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Original article

Moscovian to Capitanian foraminifers contained in limestone breccias of debris avalanche deposits of the Upper Cretaceous Ise Formation in Irino, NE of Tatsuno, Hyogo －Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Part 8－

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Abstract

Geologic age of the Tatsuno Group in the eastern part of Tatsuno area, western Hyogo, Japan had been determined by five genera of Early and Middle Permian fusulinoideans from small limestone blocks. Recent volcani-stratigraphy in this area revealed that limestone and other Upper Paleozoic blocks are unexceptionally blocks or breccias contained in debris avalanche deposits of the Upper Cretaceous Ise Formation, as the result of collapse of caldera wall at the late stage of volcanism.

Fifty-two species of foraminifers ranging in age from Moscovian to Capitanian were identified from limestone breccias at the abandoned quarry of Irino, east of Tatsuno. Limestone breccias consist mostly of angular to subangular, granule- to cobble-sized limestone densely packed within varicolored, ill-sorted siliciclastic and tuffaceous matrices. Among these limestone fragments, Middle Permian ones are most prolific and contain many species especially of *Neoschwagerina* and *Yabeina*. Non-fusulinoidean foraminifers are also commonly found in association with these age-diagnostic fusulinoideans from Moscovian to Capitanian. *Hemigordiopsis harimensis*, n. sp., *Hemigordiopsis*? sp. and *Kamurana*? sp., and seven species of fusulinoideans (*Pamirina leveni, Montiparus matsumotoi, Maklaya zarodensis, Gifuella* sp., *Yabeina higoensis*, *Y. kaizensis and Y. katoi*) are systematically described in this paper. *Hemigordius harimensis* is characterized by large proloculus, completely involute second tubler chamber, and relatively thin wall for the genus.

Key words: Foraminifers, Moscovian to Capitanian, Irino, limestone breccias, Upper Cretaceous debris avalanche deposits

Introduction

Upper Cretaceous volcanic and volcani-clastic rocks are extensively distributed in hilly mountains south of the Chugoku-Highway between lower streams of Ibo-gawa and Ichi-kawa, Hyogo prefecture. In these mountains, Permian and Triassic fossils are reported from four localities in the eastern part of the Tatsuno area. Permian fusulinoideans are known from the Tatsuno Group at two localities of Irino (Tanaka and Goto, 1984; Goto, 1986) and from the "Nakai Breccia" of the Cretaceous Aioi Group at Nakai (Tanaka and Goto, 1984). Middle Triassic bivalve, *Daonella* sp. is recorded from black shale at Keyakizaka (Nakazawa, 1961; Tanaka and Goto, 1978).

These fossils had been thought to be available for age determination of Paleozoic and Mesozoic strata in the eastern part of the Tatsuno area except for fusulinoideans from the "Nakai Breccia". Recently, Yamamoto et al. (2000), however, concluded that limestone and shale having these fossils are unexceptionally blocks or breccias contained in debris avalanche deposits of the Upper Cretaceous Ise Formation as the result of collapse of caldera wall at the late stage of volcanism of the formation.

Many specimens of Carboniferous and Permian foraminifers were obtained from limestone breccias at the abandoned quarry of Irino, NE of Tatsuno (Figure 1), corresponding to Loc. 2 by Goto in Tanaka and Goto (1984) and Loc. 261 in Kobayashi and Takemura (1995).

This paper describes these foraminifers as the eighth of the serial descriptive works under the title of Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan. Ten species including one new species of *Hemigordiopsis harimensis* are systematically described and discussed. One hundred limestone thin sections used in this paper are stored in the Museum of Nature and Human Activities, Sanda, Hyogo, Japan (Fumio Kobayashi Collection, MNHAH).

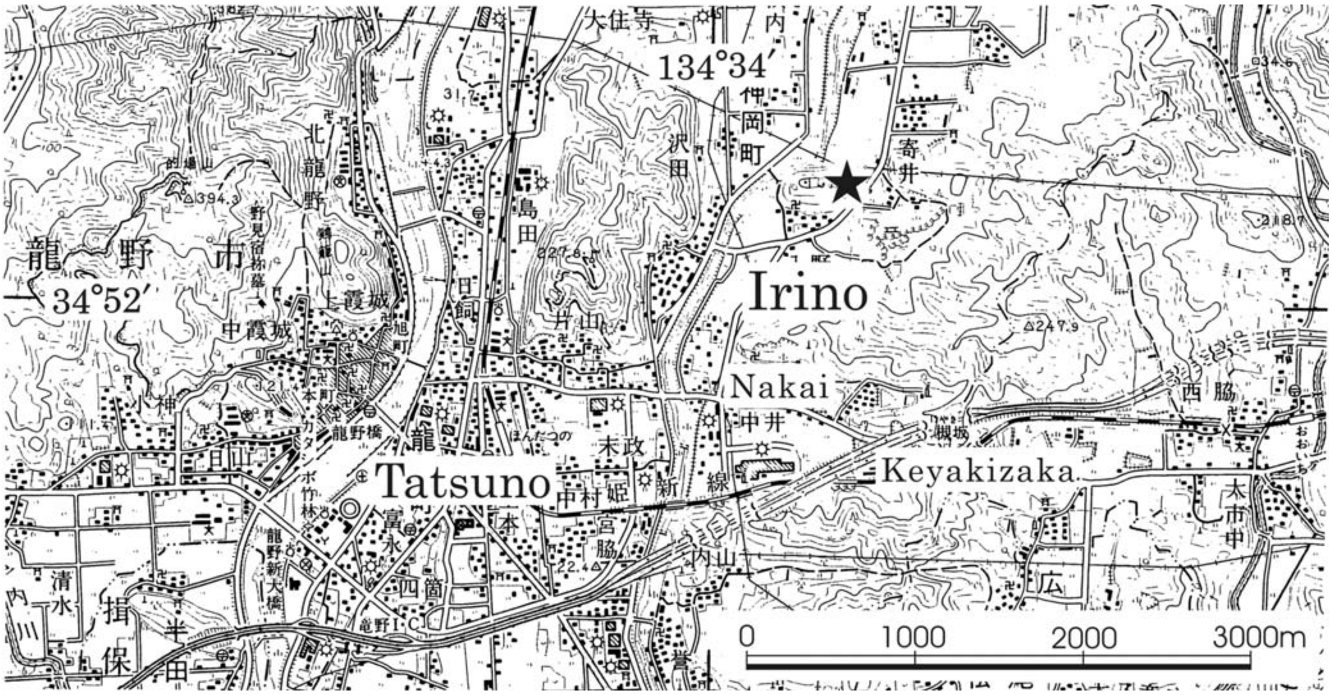

Figure 1. Fossil locality of Irino. Topographic map is from 1: 50,000 map "Tatsuno" of Geographical Survey Institute of Japan.

Samples

Pre-Cretaceous rock fragments of variable sizes and shapes are well exposed in quarries of Irino, NE of Tatsuno. They are intermingled within the Upper Cretaceous volcani-clastic rocks. Limestone samples studied were collected from the upper part of the Ise Formation at the abandoned quarry in front of the quarry now in operating, where the Ise Formation is conformably overlain by the Matobayama Formation (Figure 2).

Limestone breccias are less than 1.5 m in length in the abandoned quarry and composed mostly of angular to subangular, granule- to cobble-sized limestone densely packed within varicolored, ill-sorted siliciclastic and tuffaceous matrices (Figure 2). Limestone fragments are light to dark gray, more or less conglomeratic, lithologically diversified, and classified into dominant lime-mudstone, wackestone, bioclastic packstone, and subordinate bioclastic grainstone, ooid grainstone, and pelloid wackestone (Figure 3). Limestones, except for those strongly dolomitized and recrystallized, are generally fossiliferous, and contain crinoids, marine algae, foraminifers, brachiopods, corals, bryozoans, and others.

Figure 2. Exposure of debris avalanche deposits of the Ise Formation and overlying pyroclastic flow deposits of the Matobayama Formations in the abandoned quarry at Irino (upper photograph). Limestone breccias contained in the Ise Formation, consisting of angular, granule- to cobble-size, limestone fragments densely packed within narrowly spaced, ill-sorted siliciclastic and tuffaceous matrices (lower photograph).

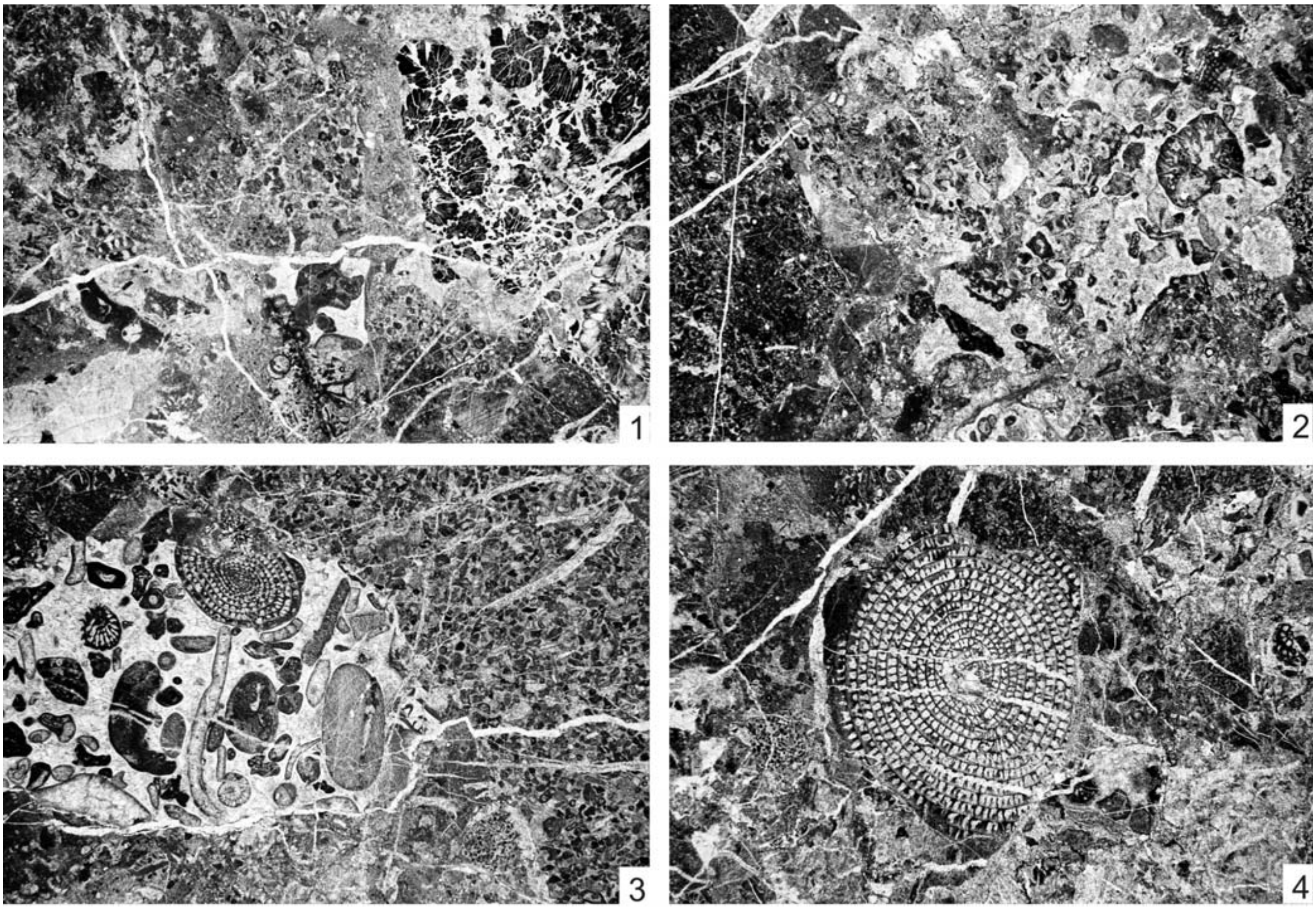

Figure 3. Conglomeratic limestone consisting of various sized granules and pebbles of limestone in limestone breccias of the Ise Formation. 1: Many pebbles and granules obscure in their outline and dark brown dolostone pebble at upper right side. 2: Subangular pebble of bioclastic packstone/grainstone. 3: Well-washed bioclastic grainstone pebble surrounded by pelloid wackestone. 4: Bioclast of *Yabeina kaizensis* in the central part. All ×6.

Notes on fusulinoideans previously reported

Goto in Tanaka and Goto (1984) reported the Early and Middle Permian fusulinoideans from limestone breccias of the lower and middle formations of the Tatsuno Group, respectively, at two localities in Irino. They are unnamed five species of *Triticites, Paraschwagerina tatsunoensis* (the same specimen as named *Parafusulina tatsunoensis* illustrated by Goto in Tanaka and Goto, 1978), and *Schubertella* sp. from the lower formation; and *Misellina* cf. *claudiae* (Deprat, 1912), *Neoschwagerina* cf. *margaritae* Deprat, 1913, *Neoschwagerina* sp., and *Schubertella* sp. from the middle formation. Five forms of *Triticites* are thought to be conspecific. *Paraschwagerina tatsunoensis*, referred to a new species, is not valid taxonomically because of absence of description. *M.* cf. *claudiae* is not compared with the original ones by Deprat (1912) and identical with *Maklaya zarodensis* (Sosnina, 1965) in this paper.

Goto in Tanaka and Goto (1984) also reported Middle Permian fusulinoidean genera of *Afghanella, Pseudododoliolina, Chusenella,* and *Parafusulina* from limestone fragments of the "Nakai Breccia". One specimen named as *Afghanella,* shown in Fig. 10-1 in Tanaka and Goto, 1984, is possibly identified with *Presumatrina neoschwagerinoides* (Deprat, 1913). Other two specimens of *Afghanella* in Fig. 10-2 and 10-3 may be probably identical with *Afghanella ozawai* Hanzawa, 1954. Two specimens of *Parafusulina* are thought to represent incomplete specimens of *Parafusulina kaerimizensis* (Y. Ozawa, 1925b). These fusulinoideans from the "Nakai Breccia" are important faunistically in relation to Middle Permian paleobiogeography of Japan (Kobayashi, 1997), especially of *Presumatrina* and *Afghanella* characteristic in the limestone blocks of the Permian accreted terrane of Southwest Japan.

Age distribution of limestone fragments

In addition to fusulinoideans reported by Goto in Tanaka and Goto (1984) from limestone breccias of the Ise Formation, many Late Paleozoic foraminifers are identified. They amount to 52 species (Table 1, Plates 1-3). Among them, almost all fusulinoideans are characteristic in the Chichibu Fauna recognized in limestone blocks of the Jurassic terranes of Japan and other Circum-Pacific regions (Kobayashi, 1997; 2005a). Possible ages of limestone fragments contained in limestone breccias of Irino are estimated on the basis of comparison with age-diagnostic taxa known from the Itsukaichi-Ome area and fusulinoidean biostratigraphy of the Jurassic terranes of Japan (Kobayashi, 2005a).

The oldest limestone is as old as Moscovian because of the presence of a few specimens assignable to the genus *Fusulinella*, though they are not well oriented. Middle Kasimovian age is determined by *Montiparus matsumotoi* (Kanmera, 1955). Based on the fusulinoidean biostratigraphy of the Akiyoshi Limestone (T. Ozawa and Kobayashi, 1990), Gzhelian age is very probable from some limestone fragments of Irino with *Carbonoschwagerina* sp., presumably comparable with either *C. satoi* (Y. Ozawa, 1925b) or *C. morikawai* (Igo, 1957).

Pseudoschwagerina sp. A has a similar test morphology to that of *Pseudoschwagerina muongthensis* (Deprat, 1915) and suggests the Asselian age. The limestone with *Biwaella omiensis* Morikawa and Isomi, 1961 is either Sakmarian or Artinskian, and that with *Pamirina leveni* Kobayashi, 1977 is certainly Artinskian in age. Kungurian and Roadian (Bolorian and Kubergandian in the Tethyan time scale) ages are assigned to limestone fragments with *Misellina dyhrenfurthi* (Dutkevich in Likharev, 1939), and *Maklaya zarodensis* and *Armenia sphaera* (Y. Ozawa, 1927), respectively. Wordian (Murbabian in the Tethyan time scale) age is determined by the presence of *Neoschwagerina simplex* Y. Ozawa, 1927, *N. craticulifera* (Schwager, 1883), and *N. margaritae*. Limestones of the Wordian are the commonest in limestone fragments at Irino. Subdivision of them into early, middle, and late Wordian is also possible by these three marker species. The occurrence of limestone fragments with *Yabeina higoensis* Kobayashi, 2001 and *Y. kaizensis* Huzimoto, 1936 is common next to those with *Neoschwagerina.* The youngest limestone fragment ranges up to as old as Capitanian based on the presence of *Yabeina katoi* (Y. Ozawa, 1927), diagnostic species commonly associated with *Y. globosa* (Yabe, 1906), and stratigraphic

Species	Plate (Figure)
Palaeotextularia sp.	1(1)
Globivalvulina sp.	1(4–6)
Endothyra sp.	
Postendothyra sp.	1(9)
Tetrataxis conica	1(2,3)
Pamirina leveni	1(47–49)
Sichotenella sp.	1(50)
Rauserella sp	
Schubertella cf. *giraudi*	
Mesoschubertella? sp.	2(8)
Dunbarula cascadensis	2(1–4, 6, 7?)
Dunbarula cf. *schubertellaeformis*	2(17)
Dunbarula? sp.	2(9)
Fusulinella sp.	
Biwaella omiensis	2(13, 14)
Montiparus matsumotoi	2(10)
Carbonoschwagerina sp.	
Chusenella sp.	2(5)
Pseudoschwagerina sp. A	2(11)
Pseudoschwagerina sp. B	
Pseudofusulina sp. A	2(12, 16)
Pseudofusulina sp. B	2(15)
Pseudofusulina spp.	
Misellina dyhrenfurthi	2(18, 19)
Misellina sp.	2(26)
Pseudodoliolina cf. *ozawai*	
Pseudodiolina pseudolepida	2(20)
Armenina sphaera	2(23)
Maklaya zarodensis	2(21, 22, 25)
Neoschwagerina simplex	2(29–31), 3(10, 11?, 12–14)
Neoschwagerina craticulifera	2(24, 28)
Neoschwagerina? sp.	2(27)
Neoschwagerina margaritae	3(1)
Yabeina higoensis	3(4–7, 9)
Yabeina kaizensis	3(2, 3)
Yabeina katoi	3(8)
Gifuella sp.	2(31)
Pseudoendothyra sp. A	1(40–43)
Pseudoendothyra sp. B	1(44, 45, 46?)
Agathammina? sp.	1(21, 22)
Hemigordius sp.	1(8, 29)
Hemigoudiopsis harimaensis	1(16–18)
Hemigordiopsis renzi	1(38, 39)
Hemigordiopsis? sp.	1(19)
Neodiscus spp.	1(27, 31–36)
Baisalina sp.	1(25, 26)
Pachyphloia spp.	1(7, 10–15)
Nodosinelloides sp.	1(30)
Protonodosaria sp.	1(24)
Kamurana? sp.	1(37)
Langella sp.	1(23, 28)
Partisania sp.	1(20)

Table 1. List of identified foraminifers contained in limestone breccias of the Upper Cretaceous Ise Formation.

distribution and correlation of *Yabeina* faunas in the Circum-Pacific regions (Kobayashi et al., 2007).

There are more limestone fragments of unknown age among samples examined herein than those of Moscovian to Capitanian. Most of them are presumable to be Late Paleozoic. The limestone fragments of Changhsingian, Anisian, and possibly post-Triassic in age determined by foraminifers have been obtained from other Upper Cretaceous formations of Hyogo prefecture (author's unpublished data). Lithologically similar limestone to them is also present in Irino. Younger limestone fragment than Capitanian one is, accordingly, possible among limestone fragments contained in debris avalanche deposits of the Upper Cretaceous Ise Formation.

Systematic paleontology

Order FORAMINIFERIDA Eichwald, 1830
Suborder Fusulinina Wedekind, 1937
Superfamily Fusulinoidea von Möller, 1879
Family Ozawainellidae Thompson and Foster, 1937
Genus ***Pamirina*** Leven, 1970
Pamirina leveni Kobayashi, 1977
Plate 1, Figures 47-49

Pamirina leveni Kobayashi, 1977, p. 11-14, pl. 1, figs. 13-38.
Pamirina tethydis Kobayashi, 1977, p. 11, pl. 1, figs. 1-12.

Material.―Two tangential and one oblique sections, and others.

Discussion. ― *Pamirina tethydis* is thought to be synomymous with *P. leveni* based on wide morphologic variations and co-occurrence in the same samples of the Hanagiri Limestone (Kobayashi, 2005b). The Irino specimens are also variable in size and shape of a test, the number of whorls, and thickness of wall. They are, however, identical with the original and subsequent ones from the Artinskian limestone of Akiyoshi (Ueno, 1991), Itsukaichi-Ome area (Kobayashi, 2005a), and others.

Family Schwagerinidae Dunbar and Henbest, 1930
Genus ***Montiparus*** Rozovskaya, 1948
Montiparus matsumotoi (Kanmera, 1955)
Plate 2, Figure 10

Triticites matsumotoi Kanmera, 1955, p. 184-186, pl. 11, figs. 6-25.
Triticites matsumotoi kattoi Suyari, 1962, p. 15, 16, pl. 5, figs. 1-3.
Triticites matsumotoi suitaensis Suyari, 1962, p. 16, 17, pl. 5, figs. 4-6.
Protriticites (Protriticites) matsumotoi (Kanmera): T. Ozawa, 1975a, pl. 8, figs. 29-31.
Montiparus matsumotoi (Kanmera): T. Ozawa and Kobayashi, 1990, pl. 4, figs. 4, 5.
Montiparus matsumotoi matsumotoi (Kanmera): Watanabe, 1991, Fig. 18.7-12, Fig. 22.4-7.
Montiparus matsumotoi inflatus Watanabe, 1991, Fig. 18.1-6, Fig. 20.29-37, Fig. 22.12,13 (nomen nudum).

Material.―One axial and a few oblique sections.

Discussion. ― Many characters such as massive chomata, proloculus size and test expansion, and weakly folded septa in polar regions of the present material well agree with those of the original one by Kanmera (1955) from the Yayamadake Limestone of Kyushu and subsequent ones from the Upper Carboniferous limestones of Japan. Alveolar keriotheca in the Irino specimens is indistinct due to weak recrystalization of outer whorls of a test.

This species were subdivided into several subspecies based on some morphological differences, and assigned to different genera because of different criteria by authors of the primitive genera more or less similar to *Triticites.* Assignment of this species into *Montiparus* is most reasonable on account of its thicker wall with distinct alveolar wall in outer whorls and more well-developed chomata in comparison with similar genera such as *Protriticites.*

Family Neoschwagerinidae Dunbar and Condra, 1928
Genus ***Maklaya*** Kanmera and Toriyama, 1968
Maklaya zarodensis (Sosnina, 1965)
Plate 2, Figures 21, 22, 25

Cancellina zarodensis Sosnina, 1965, p. 152, 153, pl. 2, figs. 2-4.
Maklaya zarodensis (Sosnina): Kobayashi, 2005a, p. 429, Figs. 8.18, 8.19.

Material. ― One axial and two oblique sections illustrated and others.

Discussion.―Many test characters, especially thick wall and degree of development of transverse septula and parachomata of the Irino specimens, well agree with the original ones from Shikote-Alin that were assigned to *Cancellina* (Sosnina, 1965) and the subsequent ones from the Itsukaichi-Ome area (Kobayashi, 2005a). The latter is distinguished from *Neoschwagerina* simplex by more well-developed transverse septula.

Genus ***Gifuella*** Honjo 1959, emend. Kobayashi, 2005b

Type species.―*Gifuella gifuensis* Honjo, 1959, p. 134-136, pl. 6, fig. 7; pl.7, figs.3-7, pl. 8.
Gifuella Honjo, 1959, p.131-134 (original designation)

Neoschwagerina (Gifuella) Chisaka, 1960, p. 25 (nomen transl.)

Diagnosis. — Fusiform test with larger proloculus, thinner wall, and more slender septa, septula, and parachomata than those of genera assignable to Subfamily Neoschwagerininae Dunbar and Condra, 1928, and smaller proloculus and thicker wall than those of genera to Subfamily Lepidolininae A. D. Miklukho-Maklay, 1958. Secondary transverse septula completely lacking in primitive and moderately evolved forms, and not well-developed even in advanced forms sometimes with a test more than 10 mm and more than 15 whorls.

Discussion. — *Gifuella* was regarded to be a junior synonym with *Neoschwagerina* Yabe, 1903 by Thompson (1964) and with *Colania* Lee, 1933 by T. Ozawa (1970). This genus is, however, thought to be taxonomically valid on the basis of reexamination of topotype specimens from the Akasaka Limestone and comparison with other neoschwagerinids (Kobayashi, 2005b). Distinct evolutionary trend is recognized from smaller and more primitive *G. amicula* Honjo, 1959 to larger and more evolved *G. larga* (Morikawa and Suzuki, 1961) through *G. gifuensis,* Honjo, 1959 and a few unnamed species of the genus. Gradual evolution of *Gifuella* is supported by biostratigraphic distribution and morphological analysis of these species in the Akasaka Limestone (author's unpublished data). *Gifuella* was tentatively assigned to Lepidolininae in Kobayashi (2005a), but it is belonged to Neoschwagerinidae without subdivision into subfamily in this paper. Although proposal of a new subfamily of Neoschwagerinidae based on the distinct, gradual, one-way trend evolution of *Gifuella* is possible, this problem will be taken at another opportunity.

Gifuella sp.

Palte 2, Figure 32

Material. — Incomplete axial section illustrated and a few others.

Discussion. — Illustrated specimen is safely assignable to *Gifuella* from relatively large proloculus, slender transverse septula and parachomatala, and lack of secondary transverse septula. Its specific identification and more comparison are difficult because of small number of specimens.

Genus **_Yabeina_** Deprat, 1914

Yabeina higoensis Kobayashi, 2001

Plate 3, Figures 4-7, 9

Yabeina higoensis Kobayashi, 2001, p. 72, Figs. 6.4, 6.8; pl. 5, figs. 1-9.

Material. — Illustrated one axial, one sagittal and two oblique sections, and others.

Discussion. — Wide morphologic variation of the original and subsequent materials of *Yabeina higoensis* was recognized in shape and size of a test, proloculus size, development of secondary transverse septula and others (Kobayashi, 2001; 2006). The Irino specimens are variable in thickness of wall and septula, number of whorls, and development of secondary transverse septula. These different appearances are thought to be resulted from wide morphologic variation of this species and partly due to an orientation of sections.

Yabeina kaizensis Huzimoto, 1936

Plate 3, Figures 2, 3

Yabeina kaizensis Huzimoto, 1936, p. 121, 122, pl. 25, figs. 5-10; Kobayashi, 2006, p. 189, 191; Figures 7.1-7.11.

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

Discussion. — Kobayashi (2006), designating the lectotype, redefined this species. Topotype specimens of *Yabeina kaizensis* are characterized by relatively large proloculus and less well-developed secondary transverse septula for the genus *Yabeina*. The Irino specimens are identical with topotype ones from Saku Basin of Nagano prefecture, though slight differences are recognized between them in development of secondary transverse septula.

Yabeina katoi (Y. Ozawa, 1927)

Plate 3, Figure 8

Neoschwagerina katoi Y. Ozawa, 1927, p. 159, pl. 41, figs. 1, 10; pl. 42, fig. 3; pl. 43, figs. 1a, 2a, 3, 5, 6.

Yabeina katoi (Y. Ozawa, 1927): Morikawa and Suzuki, 1961, p. 68, 69, pl. 10, fig. 1; pl. 21, figs. 2, 3.

Yabeina morikawai Yabe, 1967, p. 658 (nom. subst. pro *Yabeina katoi*).

Material. — Illustrated one oblique section and others.

Discussion. — Large-sized neoschwagerinids identical with *Yabeina katoi* were rarely found. Although they are not well oriented and outer whorls are not well preserved, they are similar to the most common form of *Y. katoi* showing wide morphologic variation in the Akasaka Limestone. The Irino specimens have simpler test characters than the advanced form of this species as described and discussed below.

Generic assignment of this species either *Yabeina or Neoschwagerina* and the designation of junior homonym by Yabe (1967) depend on the absence of "auxiliary meridional septa" (secondary transverse septula) in the original description by Y. Ozawa (1927) from the Akasaka Limestone. Although well-oriented axial sections were not shown, secondary transverse septula are undoubtedly distinguishable in all three, deep, oblique tangential sections illustrated, against the Y. Ozawa's observation.

One-way trend evolution in some species groups of neoschwagerinids is well understood on the basis of morphologic analysis of many characters (e.g., T. Ozawa, 1970; 1975b). Furthermore, highly variable morphologic variation within the same population is recognized in many species of *Yabeina* (Kobayashi et al., 2007). In addition to these facts, taking other characters common in many specimens of *katoi* and all characters gradually changing at every populations in the Akasaka Limestone (author's other unpublished data) into consideration, this species is thought to be reasonably assigned to *Yabaina*. *Yabeina katoi* differs from *Y. globosa* (Yabe, 1906) most clearly in shorter secondary transverse septula and axial septula, and slenderer parachomata, primary transverse, secondary transverse, and axial septula of the former.

Suborder Miliolina Delange and Hėrouard, 1896

Superfamily Cornuspiracea Schultze, 1854

Family Hemigordiopsidae Nikitina, 1969

Genus ***Hemigordiopsis*** Reichel, 1945

Hemigordiopsis harimaensis Kobayashi, n. sp.

Plate 1, Figures 16-18

Derivation of name. — From regional and ancient geographic name, Harima, western part of Hyogo prefecture.

Type specimens. — Holotype D2-035567 (tangential section, Pl. 1, Fig. 16). Paratypes D2-035580 (oblique axial section, Pl. 1, Fig. 17), D2-035567 (incomplete oblique section, Pl. 1, Fig. 18).

Type locality. —Irino, Tatsuno City, Hyogo pefecture.

Diagnosis. — Large *Hemigordiopsis* with large proloculus, involute second tubler chamber, and relatively thin wall for the genus.

Description. — Test globular, 2.3 mm or more in diameter, with shallow umbilical depressions. Large subspherical proloculus of about 0.25 mm followed by enrolled tubler nonseptate second chamber. Early one to two whorls streptospiral. Later five to six whorls completely planispiral and involute throughout growth. Tubler chamber becoming gradually from subspherical to spherical. Chambers low relative to thick wall and broad, extending to the umbilicus on each side.

Wall dark, calcareous, imperforate, porcelaneous, and as thick as the height of the chamber. Wall appears to be partially differentiated into a few layers and variable in thickness. Calcareous and porcelaneous materials weakly developed in umbilical sutures of outer whorls.

Material. —Illustrated three specimens.

Discussion. — This new species is much alike *Hemigordiopsis subglobosa* described by Wang (1982) from the Lower Permian of Xizang in thickness of wall and mode of coiling in the second tubler chamber. But the former has a more spherical test than the latter. *Hemigordiopsis harimaensis* is distinguished by its larger proloculus, fewer number of whorl, and thinner wall from *Hemigordiopsis renzi* Reichel, 1945 described and illustrated from the Middle to Upper Permian of Cyprus (Reichel, 1945), Turkey (Zaninetti et al, 1981), Tunisia (Gargouri and Vachard, 1988), Myanmar (Brönnimann et al., 1978), Yunnan (Sheng and He, 1983), and Primorye (Nikitina, 1969). It is more closely similar to three species of "*Gansudiscus*", considered to be a junior synonym of *Hemigordiopsis* (Loeblich and Tappan, 1988), proposed by Wang and Sun (1973) from the Lower Permian of the Chinling Range. However, this new species has thinner wall than the Chinese ones, and has completely planispiral tubler second chamber.

Geologic age. — Wordian (Murgabian in the Tethyan time scale) according the association with unidentified species of *Neoschwagerina.*

Hemigordiopsis ? sp.

Plate 1, Figure 19

Material. —One incomplete oblique section.

Discussion. — This specimen seems to be tangential section of rounded staffellid genus such as *Staffella* Y. Ozawa, 1925a or *Sphaerulina* Lee, 1933. However, this specimen differs from staffellid fusulinoideans by its nonseptate second chamber and thicker, presumably porcelaneous wall, which was altered to be thinner and uneven due to recrystallization of a test. It is tentatively assigned to *Hemigordiopsis* with reservation.

Superfamily Soritacea Ehrenberg, 1839

Family Milioliporidae Brönnimann and Zaninetti in Brönnimann et al, 1971

Genus ***Kamurana*** Altiner and Zaninetti, 1977

Kamurana ? sp.

Plate 1, Figure 37

Material. —Illustrated one oblique section and others.

Discussion. —Large test more than 2 mm in diameter, undivided, sigmoidly enrolled, tubler second chamber, and calcareous and porcelaneous wall of the specimens examined suggest their generic assignment to *Kamurana*, proposed by Altiner and Zaninetti (1977) from the Upper

Permian of the eastern part of the Taurus Mountains, Turkey. However, they are questionably belonged to the genus because of indistinct coarsely perforate wall and obscure test characters of outer whorls.

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Plate 1.

Fig. 1. *Palaeotextularia* sp. D2-028624, ×20.

Figs. 2, 3. *Tetrataxis conica* (Ehrenberg). 2: D2-028617, ×50; 3: D2-028617, ×40.

Figs. 4-6. *Globivalvulina* sp. 4: D2-028603; 5: D2-028623; 6: D2-028626, all ×50.

Figs. 7, 10-15. *Pachyphloia* spp. 7: D2-028617; 10: D2-028614; 11: D2-028581; 12: D2-028609; 13: D2-035579; 14: D2-028626; 15: D2-035579, 15:×30; others:×50.

Figs. 8, 29. *Hemigordius* sp. 8: D2-028627; 29: D2-035578, both ×40.

Fig. 9. *Postendothyra* sp. D2-028631, ×50.

Figs. 16-18. *Hemigordiopsis harimaensis,* n. sp. 16: D2-035567, ×15; 17: D2-035580, ×20; 18: D2-035567, ×20.

Fig. 19. *Hemigordiopsis?* sp. D2-028599, ×15.

Fig. 20. *Partisania* sp. D2-028599, ×30.

Figs. 21, 22. *Agathammina?* sp. 21: D2-028609; 22: D2-028606, both ×40.

Figs. 23, 28. *Langella* sp. 23: D2-028609, ×30; 28: D2-028631, ×50.

Figs. 24. *Protonodosaria* sp. D2-028589, ×50.

Figs. 25, 26. *Baisalina* sp. 25: D2-028596, ×30; 26: D2-028590, ×40.

Fig. 30. *Nodosinelloides* sp. D2-028584, ×50.

Figs. 27, 31-36. *Neodiscus* spp. 27: D2-028590; 31: D2-035586; 32: D2-028578; 33: D2-035586; 34: D2-035567; 35: D2-028632; 36: D2-028596, 27, 32, 33, 35: ×40; 31, 34: ×50; 36: ×30.

Fig. 37. *Kamurana?* sp. D2-035564, ×20.

Figs. 38, 39. *Hemigordiopsis renzi* Reichel. 38: D2-035581; 39: D2-035581, both ×20.

Figs. 40-43. *Pseudoendothyra* sp. A. 40: D2-028622; 41: D2-028592; 42: D2-028629; 43: D2-028629, 40: ×40; others: ×50.

Figs. 44, 45, 46(?). *Pseudoendothyra* sp. B. 44: D2-035578, ×40; 45: D2-28632, ×40; 46: D2-028632, ×50.

Figs. 47-49. *Pamirina leveni* Kobayashi. 47: D2-028615,×40; 48: D2-028579,×40; 49: D2-028624, ×50.

Fig. 50. *Sichotenella* sp. D2-028611, ×50.

Plate 2.

Figs. 1-4, 6, 7(?). *Dunbarula cascadensis* (Thompson, Wheeler, and Danner). 1: D2-035579, ×40; 2: D2-028636, ×30; 3: D2-028629, ×50; 4: D2-028581, ×40; 6: D2-028620, ×30; 7: D2-02809, ×40.
Fig. 5. *Chusenella* sp. D2-035562, ×10.
Figs. 8. *Mesoschuberetella?* sp. D2-035580, ×30.
Fig. 9. *Dunbarula?* sp. D2-028585, ×40.
Fig. 10. *Montiparus matsumotoi* (Kanmera). D2-028627, ×15.
Fig. 11. *Pseudoschwagerina* sp. A. D2-028616, ×15.
Figs. 12, 16. *Pseudofusulina* sp. A. 12: D2-035582, 16: D2-028629, both ×10.
Figs. 13, 14. *Biwaella omiensis* Morikawa and Isomi. 13: D2-035560, 14: D2-028600, both ×20.
Fig. 15. *Pseudofusulina* sp. B.
Fig. 17. *Dunbarula cf. schubertellaeformis* Sheng. D2-028622, ×30.
Figs. 18, 19. *Misellina dyhrenfurthi (Dutkevich). 18: D2-028579, 19: D2-028632, both ×25.*
Fig. 20. *Pseudodoliolina pseudolepida* (Deprat). D2-028630, ×15.
Figs. 21, 22, 25. *Maklaya zarodensis* (Sosnina). 21: D2-028633, ×12; 22: D2-028585, ×20; 25: D2-035576, ×10.
Fig. 23. *Armenina sphaera* (Y. Ozawa). D2-028602, ×25.
Figs. 24, 28. *Neoschwagerina craticulifera* (Schwager). 24: D2-028641, 28: D2-028575, ×15.
Fig. 26. *Misellina* sp. D2-028583, ×25.
Fig. 27. *Neoschwagerina?* sp. D2-028631, ×10.
Figs. 29-31. *Neoschwagerina simplex* Ozawa. 29: D2-028586, ×15; 30: D2-028581, ×25; 31: D2-08609, ×25.
Fig. 31. *Gifuella* sp. D2-028576, ×15.

Plate 3.

Fig. 1. *Neoschwagerina margaritae* Deprat. D2-028590, ×10.
Figs. 2, 3. *Yabeina kaizensis* Huzimoto. 2: D2-035570, 3: D2-035586, both ×10.
Figs. 4-7, 9. *Yabeina higoensis* Kobayashi. 4: D2-035559, ×10; 5: D2-028596, ×12; 6: D2-028610, ×15; 7: D2-035580, ×15; 9: D2-028572, ×10.
Fig. 8. *Yabeina katoi* (Y. Ozawa). D2-028634, ×10.
Figs. 10, 11(?), 12-14. *Neoschwagerina simplex* Y. Ozawa. 10: D2-0286620; 11: D2-035566; 12: D2-028609; 13: D2-028617; 14: D2-028572, 10, 13: ×20; 11: ×25; 12, 14: ×15.

Plate 1

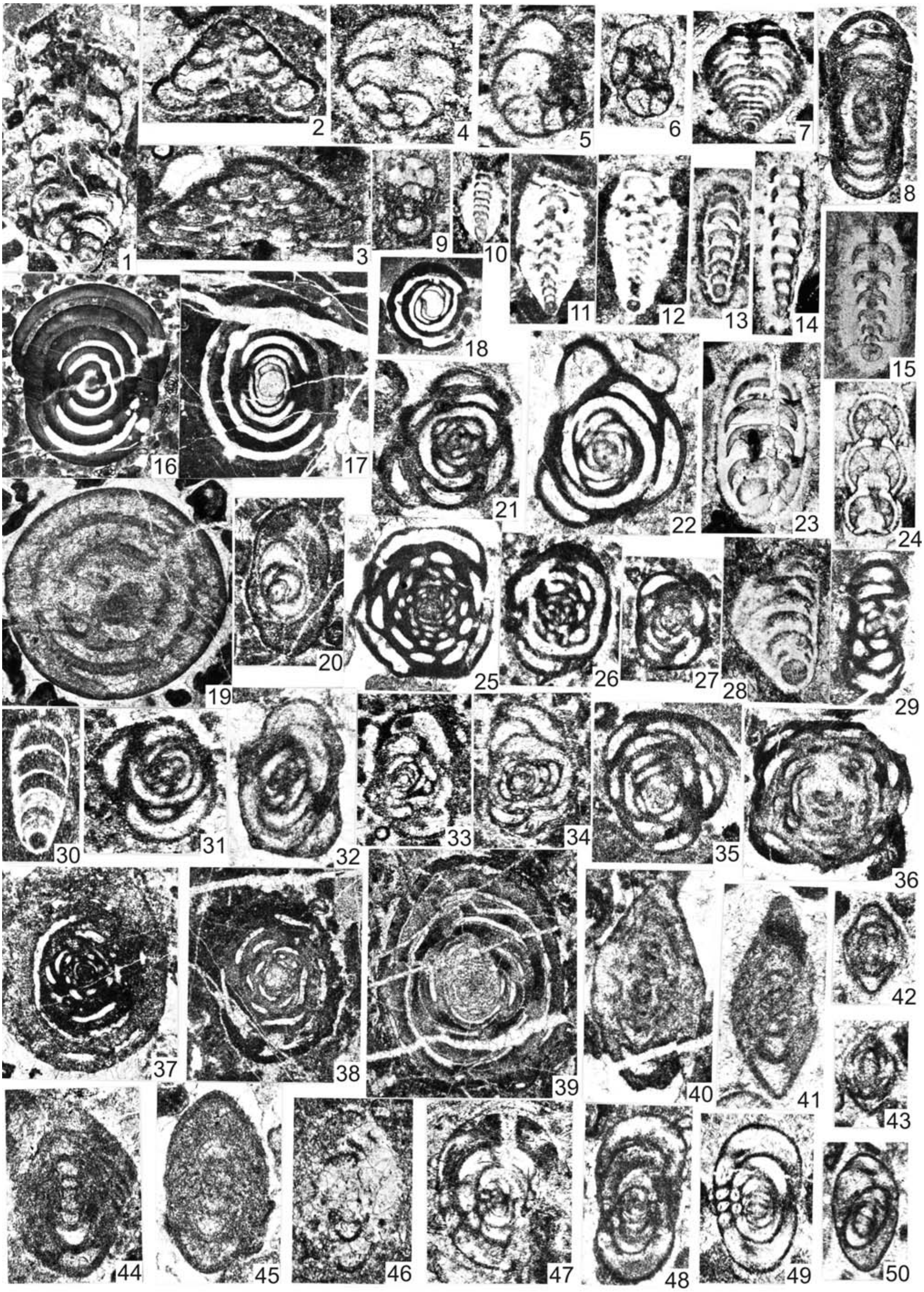
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Plate 2

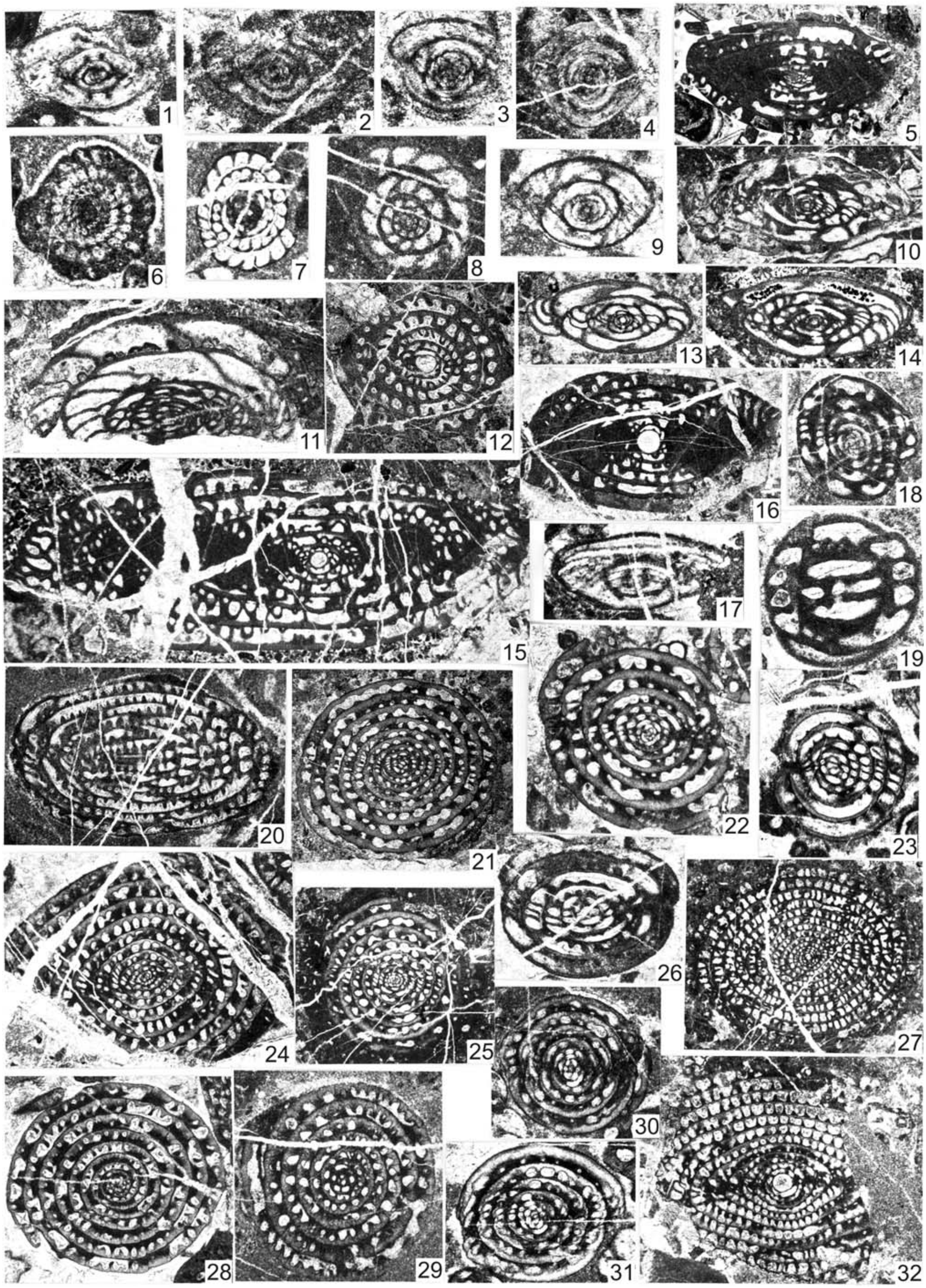
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Plate 3