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Report

Early Permian fusulines from the western part of Mt. Ryozen, Shiga Prefecture, Japan

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Abstract

We discriminated forty-seven species of Early Permian foraminifers, 29 fusulines and 18 non-fusuline foraminifers, in 14 limestone samples collected at seven localities in the western part of Mt. Ryozen, Shiga Prefecture, Japan. Among them 20 species of fusulines are described and their systematic problems are discussed. They include *Pseudoschwagerina ryozenensis* n. sp. and *Paraschwagerina? sublineata*. The former has a large and inflated fusiform test characterized by its irregularly fluted septa that produce a few chamberlets. Tha latter is important to consider taxonomy and phylogeny of schwagerinid species with inflated test.

Key words: Early Permian fusulines, *Pseudoschwagerina ryozenensis* n. sp., Mt. Ryozen, Mino Terrane

Introduction

The greenstone-limestone facies in the Mino Terrane of Inner Zone of Southwest Japan is represented by large limestone blocks of Mts. Funabuse, Ibuki, and Ryozen (Figure 1). Various fossils, especially of Permian fusulines, are prolific and were studied in: Mt. Ibuki and neighboring areas (M. Kobayashi, 1957; Morikawa and Isomi, 1961), Mt. Funabuse (Hy. Igo and Ogawa, 1958; Ishii, 1964), Mt. Uokane (Sashida, 1980), Akasaka (e.g., Ozawa, 1927; Morikawa, 1958; Honjo, 1959), Hachiman (Kanuma, 1959; Hh. Igo, 1996), and Nyukawa (Hy. Igo, 1964; 1965).

The largest limestone block attains to several hundreds meters thick exposed in Mt. Ryozen and neighboring areas, Shiga Prefecture. According to the previous works, all these limestones are Lower Permian (Miyamura et al., 1976), and the depositional period of limestone is shorter in the Ryozen than in other large limestone blocks of the Mino Terrane.

We have recognized that the Ryozen fusulines are more prolific and taxonomically diverse than presumed by previous workers (e.g., Miyamura et al., 1976). They contain valuable species for faunal consideration of Early Permian schwagerinids. In this paper, we list foraminifers identified in 14 limestone samples collected from the western part of Mt. Ryozen. We describe 20 species of fusulines, including new species of *Pseudoschwagerina*, *P. ryozenensis*, among 47 species of Early Permian foraminifers discriminated. Faunal comparison of these foraminifers is postponed until the whole aspects of the fauna in the Ryozen are clarified. Microphotographs of many fusulines are illustrated so that broad morphologic variation of fusulines can be easily understood visually, and they can be compared with the contemporaneous faunas of Japan and outside Japan. Limestone thin sections of 234 slides are prepared for this study, and stored in the collection of the Museum of Nature and Human Activities, Hyogo, Japan (Fumio Kobayashi Collection, MNHAH).

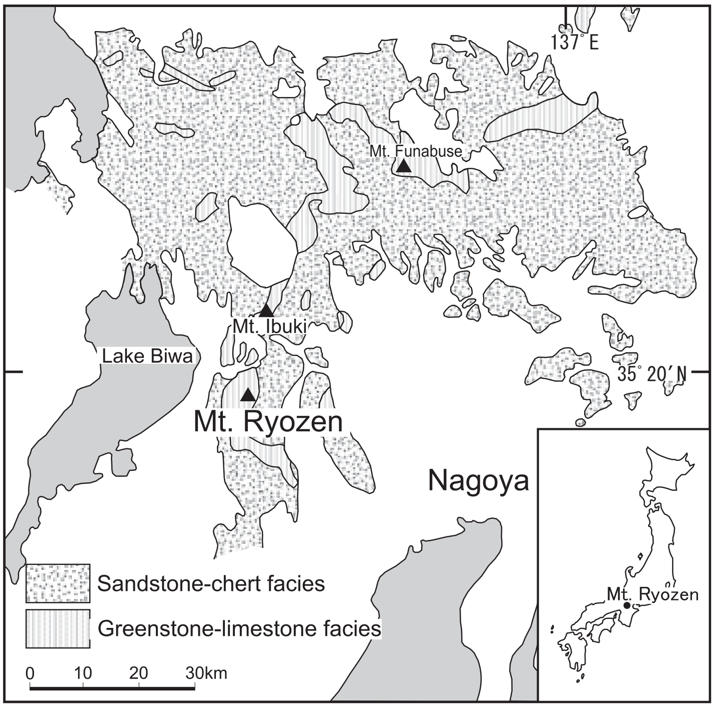

Figure 1. Distribution of greenstone-limestone facies and sandstone-chert facies in the western half of the Mino Terrane, central Japan.

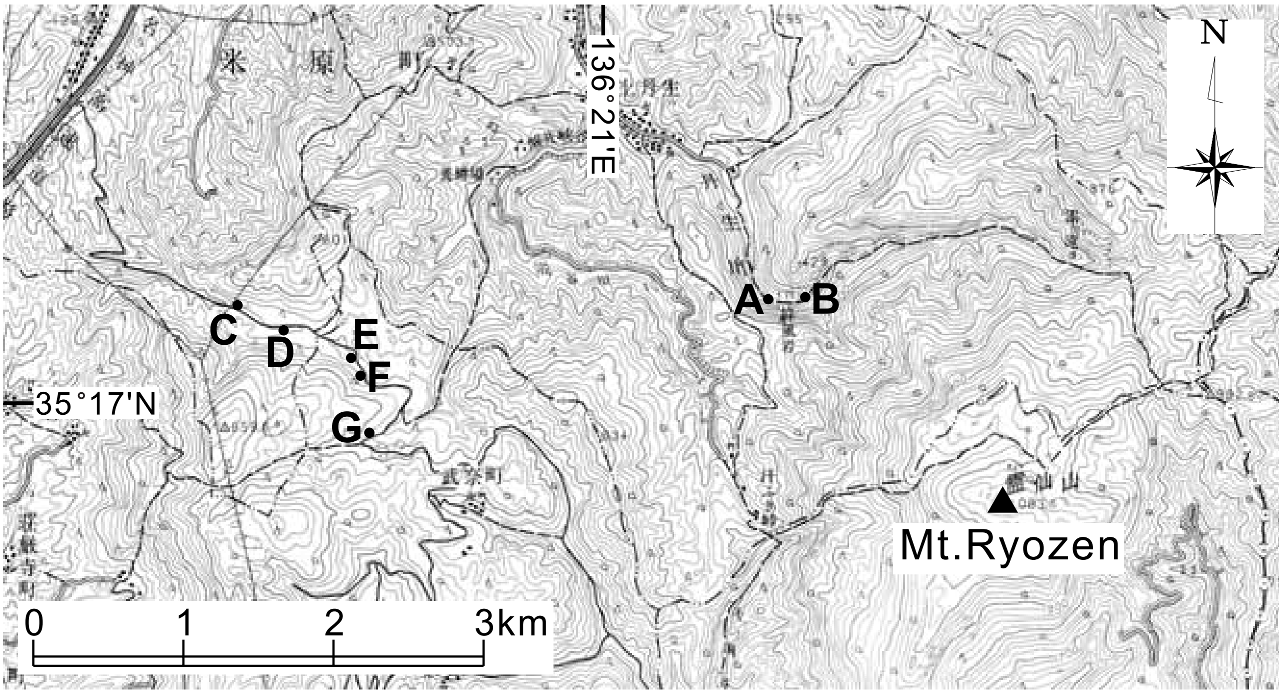

Figure 2. Sample localities of limestone in the western part of Mt. Ryozen. Topographic map is from 1:50,000 map of "Hikone-tobu" of Geographical Survey of Japan.

Material and discriminated species

Fourteen limestone samples studied herein were collected at seven localities of isolated blocks of limestone in the western part of Mt. Ryozen (Figure 2). Samples A-1 to A-5 at Loc. A, B-4 at Loc. B, and D-1 at Loc. D are from erratic limestones, and other ones are from surface exposures at Locs. B, C, E, F, and G. They are light gray to black and massive without distinct stratification except at Loc. G, and contain various kinds of fossils such as foraminifers, cyanobacteria, green algae, crinoids, bryozoans, brachiopods, ostracodes, corals, and sponges.

Most of these limestones are more or less dolomitized. Some of them commonly contain stylolite seams of volcaniclastic materials and dolomite. The stratigraphic relationships of each sample are obscure, because limestones exposed in the sampled area are complicated by faulting and folding.

Among 14 samples, Sample A-3, A-4, A-5, D-1, E-1, and F-1 are light-gray to gray, Sample A-1, B-1, B-2, B-3, B-4, and D-1 are dark-gray to black, and Sample A-2 and G-1 are black. They are classified largely into packstone (Sample A-1, A-2, A-3, B-1, E-1, and F-1), bioclastic grainstone to bioclastic grainstone/packstone (Sample A-5, B-2, B-3, and G-1), wackestone (Sample A-4 and C-1), and rudstone densely packed with abundant fusulines (Sample B-4 and D-1). Sample A-2 is bituminous and partly silicified. Sample B-1 is also partly silicified. Sample A-4 is most remarkably dolomitized among 14 samples.

Fusulines are commonly well preserved, but

Species	Sample													
	A-1	A-2	A-3	A-4	A-5	B-1	B-2	B-3	B-4	C-1	D-1	E-1	F-1	G-1
Eotuberitinina sp.	×	×	×			×	×	×	×	×	×			×
Tuberitinina sp.	×	×	×						×					×
Pseudoglomospira sp.	×				×		×							×
Brunsia? sp.		×			×									×
Spireitlina sp.		×	×		?									×
Palaeotextularia sp.					×									×
Climacammina? sp. A					×		×							×
Climacammina? sp. B	×	×				×	×							
indeterminate Palaeotextulariidae	×				×	×	×	×	×	×	×			
Globivalvulina sp. A							×	×						×
Globivalvulina spp.	×	×			×	×	×	×	×					×
Endothyra sp. A		×			×					×	×			×
Endothyra sp. B	×	×	×											×
Tetrataxis sp. A														×
Tetrataxis spp.		×			×									×
Calcitornella sp.														×
Hemigordius sp. A		×												
Hemigordius sp. B								×						
Pamirina sp. cf. *P. darvasiva*														×
Pseudoendothyra sp.								×						
Pseudoreichelina sp.					×									
Neofusulinella giraudi		×			×	×	×	×				×		×
Schubertella kingi			×		×		×	×	×					
Schubertella spp.	×	×						×				×	×	×
Chalaroschwagerina? sp.							×							
Cuniculinella isomie		×				×								×
Cuniculinella tumida			×											×
Cuniculinella sp. aff. *C. tumida*			×			×		×	?					
Cuniculinella vulgarisiformis												×		×
Darvasites ikenoensis		×						×	×					×
Darvasites sp. cf. *D. ovata*			×											
Pseudofusulina fusiformis							×							×
Pseudofusulina gundaraensis			×		?	×	×	×	?			×		×
Pseudofusulina quasifusuliniformis					?				×		?			×
Pseudofusulina sp.						×								×
Schwagerina sp.			×											×
Biwaella omiensis		×	×		×		×	×				×		×
Biwaella sp.					×		×							×
Biwaella? sp.														×
Acervoschwagerina endoi						×								
Paraschwagerina elongata							?		×				?	
Paraschwagerina sp. aff. *P. dlakshanensis*		×												
Paraschwagerina? *sublineata*		×				×								
Pseudoschwagerina robusta	×	×												
Pseudoschwagerina ryozenensis										×				
Pseudoschwagerina spp.							×	×	×		×		×	×
indeterminate Schwagerinidae	×			×	×		×		×			×	×	

Table 1. Early Permian foraminifers discriminated in the western part of Mt. Ryozen.

large schwagerinids with thin wall and septa, such as *Acervoschwagerina*, *Pseudoschwagerina*, and *Paraschwagerina* are deformed and flattened in Sample B-4 and D-1. Forty-seven species of foraminifers, 29 fusulines and 18 non-fusuline foraminifers, were discriminated in these 14 samples (Table 1). Taxonomic diversity is low in Samples C-1, D-1, and F-1, and highest in Sample G-1. Low diversity in Sample A-4 is due to dolomitization. These foraminifers are Sakmarian and Artinskian (Yakhtashian) in age based on the association of index species of schwagerinids and *Pamirina* sp. cf. *P. darvasica*.

Systematic Paleontology

(F. Kobayashi)

Superfamily Fusulinoidea von Möller, 1878
Family Ozawainellidae Thompson and Foster, 1937
Genus ***Pamirina*** Leven, 1970
Pamirina* sp. cf. *P. darvasica Leven, 1970
Plate 1, Figure 22

Compare: *Pamirina darvasica* Leven, 1970, p. 23, 24, pl. 1, figs. 1-12, 21-24.

Material examined.—Illustrated one tangential and other few oblique sections.

Discussion.—Only one tangential section of *Pamirina* obtained from Sample G-1 resembles *Pamirina darvasica* from the Artinskian of Southwest Darvas (Leven, 1970) and from limestone pebbles in north of Itsukaichi, west Tokyo (F. Kobayashi, 1977). The mentioned specimens have more narrowly rounded periphery and larger test than those of the present Ryozen specimens.

Family Schubertellidae Skinner, 1931
Genus ***Neofusulinella*** Deprat, 1912
Neofusulinella giraudi Deprat, 1915
Plate 1, Figures 23-52

Neofusulinella giraudi Deprat, 1915, p. 11, 12, pl. 1, figs. 6-11.

Material examined.—Illustrated 21 axial, eight sagittal, and one tangential sections, and others.

Description.—Test fusiform with broadly ached periphery and pointed to rounded poles. Mature test consists of five to five and a half whorls, 0.75 to 1.06 mm in length, 0.44 to 0.58 mm in width, and 1.6 to 1.9 in form ratio. Proloculus spherical, minute, and 0.02 to 0.05 mm in diameter. Inner two to two and a half whorls endothyroid and tightly coiled. Succeeding fusiform whorls are rapidly expanding.

Wall thin, about 0.005 mm in inner whorls, about 0.03 mm in outer whorls, not differentiated in juvenile whorls, consists of a tectum and underlying thicker less dense layer in outer fusiform whorls, and finely perforated in outer two whorls. Septa closely spaced, inclined anteriorly, and almost plane throughout the test. Septal counts in the last whorl 15 to 17 in the illustrated eight specimens. Septa are perforated by many distinct pores in outer whorls. Tunnel is low, broad, and bordered by distinct but rather asymmetrical chomata in outer whorls.

Discussion.—The Ryozen specimens resemble closely the original ones by Deprat (1915) in test characters such as size and shape of the test, relatively thick wall for the test size, and well developed septal pores. Smaller appearance of some of the Ryozen specimens is apparently due to their unfavorable preservation. They differ from those of elongate form of *Schubertella*, referable to *S. kingi* illustrated in Pl. 1, Figs. 53-57. Although this species was reassigned to *Schubertella* by some later authors (e.g., Sheng, 1963; Kanmera, 1963), it is better to be assigned to *Neofusulinella* as in the original description by Deprat (1915). *Neofusulinella*, including type species (*N. lantenoisi* Deprat, 1913) and this species, has thicker and more clearly perforated wall than that of *Schubertella*.

Family Schwagerinidae Dunbar and Henbest, 1930
Subfamily Schwagerininae Dunbar and Henbest, 1930
Genus ***Cuniculinella*** Skinner and Wilde, 1965
Cuniculinella isomie (Hy. Igo, 1965)
Plate 5, Figures 3, 4, 6

Pseudofusulina isomie Hy. Igo, 1965, p. 219, 220, pl. 29, fig. 6; pl. 50, figs. 5, 6.

Pseudofusulina aff. *P. isomie* Hy. Igo, 1965: Hy. Igo, 1965, pl. 31, figs. 6, 7.

Cuniculinella? *isomie* (Hy. Igo): F. Kobayashi, 2008b, p. 29, 30, pl. 2, figs. 1?6.

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

Discussion.—Hy. Igo (1965) proposed this species from the Lower Permian limestone block in Nyukawa of the northern Mino Terrane. F. Kobayashi (2008b) reported this species from Kamiishizu, east of Mt. Ryozen and recognized broad morphologic variation. Moreover, he doubtfully reassigned this species to *Cuniculinella* based on the presence of cuniculi. Cuniculi are also recognized in the incomplete oblique section of the present material, by which this species is assigned to *Cuniculinella*.

Cuniculinella tumida Skinner and Wilde, 1965
Plate 6, Figures 4, 9-11

Cuniculinella tumida Skinner and Wilde, 1965, p. 84, pl. 35, figs. 13-18.

? *Pseudofusulina* cf. *vulgaris* (Schellwien in Schellwien and Dyhrenfurth, 1909): M. Kobayashi, 1957, p. 282, pl. 2, fig. 6.

Material examined.—Illustrated two axial and two tangential sections.

Description.—Test inflated fusiform with broadly arched periphery, slightly concave or convex lateral sides, rounded poles, and straight to broadly arched axis of coiling. Mature test with seven whorls, 8 to 10 mm in length, 5.5 to 6 mm in width, and 1.5 to 1.8 in form ratio. Proloculus spherical to subspherical, 0.45 to 0.55 mm in longer diameter. Inner five whorls are globular to subglobular having protruding poles, loosely coiled, and gradually increas their length and width. Later two or more whorls inflated fusiform with slightly concave or convex lateral sides and rounded to bluntly pointed poles.

Septa intensely and irregularly fluted throughout the test. Septal folds high and some reaching to the tops of chambers. Low and narrow cuniculi well developed in the median part of outer whorls. Phrenotheca present in outer whorls.

Wall, as thick as 0.15 to 0.2 mm in outer two to three whorls, composed of a tectum and coarse alveolar keriotheca. Rudimentary chomata only on proloculus. No axial filling present. Tunnel low and narrow, and its path irregular.

Discussion.—The specimen illustrated in Pl. 6, Fig. 4 has a characteristic lateral sides of outer whorls. Its concave outline differs from straight to gentle convex one in the specimen in Pl. 6, Fig. 11. Septa in the latter are more strongly folded than those in the former. Although enough specimens to discuss these morphologic variations have not been obtained, these two forms from different limestone blocks are conspecific. Among the described species, they are the closest to and identical with *Cuniculinella tumida* Skinner and Wilde, 1965. In Japan, *Cuniculinella tumida* was described from the limestone block exposed at Hijima, Hyogo Prefecture (F. Kobayashi et al., 2007).

This species resembles "*Pseudofusulina*" *tambensis* Sakaguchi, 1963 from the limestone block at Izuriha (Sakaguchi, 1963) in association with *Neoschwagerina craticulifera* (Schwager, 1883) and others. "*P.*" *tambensis* might be reassigned to the genus *Cuniculinella* though it is uncertain whether cuniculi are present or not. Size and external shape of the external test and also each whorl of the Ryozen specimens are similar to those in *tambensis*. "*Pseudofusulina*" *tambensis*, however, is distinguished from *Cuniculinella tumida* by having more irregular and larger proloculus, thicker wall, and weak axial filling. Unnamed species compared with *Pseudofusulina vulgaris* (Schellwien in Schellwien and Dyhrenfurth, 1909) from Mt. Ibuki by M. Kobayashi (1957) seems to be identical with this species.

Cuniculinella vulgarisiformis (Morikawa)
Plate 4, Figures 20-22

Parafusulina? *vulgarisiformis* Morikawa, 1952, p. 31, 32, pl. 1, figs. 1-4.

Pseudofusulina vulgaris (Schellwien in Schellwien and Dyhrenfurth, 1909): Huzimoto, 1936, p. 75-77, pl. 11, figs. 1-7.

Pseudofusulina globosa (Deprat, 1912): Ishizaki, 1962, p. 149, 150, pl. 8, fig. 6.

non. *Parafusulina vulgarisiformis* Morikawa: Leven, 1967, p. 176, pl. 28, figs. 3, 5.

Material examined.—Illustrated three axial sections and others.

Discussion.—A schwagerinid species originally described under the name of *Fusulina vulgaris* from Darvas by Schellwien (Schellwien and Dyhrenfurth, 1909) and its allied species are common in the Lower Permian of the Tethyan regions. Definition of these species and their generic assignment, however, are different and seem to be confused among authors. *Cuniculinella vulgarisiformis* is an example of this problem.

This species was proposed by Morikawa (1952) for additional specimens collected by Morikawa from the same locality of the Kanto Mountains as Huzimoto's (1936). Huzimoto originally identified them with *Pseudofusulina vulgaris*, but Morikawa separated them from *vulgaris* by newly introducing the name of *vulgarisiformis*, and assigned them questionably to *Parafusulina* based on the presence of cuniculi. This taxonomic treatment by Morikawa was supported by Leven (1967). Morphologically similar specimen to these Kanto ones was reported from the limestone block of western Shikoku by Ishizaki (1962).

Leven (1967) recognized the taxonomic validity of *vulgarisiformis* and made sure of its assignment to *Parafusulina*. Leven's *vulgarisiformis* from Southeast

Pamir, however, is different from the Japanese ones in having inflated fusiform test with pointed to sharply pointed poles throughout whorls. It is thought to be conspecific with "*Parafusulina*" *globosaeformis* proposed by Leven (1967) from Southeast Pamir.

The Rozen specimens are identified with those by Huzimoto (1936) and Morikawa (1952). Apparent differences from "*Pseudofusulina*" *vulgaris* are more strongly fluted septa, not straight but convex lateral sides and rather rounded poles of the test, and commoner appearance of cuniculi in the *vulgarisiformis*. This species is assigned to *Cuniculinella* in having more strongly, rather irregularly folded septa and better development of cuniculi than those of *Chalaroschwagerina* and *Pseudofusulina*.

Cuniculinella **sp. aff.** ***C. tumida*** Skinner and Wilde, 1965

Plate 5, Figures 1, 2

Compare: *Cuniculinella tumida* Skinner and Wilde, 1965, p. 84, pl. 35, figs. 13?18.

Material examined.—Illustrated two axial sections and others.

Discussion.—The present *Cuniculinella* aff. *tumida* has more elongate test with pointed poles, smaller proloculus, and smaller heights in the corresponding whorls than those of *C. tumida*. Skinner and Wilde (1965) classified *Cuniculinella* from northern California into 13 species. Some (e.g., *C. ventricosa*) are similar to and might be conspecific with *C. tumida*. Morphologic variation of *C. tumida* is not satisfactorily clarified in the Ryozen material as well as in the northern California one. Further taxonomic discussion of this unidentified species is postponed until additional materials are accumulated.

Genus ***Darvasites*** A. D. Miklukho-Maklay, 1959

Darvasites ikenoensis (Morikawa and Isomi, 1961)

Plate 3, Figures 1-27

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

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

Material examined.—Illustrated 20 axial, four sagittal, two tangential, and one oblique sections.

Description.—Test ellipsoidal fusiform to subcylindrical, with broadly arched periphery, bluntly pointed to rounded poles, and straight axis of coiling. Mature test with eight to nine whorls, 2.67 to 4.21 mm in length, 1.15 to 1.79 mm in width, and 1.89 to 3.54 in form ratio.

Proloculus spherical, 0.05 to 0.14 mm in outside diameter. The first whorl subspherical to oval and inner four whorls tightly coiled. Later whorls gradually and regularly increase their length and width. From the first to eighth whorl, short ellipsoidal form illustrated in Pl. 3, Fig. 4 (D2-042152) has 0.27, 0.37, 0.73, 1.13, 1.55, 2.18, 2.77, and 3.44 mm in length; 0.16, 0.24, 0.35, 0.49, 0.68, 0.93, 1.30, and 1.74 mm in width; 1.69, 1.54, 2.09, 2.31, 2.28, 2.34, 2.13, and 1.98 in form ratio; and subcylindrical form in Pl. 3, fig. 12 (D2-042122) has 0.27, 0.56, 1.02, 1.45, 1.96, 2.62, 3.40, and 4.11 mm in length; 0.15, 0.19, 0.27, 0.38, 0.53, 0.72, 0.95, and 1.16 mm in width; 1.80, 2.95, 3.78, 3.82, 3.70, 3.64, 3.58, and 3.54 in form ratio.

Septa closely spaced with shallow sutural depressions in the outer whorls. In the median part of test, septa plane in inner whorls and almost plane to weakly fluted in outer whorls. Fluting is rather regular and restricted to the lower half of septa in most specimens. Wall is very thin in inner tightly coiled whorls, gradually thickens outward, and 0.05 to 0.08 mm thick in the last whorl. Alveolar keriothecal structure is evident in outer test. Wall undifferentiated in initial few whorls, consists of a tectum and porous translucent layer in the succeeding ones

Chomata are prominent throughout, and massive, tall, and not extending to pole-sides. They are hook-like or node-like, and partly overhanging toward tunnel-sides. Weak secondary deposits present in axial regions of the median part of test in most specimens. Tunnel is distinct and as tall as a half to one-thirds of the chamber height. Its path is generally straight and more or less zigzag in specimens. Its angle varies from 20 to 30 degrees in outer whorls.

Discussion.—This species was originally proposed by Morikawa and Isomi (1961) from Ikeno-oku, 22 km NNW of Mt. Ryozen. The present specimens have diagnostic characters closely similar to those of the original ones in form and size of the test, the number of whorl, mode of septal fluting, and distinct chomata and tunnel. By these close similarities they are certainly identical with "*Nagatoella*" *ikenoensis*. Although these characters are variable from specimen to specimen as shown in the illustrated 27 specimens, these differences are thought to represent the wide intraspecific variation.

Distinct tunnel path and well-developed chomata throughout the test well agree with those of *Nagatoella*. However, this species has smaller test and fewer whorls than *Nagatoella*, by which it is reassigned to *Darvasites*, as already done by F. Kobayashi (2005).

Darvasites ikenoensis is distinguished from *D. contractus* (Schellwien in Schellwien and Dyrenfurth, 1909), type species of the genus from Darvas, in smaller proloculus, more tightly coiled inner whorls, and more number of whorls. These two species resemble each other in other characters. This species resembles "*Triticites*" *ellipsoidalis* from the Akiyoshi Limestone (Toriyama, 1958) and from limestone pebbles of the Lower Cretaceous Sasayama Group (F. Kobayashi and Adachi, 2007) in size of the test, development of chomata and tunnel, and mode of septal folds. Some of the Ryozen specimens, especially of smaller ones, seem to be closer to "*T*." *ellipsoidalis* than to the types of *ikenoensis*. However, this species is considered to be independent and different from "*T*" *ellipsoidalis* by having larger test, smaller proloculus, and more distinct juvenile whorls.

Size and expansion of the test, and septal folds of *Nagatoella* sp. from the Kozaki Formation in the Kurosegawa Terrane (Kanmera, 1963) are similar to those of *Darvasites ikenoensis*. However, the former has more massive chomata extending to pole-sides. *Darvasites minatoi* from the Sakamotozawa Formation in the Southern Kitakami Terrane (Kanmera and Mikami, 1965) is also similar to this species, but the former has larger test and thicker wall than the latter.

Darvasites* sp. cf. *D. ovata (Chang, 1963a)
Plate 3, Figure 28

Compare: *Hemifusulina ovata* Chang, 1963a, p. 51, 60, 61, pl. 3, figs. 14, 15.

Material examined.—Illustrated one axial section and few other incomplete sections.

Discussion.—Schwagerinids referable to *Darvasites*, but different from *D. ikenoensis*, are rarely contained only in Sample A-3 without association of *D. ikenoensis*. They have thicker wall in outer four whorls than *D. ikenoensis*. As to relatively thick wall in outer whorls, expansion and size of the test, and rather regularly folded septa, they are comparable to *D. ovata* from Xinjiang Tienshan (Chang, 1963a). They are also like *Darvasites trucatus* (Chen, 1934) from the Maping Limestone of Guangxi in these respects.

Genus ***Pseudofusulina*** Dunbar and Skinner, 1931

Pseudofusulina fusiformis Schellwien in Schellwien and Dyhrenfurth, 1909
Plate 5, Figures 14-17

Fusulina vulgaris var. *fusiformis* Schellwien in Schellwien and Dyhrenfurth, 1909, p. 165?168, pl. 15, figs. 1-4.

Material examined.—Illustrated four axial sections and others.

Discussion.—This species was originally described by Schellwien as a variety of *Fusulina vulgaris*. Specific diagnosis of this species was made clear by Kalmykova (1967). Illustrated four Ryozen specimens of *Pseudofusulina fusiformis* well agree with the specimens from Darvas (Schellwien in Schellwien and Dyhrenfurth, 1909; Kalmykova, 1967). Three specimens of *Pseudofusulina* sp. illustrated in Pl. 5, Figs. 11-13 are separated from *Pseudofusulina fusiformis* by their smaller proloculus and more sharply pointed poles.

Pseudofusulina gundaraensis Kalmykova, 1967
Plate 4, Figures 1-19; Plate 10, Figures 1, 2

Pseudofusulina gundaraensis Kalmykova, 1967, p. 186, 187, pl. 12, figs. 1-7.

Material examined.—Illustrated 19 axial, one sagittal, and one tangential sections.

Description.—Test fusiform to inflated fusiform, with broadly arched periphery, convex lateral sides, bluntly pointed to rounded poles, and straight axis of coiling. Mature test with seven to eight whorls, 4.42 to 6.85 mm in length, 2.44 to 3.4 (?) mm in width, and 1.5 to 2.4 in form ratio.

Proloculus spherical, 0.16 to 0.28 mm in outer diameter. The first whorl subspherical to fusiform. Later ones fusiform to inflated fusiform and gradually increase their length and width. Length, width, and form ratio from the first to eighth whorl, 0.38, 0.74, 1.29, 2.10, 2.78, 3.86, 5.07, and 6.33 mm; 0.22, 0.32, 0.49, 0.71, 1.05, 1.56, 2.24, and 2.98 mm; 1.7, 2.3, 2.6, 3.0, 2.6, 2.5, 2.3, and 2.1 in the fusiform form shown in Pl. 4, Fig. 10 (D2-042141). Those from the first to seventh whorl, 0.32, 0.84, 1.94, 2.28, 3.06, 4.13, and 5.15 mm; 0.40, 0.56, 0.86, 1.27, 1.81, 2.42, and 3.18 mm; 0.8, 1.5, 2.3, 1.8, 1.7, 1.7, and 1.6 in the inflated fusiform form shown in Pl. 4, Fig. 8 (D2-042158).

Septa closely spaced, moderately and rather regularly folded. Septal counts from the first to fifth whorl 9, 16, 26, 27, and 26, respectively, in the specimen shown in Pl. 10, Fig. 2 (D2-042007). Cuniculi developed by specimens. Septal folds about one half as high as chambers in most whorls, but some reaching the tops of chambers in outer whorls of some specimens. Weak phrenotheca partly developed in outer whorls. Wall is thin in inner whorls, gradually thickens outwards, about 0.08 to 0.13 mm in the thickest part of outer whorls. Wall composed of a distinct tectum and keriotheca, but alveolar keriotheca is absent or indistinct in inner whorls.

Chomata well developed in inner whorls. They are indistinct in outer two or three whorls of most specimens. Axial filling not present. Tunnel narrow and well discernible in inner whorls, but obscure in outer ones. Its path rather straight in inner whorls.

Discussion.—The Ryozen specimens are characteristic in rather regularly fluted septa partly producing cuniculi in the tunnel region and absence of axial filling, and identical with *Pseudofusulina gundaraensis* Kalmykova, 1967 from the Lower Permian of Darvas. Among the recognized species of *Pseudofusulina* from Ryozen, this species differs from *P. fusiformis* and *P.* sp. in absence of axial filling and from *P. quasifusuliniformis* in having thicker wall and no axial filling. It is dissimilar to *Schwagerina* sp. in this paper in having more irregular septal fluting and no axial filling.

Pseudofusulina quasifusuliniformis Leven, 1967
Plate 6, Figures 7, 8

Pseudofusulina quasifusuliniformis Leven, 1967, p. 151, 152, pl. 12, figs. 7-9.

Material examined.—Illustrated two axial sections and others.

Discussion.—This species is characteristic in its *Quasifusulina*-type appearance as to strong axial filling, rather thin wall, and large and subspherical to irregular-shaped proloculus. However, it is belonged to *Pseudofusulina* by its wall structure of a tectum and keriotheca (Leven, 1967).

Genus ***Schwagerina*** von Möller, 1877
***Schwagerina* sp.**
Plate 5, Figures 5, 7-10

Material examined.—Illustrated four axial and one tangential sections and others.

Discussion.—This unidentified species in Samples A-3 and G-1, is assignable to *Schwagerina* than to *Pseudofusulina* or other genus in having inflated test and regularly folded septa. They have partly cuniculi in outer whorls, and are similar to *Schwagerina guembeli* Dunbar and Skinner, 1937 from the Glass Mountains of Texas and *Schwagerina* sp. A reported by F. Kobayashi et al. (2007) from Hijima, Hyogo Prefecture. The Texas specimens have thinner wall than the present ones and thin appearance of the wall in the Hijima's is due to recrystallization of the test. It is allied to *Schwagerina paraguembeli* by Morikawa (1955) from the Kanto Mountains, though the latter has larger proloculus.

Subfamily Biwaellinae Davydov, 1984
Genus ***Biwaella*** Morikawa and Isomi, 1960
Biwaella omiensis Morikawa and Isomi, 1960
Plate 2, Figures 1-26

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

Synonyms of *Biwaella omiensis*: See F. Kobayashi (2005).

Material examined.—Illustrated 16 axial and 10 sagittal sections, and others.

Description.—Test inflated to elongate fusiform, with broadly arched periphery, nearly straight lateral sides, bluntly pointed to rounded poles, and straight axis of coiling. Mature test with six, rarely seven whorls, 1.3 to 2.6 mm in length, 0.7 to 1.2 mm in width, and 1.8 to 3.1 in form ratio (Table 2).

Proloculus spherical, 0.03 to 0.07 mm in outer diameter. Inner one to three whorls are lenticular, subspherical, or oval, and tightly coiled, with abrupt changes of axis of coiling. Later whorls gradually and regularly increase their length and width (Table 2).

Septa sparsely spaced and gently inclined anteriorly with shallow sutural depressions in outer whorls. They are plane and not fluted throughout the test. Septal counts from the first to fifth whorls, 5 or 6, 7 to 9, 9 to 11, 10 to 12, and 10 to 14, respectively, in four specimens illustrated.

Wall very thin and undifferentiated in inner one to two whorls, rather abruptly thickened and composed of a tectum and translucent layer partly with fine porous structure in fusiform whorls. The last and/or the preceding one whorls consist of a tectum and very fine alveolar keriotheca. Approximate thickness of wall in the last whorl varies 0.03 to 0.06 mm.

Chomata massive, hook-like or node-like and well developed in inner whorls, becoming asymmetrical and discontinuous in outer ones. Tunnel angle 30 to 60 degrees in outer fusiform whorls.

Discussion.—Morphologic variation of *Biwaella omiensis* can not be clearly understood in 12 type specimens illustrated by Morikawa and Isomi (1960, 1961). Kobayashi (1993, 2005) recognized broad morphologic variation of this species in the shape and size of the test, and mode of septal fluting, based on

Fig. in Pl.	No. whorl	Length	Width	Form Ratio	Prolo-curus	Length of whorl							Width of whorl							Form Ratio of whorl						
						1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Pl. 2, Fig. 1	6	1.95	0.88	2.2	0.03?	–	0.30	0.63	1.05	1.42	1.95	–	0.09	0.15	0.26	0.41	0.58	0.88	–	–	2.0	2.4	2.6	2.5	2.2	–
Pl. 2, Fig. 2	6	–	0.94	–	0.05	0.10	0.28	0.68	1.22	1.64	–	–	0.12	0.16	0.28	0.45	0.66	0.94	–	0.8	1.8	2.4	2.7	2.5	–	–
Pl. 2, Fig. 4	6	1.5?	0.83?	1.8?	0.04	–	0.19	0.33	0.59	1.01	1.5?	–	0.10	0.18	0.27	0.40	0.57	0.83?	–	–	1.1	1.2	1.5	1.8	1.8?	–
Pl. 2, Fig. 5	6	2.28	0.86	2.7	0.05	0.09	0.32	0.62	1.13	1.64	2.28	–	0.10	0.16	0.24	0.38	0.64	0.86	–	1.0	2.0	2.6	3.0	2.6	2.7	–
Pl. 2, Fig. 7	7	2.58	1.22	2.1	0.05	0.09	0.18	0.41	0.74	1.22	1.95	2.58	0.12	0.20	0.27	0.41	0.57	0.86	1.22	0.8	0.9	1.5	1.8	2.1	2.3	2.1
Pl. 2, Fig. 8	6	2.25	0.72	3.1	0.04	0.05	0.12	0.31	0.82	1.43	2.25	–	0.09	0.16	0.19	0.30	0.49	0.72	–	0.6	0.8	1.6	2.7	2.9	3.1	–
Pl. 2, Fig. 9	6	1.62?	0.84	1.9?	0.07	0.06	–	0.44	0.66	1.10	1.62?	–	0.13	0.15	0.28	0.40	0.60	0.84	–	0.5	–	1.6	1.7	1.8	1.9?	–
Pl. 2, Fig. 11	5.5	–	–	–	0.04	–	0.28	0.61	1.05	1.39	–	–	0.11	0.19	0.29	0.43	0.63	–	–	–	1.5	2.1	2.4	2.2	–	–
Pl. 2, Fig. 12	6	1.32	0.66	2.0	0.05	0.05	0.10	0.24	0.48	0.84	1.32	–	0.08	0.14	0.20	0.29	0.45	0.66	–	0.6	0.7	1.2	1.7	1.9	2.0	–
Pl. 2, Fig. 24	6	2.01?	0.72	2.8?	0.06	0.13	0.23	0.48	0.95	1.50?	2.01?	–	0.11	0.15	0.22	0.33	0.49	0.72	–	1.2	1.5	2.2	2.9	3.1?	2.8?	–

Table 2. Measurement of *Biwaella omiensis* Morikawa and Isomi

materials from the Kanto Mountains.

Biwaella sp. illustrated in Pl. 2, Figs. 27-31 differs from *B. omiensis* in having more elongate subcylindrical test, and smaller width and thinner wall in the corresponding whorls. Details on *Biwaella*? sp. shown in Pl. 2, Fig. 32 are uncertain due to recrystallization of outer test. It is separated from *Biwaella* sp. in this paper and questionably belonged to *Biwaella* by having axial filling and narrower tunnel.

Subfamily Pseudoschwagerininae Chang, 1963b

Genus ***Acervoschwagerina*** Hanzawa, 1949

Acervoschwagerina endoi Hanzawa, 1949

Plate 9, Figure 7; Plate 10, Figures 3, 4, 7

Paraschwagerina (*Acervoschwagerina*) *endoi* Hanzawa, 1949, p. 208, 209, pl. 42, figs. a-d.

Material examined.—Illustrated three axial and one tangential sections and others.

Discussion.—The Ryozen specimens are larger and have thicker wall in outer whorls than the topotype ones of *Acervoschwagerina endoi* by Thompson (1954). They have smaller proloculus and more tightly-coiled inner whorls than those of the Uokaneyama Limestone (F. Kobayashi, 2008a).

Genus ***Paraschwagerina*** Dunbar and Skinner, 1931

Paraschwagerina elongata Skinner and Wilde, 1965

Plate 10, Figures 5, 6

Paraschwagerina elongata Skinner and Wilde, 1965, p. 69, pl. 32, figs. 9-13.

Material examined.—Illustrated two axial sections and others.

Discussion.—The present specimens are common in Sample B-4 and questionably in Samples B-2 and F-1. Their outer whorls are mostly destroyed and detailed comparison with other species is difficult. Most of them resemble *Paraschwagerina elongata* and *Paraschwagerina fax* both from the upper part of the McCloud Limestone (Skinner and Wilde, 1965) in association with *Pseudoschwagerina robusta*. The Ryozen specimens are identified with *P. elongata* by having similar shape and size of the test, and strongly fluted septa, some of which reach the tops of chambers.

Paraschwagerina* sp. aff. *P. dlakshanensis Chang, 1963b

Plate 6, Figures 1-3, 6

Compare: *Paraschwagerina dlakshanensis* Chang, 1963b, p. 208, 209, 223, 224, pl. 5, fig. 5.

Material examined.—Illustrated one mature axial, and three incomplete sections (two immature axial and one tangential sections).

Discussion.—This unidentified species is found out only from Sample A-2 in association with *Paraschwagerina*? *sublineata*. Juvenile whorls of these two are alike (Pl. 6, Fig. 1a versus Pl. 9, Fig. 5), but these two species are different in size and shape, and expansion of the test.

Paraschwagerina dlakshanensis Chang, 1963b was described from the Sakmarian (?) of Xinjiang Tienshan based on one axial section. This species is distinguished from *P. pseudomira* described from southern Fergana (Miklukho-Maklay, 1949) and *P. inflata* Chang, 1963b from Xinjiang Tienshan in thinner wall and septa. Although detailed comparison is impossible because of a few specimens, the present mature specimen appears to be alike to *Paraschwagerina dlakshanensis*. The Fergana species has more weakly fluted septa and more juvenile whorls than the Xinjiang one. This species is larger than most forms of *Paraschwagerina* reported from Japan, along with further larger *Paraschwagerina magna* Skinner and Wilde, 1965 described from the Kanto Mountains by F. Kobayashi (2005).

Paraschwagerina*? *sublineata (Hy. Igo, 1965)

Plate 6, Figure 5; Plate 7, Figures 5-8; Plate 8, Figures 8, 9; Plate 9, Figures 5, 6; Plate 10, Figure 10

Parafusulina sublineata Hy. Igo, 1965, p. 221, 222, pl. 30, figs. 1-3; pl. 32, figs. 1, 2.

? *Parafusulina*? *sublineata* Hy. Igo: Hh Igo, 1996, p. 634, Figs. 9-8?15.

Schwagerina higashidaniensis Hy. Igo, 1964: Hh. Igo, 1996, p. 632, Figs. 8-16, 8-17.

Material examined.—Seven axial sections illustrated and others.

Discussion.—This schwagerinid species has subcylindrical to elongate fusiform test with slightly curved axis of coiling, thin wall and septa throughout, gently undulated wall in outer whorls, strongly and irregularly folded septa some of which extend to the tops of chambers, minute proloculus, and tightly coiled inner four to five whorls. These peculiar characters are largely different from generic diagnosis of the known genera. Besides their tightly coiled initial whorls, they resemble *Acervoschwagerina* as to thin, irregularly and strongly folded septa and some *Paraschwagerina* as to mode of septal fluting. However, with respect to other test characters they are different from these two genera. This form is assigned questionably to *Paraschwagerina* in this paper.

Schwagerinids more or less similar to this species were previously described from the Mino Terrane. Among them, the present specimens are the closest to "*Parafusulina*" *sublineata* Hy. Igo, 1965 from Nyukawa. Hh. Igo (1996) recognized more variable characters of this species and questionably assigned it to *Parafusulina* based on the Hachiman material. However, the illustrated specimens from Hachiman are different from those from Ryozen with respect to proloculus size, juvenile whorls, and thickness of wall.

The holotype of *Schwagerina higashidaniensis* Hy. Igo, 1964 from Nyukawa is similar to the Ryozen specimens, but the former has larger proloculus, lesser distinct juvenile whorls, and thicker wall. *Schwagerina higashidaniensis* described by Hh. Igo (1996) from Hachiman is more similar to the types of "*Parafusulina*" *sublineata* than those of *Schwagerina higashidaniensis*. Except size of the test, "*Parafusulina*" *sublineata* and the holotype of *Parafusulina takanoe* Hy. Igo, 1965 are similar each other, excluding two other type specimens of *takanoe*. There are interesting problems concerning these species in relation to taxonomy and phylogeny of inflated schwagerinids. Variation of them in these taxa, however, has not yet been clarified, hence further discussion is postponed.

Genus ***Pseudoschwagerina*** Dunbar and Skinner, 1936

Pseudoschwagerina robusta (Meek, 1864)

Plate 7, Figures 1-4; Plate 9, Figures 1-4; Plate 10, Figures 8, 9

Fusulina robusta Meek, 1864, p. 3, 4, pl. 3, figs. 3, 3a-c.

Pseudoschwagerina robusta (Meek): Thompson and Wheeler, 1946, p. 28, 29, pl. 3, figs. 1-3; pl. 6, figs. 6, 7.

Material examined.—Illustrated eight axial and two sagittal sections, and others.

Description.—Test ellipsoidal, with broadly arched periphery, rounded poles and almost straight axis of coiling. Mature test with five to six whorls, 8.5 to 11 mm in length, 5.7 to 7.5 mm in width, and 1.4 to 1.6 in form ratio. Proloculus spherical and 0.22 to 0.38 mm in diameter. Inner one and a half to two and a half whorls relatively tightly coiled and *Triticites*-type. Succeeding whorls inflated fusiform to ellipsoidal and rapidly enlarging. The last whorl gradually decreases its height outward.

Septa closely spaced throughout whorls, thick and perpendicular to wall in the inner *Triticites*-type whorl, very thin, long, and gently inclined anteriorly in the succeeding ones, and again shortened and thickened in the terminal whorl. In the median part of test, they are plane and very weakly and irregularly folded in some specimens. Septa weakly folded in polar regions of outer whorls. Septal counts from the first to sixth whorl 10, 16, 18, 24, 30 and 39(?) in the specimen shown in Pl. 10, Fig. 9; and 10(?), 17, 16(?), 20(?), 33, and more than 40 in Pl. 10, Fig. 8, respectively.

Wall mostly less than 0.05 mm thick in the *Triticites*-type and subsequent whorls, and as thick as 0.1 mm or slightly more in the thickest part of the last two ones. Wall composed of a tectum and keriotheca, and fine alveolar in inner whorls and coarse alveolar in the last two ones. Chomata exclusively present on a proloculus and inner *Triticites*-type whorl. Narrow and straight tunnel developed in inner *Triticites*-type whorl.

Discussion.—The Ryozen specimens of *Pseudoschwagerina* are classified largely into two. One is *Pseudoschwagerina robusta* similar to the topotypes of northern California and the other is also similar to some American *Pseudoschwagerina* but referable to a new species.

Pseudoschwagerina robusta (Meek, 1864) was redefined by Thompson and Wheeler (1946) based on topotype specimens from the Shasta County of northern California. Most of the Ryozen specimens have more similar characters to those of the other topotypes described by Skinner and Wilde (1965) than of the neotypes designated by Thompson and Wheeler (1946). Some of the Ryozen specimens having relatively large form ratio of the test are similar to *Pseudoschwagerina uddeni* (Beede and Kniker, 1924). They are more similar to *P. uddeni* described by Dunbar and Newell (1946) from Peru than the lectotype of *uddeni* designated by Thompson (1948) from the Hueco Limestone in having more rounded test and weakly folded septa. *Pseudoschwagerina robusta* also resembles *Pseudoschwagerina roeseleri* Thompson and Wheeler, 1946 from southern California. The latter has more initial whorls and more slowly expanding outer whorls than the former.

Pseudoschwagerina robusta from Ryozen has larger test and fewer initial whorls than those described in western to central Tethyan regions, such as Turkey (F. Kobayashi and Altiner, 2008), Kazakhstan (Scherbovich, 1969), Afghanistan (Leven, 1971), Darvas (Leven and Scherbovich, 1978), and Fergana (Bensh, 1972). It is also larger than other species of the genus from Southeast Asia and China (e.g., Deprat, 1915; Chen, 1934; Chang, 1963b; Wang et al., 1981; Yang et al., 1996). *Pseudoschwagerina robusta* is distinguished from these species in having much larger height of whorls. *P. robusta* and its allied species have not been reported from Japan.

Pseudoschwagerina ryozenensis Kobayashi, n. sp.

Plate 8, Figures 1, 2

Derivation of name.—Mt. Ryozen, Maibara City, Shiga Prefecture.

Type specimens.—Holotype D2-042082 (axial section, Pl. 8, Fig. 1), Paratype D2-042084 (axial section, Pl. 8, Fig. 2).

Type locality.—2 km WNW of Mt Ryozen, and 4 km SSE of the JR Samegai station.

Diagnosis.—Large and inflated fusiform species of *Pseudoschwagerina* having one to one and a half *Triticites*-type juvenile whorl followed by rapidly expanding later ones, and irregularly fluted septa, some of which wave loosely in the lower part of chambers as to partly produce a few chamberlets.

Material examined.—Two axial sections and others.

Description.—Test inflated fusiform, with broadly arched periphery, rounded poles, and straight axis of coiling. Mature test with five whorls, more than 13.5 mm in length, more than 6.5 mm in width, and possibly 2.1 in form ratio. Proloculus spherical and 0.39 mm in the holotype and 0.32 mm in the paratype. Inner one and a half, *Triticites*-type whorl is tightly coiled relatively against the later whorls that are inflated fusiform and rapidly enlarging. The last whorl decreases its width and length.

Septa closely spaced, and plane in *Triticites*-type whorl and irregularly fluted in later whorls. Some of them loosely wave in the lower part of chambers as to partly produce a few chamberlets in outer whorls. Septal counts in the last whorl are 38 in one parallel section (D2-042080) and 42 in another parallel section (D2-042081). Wall thin, less than 0.03 mm in inner three whorls, and about 0.05 to 0.1 mm in the last two ones, and composed of a tectum and keriotheca, fine alveolar in inner whorls and coarse alveolar in the last two ones. Chomata present on a proloculus and inner *Triticites*-type whorl.

Discussion.—Although well-oriented sections are a few, this new species is proposed by characteristic septal folds that are different from those of *Pseudoschwagerina* previously described. As to large inflated fusiform test with thin wall for the test size and closely spaced numerous septa, this new species is somewhat similar to *Pseudoschwagerina gerontica* Dunbar and Skinner, 1937 described by Thompson

(1954) from the Hueco Limestone of Texas. However, septa are more irregularly and strongly fluted and juvenile whorls are fewer in the former than in the latter.

Occurrence.—Rare in black wackestone (Sample C-1) from Loc. C in exclusive association with rare, small non-fusuline foraminifers.

Pseudoschwagerina spp.
Plate 8, Figures 3-7, 10

Material examined.—Illustrated six specimens and others.

Discussion.—Several poorly preserved specimens assigned to *Pseudoschwagerina* were obtained. The one of largest one attains to more than 15 mm in length. Some of these unnamed forms are close to *Pseudoschwagerina robusta*.

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Plate 1.

Figs. 1, 2. *Palaeotextularia* sp. both D2-042102, Sample G-1, ×25.
Figs. 3, 4. *Climacammina*? sp. A. 3: D2-042130; ×4: D2-042154, both Sample G-1, ×25.
Fig. 5. *Climacammina*? sp. B. D2-041968, Sample A-2, ×20.
Figs. 6-8. *Endothyra* sp. A.
6: D2-042123, Sample G-1, ×50; 7: D2-042132, Sample G-1, ×50; 8: D2-041962, Sample A-2, ×40.
Fig. 9. *Endothyra* sp. B. D2-041972, Sample A-2, ×40.
Figs. 10-16. *Globivalvulina* sp. A.
10: D2-042056; 11: D2-042163; 12: D2-042123; 13: D2-042060; 14: 14: D2-042168; 15: D2-042135; 16: D2-042062, 10, 13, 16: Sample B-3; 11, 12, 14, 15: Sample G-1, all ×50.
Fig. 17. *Hemigordius* sp. B. D2-042044, Sample B-3, ×30.
Fig. 18. *Hemigordius* sp. A. D2-041962, Sample A-2, ×40.
Fig. 19. *Tetrataxis* sp. A. D2-042174, Sample G-1, ×50.
Fig. 20. *Pseudoendothyra* sp. D2-042058, Sample B-3, ×30.
Fig. 21. *Pseudoreichelina* sp. D2-041996, Sample A-5, ×30.
Fig. 22. *Pamirina* sp. cf. *P. darvasica* Leven. D2-042135, Sample G-1, ×40.
Figs. 23-52. *Neofusulinella giraudi* Deprat
23: D2-42054; 24: D2-042039; 25: D2-042134; 26: D2-0420574-22 27: D2-042041; 28: D2-042048; 29: D2-042003; 30: D2-042037; 31:d2-042123; 32: D2-042039; 33: D2-042049 34: D2-041971; 35: D2-042053; 36: D2-042039; 37: D2-042048; 38: D2-042146; 39: D2-042165; 40: D2-041971; 41: D2-042009; 42: D2-042057; 43: D2-042165; 44: D2-042103; 45: D2-042063; 46: D2-042175; 47: D2-042111; 48: D2-042150; 49: D2-042169; 50: D2-042158; 51: D2-041971; 52: D2-042151; 23, 24, 26, 27, 28, 32, 33, 35-37, 42, 45: Sample B-3; 25: Sample D-1; 29: Sample A-5; 30: Sample B-2; 31, 38, 39, 43, 44, 46?50, 52: Sample G-1; 34, 40, 51: Sample A-2; 41: Sample B-1;29, 30, 35: ×30; others ×40.
Figs. 53-57. *Schubertella kingi* Dunbar and Skinner
53: D2-042075; 54: D2-042034; 55: D2-042024; 56: D2-042041; 57: D2-042027
53: Sample B-4; 54, 55, 57: Sample B-2; 56: Sample B-3; 53, 56: ×40; others: ×30.

Plate 2.

Figs. 1–26. *Biwaella omiensis* Morikawa and Isomi
1: D2-042107; 2: D2-042164; 3: D2-042108; 4: D2-042059; 5: D2-042165; 6: D2-042120; 7: D2-042109; 8: D2-042120; 9: D2-042140; 10: D2-041979; 11: D2-042100; 12: D2-04175; 13: D2-042034; 14: D2-042126; 15: D2-042145; 16: D2-042040; 17: D2-042058; 18: D2-042164; 19: D2-042046; 20: D2-042033; 21: D2-042030; 22: D2-042036; 23: D2041995; 24: D2-042135; 25: D2-042116; 26: D2-042128; 4, 16, 17, 19: Sample B-3; 10: Sample A-3; 12: Sample A-2; 13, 20, 21, 22: Sample B-2; 23: Sample A-5; others: Sample G-1; 7a: ×20; 7b, 8b: ×50; others: ×30.
Figs. 27–31. *Biwaella* sp.
27: D2-042033; 28: D2-042036; 29: D2-042027; 30: D20-42144; 31: D2-042034, 30: Sample G-1; others: Sample B-2, all ×30.
Figs. 32. *Biwaella*? sp. D2-042133, Sample G-1, ×40.

Plate 3.

Fig. 1-27. *Darvasites ikenoensis* (Morikawa and Isomi)
1: D2-042138; 2: D2-042106; 3: D2-042120; 4: D2-042152; 5: D2-042145; 6: D2-042115; 7: D2-042145; 8: D2-042048; 9: D2-042102; 10: D2-042105; 11: D2-042166; 12: D2-042122; 13: D2-042159; 14: D2-042143; 15: D2-042103; 16: D2-042100; 17: D2-042150; 18: D2-042059; 19: D2-042173; 20: D2-042115; 21: D2-042169; 22: D2-042104; 23: D2-042120; 24: D2-042111; 25: D2-042074; 26: D2-042070; 27: D2-042043; 8, 18, 27: Sample B-3; 25, 26: Sample B-4; others: Sample G-1; 4b, 5b: ×40; 6b: ×50; 8, 11, 18, 23: ×20; others: ×15.
Fig. 28. *Darvasites* sp. cf. *D. ovata* (Chang). D2-041985, Sample A-3, ×15.

Plate 4.

Fig. 1-19. *Pseudofusulina gundaraensis* Kalmykova (See also Plate 10, Figs. 1, 2)
1: D2-042117; 2: D2-042119; 3: D2-042117; 4: D2-042102; 5: D2-042124; 6: D2-042153; 7: D2-042121; 8: D2-042158; 9: D2-042160; 10 : D2-042141; 11: D2-042139; 12 : D2-042112; 13: D2-042148; 14 : D2-042160; 15: D2-042101; 16 : D2-042125; 17: D2-042131; 18: D2-042127; 19: D2-042145, all: Sample G-1, all ×10.
Fig. 20-22. *Cuniculinella vulgarisiformis* (Morikawa)
20: D2042110, Sample G-1; 21: D2-042094, Sample E-1; 22: D2-042133, Sample G-1, all ×10.

Plate 5.

Fig. 1,2. *Cuniculinella* sp. aff. *C. tumida* Skinner and Wilde
1: D2-041983, Sample A-3; 2: D2-042047, Sample B-3, both ×10.
Fig. 3,4,6. *Cuniculinella isomie* (Hy. Igo)
3: D2-042020, Sample B-1; 4: D2-041969, Sample A-2; 6: D2-042175, Sample G-1, all ×10.
Fig. 5,7-10. *Schwagerina* sp.
5: D2-042167; 7: D2-042136; 8: D2-042138; 9: D2-042163; 10: D2-042147, all Sample G-1, all ×10.
Fig. 11-13. *Pseudofusulina* sp.
11: D2-042129; Sample G-1; 12: D2-042005, Sample B-1; 13: D2-042174, Sample G-1, all ×10.
Fig. 14-17. *Pseudofusulina fusiformis* (Schellwien)
14: D2-042168; 15: D2-042161; 16: D2-042151; 17: D2-042100, all: Sample G-1, all ×10.

Plate 6.

Fig. 1-3,6. *Paraschwagerina* sp. aff. *P. dlakshanensis* Chang
1: D2-041966; 2: D2-041977; 3: D2-041965; 6: D2-041958, all Sample A-2,
1b: ×20; others: ×10.
Fig. 4,9-11. *Cuniculinella tumida* Skinner and Wilde
4: D2-042155, Sample G-1; 9: D2-042156, Sample G-1; 10: D2-041980, Sample A-3; 11: D2-041979, Sample A-3, all ×10.
Fig. 5. *Paraschwagerina*? *sublineata* (Hy. Igo) (See also Plate 7, Figs. 5?8; Plate 8, Figs. 8, 9; Plate 9, Figs. 5, 6; Plate 10, Fig. 10)
The same specimen as shown in Plate 7, Fig. 6. ×20
Fig. 6,7. *Pseudofusulina quasifusuliniformis* Leven
6: D2-042130; 7: D2-042138, both Sample G-1; ×10.

Plate 7.

Fig. 1-4. *Pseudoschwagerina robusta* (Meek) (See also Plate 9, Figs. 1?4; Plate 10, Figs. 8, 9)
1: D2-041949; 2: D2-041950; 3: D2-041947; 4: D2-041954, all Sample A-1, all ×10.
Fig. 5-8. *Paraschwagerina*? *sublineata* (Hy. Igo) (See also Plate 6, Fig. 5; Plate 8, Figs, 8, 9; Plate 9, Figs. 5, 6; Plate 10, Fig. 10)
5: D2-041968; 6: D2-041963; 7: D2-041959; 8: D2-041976, all Sample A-2, all ×10.

Plate 8.
Fig. 1,2. *Pseudoschwagerina ryozenensis* Kobayashi, n. sp.
1: D2-042082; 2: D2-042084, both Sample C-1; ×10.
Fig. 3-7,10. *Pseudoschwagerina* spp.
3: D2-042087, Sample D-1; 4: D2-042078, Sample B-4; 5: D2-042052, Sample B-3; 6: D2-042126, Sample G-1; 7: D2-042085, Sample D-1; 10: D2-042098, Sample F-1, all ×10.
Fig. 8,9. *Paraschwagerina*? *sublineata* (Hy. Igo) (See also Plate 6, Fig. 5; Plate 7, Figs, 5?8; Plate 9, Figs. 5, 6; Plate 10, Fig. 10)
8: D2-041962; 9: D2-041975, both Sample A-2; ×10.

Plate 9.
Fig. 1-4. *Pseudoschwagerina robusta* (Meek) (See also Plate 7, Figs. 1?4; Plate 10, Figs. 8, 9)
1: D2-041971; 2: D2-041964; 3: D2-041974; 4: D2-041972, all Sample A-2, 1b: ×20; others: ×10.
Fig. 5,6. *Paraschwagerina*? *sublineata* (Hy. Igo) (See also Plate 6, Fig. 5; Plate 7, Figs, 5?8; Plate 8, Figs. 8, 9; Plate 10, Fig. 10)
5: the same specimen as shown in Plate 7, Fig. 5. 6: the same specimen as shown in Plate 10, Fig. 9. both ×20
Fig. 7. *Acervoschwagerina endoi* Hanzawa (See also Plate 10, Figs. 3, 4, 7)
D2-042009, Sample B-1, ×10.

Plate 10.
Fig. 1,2. *Pseudofusulina gundaraensis* Kalmykova (See also Plate 4, Figs. 1?19)
1: D2-041982; Sample A-3, 2: D2-042007; Sample B-1, both ×10.
Fig. 3,4,7. *Acervoschwagerina endoi* Hanzawa (See also Plate 9, Fig. 7)
3: D2-042008; 4: D2-042006; 7: D2-042012, all Sample B-1, all ×10.
Fig. 5,6. *Paraschwagerina elongata* Skinner and Wilde
5: D2-042067; 6: D2-042079, both: Sample B-4; ×10.
Fig. 8,9. *Pseudoschwagerina robusta* (Meek) (See also Plate 7, Figs. 1?4; Plate 9, Figs. 1?4)
8: D2-041954; 9: D2-041945, both: Sample A-1; ×10.
Fig. 10. P*araschwagerina*? *sublineata* (Hy. Igo) (See also Plate 6, Fig. 5; Plate 7, Figs, 5?8; Plate 8, Figs. 8, 9; Plate 9, Figs. 5, 6)
D2-041978, Sample A-2, ×10.

滋賀県霊仙山西部のペルム紀前期フズリナ化石

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滋賀県霊仙山西部の 7 地点で採集した 14 サンプルの石灰岩からペルム紀前期の有孔虫化石 47 種（フズリナ類 29 種，フズリナ類以外の有孔虫類 18 種）を識別した．そのうち，*Pseudoschwagerina ryozenensis*（新種）と *Paraschwagerina*? *sublineata* を含む 20 種のフズリナ類を記載し，それらの分類上の問題点を議論した．*Pseudoschwagerina ryozenensis* は大型の膨らんだ紡錘形の殻をもつ *Pseudoschwagerina* で，その隔壁 は不規則に褶曲し，少数の小室を生じる．*Paraschwagerina*? *sublineata* は膨らんだ殻を有するタイプの *Schwagerina* 類の分類と系統の考察に重要な種である．

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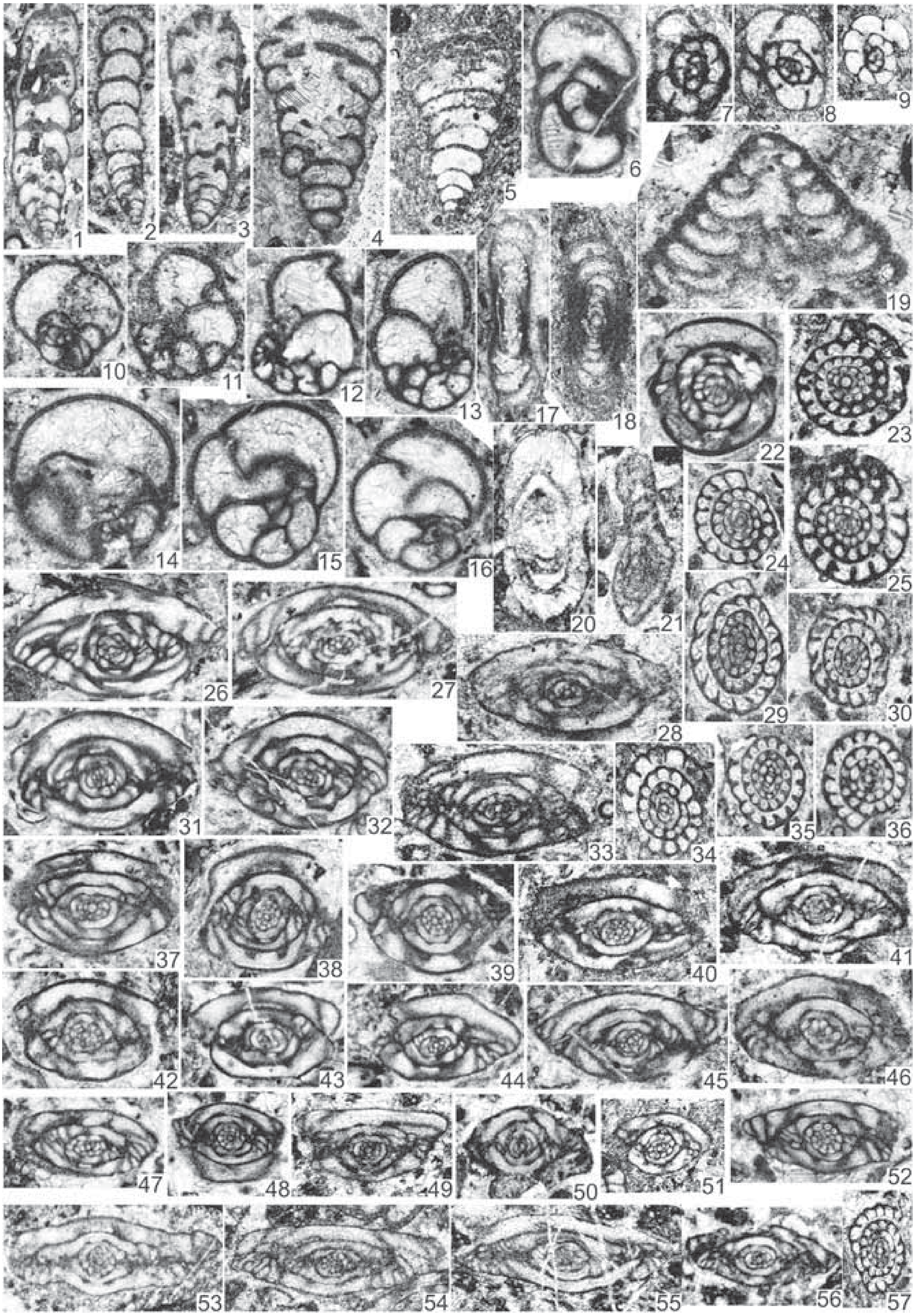
Plate 1.



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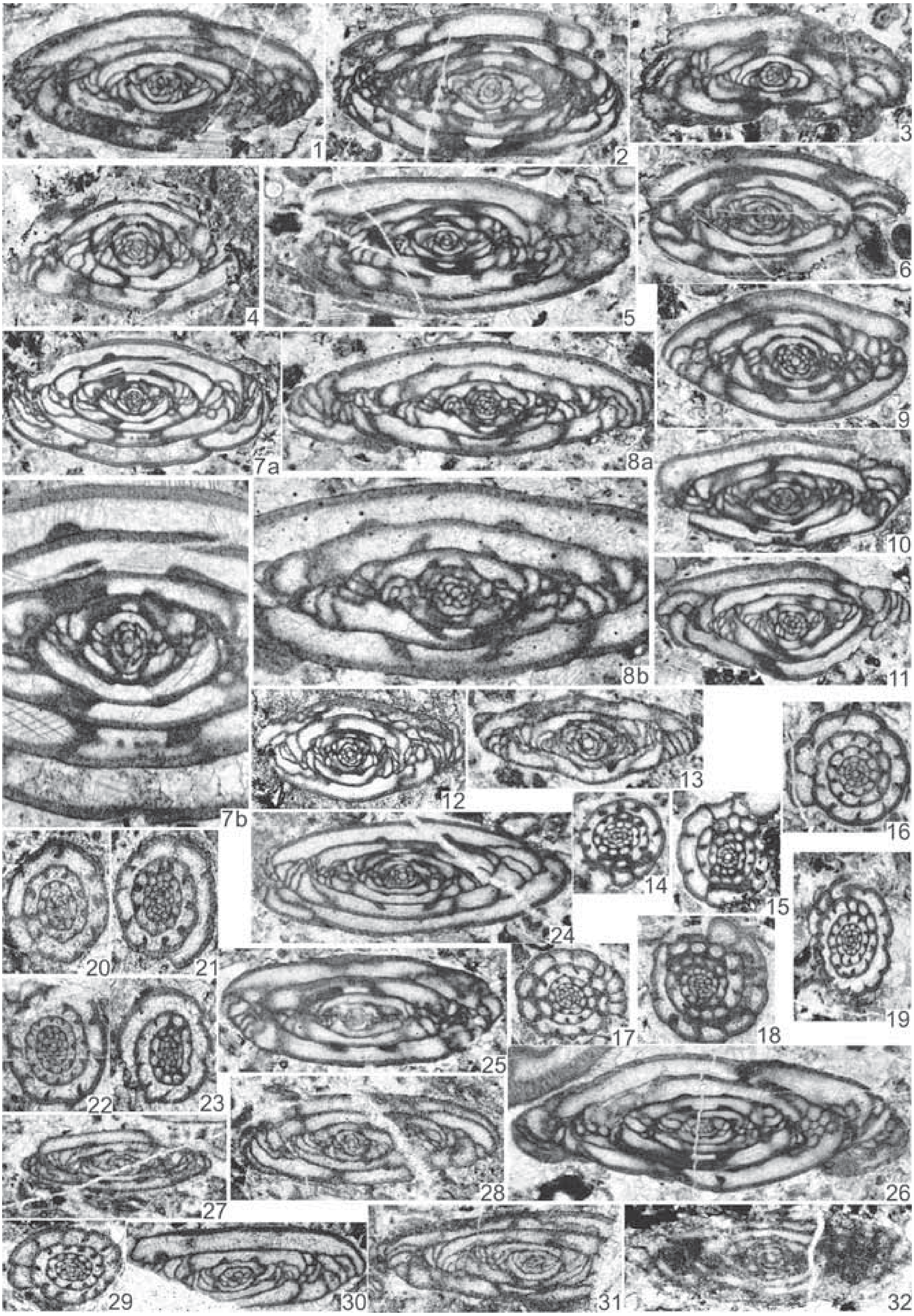
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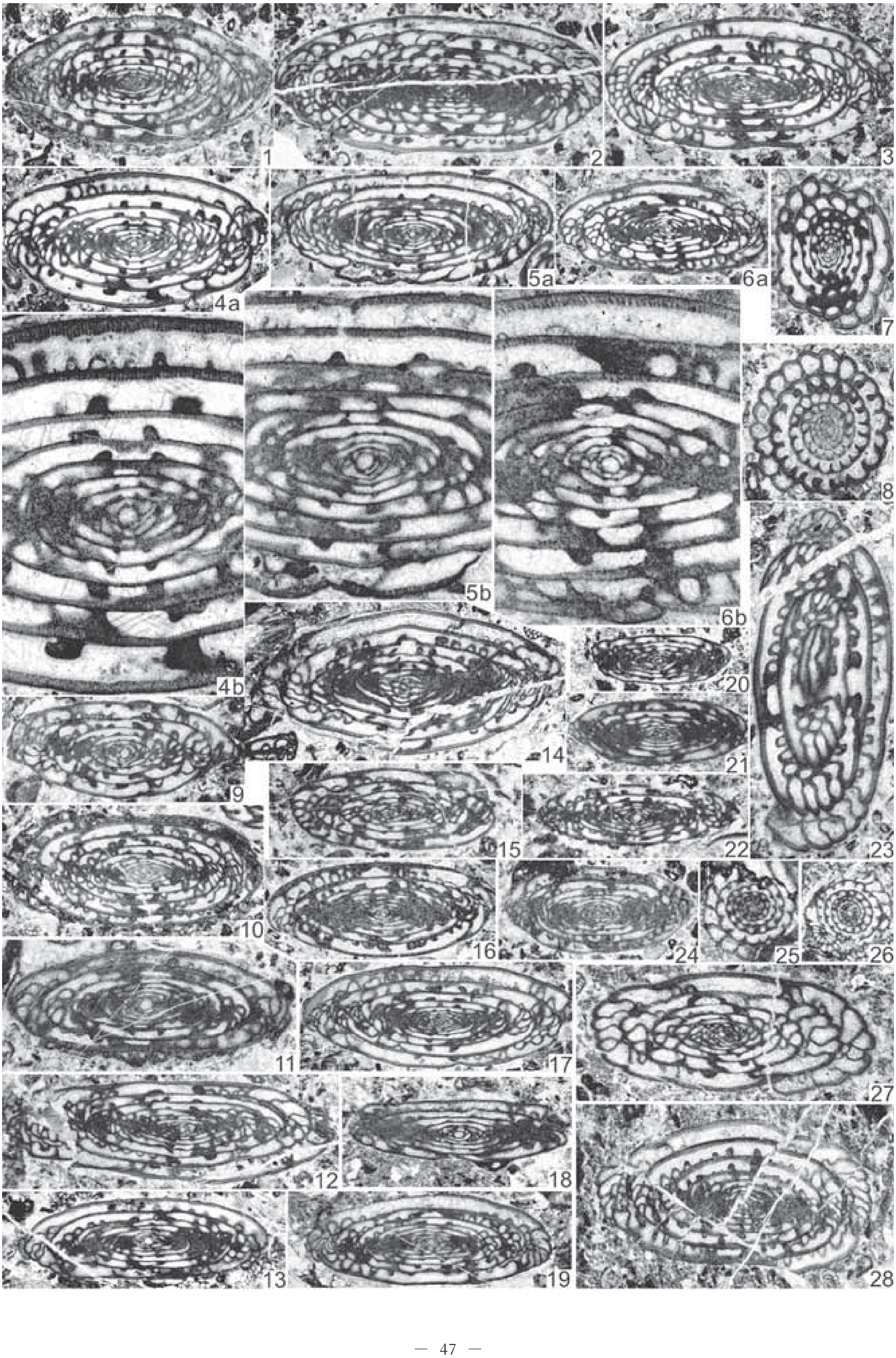
Plate 3.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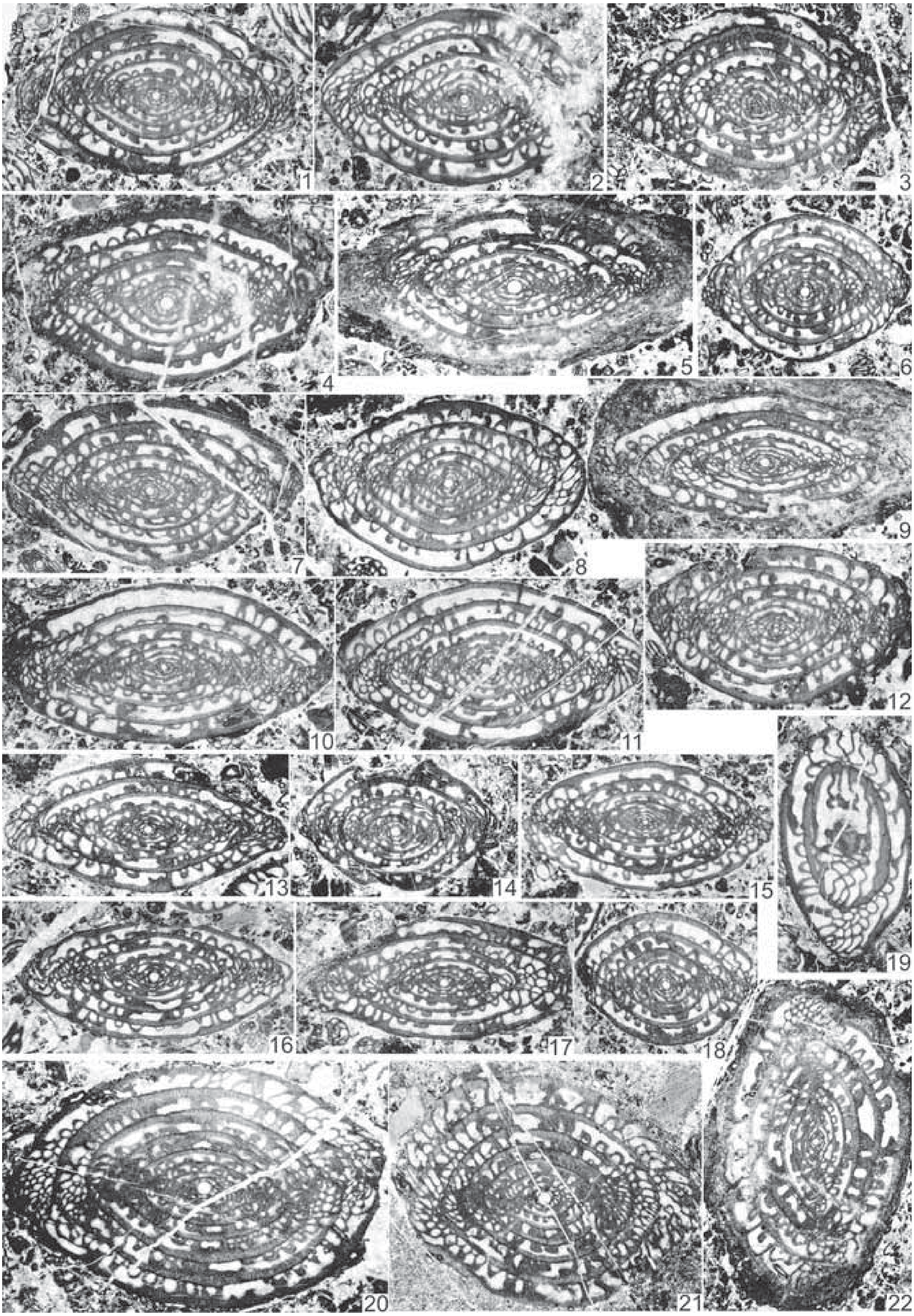

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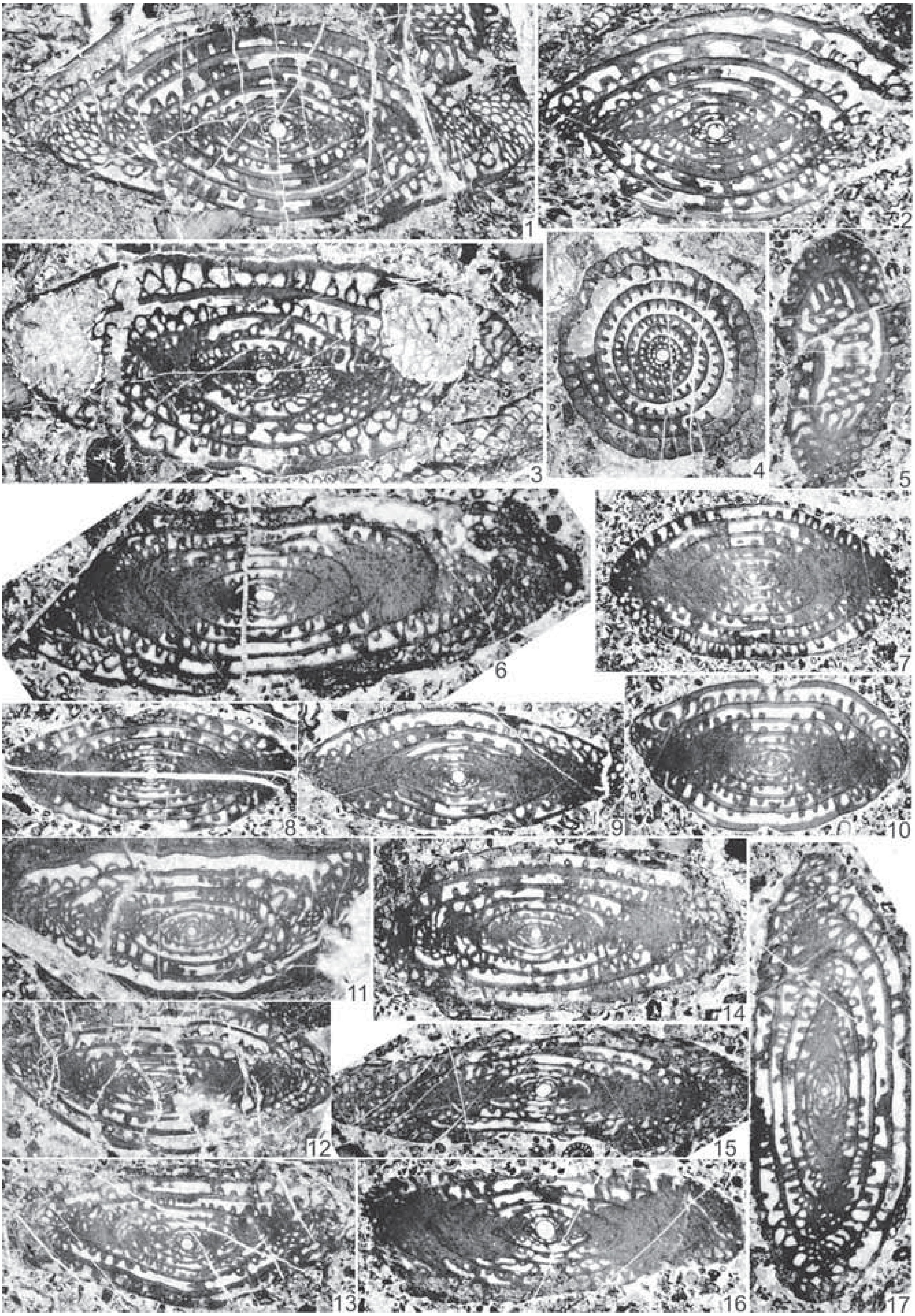

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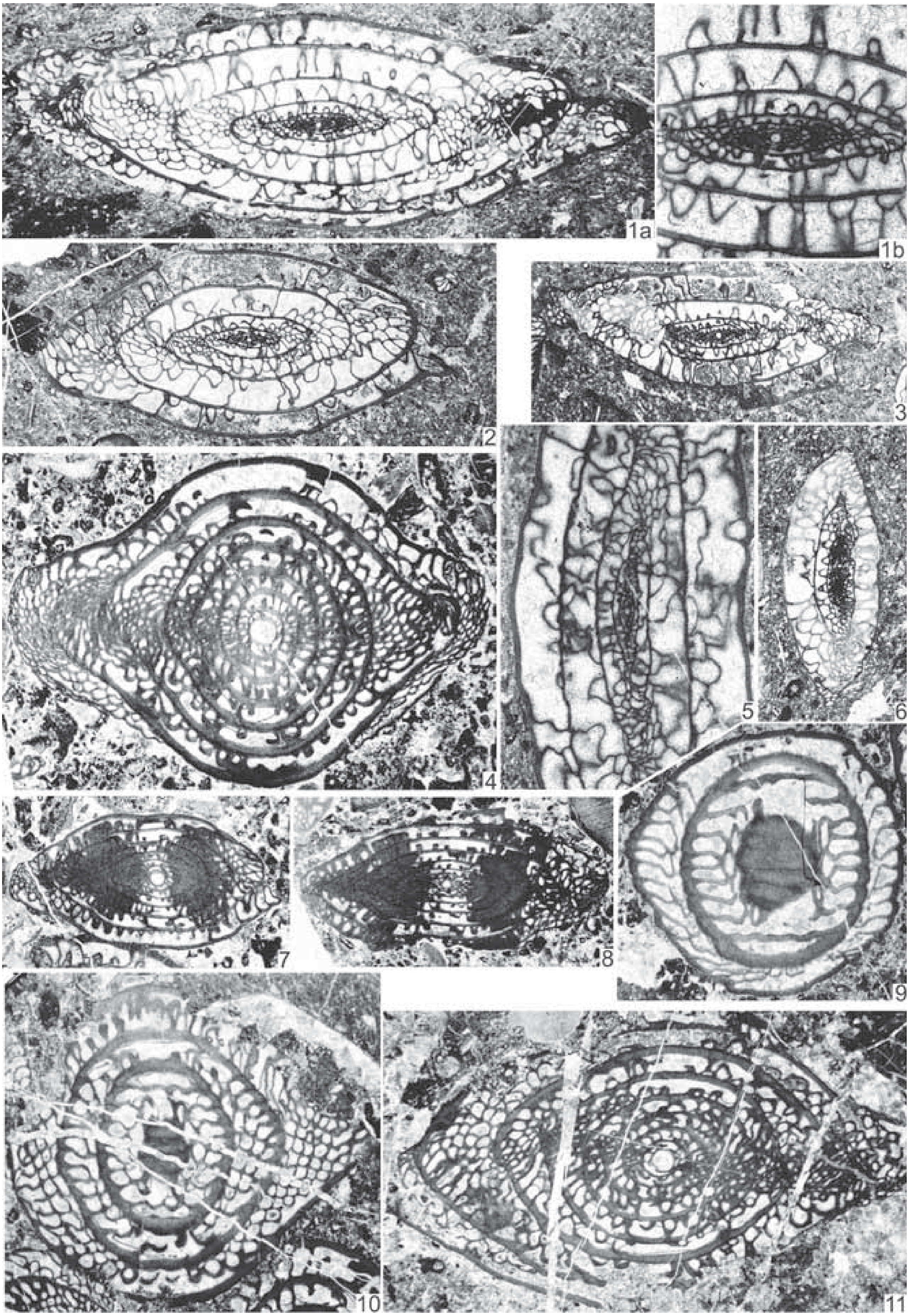

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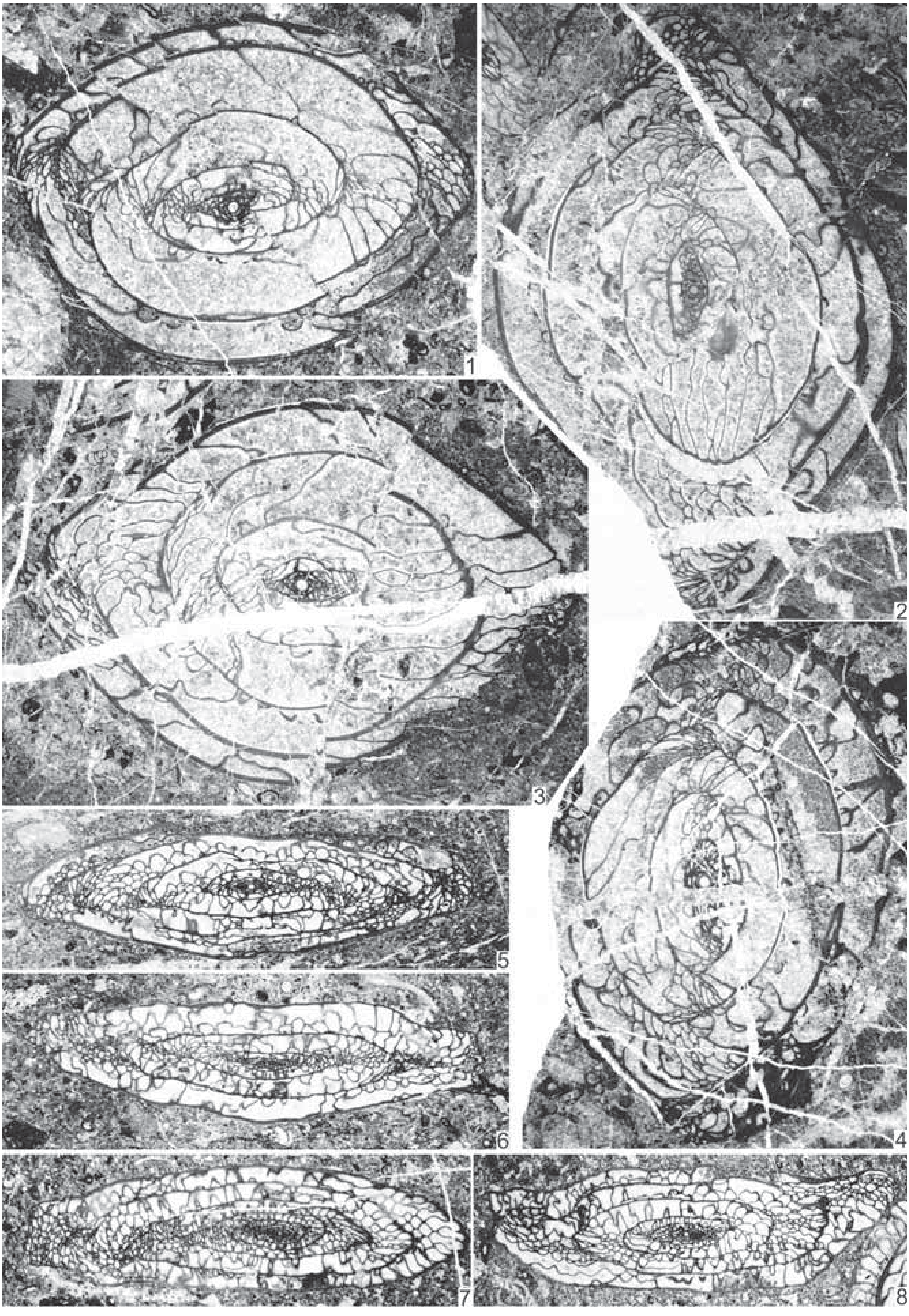

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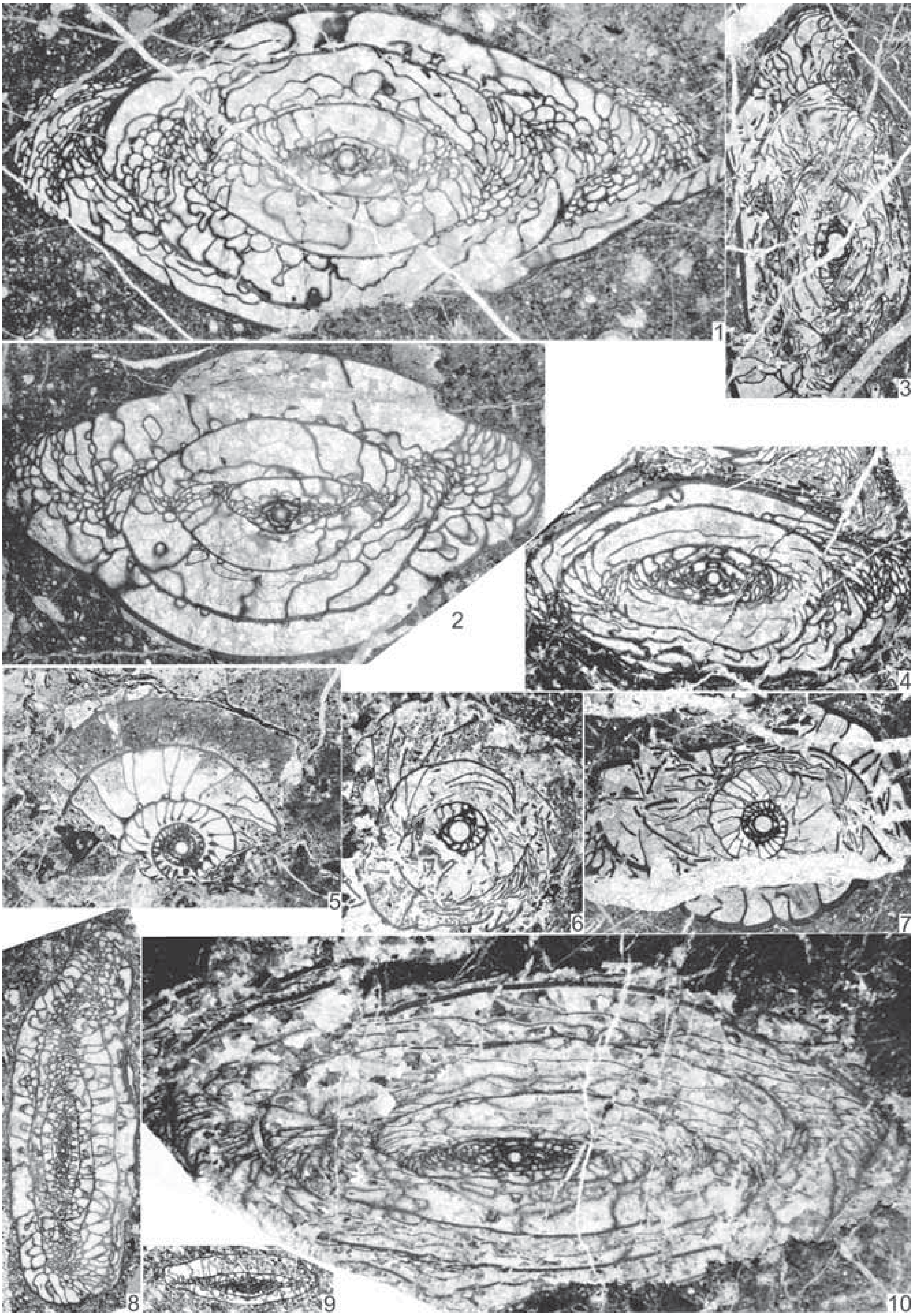

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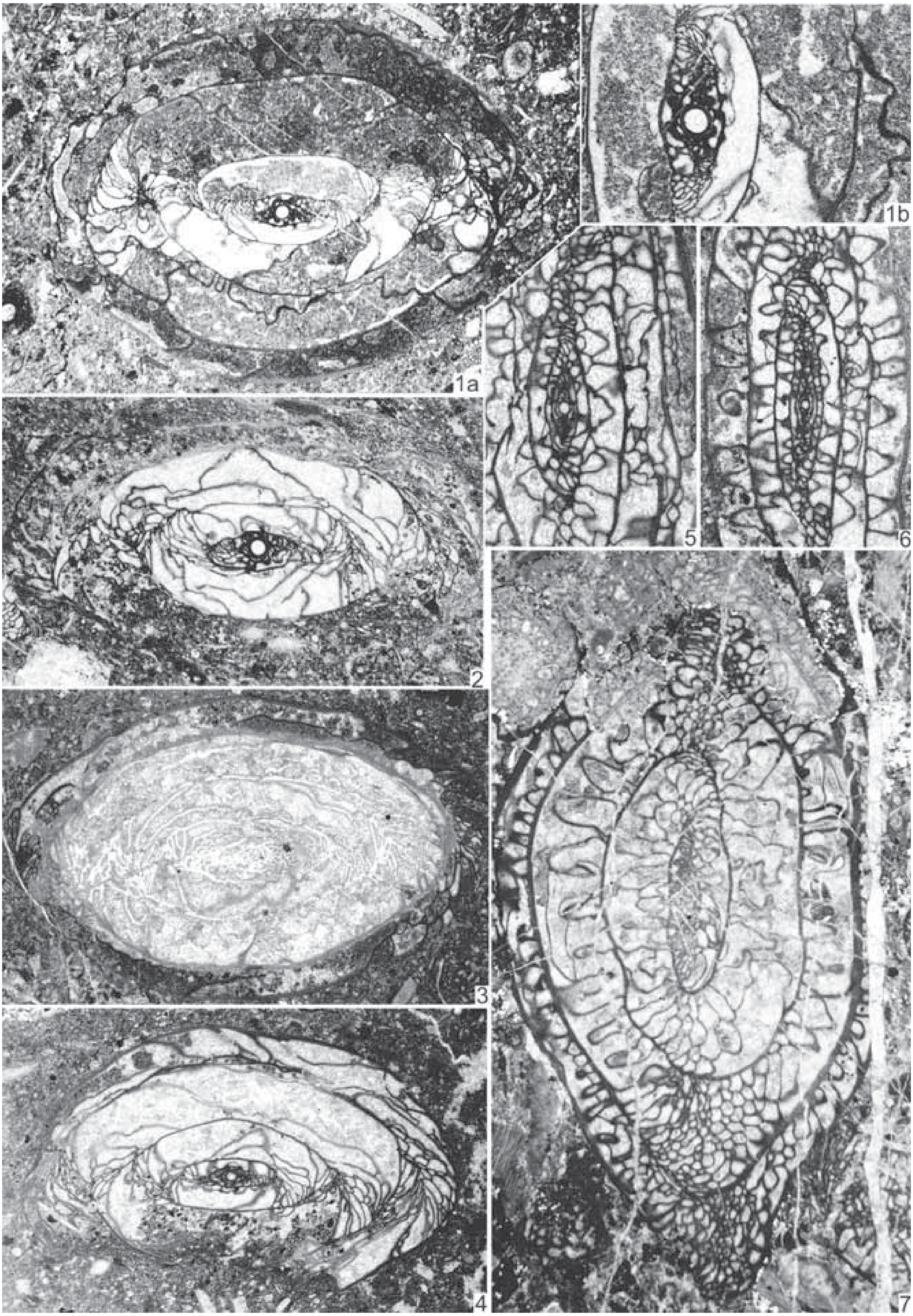

Plate 10.