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Original article

Early Late Permian (Wuchiapingian) foraminifers in the Tatsuno area, Hyogo－Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan, Part 4－

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Abstract

The Late Permian foraminiferal fauna from the limestone of the Tatsuno Group in the Tatsuno area consists of 21 species assignable to 17 and two indeterminate genera. The characteristic taxa are *Colaniella parva, Codonofusiella* cf. *kwangsiana, Nanlingella*? *simplex, Reichelina changhsingensis*, *Paraglobivalvulina mira*, *Dagmarita chanakchiensis*, and *Robuloides lens*. These foraminifers indicate the early Late Permian (Wuchiapingian) age of this fauna, and not the latest Permian (Changhsingian) age, as previously thought. They are easily distinguished from the Changhsingian foraminiferal fauna from the Mikata area by the absence of *Palaeofusulina*. *Colaniella parva* and *Septoglobivalvulina*? sp. are systematically described and discussed herein.

Key words: Foraminifers, early Late Permian (Wuchiapingian), Tatsuno area, Hyogo, serial descriptive work.

Introduction

Permian and Triassic formations are narrowly distributed in the Tatsuno area, about 20 km west of Himeji. The lithology and fossils from these formations and their close association with gabbroic rocks referable to the Yakuno complexes show their tectonic assignment to the Maizuru Terrane. In this area, dominant basic rocks partly interbedded with argillaceous rocks are locally called “B formation” (Hase et al., 1981) or the “middle formation” (Goto, 1986) of the Tatsuno Group. Mudstone intercalating thin beds of sandstone, conglomerate, and limestone is named “C formation” (Hase et al., 1981) or the “upper formation” (Goto, 1986) of the Tatsuno Group. The former and latter lithostratigraphic units are respectively correlatable to the lower formation and upper formation of the Maizuru Group in the type area.

Fossils available for the correlation and age determination of the Permian and Triassic formations in the Tatsuno area are: (1) the Late Permian (Lopingian) foraminifer, *Colaniella* from “C formation” exposed at the north of Nakagaichi (Hase et al., 1981), and (2) the Middle Triassic (Anisian) foraminifer, *Meandrospira* from the Hiraki Formation near the locality of Colaniella (Goto, 1986). The *Colaniella* fauna of the Tatsuno area was compared with the latest Permian (Changhsingian) Palaeofusulina aff. *sinensis*-*Colaniella parva* fauna from the upper formation of the Maizuru Group (Ishii et al., 1975; Hase et al, 1981). The *Lepidolina kumaensis* fauna which is very common in the middle formation of the Maizuru Group has not been reported from the Tatsuno area.

Limestone samples collected from the same locality as that of the previous workers in the

Tatsuno area contain many colaniellids and other foraminifers. Some of them are uncommon or unknown from other localities of the Upper Permian of Japan. These foraminifers are undoubtedly early Late Permian (Wuchiapingian) in age based on the association of *Colaniella parva* (Colani) with *Codonofusiella* cf. *kwangsiana* Sheng, both of which were cited in Kobayashi (2003) as the representative age-diagnostic taxa of the Maizuru Group. They are listed and illustrated herein with a note on their faunal characteristics, as the fourth paper of the serial descriptive work by the author under the title of Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan. Among 21 species assignable to 17 and two indeterminate genera of foraminifers, *Colaniella parva* (Colani) and Septoglobivalvulina? sp. are systematically described and discussed.

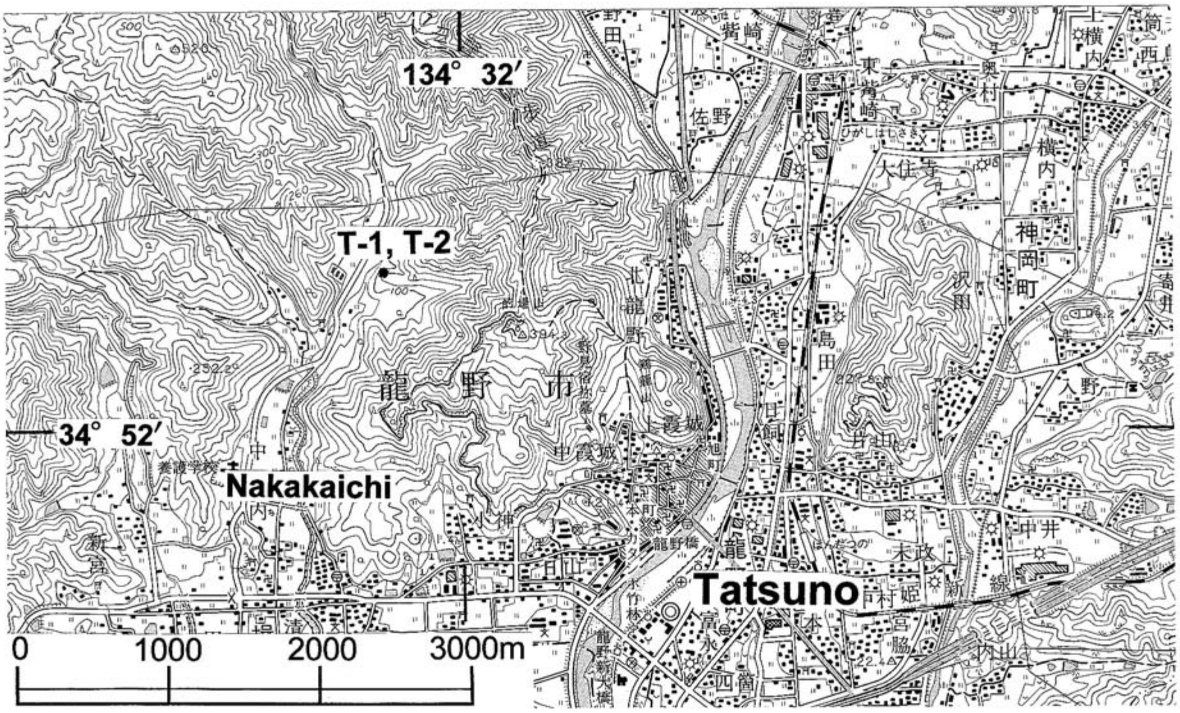

Figure 1. Sample locations in the Tatsuno area. Topographic map is from 1:50,000 map "Tatsuno" of Geographical Survey Institute of Japan.

Material and Foraminiferal fauna

The limestone with early Late Permian foraminifers crops out only in the north of Nakakaichi in the Tatsuno area (Figure 1), corresponding to Locality 265 in Kobayashi and Takemura (1995). From this locality, Ishii et al. (1975) listed 8 species belonging to 3 genera of foraminifers. Hase et al. (1981) distinguished 14 species belonging to 8 genera and illustrated them. They are Colaniella inflata (Wang), *C. cylindrica* Miklukho-Maklay, *C. minima* Wang, *C. xikouensis* Wang, *C.* cf. *parva* (Colani), *C.* cf. *media* Miklukho-Maklay, *C.* n. sp., *Wanganella* sp., *Pseudocolaniella* sp., *Nodosaria* sp., *Globivalvulina* sp., *Hemigordius* sp., *Robuloides* sp., and *Reichelina* sp.

This limestone is a few meters in thickness and is intercalated within black slate of the Tatsuno Group. Two samples, T-1 and T-2, were collected from this limestone. They are highly fossiliferous and contain calcisponges, crinoids, foraminifers, marine algae, and others, and lithologically classified into packstone/floatstone and packstone. Some of them irregularly contain argillaceous seams and are partly conglomeratic. Foraminifers are particularly abundant in the coarse-grained packstone with many bioclasts of crinoids (Figure 2-2) but are rather rare in floatstone (Figure 2-1).

Twenty-one species assignable to 17 and two indeterminate genera of the Late Permian foraminifers were identified from the two limestone samples (Table 1, Plates 1 and 2). Among them, *Colaniella parva* is highly dominant and the other taxa are rare to very rare.

Colaniella parva is the most dominant not only in the Tatsuno area, but also in other Late Permian

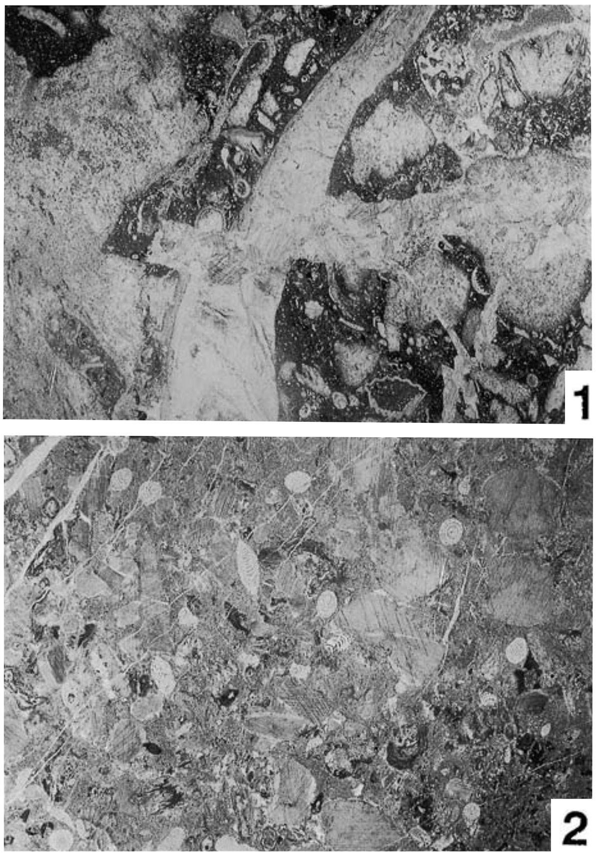

Figure 2. Photomicrographs of the limestone in the Tatsuno area, both: T-1 and ×5.1. 1. Floatstone containing many calcisponges and other fossils. 2. Packstone with many foraminifers mostly of Colaniella parva and bioclasts of crinoids.

faunas from the Iwai-Kanyo area (Kobayashi, 1997), the Kesennuma area (Kobayashi, 2002), and the Mikata area (Kobayashi, 2006). The limestone in these areas is common in that it contains many detrital quartz grains which suggest its deposition under the shallow shelf environment. However, it is not found from the Wuchiapingian limestone of the southern Kanto Mountains (Kobayashi, 2001) and the Lopingian one of the Shirokawa-Nomura area (Kobayashi, 2004). These two limestones occur as an exotic block intermingled within the Jurassic accretionary complexes and originating in the Panthaslassan seamount.

Other foraminifers such as *Dagmarita chanakchiensis* Reytlinger, *Robuloides lens* Reichel, *Paraglobivalvulina mira* Reytlinger, *Nanlingella*? *simplex* (Sheng and Chang), and *Codonofusiella* cf. *kwangsiana* Sheng are also the representative taxa from the Upper Permian. The former three are widely distributed throughout the Tethyan regions, and *Codonofusiella kwangsiana* is restricted to the lower part of the Upper Permian (Wuchiapingian) in East Asia including Japan (Kobayashi, 1999).

The Tatsuno fauna is undoubtedly said to be Wuchiapingian in age from these age diagnostic genera and species and from the complete absence of *Palaeofusulina*. From its characteristic faunal composition, the Tatsuno fauna is distinguished from the Mikata fauna (Kobayashi, 2006), although highly dominant occurrence of *Colaniella parva* is common in both faunas.

Table 1. Early Late Permian foraminifers discriminated in the Tatsuno area.

	T-1	T-2	Plate (Figure)
Colaniella parva (Colani)	X	X	1 (1-20, 22-41)
Wanganella sp.		X	2 (19)
Climacammina sp.	X		
Palaeotextulariidae gen. and sp. indet.	X	X	
Tetrataxis sp.	X	X	1 (42)
Dagmarita chanakchiensis Reytlinger	X	X	2 (28)
Paraglobivalvulina mira Reytlinger	X	X	2 (14)
Paraglobivalvulina sp.		X	2 (13)
Septoglobivalvulina? sp.		X	2 (9-12)
Endothyra sp.		X	2 (21)
Reichelina changhsingensis Sheng and Chang	X	X	2 (4-8)
Codonofusiella cf. *kwangsiana* Sheng		X	2 (2, 3)
Nanlingella? *simplex* s (Sheng and Chang).		X	2 (1)
Agathammina sp.	X	X	2 (22, 23)
Hemigordius sp.	X		2 (29, 30)
Nodosinelloides sp. A	X	X	1 (21)
Nodosinelloides sp. B		X	2 (18)
Pachyphloia ovata Lange	X	X	2 (15-15, 20)
Frondina sp.		X	2 (27)
Robuloides lens Reichel	X	X	2 (24, 25, 26)
Lagenina fam., gen., and sp. indet.		X	1 (43)

Systematic paleontology

The system of higher foraminiferal taxa used in this paper follows that proposed by Loeblich and Tappan (1988). All specimens described and illustrated are stored in the collection of the Museum of Nature and Human Activities, Sanda, Hyogo, Japan (Fumio Kobayashi Collection).

Order FORAMINIFERIDA Eichwald, 1830
Suborder FUSULININA Wedekind, 1937
Superfamily Colanielloidea Fursenko, 1959
Family Colaniellidae Fursenko, 1959
Genus ***Colaniella*** Likharev, 1939
Colaniella parva (Colani, 1924)
Plate 1, Figures 1−20, 22−41

Pyramis parva Colani, 1924, p. 181, pl. 29, figs. 2, 4−14, 15a−15f, 16, 17, 19, 21, 24.

Colaniella parva (Colani). Ishii et al., 1975, pl. 1, figs. 1−3, pl. 4, fig. 4.

Colaniella spp. Ishii et al., 1975, pl. 1, figs. 4−10.

Colaniella cylindrica K. V. Miklukho-Maklay. Ishii et al., 1975, pl. 4, fig. 1; Hase et al., 1981, Fig. 4-4.

Colaniella inflata (K. L. Wang). Ishii et al., 1975, pl. 4, fig. 2; Hase et al., 1981, Fig.4-6.

Colaniella xikouensis K. L. Wang. Ishii et al., 1975, pl. 4, fig. 3; Hase et al., 1981, Fig. 4-5.

Colaniella sp. Ishii et al., 1975, pl. 4, fig. 5.

Pseudocolaniella sp. Ishii et al., 1975, pl. 4, fig. 6.

Colaniella cf. *media* K. L. Wang. Hase et al., 1981, Figs. 4-1−3, 4-12, 4-14.

Colaniella sp. Hase et al., 1981, Fig. 4-7.

Colaniella minima K. L. Wang. Hase et al., 1981, Figs. 4-8, 4-13.

Pseudocolaniella sp. Hase et al., 1981, Fig. 4-10.

Material.—Illustrated 40 and many other specimens.

Description.—Test subfusiform, deviating to the terminal part. Maximum width of test about 0.8 mm, and maximum length about 1.4 mm. Spherical minute first chamber succeeded by uniserially arranged, 17 to 20 chambers, strongly overlapping and gradually increasing their height and width.

Chambers divided into chamberlets by radially arranged primary, secondary, and tertiary platy partitions. Primary platy partitions about 16 and developed throughout the test. Each chamberlet divided by primary platy partitions is further subdivided by two or three secondary ones between adjacent primary ones even in the early ontogenetic stage. Differentiation into chamberlets in a few chambers in the initial stage sometimes indistinct due to mineralization. Tertiary ones only present at test margins in the middle and late ontogenetic stages.

Wall perforate with fibrous or radial structure. Indistinct thin translucent layer sometimes present in inner side of perforate wall. Aperture terminal and radiate.

Discussion.—The Tatsuno specimens show a highly variable shape and size of the test in thin sections as well as those from other localities. Among the well-oriented many specimens, 40 are selectively illustrated in this paper. They are identical with the original ones described from Vietnam by Colani (1924), and many specimens from the uppermost Permian limestone in the Iwai-Kanyo area (Kobayashi, 1997), the Kesennuma area (Kobayashi, 2002), and the Mikata area (Kobayashi, 2006).

The appearances of this and other species of *Colaniella* are highly variable in the orientation of thin sections, and are understood from the reconstruction of the external and internal test structure (Reichel, 1946, Fig. 33), and from the illustration showing variable appearances of the test characters depending on the orientation of the thin sections (Reichel, 1946, Fig. 32). The important characters are the size and shape of the test and their ontogenetic changes, the number of the chamber, and the degree of development of the platy partitions. Reliable identification of *Colaniella* is possible on the basis of careful examination of these characters from variously-oriented thin sections including many well-oriented ones.

The size and outline of the test, apical angle, degree of tapering of test and overlapping of chambers are highly variable by the orientation of the thin sections. They are also variable in the definitely oriented specimens from a single rock sample. These different appearances in many test characters gradually changing from specimen to specimen are apparently due to the wide intraspecific variation of *Colaniella parva,* as exemplified by Kobayashi (1997; 2002; 2006).

Several species of *Colaniella* classified by Ishii et al. (1975) from the Mikata area and by Hase et al. (1981) from the Tatsuno area were produced artificially by their inadequate recognition for the orientation of thin sections and for the wide morphologic variation of *Colaniella parva*. Furthermore, the variable appearance and wide intraspecific variation of colaniellids are strongly suggestive of the junior synonyms of *Paracolaniella* and *Pseudocolaniella* proposed by K. L. Wang (1966) from South China with *Colaniella*.

Superfamily Palaeotextularoidea Galloway, 1933
Family Biseriamminidae Chernysheva, 1941
Subfamily Biseriammininae Chernysheva, 1941
Genus ***Septoglobivalvulina*** J. X. Lin, 1978
Septoglobivalvulina? sp.
Plate 2, Figures 9－12

Material.－Four oblique sections, all excentered.

Discussion.－The unnamed species is marked by an involute spherical test more than 0.6 mm in diameter with secondary septal partitions and undifferentiated thin wall. Although the chamber arrangement of them is similar to that of some involute forms of a large-sized *Globivalvulina*, the wall structure is different between the two. Among the known genera, the present specimens seem to be closest to *Septoglobivalvulina* proposed by J. X. Lin (1978) from the lower Upper Permian of Guangxi, especially in the spherical involute test and undifferentiated thin wall. However, the mode of the biseriality is different between the two. Loeblich and Tappan (1988) recognized a junior synonymy of *Septoglobivalvulina* with *Paraglobivalvulina*. However, the former has a much thinner wall and less well-developed chamberlets. For these reasons, this unnamed species was questionably assigned to *Septoglobivalvulina*.

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Plate 1.

Figs. 1—20, 22—41. *Colaniella parva* (Colani).
1: D2-027285a; 2: D2-027298a; 3: D2-027294; 4: D2-027270a; 5: D2-027261a; 6: D2-027280a; 7: D2-027290a; 8: D2-027280b; 9: D2-027289; 10: D2-027291a; 11: D2-027298b; 12: D2-027296a; 13: D2-027286; 14: D2-027274a; 15: D2-027301a; 16: D2-027301b; 17: D2-027257; 18: D2-027285; 19: D2-027297a; 20: D2-027281a; 22: D2-027297b; 23: D2-027297c; 24: D2-027292a; 25: D2-027283; 26: D2-027288a; 27: D2-027301c; 28: D2-027275; 29: D2-027281b; 30: D2-027300a; 31: D2-027299a; 32: D2-027276a; 33: D2-027266a; 34: D2-027276b; 35: D2-027277; 36: D2-027258; 37: D2-027286b; 38: D2-027271; 39: D2-027295a; 40: D2-027296b; 41: D2-027299b; 4, 5, 17, 33, 36: T-1, others: T-2; 1—17: ×30; others: ×40.

Fig. 21. *Nodosinelloides* sp. A
D2-027290b, T-2, ×50.

Fig. 42. *Tetrataxis* sp.
D2-027253, T-1,×30.

Fig. 43. Lagenina fam., gen., and sp. indet.
D2-027280c, T-2, ×40.

Plate 2.

Fig. 1. *Nanlingella*? *simlex* (Sheng and Chang).
D2-027278, T-2, ×75.

Figs. 2, 3. *Codonofusiella* cf. *kwangsiana* Sheng.
2: D2-027297d; 3: D2-027301d, both T-2, ×40.

Figs. 4—8. *Reichelina changhsingensis* Sheng and Chang.
4: D2-027296c; 5: D2-027292b; 6: D2-027288b; 7: D2-027272; 8: D2-027270b, 8: T-1; others: T-2, all ×50.

Figs 9—12. *Septoglobivalvulina*? sp.
9: D2-027293a; 10: D2-027296d; 11: D2-027299c; 12: D2-0293b, all T-2, ×50.

Fig. 13. *Paraglobivalvulina* sp.
D2-027282, T-2, ×15.

Fig. 14. *Paraglobivalvulina mira* Reytlinger.
D2-027290b, T-2, ×20.

Figs. 15－17, 20. *Pachyphloia ovata* Lange.
15: D2-027265; 16: D2-027297e; 17: D2-027292c; 20: D2-027274b; 15: T-1, ×40; others: T-2, ×50.
Fig. 18. *Nodosinelloides* sp. B
D2-027300c, T-2, ×50.
Fig. 19. *Wanganella* sp.
D2-027288c, T-2, ×50.
Fig. 21. *Endothyra* sp.
D2-027274b, T-2, ×50.
Figs. 22, 23. *Agathammina* sp.
22: D2-027266b; 23: D2-027261b, both T-1, ×40.
Figs. 24?, 25, 26. *Robuloides lens* Reichel.
24: D2-027246, T-1; 25: D2-027295c, T-2; 26: D2-027291b, T-2; all ×50.
Figs. 27. *Frondina* sp.
D2-027276c, T-2, ×50.
Fig. 28. *Dagmarita chanakchiensis* Reytlinger.
D2-027301e, T-2, ×50.
Figs. 29, 30. *Hemigordius* sp.
29: D2-027261c; 30: D2-027268, both T-1, ×40.

Plate 1

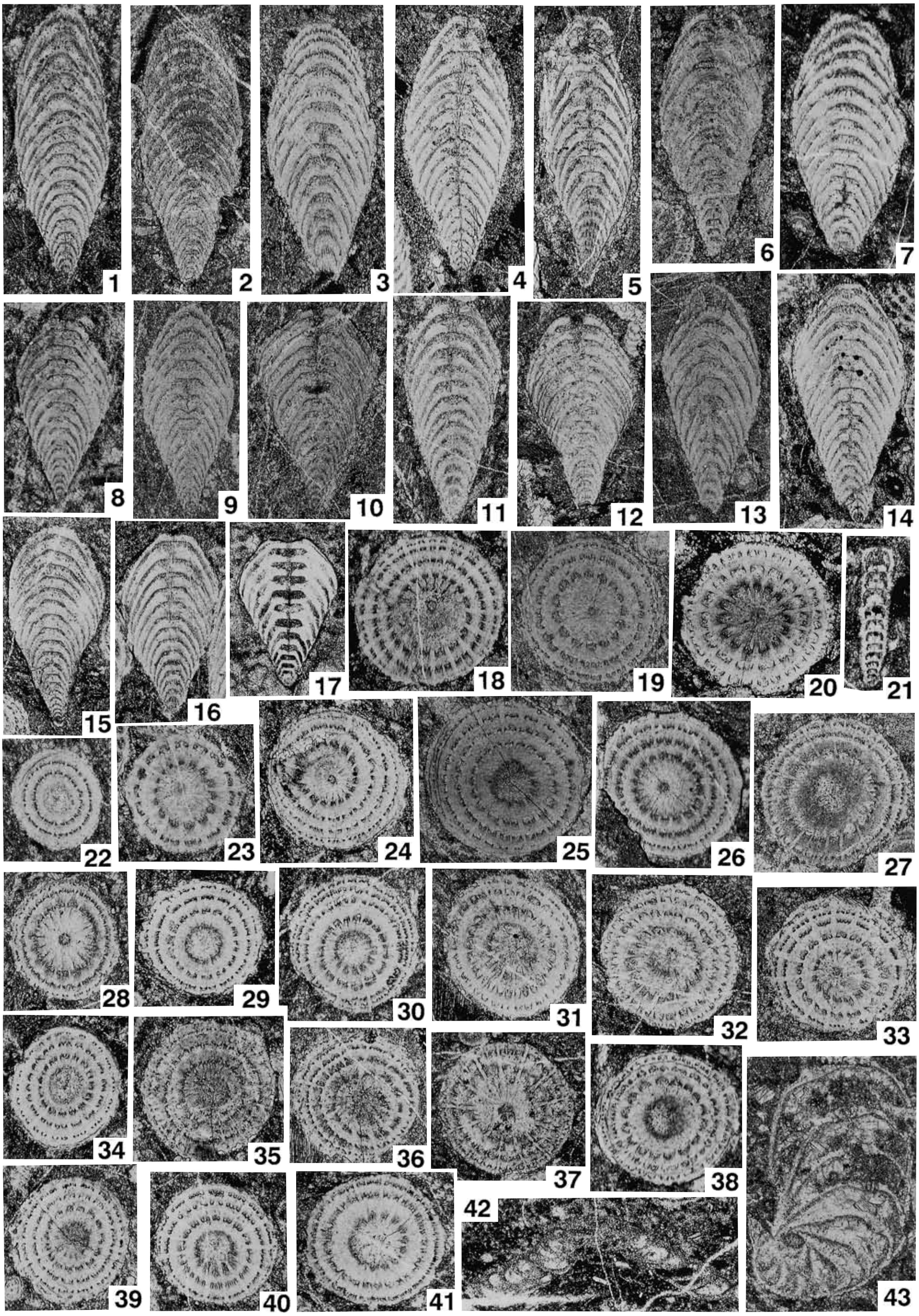
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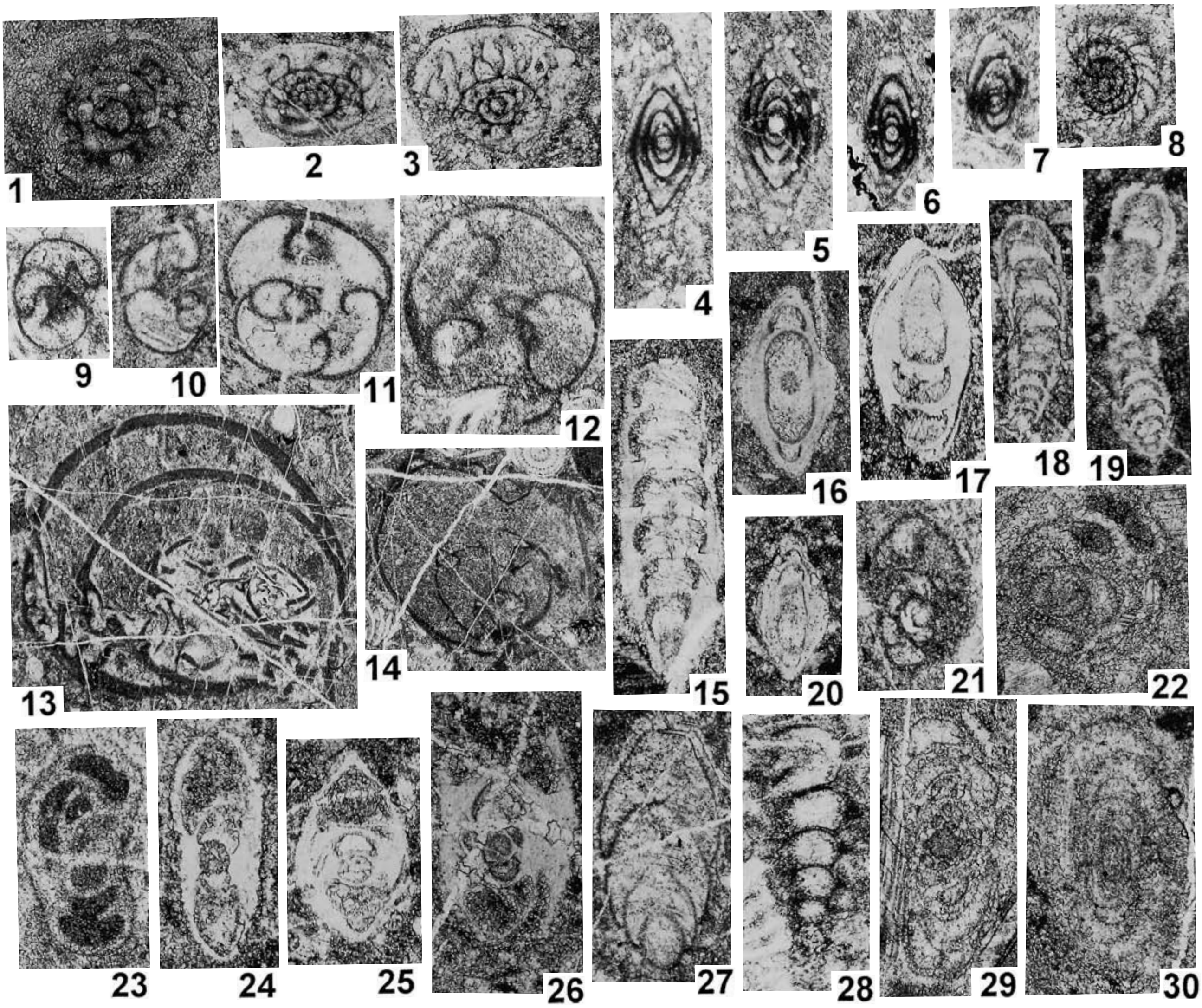
Plate 2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