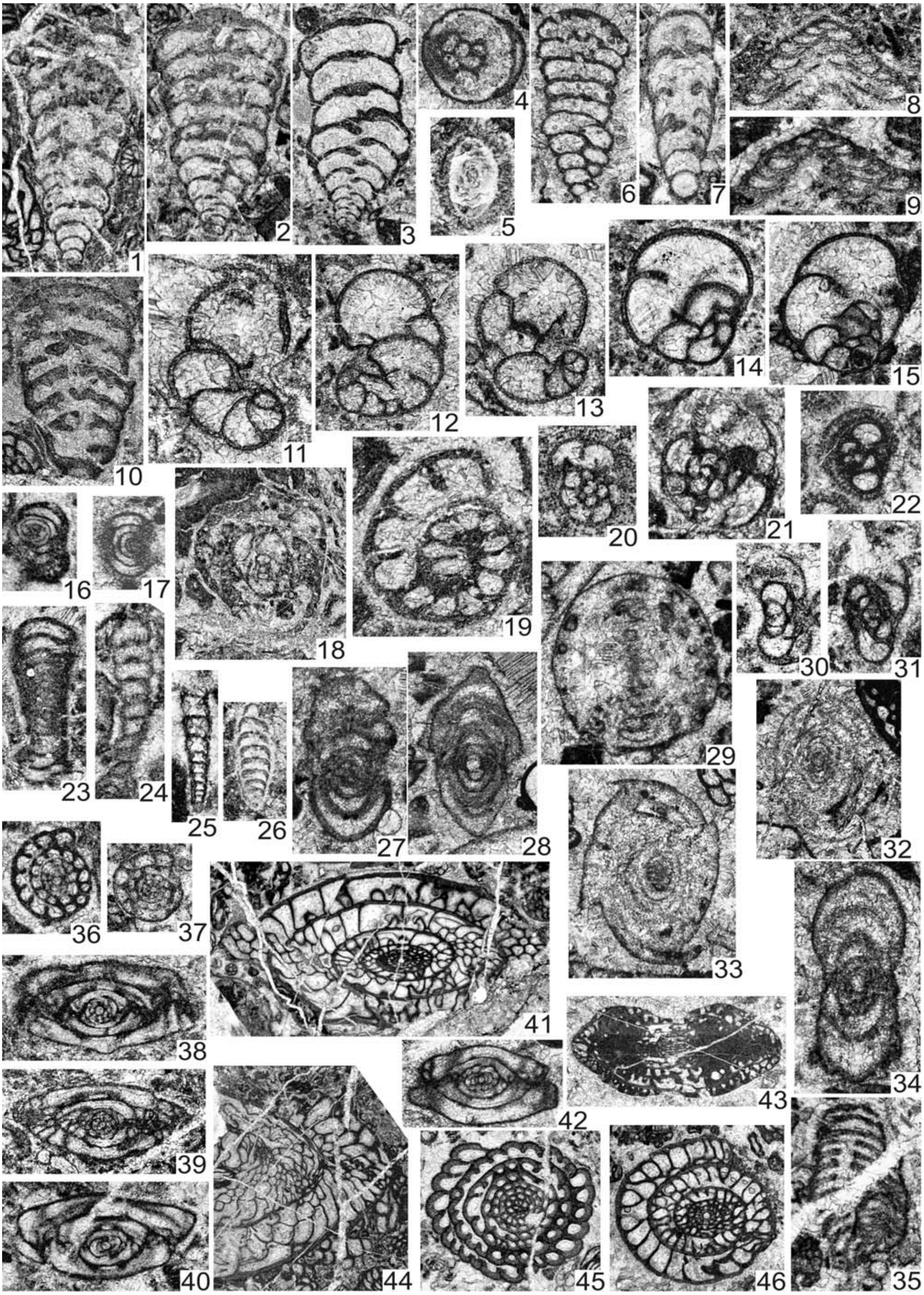
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

Plate 2

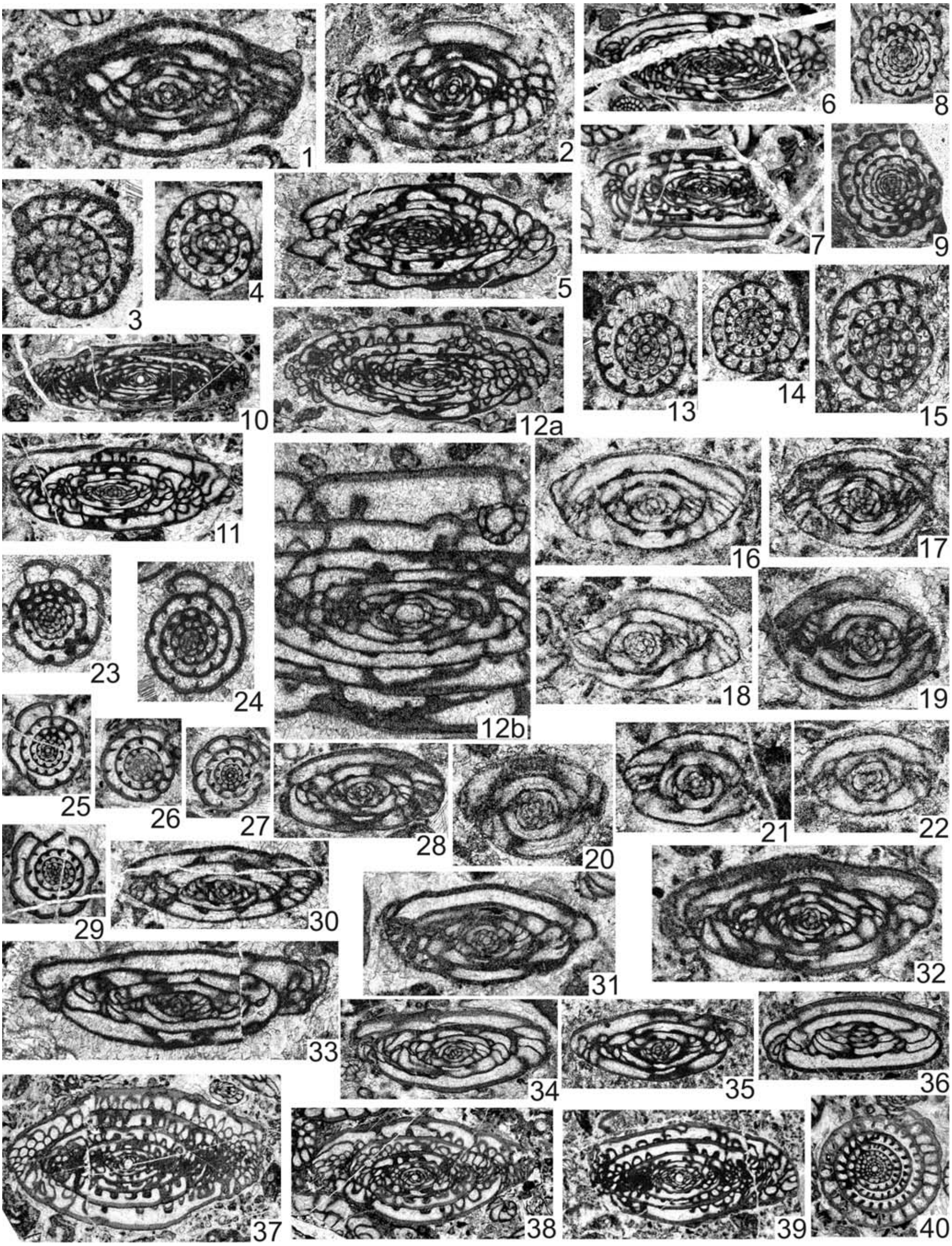
1
2
3
4
5
6
7
8
9
10
11
12a
12b
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

Plate 3