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Original article

Late Early Permian (Kungurian) fusulines from Kamiishizu, south of Sekigahara, Gifu Prefecture, Japan

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Abstract

Skinnerella kamiishizuensis sp. nov. and *Cuniculinella*? *isomie* (Igo) are systematically described. These two fusulines were collected from conglomeratic limestone exposed at Kamiishizu, south of Sekigahara, Gifu Prefecture, central Japan. They indicate late Early Permian (late Kungurian in the standard time-scale, Bolorian in the Tethyan) by their association with *Misellina dyhrenfurthi* (Dutkevich). *Skinnerella kamiishizuensis* is distinguished from the previously described species in having strongly and rather regularly fluted septa throughout the test, indistinct cuniculi, and well-developed axial filling. This species is assignable to the genus by almost the same test size both in the megalospheric and microspheric forms.

Key words: *Skinnerella kamiishizuensis* sp. nov., late Early Permian, Kamiishizu, Mino Terrane

Introduction

In the mountain area south of Sekigahara between the Suzuka and Yoro Mountains, several tectonic blocks consisting of greenstone and limestone are isolated in the distributional area of non-calcareous rocks of the Jurassic age. These isolated greenstone-limestone blocks are considered to be the erosional remnants, which were primarily continuous with the westward greenstone-limestone facies around the Mt. Ryozen (Miyamura et al., 1976). It is referable lithologically to the Nyukawa facies (Igo, 1961) and tectonostratigraphically to the Funafuseyama Unit (Wakita, 1988) in the Mino Terrane. The greenstone-limestone facies in this area, previously assigned to the Lower Permian by fusulines (Miyamura et al., 1976), are considered to be the Jurassic accretionary complex by radiolarian fossils from mudstone (Kurimoto, 1987; Harayama et al., 1989). Details on the faunal composition of fusulines and precise age of the limestone exposed around Mt. Ryozen remained uncertain.

Recently, a fossiliferous limestone collected from 2.3 km NNW of Kamiishizu, Ogaki City, Gifu Prefecture (Figure 1) was provided by K. Handa to the author for study. This limestone represents one of the limestone blocks of the erosional remnant of greenstone-limestone facies exposed in the north of Kamiishizu according to the geological map of Miyamura et al. (1976).

This paper mentions limestone lithology, foraminiferal fauna, age of this sample, and describes systematically two species of schwagerinid fusulines, *Skinnerella kamiishizuensis* sp. nov. and *Cuniculinella*? *isomie* (Igo, 1965). Fifty-four limestone thin sections prepared from this limestone sample are stored in the collection of the Museum of Nature and Human Activities, Hyogo, Japan (Fumio Kobayashi Collection, MNHAH).

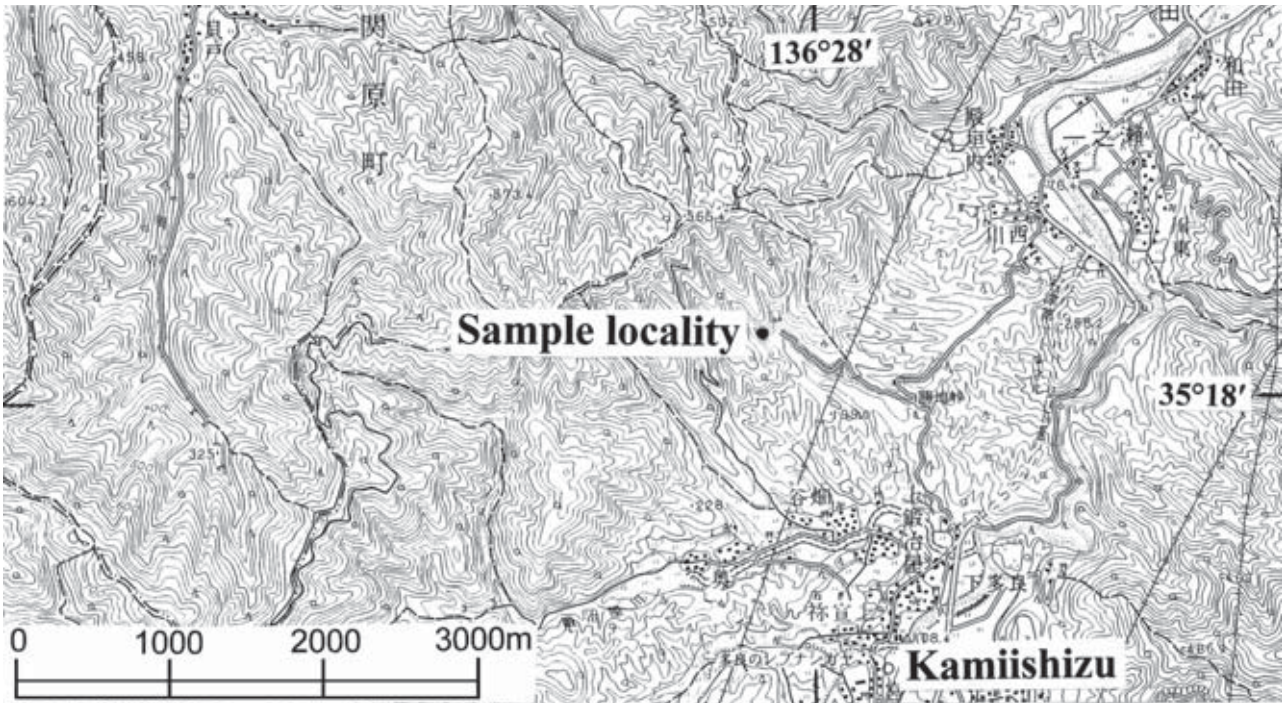

Figure 1. Sample locality of conglomeratic limestone. Topographic map is from 1:50,000 map "Hikone-tobu" of Geographical Survey of Japan.

Lithology, Fauna, and Age

The sample studied is conglomeratic limestone of algal pelloid wackestone and algal packstone, both of which are partly dolomitized and in stylolite contact with dolomite seams. Fusuline assemblage is different between the two as represented by *Skinnerella kamiishizuensis* dominant in the algal pelloid wackestone and by *Cuniculinella*? *isomie* in the algal packstone (Pl. 2, fig. 22). Rugose corals, *Yatzengia* sp., only occur in the former (Pl. 2, fig. 23). *Misellina dyhrenfurthi* (Dutkevich in Likaharev, 1939) (Pl. 2, figs. 7–13) is common in the latter and rare in the former. Other foraminifers are very rarely contained, such as *Schubertella* sp. (Pl. 2, fig. 18), *Pseudoendothyra* sp. (Pl. 2, fig. 17), *Tetrataxis* sp. (Pl. 2, fig. 19), *Palaeotextularia* sp. (Pl. 2, figs. 20, 21), *Pachyphloia*? sp., and *Hemigordius*? sp.

Among these foraminifers, *Misellina dyhrenfurthi* is the most useful for age determination of this limestone. This species is restricted to the upper part of the Kungurian (Bolorian in the Tethyan standard) and common in the Tethyan regions (e.g., Leven, 1975). It occurs biostratigraphically in the lower level than that of *Misellina claudiae* in the Akiyoshi Limestone (T. Ozawa and Kobayashi, 1990; Ueno, 1991). The occurrence of *Misellina dyhrenfurthi* in the Kamiishizu limestone sample is apparently dated to be late Kungurian (Bolorian) age.

Systematic Paleontology

Superfamily Fusulinoidea von Möller,1878
Family Schwagerinidae Dunbar and Henbest, 1930
Genus *Skinnerella* Coogan, 1960
Skinnerella kamiishizuensis, sp. nov.
Plate 1, Figures 1–19; Plate 2, Figures 14–16

Drivation of name.—Local geographic name, Kamiishizu, Ogaki City, Gifu Prefecture.

Type specimens.—Holotype D2-037799 (axial section, Pl. 1, Fig. 1), Paratypes D2-037812 (axial section, Pl. 1, Fig. 2), D2-037822 (tangential section of a microspheric form, Pl. 1, Fig. 3), D2-037820 (parellel section of a microspheric form, Pl. 1, Fig. 4), D2-037816 (axial section, Pl. 1, Fig. 5), D2-037778 (axial section, Pl. 1, Fig. 6), D2-037811 (axial section, Pl. 1, Fig. 7), D2-037798 (sagittal section, Pl. 1, Fig. 8), D2-037779 (sagittal section, Pl. 1, Fig. 9), D2-037808 (axial section, Pl. 1, Fig. 10), D2-037821 (axial section, Pl. 1, Fig. 11), D2-037810 (axial section, Pl. 1, Fig. 12), D2-037814 (sagittal section, Pl. 1, Fig. 13), D2-037805 (axial section, Pl. 1, Fig. 14), D2-037806 (axial section, Pl. 1, Fig. 15), D2-037794 (axial section, Pl. 1, Fig. 16), D2-037790

(axial section, Pl. 1, Fig. 17), D2-037802 (tangential section, Pl. 1, Fig. 18), D2-037819 (axial section, Pl. 1, Fig. 19), D2-037784 (axial section, Pl. 2, Fig. 14), D2-037801 (axial section, Pl. 2, Fig. 15), D2-037779 (sagittal section, Pl. 2, Fig. 16).

Type locality.—2.3 km NNW of Kamiishizu municipal office, Kamiishizu-cho, Ogaki City, Gifu Prefecture.

Diagnosis.—*Skinnerella* having strongly and rather regularly fluted septa throughout the test, indistinct cuniculi, well-developed axial filling in axial regions and both sides of the tunnel in inner whorls, and test size almost the same both in megalospheric and microspheric forms.

Description.—Test fusiform with broadly arched periphery, straight to slightly convex lateral slopes, rounded to bluntly pointed poles, and straight axis of coiling. Mature test with eight to nine whorls, 9 to 11 mm in length, 4 to 5 mm in width, and about 1.9 to 2.6 in form ratio in megalospheric forms. Approximate length, width, and form ratio 10 mm, 2.8 mm, and 3.6, respectively in the tangential section of a microspheric form shown in Pl. 1, fig. 3. in the microspheric form. Proloculus nearly spherical, 0.34 to 0.52 mm in outer diameter. Test gradually increasing in length and width. Length, width, and form ratio in the first to eighth whorls of the holotype, 0.8?, 1.3?, 2.4?, 3.9?, 5.4, 7.2, 8.9, 10.7 mm; 0.49, 0.72, 1.10, 1.63, 2.30, 2.98, 3.72, 4.48 mm; and 1.6?, 1.8?, 2.2?, 2.4?, 2.3, 2.4, 2.4, 2.4, respectively.

Septa strongly fluted throughout test, especially in the polar regions. Septal folds rather regular for the genus, more than a half as high as chambers, partly reaching the top of chambers, and partly producing cuniculi. Septal counts from the first to eighth whorls 13, 20, 28, 40, 40, 41, 52, 51, and 61? in the paratype illustrated in Pl. 1, Fig. 13. Phrenotheca partly developed in outer whorls. Wall gradually thickened outwards and 60 to 100 microns in most of outer two whorls, and consisting of tectum and fine alveolar keriotheca. Rudimentary chomata present on the proloculus and partly in the first whorl. Tunnel narrow, low and its path irregular. Dense axial filling well developed in axial regions and both sides of the tunnel in inner whorls.

Material examined.—Twenty-two types and other specimens.

Discussion.—As discussed in Kobayashi (2005b), there are some schwagerinid species uneasily determinable in their generic affinity to and level of either *Parafusulina* (*Parafusulina*) or *Parafusulina* (*Skinnerella*), or *Parafusulina* or *Skinnerella*. Much larger test size of microspheric forms of the former genus or subgenus than those of the latter (Skinner, 1971) is thought to be highly available taxonomically on account of one of quite different test characters between dimorphic forms in close relation to the evolution of advanced forms of schwagerinids (Kobayashi, 2005b).

The presence of microsperic forms as large as megalospheric ones in the Kamiishizu limestone strongly suggests the generic assignment of this new species to *Skinnerella*, and taxonomic validity of *Skinnerella* and its distinction from *Parafusulina* in the generic level.

In such test characters as strongly fluted and closely spaced septa resulting indistinct cuniculi, this new species resembles closely *Skinnerella yabei* (Hanzawa, 1942), which was thought to be one of the typical examples of *Skinnerella* (e.g., Coogan, 1960; Kanmera, 1963; Skinner, 1971). However, the former has smaller and more inflated test than the latter.

Skinnerella kamiishizuensis is also similar to *Schwagerina hawkinsiformis* Igo from the Kanto Mountains by Kobayashi (2005a) in many respects, but the former has cuniculi and stronger axial filling than the latter. Axial filling is less well developed in the original description of *Schwagerina hawkinsiformis* by Igo (1965).

Genus *Cuniculinella* Skinner and Wilde, 1965

Cuniculinella? *isomie* (Igo, 1965)

Plate 2, Figures 1–6

Pseudofusulina isomie, Igo, 1965, p. 219, 220, pl. 29, fig. 6; pl. 30, figs. 5, 6.

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

Material examined.—Three axial, two sagittal, and one tangential sections

Description.—Test inflated fusiform, showing hexagonal outline in the axial plane, with slightly concave periphery, straight to slightly convex lateral slopes, bluntly pointed poles, and straight axis of coiling. Mature test with eight or more whorls, more than 11 mm in length, and more tha 4.5 mm in width. Proloculus spherical to subspherical, 0.35 to 0.57 mm in outer diameter. Inner three to four fusiform whorls with broadly rounded periphery, outer ones with straight to slightly convex periphery.

Septa stout, strongly fluted throughout test, but not so intensely folded in tunnel regions as in the polar regions. Septal folds rather regular, more than a half as

high as chambers partly reaching the top of chambers and partly resulting cuniculi. Septal counts from the first to sixth whorls 8?, 18, 23, 32, 36, and 40, and uncertain in further outer whorls in the specimen illustrated in Pl. 2, fig. 2. Phrenotheca present in outer whorls. Wall thin in the first and as thick as 150 to 200 microns in outer whorls, and consisting of tectum and coarse alveolar keriotheca. Rudimentary chomata present on the proloculus. Tunnel low, as wide as 30 to 40 degrees in outer whorls. Dense axial filling well developed in axial regions. The surface and interior of septal folds are covered with and filled with secondary dark calcareous materials.

Discussion.—Igo (1965) described and illustrated *Pseudofusulina kraffti* (Schellwien in Schellwien and Dyhrenfurth, 1909) and many similar forms to *P. kraffti* from the northern part of the Mino Terrane. One of them described as the new species is *Pseudofusulina isomie* which closely resembles the Kamiishizu specimens especially in well-developed axial filling and straight to slightly concave periphery in outer whorls. Igo (1965) pointed out the differences of this species from P. *kraffti* in its larger and more elongate test, thinner and more regularly fluted septa, and stronger axial filling.

Slight morphological differences between the present specimens and types are considered to represent the intraspecific variation of this species as Igo (1965) recognized wide morphologic variation in the types. However, this species is questionably assigned to the genus *Cuniculinella* based on the presence of cuniculi in the Kamiishizu specimens.

Along with this species, *Parafusulina postkraffti* originally described from the *Misellina* Zone of Pamir by Leven (1967) and *Paraleeina postkraffti* (Leven, 1967) from the Bolorian of eastern Iran by Leven and Mohaddam (2004) are thought to be ally to and might to be a descendent of *Pseudofusulina kraffti*. Generic validity of *Paraleeina* proposed by Leven in Leven and Mohaddam (2004), however, is postponed with reservation, though Leven insisted that the *Paraleeina* is distinguishable from *Parafusulina* and *Skinnerella* by having more irregular septal fluting and massive secondary deposits.

The Kamiishizu specimens are common to *Parafusulina edoensis* (Y. Ozawa, 1925) in their thick wall, rather regularly fluted septa, the presence of cuniculi and others. The former seems to be different from the latter in its more inflated test, more number of whorls, and more massive axial filling.

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References

Coogan, A. H. (1960) Stratigraphy and paleontology of the Permian Nosoni and Dekka Formations (Bollibokka Group). *Univ. California Publ., Geol. Sci.*, **36**: 243–316.

Dunbar, C. O. and Henbest, L. G. (1930) The fusulinid genera *Fusulina, Fusulinella* and *Wedekindella*. *Amer. Jour. Sci., Ser.* 5, **20**: 357–364.

Hanzawa, S. (1942) *Parafusulina yabei* n. sp. from Tomuro, Shimotuke Province, Japan. Japan. *Jour. Geol. Geogr.*, **16**: 127–131.

Harayama, S., Miyamura, M., Yoshida, F., Mimura, K. and Kurimoto, C. (1989) *Geology of the Gozaishoyama district*. With geological sheet map at 1:50,000, Geol. Surv. Japan, Kawasaki 145 p. (in Japanese with English abstract)

Igo, H. (1961) Limestone and dolomite mines in the Chubu district, Japan. *Sekkaiseki* (*Limestone*), 72: 1–11. (in Japanese)

Igo, H. (1965) Permian fusulinids of Nyukawa, central Japan. Part 2. Some fusulinids from the lower part of the Sote Formation. *Jour. Paleont.*, **39**: 210–223.

Kanmera, K. (1963) Fusulines of the Middle Permian Kozaki Formation of Southern Kyushu. *Mem. Fac. Sci., Kyushu Univ., Ser. D*, **14**: 79–141.

Kobayashi, F. (2005a) Early Permian fusulinaceans in the Hanagiri-Shimokuzu area, eastern part of the Kanto Mountains, Japan. *Nature and Human Activities*, **9**: 11–31.

Kobayashi, F. (2005b) Permian foraminifers from the Itsukaichi–Ome area, west Tokyo, Japan. *Jour. Paleont.*, **79**: 413–432.

Kurimoto, F. (1987) Triassic and Jurassic radiolarians from the southwestern part of the Mino Terrane. *Bull. Geol. Surv. Japan*, **38**: 67–80. (in Japanese with English abstract)

Leven, E. Ya. (1967) Stratigraphy and fusulinids of the Permian strata of Pamir. *Trudy Geol. Inst., Akad. Nauk SSSR*, **167**: 1–224. (in Russian)

Leven, E. Ya. (1975) Scale of the Permian stages for the Tethyan deposits. *Bull. Moscow Soc. Naturalists, Geol. Ser.*, **50**: 5–21. (in Russian)

Leven, E. Ya. and Mohaddam, H. V. (2004) Carboniferous-Permian stratigraphy and fusulinids of eastern Iran. The

Permian in the Bag-E-Vang section. *Riv. Ital. Paleont. Strat.*, **110**: 441–465.

Likharev, B. K, (1939) Atlas of the leading forms of the fossil fauna of the USSR, Volume 6, Permskaya Sistema. *Tsentr. Nauch.-issel. Geol.-razved. Inst.. Leningrad*, 269 p. (in Russian)

Miyamura, M., Mimura, K. and Yokoyama, T. (1976) *Geology of the Hikone-tobu district*. With geological sheet map at 1:50,000, Geol. Surv. Japan, Kawasaki 46 p. (in Japanese with English abstract)

Ozawa, T. and Kobayashi, F. (1990) Carboniferous to Permian Akiyoshi Limestone Group. In, *Guidebook for Field Trip N. 4, Akiyoshi*, The Fourth International Symposium on Benthic Foraminifera, Sendai, Japan, p. E1–E31.

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

Schellwien, E. and Dyhrenfurth, G. (1909) Monographie der Fusulininen, Teil 2: Die asiatischen Fusulininen, Die Fusulininen von Darvas. *Palaeontogr.*, **56**: 135–176.

Skinner, J. W. (1971) New Lower Permian fusulinids from Culberson County, Texas. *Univ. Kansas Paleont. Contrib.*, Paper 53: 1–10.

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

Ueno, K. (1991) Early evolution of the Families Verbeekinidae and Neoschwagerinidae (Permian Fusulinacea) in the Akiyoshi Limestone Group, Southwest Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, no. 164: 973–1002.

Wakita, K. (1988) Origin of the chaotically mixed rock bodies in the Early Jurassic to Early Cretaceous sedimentary complex of the Mino Terrane, central Japan. *Bull. Geol. Surv.*, **39**: 675–757.

小林文夫：岐阜県関ヶ原南方，上石津産ペルム紀前期後葉（クングリアン）フズリナ化石

岐阜県関ヶ原南方の上石津で採集された礫質石灰岩から産したフズリナ化石２種，*Skinnerella kamiishizuensis*（新種）と *Cuniculinella*? *isomie* (Igo) を記載した．両者の年代は，*Misellina dyhrenfurthi* (Dutkevich) と共存することから，ペルム紀前期後葉のクングリアンであるといえる．*Skinnerella kamiishizuensis* はやや規則的で強い隔壁褶曲，不鮮明ながら識別されるキュニキュリ，顕著な軸充填物により既存種と区別され，殻サイズが顕球形型と微球形型で変わらないことから *Skinnerella* 属に含められる．

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Plate 1.

Figs. 1–19. *Skinnerella kamiishizuensis* sp. nov.
1: D2-037799; 2: D2-037812; 3: D2-037822; 4: D2-037820; 5: D2-037816; 6: D2-037778; 7: D2-037811; 8: D2-037798; 9: D2-037779; 10: D2-037808; 11: D2-037821; 12: D2-037810; 13: D2-037814; 14: D2-037805; 15: D2-037806; 16: D2-037794; 17: D2-037790; 18: D2-037802; 19: D2-037819, 1–5, 13, 18:×10; others:×6.

Plate 2.

Figs. 1–6. *Cuniculinella*? *isomie* (Igo). 1: D2-037800; 2: D2-037804; 3: D2-037786; 4: D2-037825; 5: D2-037783; 6: D2-037826, all:×10.
Figs. 7–13. *Misellina dyhrenfurthi* (Dutkevich). 7: D2-037791; 8: D2-037773; 9: D2-037789; 10: D2-037797; 11: D2-037776; 12: D2-037820; 13: D2-037774, all:×20.
Figs. 14–16. *Skinnerella kamiishizuensis* sp. nov. 14: D2-037784; 15: D2-037801; 16: D2-037779, all:×6.
Fig. 17. *Pseudoendothyra* sp., D2-037820, ×30.
Fig. 18. *Schubertella* sp., D2-037793, ×30.
Fig. 19. *Tetrataxis* sp., D2-037792, ×30.
Figs. 20, 21. *Palaeotextularia* sp. 20: D2-037822;×20, 21: D2-037809;×30.
Fig. 22. Algal packstone in conglomeratic limestone, D2-037780,×5.
Fig. 23. Algal pelloid wackestone with rugose corals (*Yatzengia* sp.) in conglomeratic limestone, D2-037788, ×5.

Plate 1.

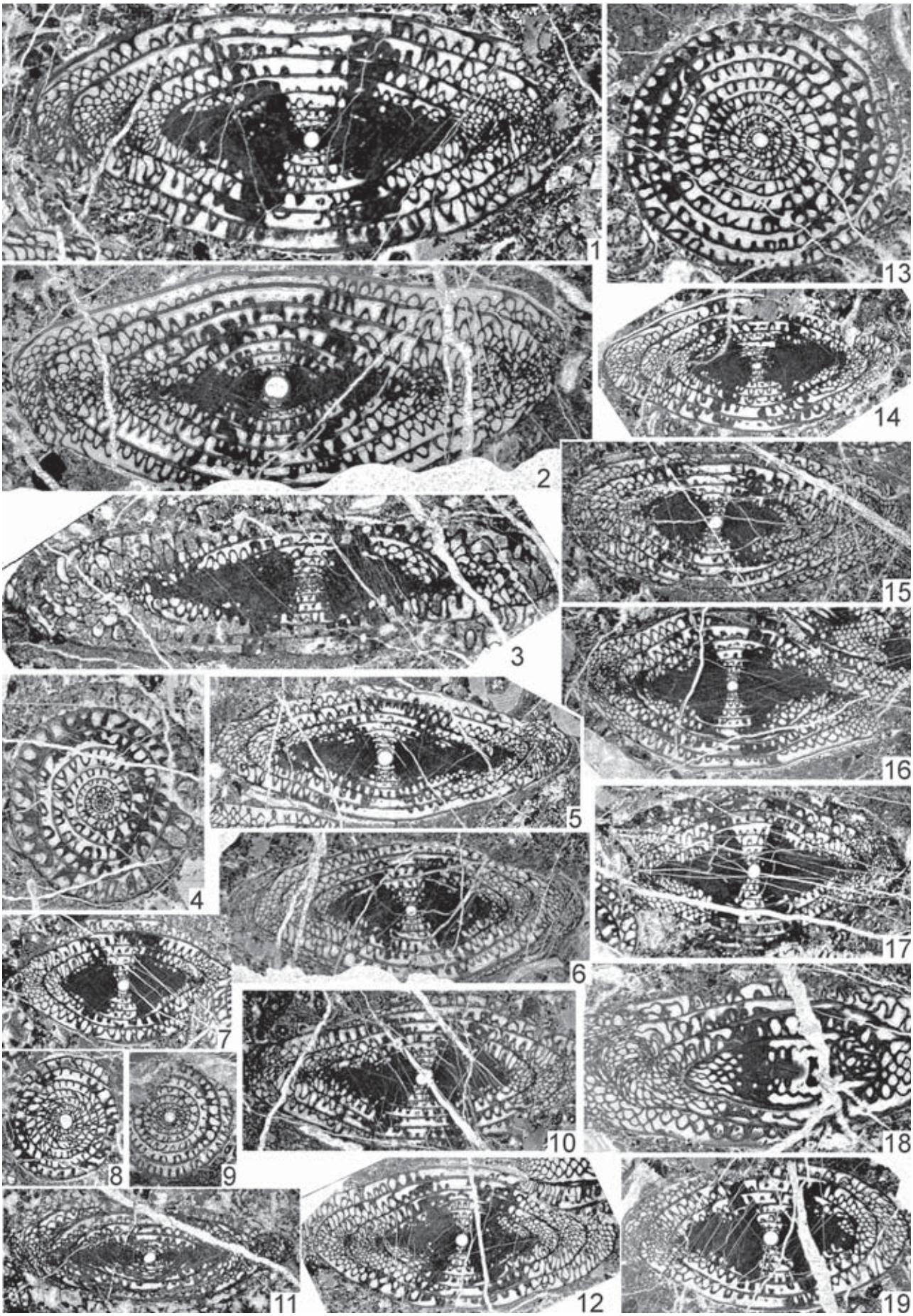

Plate 2.