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Report

Middle Permian fusulines from the Shirasaki Limestone in Yura Town, western part of the Kii Peninsula, Japan

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Abstract

Paleobiogeographically and biostratigraphically important fusulines occur in the Yura area, Southern Chichibu Terrane. Twenty-one species of fusulines and 17 species of non-fusuline foraminifers of the Middle Permian were distinguished in the Shirasaki Limestone, western end of the Yura area. They are illustrated to compare with fusulines previously figured from the limestone and to reinforce the foraminiferal information of the Southern Chichibu Terrane. Systematically described herein are 12 species of fusulines: *Neofusulinella phairayensis, Parafusulina japonica, Parafusulina kinosakii, Parafusulina shimotsukensis, Parafusulina tochigiensis, Pseudodoliolina ozawai, Verbeekina verbeeki, Neoschwagerina craticulifera, Yabeina higoensis, Yabeina katoi, Yabeina* cf. *omurensis*, and *Lepidolina*? sp.

Key words: Middle Permian, fusulines, Shirasaki Limestone, Southern Chichibu Terrane

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Introduction

Stratigraphy and tectonic development of pre-Cretaceous rocks constructed until the 1970's in the Yura area, Wakayama Prefecture (e.g. Tatebayashi, 1930; Saka, 1967), as well as those in other areas of Japan (e.g. Toriyama, 1963, 1967), were obliged to be changed and reconsidered on account of the age calibration of siliciclastic rocks determined by radiolarians introduced in the early 1980's. According to Yao (1984), the accretionary complex of the Southern Chichibu Terrane in the Yura area consists of the Chuki Group (Lower Jurassic to Lower Cretaceous) divided into the Obiki, Yura, and Kamiya formations from north to south. The Obiki Formation is further subdivided into the Oshimayama, Banshoyama, and Tatego members. These stratigraphic units zonally arranging approximately in the east to west direction are clarified to be younger from north to south based on radiolarian biostratigraphy (Yao, 1984). Pre-Cretaceous limestone, basaltic rocks, and chert are intermingled within the Lower Jurassic to Lower Cretaceous siliciclastic rocks as a tectonic block. Yao (1984) showed that the Upper Paleozoic limestone blocks in the Yura area are restricted to the Tatego Member (Callovian-Tithonian) assignable to the Obiki Formation (lower Lower Jurassic to Tithonian).

The Shirasaki Limestone, the largest limestone block in the Yura area, is remarkable in its occurrence of paleobiogeographically and biostratigraphically important fusulines, along with smaller limestone blocks exposed at Tatego and Kaimori (Fig.1). These fusulines are represented by *Protriticites*, *Obsoletes*, and *Yabeina* at Shirasaki, *Akiyoshiella* and *Profusulinella* at Kaimori, and Visean-Serpkhovian (Early Carboniferous) eostaffellins at Tatego, most of which were illustrated by Ishii (1985) without

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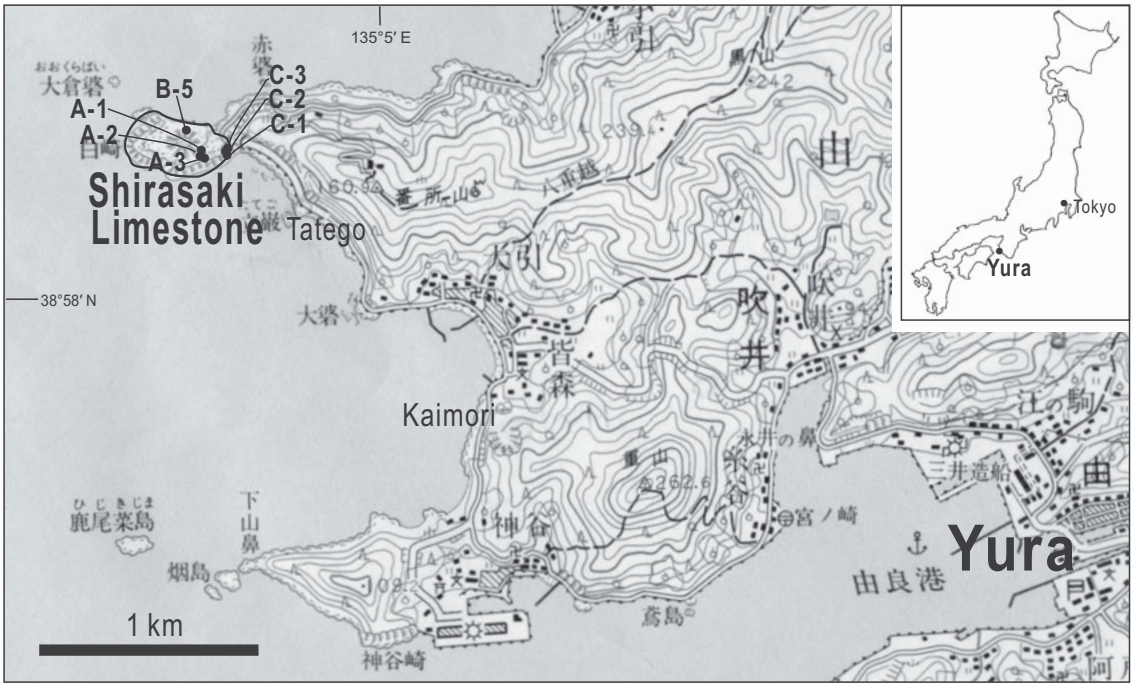

Figure 1. Location of the Shirasaki Limestone and sample localities. Using the 1:50,000 scale topographic map of "Gobo" published by the Geospatial Information Authority of Japan.

description. Kobayashi (in press) systematically described these Carboniferous fusulines, except for Permian *Yabeina*, and discussed their paleobiogeographic and biostratigraphic implications.

This report illustrates 21 species of Middle Permian fusulines and 17 coeval species of non-fusuline foraminifers (Table 1), distinguished in seven samples (A-1, A-2, A-3, B-5, C-1, C-2, C-3), that were collected from the Shirasaki Limestone (Fig.1). Sample C-3 is conglomeratic, Sample C-1 is somewhat conglomeratic, and other samples consist of bioclastic packstone/grainstone. Among 38 species of foraminifers, 12 fusulines are systematically described to compare with those illustrated by Ishii (1985) and to reinforce the foraminiferal information of the Southern Chichibu Terrane. The limestone outcrops, from which four samples (A-1, A-2, A-3, B-5) were obtained, are lost by the construction of a prefectural park at Shirasaki. Limestone thin sections of the foraminifers illustrated are stored in the collection of the Museum of Nature and Human Activities, Hyogo, Japan (Fumio Kobayashi Collection).

Systematic description

Superfamily Fusulinoidea von Möller, 1878
Family Schubertellidae Skinner, 1931

Genus *Neofusulinella* Deprat, 1912
Type species: *Neofusulinella lantenoisi* Deprat, 1913

Neofusulinella phairayensis Colani, 1924
Plate 1, Figures 40–43

Neofusulinella phairayensis Colani, 1924, p. 104, 105, pl. 16, figs. 1–5, 7–10, 12–16, 20–22; Y. Ozawa, 1927, p. 151, 152 (part), pl. 37, figs. 3b, 5, 6c; pl. 38, non. figs. 2a and 12 (=*Yangchienia compressa* Y. Ozawa, 1927), 7, 8, 11 (central part and both sides of 11=*Yangchienia compressa*); pl. 39, figs. 1, 2; pl. 44, fig. 6c, pl. 45, fig. 9; Kobayashi, 2011, p. 465, pl. 5, figs. 35–54.

Remarks.—Well-preserved specimens of *Neofusulinella* contained in Sample A-1 in association with *Parafusulina tochigiensis* Kobayashi, 2006a is apparently identified with *N. phairayensis* originally described by Colani (1924) from northern Viet-Nam in their size and mode of coiling of the test, wall structure, and development of chomata. They are distinguished from *N. giraudi* Deprat, 1915 contained in the same sample by their larger test and more numerous whorls. Some specimens named this species by Y. Ozawa (1927) from the Akasaka Limestone, originally assigned into *Fusulinella*, are

Table 1. Middle Permian foraminifers distinguished in seven samples of the Shirasaki Limestone.

	A–1	A–2	A–3	B–5	C–1	C–2	C–3
Kahlerina nautiloidea					X		X
Rauserella sp.							X
Codonofusiella? sp. A							X
Codonofusiella? sp. B						X	
Dunbarula oviformis	X						
Dunbarula schubertellaeformis					X		X
Neofusulinella giraudi	X						
Neofusulinella phairayensis	X						
Chusenella sp.							X
Chusenella andersoni					X		
Parafusulina japonica	X	X	X				
Parafusulina kinosakii	X	X		X			
Parafusulina shimotsukensis		X					
Parafusulina tochigiensis	X						
Pseudodoliolina ozawai	X						X
Verbeekina verbeeki	X				X		
Neoschwagerina craticulifera	X						
Yabeina higoensis					X		X
Yabeina katoi							X
Yabeina cf. *omurensis*					X		
Lepidolina? sp.							X
Nodosinelloides sp. A							X
Nodosinelloides sp. B		X					
Climacammina sp.	X						
Deckerella sp.		X					
Endothyra sp. A		X			X		
Endothyra sp. B	X						
Tetrataxis sp.	X						
Paradagmaritopsis sp.						X	
Geinitzina postcarbonica		X					
Geinitzina sp. A							X
Geinitzina sp. B	X						
Geinitzina? sp.					X		
Neodiscus spp.					X	X	
Frondina sp.						X	
Pachyphloia ovata	X						
Pachyphloia schwageri	X					X	
Pachyphloia? sp.	X						

assignable to *Yangchienia compressa* (Y. Ozawa, 1927) as listed above.

Family Schwagerinidae Dunbar and Henbest, 1930

Genus *Parafusulina* Dunbar and Skinner, 1931

Type species: *Parafusulina wordensis* Dunbar and Skinner, 1931

Parafusulina japonica (Gümbel, 1874)

Plate 3, Figures 1–5, 7, 9, 11–13

Fusulina japonica Gümbel, 1874, p. 479; Schwager, 1883, p. 121–124, pl. 15, figs. 1–10; Deprat, 1914, p. 7–9, pl. 1, figs. 1–9.

Fusulina (*Schellwienia*) *japonica* (Gümbel), Y. Ozawa, 1927, p. 147–149, pl. 36, figs. 1–7, pl. 37,

fig. 7a.

non. *Schellwienia japonica* (Gümbel), Lee, 1927, p. 82, pl. 13, figs. 1–3. [=*Praeparafusulina pseudojaponica* (Dutkevich in Likharev, 1939)]

Parafusulina japonica (Gümbel), Morikawa, 1958, p. 112–114, pl. 19, figs. 1–7; Kobayashi, 2006a, p. 47, figs. 12.1–12.25; Kobayashi, 2011, p. 470, 471, pl. 15, figs. 9–15; pl. 16, figs. 1–27; Kobayashi, 2016, p. 403–405, figs. 4.1–4.49, 7.1–7.8, 8.1, 8.2.

non. *Parafusulina japonica* (Gümbel), Kalmykova, 1967, p. 206, 208, pl. 25, figs. 1–4. [=*Praeparafusulina pseudojaponica* (Dutkevich in Likharev, 1939)]

Remarks.—The first confirmation of the development of the Permian in Japan is based on the occurrence of this species from the Akasaka Limestone (Gümbel, 1874). Identification and generic assignment of this species have been considerably different among authors. For example, *Schellwienia japonica* described by Lee (1927) from North China was renamed as *Parafusulina pseudojaponica* by Dutkevich in Likharev (1939), and was later designated as the type species of *Praeparafusulina* established by Tumanskaya (1962). This species was separated from *Parafusulina* (*Parafusulina*) and reassigned to *Parafusulina* (*Skinnerella*) based on the mode of septal folding by Coogan (1960). Kobayashi (2016) revealed that the microspheric specimens of this species are much more typical of those of *Parafusulina* (*Parafusulina*) and *P. japonica* will be placed in the genus *Parafusulina* without generic and subgeneric subdivisions. Further morphologic and phylogenetic studies based especially on microspheric forms are needed in the "*Parafusulina*" and its allies of the Tethyan and Panthalassan regions.

Morphologic studies based on numerous specimens of *P. japonica* have been done in Kuzu (Kobayashi, 2006a, 2013), Akasaka (Kobayashi, 2011), and Tamonouchi (Kobayashi, 2016) materials. They show the broad intraspecific variations of this species. Ten specimens illustrated herein closely resemble specimens from Kuzu, Akasaka, and Tamanouchi in important test characters such as size and form of the test and proloculus, and mode of septal folding in the megalospheric forms of *P. japonica*. Microspheric forms of the species are very few and confined to two specimens of Tamanouchi (Kobayashi, 2016) and one abraded specimen from Kuzu (Kobayashi, 2006a).

Parafusulina kinosakii (Morikawa, 1958)
Plate 2, Figures 7, 10, 11

Schwagerina kinosakii Morikawa, 1958, p. 109, 110, pl. 16, fig. 10; pl. 17, figs. 1–10.

Schwagerina yabei (Hanzawa, 1942), Morikawa, 1958, p. 110, 111, pl. 15, fig. 9.

Parafusulina kinosakii (Morikawa), Kobayashi, 2011, p. 471, pl. 13, figs. 18–28.

Remarks.—Morikawa (1958) proposed this species from the Akasaka Limestone and distinguished it from *Parafusulina yabei*, first described from Kuzu by Hanzawa (1942), based on its ellipsoidal test. Both species are similar each other and might be conspecific as supposed by Igo (1964) and Kobayashi (2006a). Topotype specimens of *P. yabei* and *P. kinosakii* were reexamined by Kobayashi (2006a, 2013) and Kobayashi (2011), respectively. Although almost all specimens of the latter are incomplete due to the abrasion of outer test, they and the original specimens of Morikawa (1958) are different from *P. yabei* in their weaker septal folding in polar regions and weaker development of axial fillings. The present Shirasaki specimens are also distinguished from *P. yabei* and identified with *P. kinosakii* by these characters, though well-oriented specimens are few. This species is separated from *Schwagerina* and reassigned to *Parafusulina* by its more strongly folded septa throughout the test.

Parafusulina shimotsukensis Kobayashi, 2006a
Plate 2, Figures 6, 9

Parafusulina shimotsukensis Kobayashi, 2006a, p. 49, 51, figs. 9.1–9.8, 10.1–10.13; Kobayashi, 2011, p. 473, pl. 15, figs. 1–3.

Remarks.—This species proposed by Kobayashi (2006a) from the Nabeyama Formation of Kuzu shows extremely broad intraspecific variations in many test characters as illustrated by numerous individuals in Kobayashi (2013) from six stratigraphic levels of the formation. The Shirasaki specimens, all of which are incomplete and/or abraded, appear to be allied to *Parafusulina yabei* rather than to *P. shimotsukensis*. However, smaller appearance of the test is apparently due to the incompleteness of the test. Outer whorls of the latter species are more rapidly expanding than those of the former.

Parafusulina tochigiensis Kobayashi, 2006a
Plate 2, Figures 1, 5, 8

Parafusulina kaerimizensis (Y. Ozawa, 1925), Yao et al., 1970, pl. 2, fig. 1 (=Ishii, 1985, fig. 17.3); Ishii, 1985, pl. 2, fig. 1.
Parafusulina tochigiensis Kobayashi, 2006a, p. 51, figs. 11.1–11.20; Kobayashi, 2011, p. 473, 474, pl. 14, figs. 1–10; pl. 15, fig. 4.

Remarks.—Kobayashi (2006a) considered that this species proposed from the Nabeyama Formation belongs to the *Parafusulina japonica* group and is the direct descendant of *P. kuzuensis* Chisaka and Fuse, 1973. *P. kuzuensis* was considered to be a junior synonym of *P. tomeganensis* Morikawa, 1958, based on the reexamination of the topotypes of the latter from the Akasaka Limestone (Kobayashi, 2011). *P. tochigiensis* is characterized by elongate fusiform to subcylindrical test with small proloculus for large test, strongly folded septa, and not well-developed cuniculi for the genus.

The Shirasaki specimens closely resemble the types from the Nabeyama Formation showing broad intraspecific variations in many test characters (Kobayashi, 2006a, 2013) and apparently identified with the species. Two specimens illustrated from the Shirasaki Limestone by Yao et al. (1970) and Ishii (1985) are reassigned to *P. tochigiensis* because of many test characters common to those of *P. tochigiensis*. They are not identified with *P. kaerimizensis*, very characteristic in the Akiyoshi Terrane, in their larger test and proloculus, and much more loosely coiled inner few whorls than those of the topotypes of the Akiyoshi Limestone.

Family Verbeekinidae Staff and Wedekind, 1910
Subfamily Misellinae Miklukho-Maklay, 1958
Genus *Pseudodoliolina* Yabe and Hanzawa, 1932
Type species: *Pseudodoliolina ozawai* Yabe and Hanzawa, 1932

Pseudodoliolina ozawai Yabe and Hanzawa, 1932
Plate 2, Figures 12–14

Pseudodoliolina ozawai Yabe and Hanzawa, 1932, p. 40–42; Thompson and Foster, 1937, p. 138–140, pl. 24, figs. 9, 10; Ishii, 1985, pl. 1, fig. 11; Kobayashi, 2011, p. 478, 480, 482, pl. 17, figs. 1–20, 22–24, 26, 27, 31.

Remarks.—As reviewed by Kobayashi (2011, p. 477, 478), Thompson and Foster (1937) made clear the generic diagnosis of *Pseudodoliolina* and taxonomic independency of *Pseudodoliolina ozawai* which were uncertain in Yabe and Hanzawa (1932). On the other hand, strict distinction of *P. ozawai* from its similar species, such as *P. oliviformis* Thompson, Wheeler, and Danner, 1950 proposed from the Twin Lakes area, Washington and *P. chinghaiensis* Sheng, 1958 from Qinghai, is not easy on account of their many similarities of test characters. Similarly, it is also uneasy to separate from incomplete forms of *P. pseudolepida* (Deprat, 1912).

Two specimens illustrated in Pl. 2, figs. 12, 13 in association with *Neoschwagerina craticulifera* (Schwager, 1883) are closely similar to the types of *P. ozawai* from the Akasaka Limestone. On the other hand, one illustrated in Pl. 1, fig. 14 in association with *Yabeina higoensis* Kobayashi, 2001 might be distinguished from *P. ozawai* by having more elongate test and slenderer parachomata. However, it is provisionally included in *P. ozawai* because of insufficient specimens in the Shirasaki materials.

Subfamily Verbeekininae Staff and Wedekind, 1910
Genus *Verbeekina* Staff, 1909
Type species: *Fusulina verbeeki* Geinitz, 1876

Verbeekina verbeeki (Geinitz, 1876)
Plate 3, Figures 6, 8, 10, 14

Fusulina verbeeki Geinitz, 1876, p. 399, 400.
Verbeekina verbeeki (Geinitz), Y. Ozawa, 1925, p. 48–51, pl. 10, figs. 6, 7; Ishii, 1985, pl. 1, fig. 8: Kobayashi, 2011, p. 492, pl. 17, figs. 34–36; pl. 20, figs. 1–13; pl. 21, figs. 1–5.

Remarks.—The specimen illustrated in Pl. 3, fig. 10 from sample C-1 has thinner wall and septa in outer whorls, and more weakly developed parachomata than other three from sample A-1. However, these four specimens are assumed to be conspecific and identified with *Verbeekina verbeeki*, taking different degree of abrasion of outer test of the present materials, and broad morphologic variations of the mode of test expansion, thickness of wall, and development of parachomata of this species described from the Akasaka Limestone (Kobayashi, 2011) into account.

Family Neoschwagerinidae Dunbar and Condra, 1927
Subfamily Neoschwagerininae Dunbar and Condra, 1927
Genus *Neoschwagerina* Yabe, 1903
Type species: *Neoschwagerina craticulifera* Schwager, 1883

Neoschwagerina craticulifera (Schwager, 1883)
Plate 4, Figures 1–15

Schwagerina craticulifera Schwager, 1883, p. 140, pl. 18, figs. 15–25.
Neoschwagerina craticulifera (Schwager), Yabe, 1906, p. 2, pl. 1, fig. 3; Ishii, 1985, pl. 1, fig. 10; Kobayashi, 2011, p. 518, 520, pl. 33, figs. 1–18; pl. 37, figs. 4–6.
Neoschwagerina (*Neoschwagerina*) *craticulifera* (Schwager), Y. Ozawa, 1927, p. 154–156, pl. 40, figs. 1–7, 10, 11a.
Neoschwagerina minoensis Y. Ozawa, 1927, Ishii, 1985, pl. 1, fig. 7.
Maklaya sp., Ishii, 1985, pl. 1, fig. 9.

Remarks.—Many species or subspecies identified with *Neoschwagerina craticulifera* were described by many workers. Those examples in the Akasaka Limestone were discussed by Kobayashi (2011). Fifteen specimens illustrated herein from the Shirasaki Limestone are all identified with *N. craticulifera*. Smaller appearance of the test in many specimens is due to the abrasion of outer test in the Shirasaki materials. This species is distinguished from *N. colaniae* Y. Ozawa, 1927 in its smaller test, fewer number of whorls, and absence or fewer number of secondary transverse septula between adjacent primary transverse septula in outer whorls. *N. minoensis* illustrated by Ishii (1985) from the Shirasaki Limestone should be undoubtedly transferred to this species (see topotype specimens of *N. minoensis* described by Kobayashi, 2011 from the Akasaka Limestone). *Maklaya* sp. illustrated by Ishii (1985) is almost the same as the specimen named *N. craticulifera*, both of which are from the Shirasaki Limestone. It has more developed primary transverse septula than typical *Maklaya*.

Genus *Yabeina* Deprat, 1914
Type species: *Neoschwagerina* (*Yabeina*) *inouyei* Deprat, 1914 [=*Yabeina globosa* (Yabe, 1906)]

Yabeina higoensis Kobayashi, 2001
Plate 4, Figures 16–21, 23

Yabeina globosa (Yabe, 1906), Ishii, 1985, pl. 1, fig. 1.
Yabeina ozawai (Honjo, 1959), Ishii, 1985, pl. 1, fig. 6.
Yabeina higoensis Kobayashi, 2001, p. 72, figs. 6.4, 6.8; pl. 5, figs. 1–9; Kobayashi, 2006c, p. 189, figs. 6.1–6.17.

Remarks.—The Shirasaki specimens identified with *Yabeina higoensis*, proposed on the basis of materials from the Kuma Formation by Kobayashi (2001) and Kaize, Saku Basin by Kobayashi (2001, 2006c), are distinguished from *Y. globosa* and *Y. katoi* (Y. Ozawa, 1927) by their diagnostic features of smaller height of the whorl in middle and late stages. They are also different from most of other species of *Yabeina* in their well development of secondary transverse septula and axial septula in comparison with a relatively small test. Based on these features of this species, the Shirasaki specimens identified with *Y. globosa* and *Y. ozawai* by Ishii (1985) are attributed to *Y. higoensis*. Smaller appearance of the latter than the former in Ishii (1985) is certainly due to the absence of a few or more outer whorls.

Yabeina katoi (Y. Ozawa, 1927)
Plate 4, Figure 26

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 aff. *globosa* (Yabe, 1906), Yao et al., 1970, pl. 2, fig. 3 (=*Yabeina globosa* in Ishii, 1985, fig. 17.1).
? *Yabeina katoi* (Y. Ozawa), Ishii, 1985, pl. 1, fig. 2.
Yabeina katoi (Y. Ozawa), Kobayashi, 2011, p. 528, 530, 532, pl. 42, figs. 1–4; pl. 43, figs. 1–5.

Remarks.—The specimen obtained only from sample C-3, though incomplete and abraded, should be separated from *Yabeina higoensis* by its larger chamber height of outer whorls. It is identified with *Y. katoi* in its thin wall, and slender primary and secondary transverse septula. The specimen, named *Y.* aff. *globosa* by Yao et al. (1970) and renamed *Y. globosa* by Ishii (1985), is reassigned to *Y. katoi* by these morphologies characteristic in *Y. katoi*, as clearly exemplified in the topotypes of the Akasaka Limestone (Kobayashi, 2011). Precise identification with this species in the Shirasaki specimen by Ishii (1985, pl. 1, fig. 2) is uneasy on account of its abrasion of outer whorls.

Yabeina cf. *omurensis* Yamagiwa and Ishii, 1958
Plate 4, Figures 22, 24

Compare to:

Yabeina omurensis Yamagiwa and Ishii, 1958, p. 62, 64, pl. 4, figs. 1–8; Ishii, 1985, pl. 1, fig. 5.

Remarks.—Although exact test size is unknown due to the abrasion of outer whorls, two illustrated specimens are compared to *Yabeina omurensis* first described by Yamagiwa and Ishii (1958) from the Shima Peninsula, Mie Prefecture and later by Ishii (1985) from the Shirasaki Limestone. They are more similar to the Ishii's (1985) specimen in their thinner wall and septa, and slenderer primary transverse septula than those of the original ones from the Shima Peninsula. Relatively poor development of secondary transverse septula and axial septula for a species of *Yabeina* is common in these Shima and Shirasaki materials.

Subfamily Lepidolilininae Miklukho-Maklay, 1958
Genus *Lepidolina* Lee, 1933 emend. T. Ozawa, 1970

Type species: *Neoschwagerina* (*Sumatrina*) *multiseptata* Deprat, 1912

Lepidolina? sp.
Plate 4, Figure 25

Remarks.—Relatively large neoschwagerinids, though exact test size is unknown on account of the section far apart from the center, were rarely recognized in sample C-3. *Yabeina higoensis*, *Pseudodoliolina ozawai*, *Chusenella* sp., *Codonofusiella*? sp. A, *Kahlerina nautiloidea* Sosnina, 1968, and others are also contained in this conglomeratic limestone. The illustrated specimen is characterized by elongate fusiform test with thin wall and well-developed, slender secondary transverse septula. By these morphologic characters and incompleteness of the test, it is questionably assigned to *Lepidolina*.

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Plate 1.

Fig 1. *Nodosinelloides* sp. A. D2-036789, Sample C-3.
Fig. 2. *Nodosinelloides* sp. B. D2-036667, Sample A-2.
Fig. 3. *Pachyphloia*? sp. D2-036650, Sample A-1.
Figs. 4–6. *Pachyphloia ovata* Lange, 1925. 4: D2-036653, 5: D2-036626, 6: D2-036650; all Sample A-1.
Figs. 7–12. *Pachyphloia schwageri* Sellier de Civrieux and Dessauvagie, 1965. 7: D2-036768, 8: D2-036774, 9: D2-036772, 10: D2-036767, 11: D2-036635, 12: D2-036654; 11, 12: Sample A-1, others: Sample C-2.
Fig. 13. *Frondina* sp. D2-036770, Sample C-2.
Fig. 14. *Deckerella* sp. D2-036659, Sample A-2.
Fig. 15. *Climacammina* sp. D2-036629, Sample A-1.
Fig. 16. *Geinitzina* sp. A. D2-036787, Sample C-3.
Fig. 17. *Paradagmaritopsis* sp. D2-036771, Sample C-2.
Fig. 18. *Tetrataxis* sp. D2-036645, Sample A-1.
Fig. 19. *Geinitzina*? sp. D2-036758, Sample C-1.
Figs. 20, 21. *Endothyra* sp. A. 20: D2-036763, Sample C-1; 21: D2-036669, Sample A-2.
Fig. 22. *Geinitzina* sp. B. D2-036631, Sample A-1.
Fig. 23. *Endothyra* sp. B. D2-036627, Sample A-1.
Fig. 24. *Geinitzina postcarbonica* Spandel, 1901. D2-036662, Sample A-2.
Fig. 25. *Rauserella* sp. D2-036781, Sample C-3.
Figs. 26–33. *Neodiscus* spp. 26: D2-036769, 27: D2-036768, 28: D2-036766, 29, 30: D2-036773, 31: D2-036771, 32: D2-036781, 33: D2-036783, 32, 33: Sample C-1, others: Sample C-2.
Figs. 34–36. *Kahlerina nautiloidea* Sosnina, 1968. 34: D2-036781, Sample C-3; 35: D2-036765, Sample C-1; 36: D2-036787, Sample C-3.
Fig. 37. *Codonofusiella*? sp. A. D2-06778, Sample C-3.
Figs. 38, 39. *Neofusulinella giraudi* Deprat, 1915. 38: D2-036635, 39: D2-036654; both Sample A-1.
Figs. 40–43. *Neofusulinella phairayensis* Colani, 1924. 40: D2-036622, 41: D2-036626, 42: D2-036651, 43: D2-036654; all Sample A-1.
Figs. 44, 45, 47, 49, 51. *Dunbarula oviformis* Kobayashi, 2006b. 44, 45: D2-036629, 47: D2-036636, 49: D2-036640, 51: D2-036636; all Sample C-1.
Figs. 46, 48. *Dunbarula schubertellaeformis* Sheng, 1958. 46: D2-036787, Sample C-3; 48: D2-036763, Sample C-1.
Fig. 50. *Codonofusiella*? sp. B. D2-036669, Sample C-2.
Scale bar shows 0.5 mm.

Plate 2.

Fig 1, 5, 8. *Parafusulina tochigiensis* Kobayashi, 2006a. 1: D2-036618, 5: D2-036634, 8: D2-036625; all Sample A-1.
Figs. 2, 3. *Chusenella* sp. 2: D2-036788, 3: D2-036778; both Sample C-3.
Fig. 4. *Chusenella andersoni* (Thompson, Wheeler and Danner, 1950). D2-036760, Sample C-1.
Figs. 6, 9. *Parafusulina shimotsukensis* Kobayashi, 2006a. 6: D2-036658, 9: D2-036663; both Sample A-2.
Figs. 7, 10, 11. *Parafusulina kinosakii* (Morikawa, 1958). 7: D2-036667, Sample A-2; 10: D2-036633, Sample A-1; 11: D2-036749, Sample B-5.
Figs. 12–14. *Pseudodoliolina ozawai* Yabe and Hanzawa, 1932. 12: D2-036647, Sample A-1; 13: D2-036618, Sample A-1; 14: D2-036786, Sample C-3.
Scale bar shows 2 mm.

Plate 3.

Figs. 1–5, 7, 9, 11–13. *Parafusulina japonica* (Gümbel, 1874). 1: D2-036666, 2: D2-036662, 3: D2-036629, 4: D2-036642, 5: D2-036615, 7: D2-036653, 9: D2-036673, 11: D2-036656, 12: D2-036664, 13: D2-036648; 1, 2, 11, 12: Sample A-2, 3–5, 7, 13: Sample A-1, 9: Sample A-3.
Figs. 6, 8, 10, 14. *Verbeekina verbeeki* (Geinitz, 1876). 6: D2-036620, 8: D2-036638, 10: D2-036763, 14: D2-036650; 10: Sample C-1, others: Sample A-1.
Scale bar shows 1 mm.

Plate 4.

Figs. 1–15. *Neoschwagerina craticulifera* (Schwager, 1883). 1: D2-036645, 2: D2-036653, 3: D-036639, 4: D2-036654, 5: D2-036632, 6: D2-036641, 7: D2-036617, 8: D2-036652, 9: D2-036635, 10: D2-036616, 11: D2-036649, 12: D2-036640, 13: D2-036651, 14: D-036634, 15: D2-036622; all Sample A-1.
Figs. 16–21, 23. *Yabeina higoensis* Kobayashi, 2001. 16: D2-036784, 17: D2-036758, 18: D2-036756, 19: D2-036757, 20: D2-036764, 21: D2-036782, 23: D2-036754; 16, 21: Sample C-3, others: Sample C-1.
Figs. 22, 24. *Yabeina* cf. *omurensis* Yamagiwa and Ishii, 1958. 22: D2-036763, 24: D2-036753; both Sample C-1.
Fig. 25. *Lepidolina*? sp. D2-036780, Sample C-3.
Fig. 26. *Yabeina katoi* (Y. Ozawa, 1927). D2-036790, Sample C-3.
Scale bar shows 1 mm.

Plate 1.

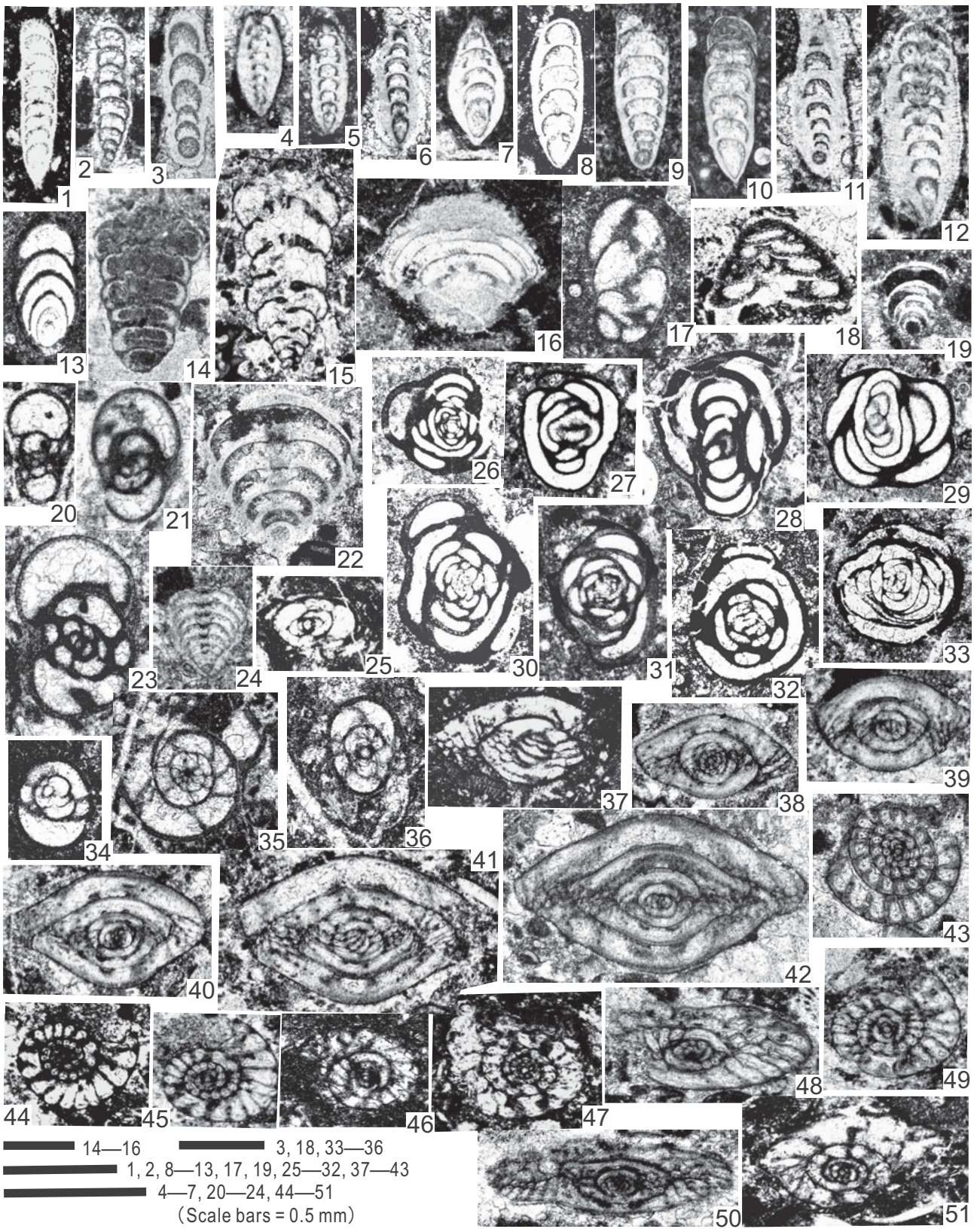
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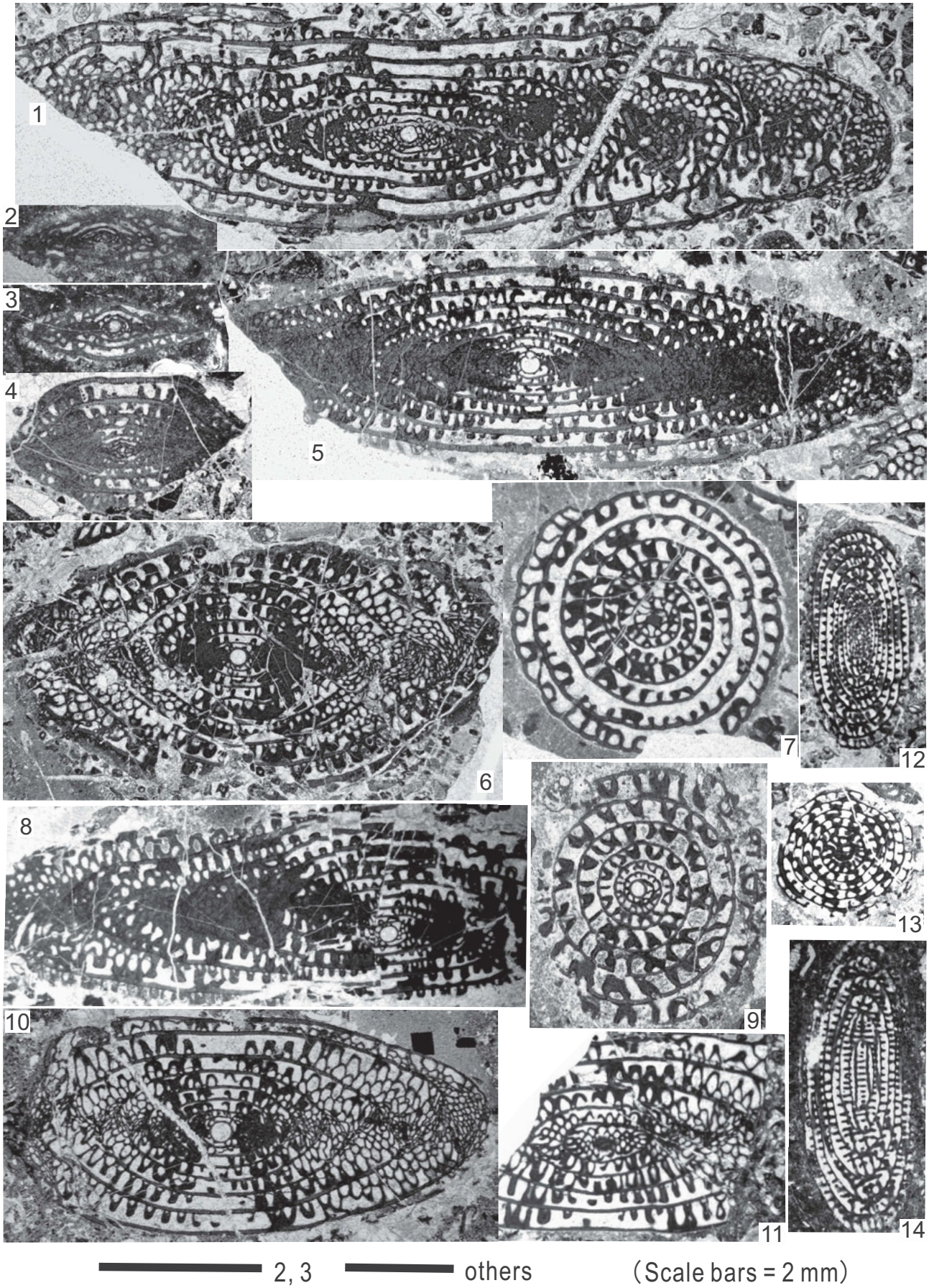
Plate 2.



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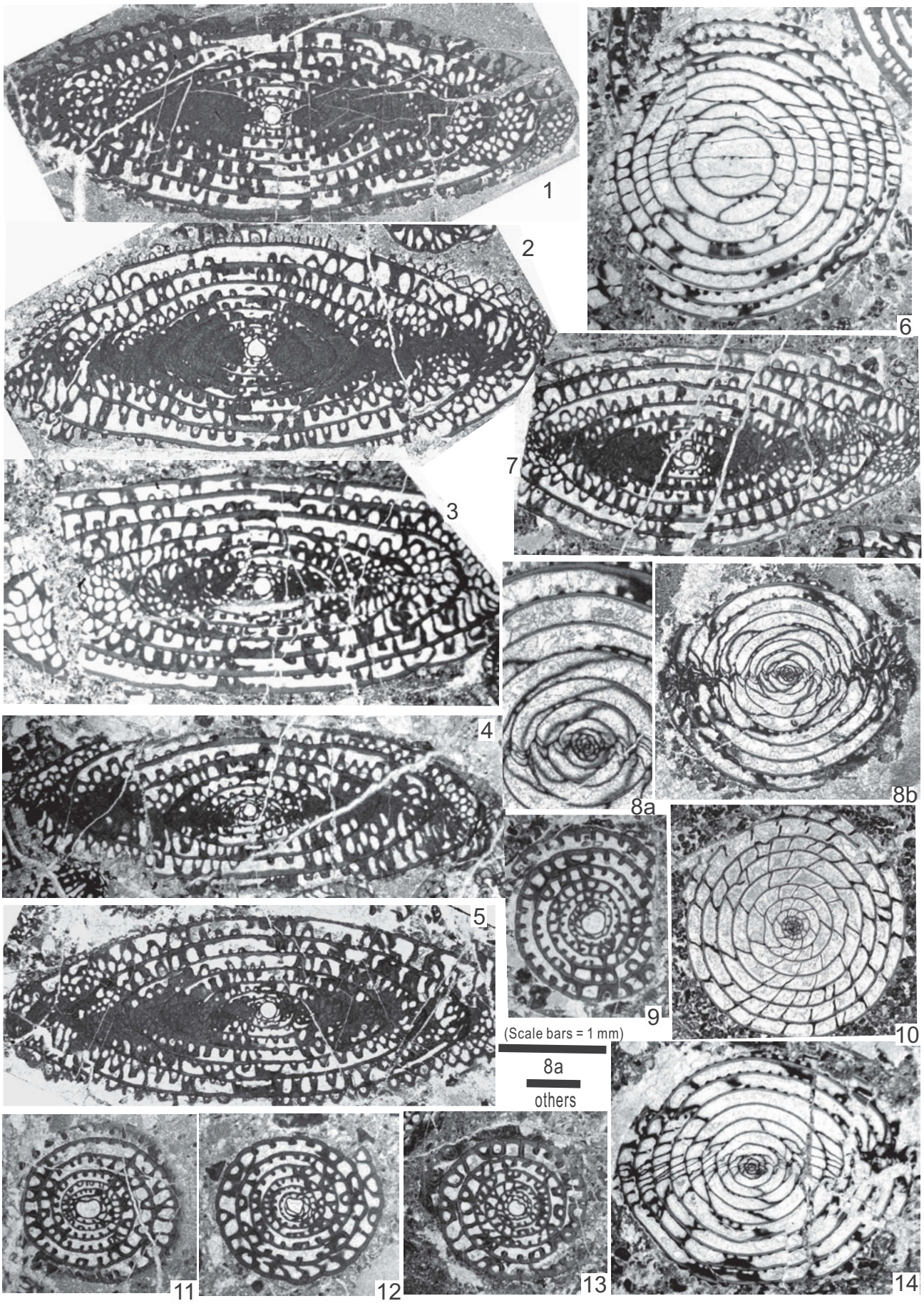

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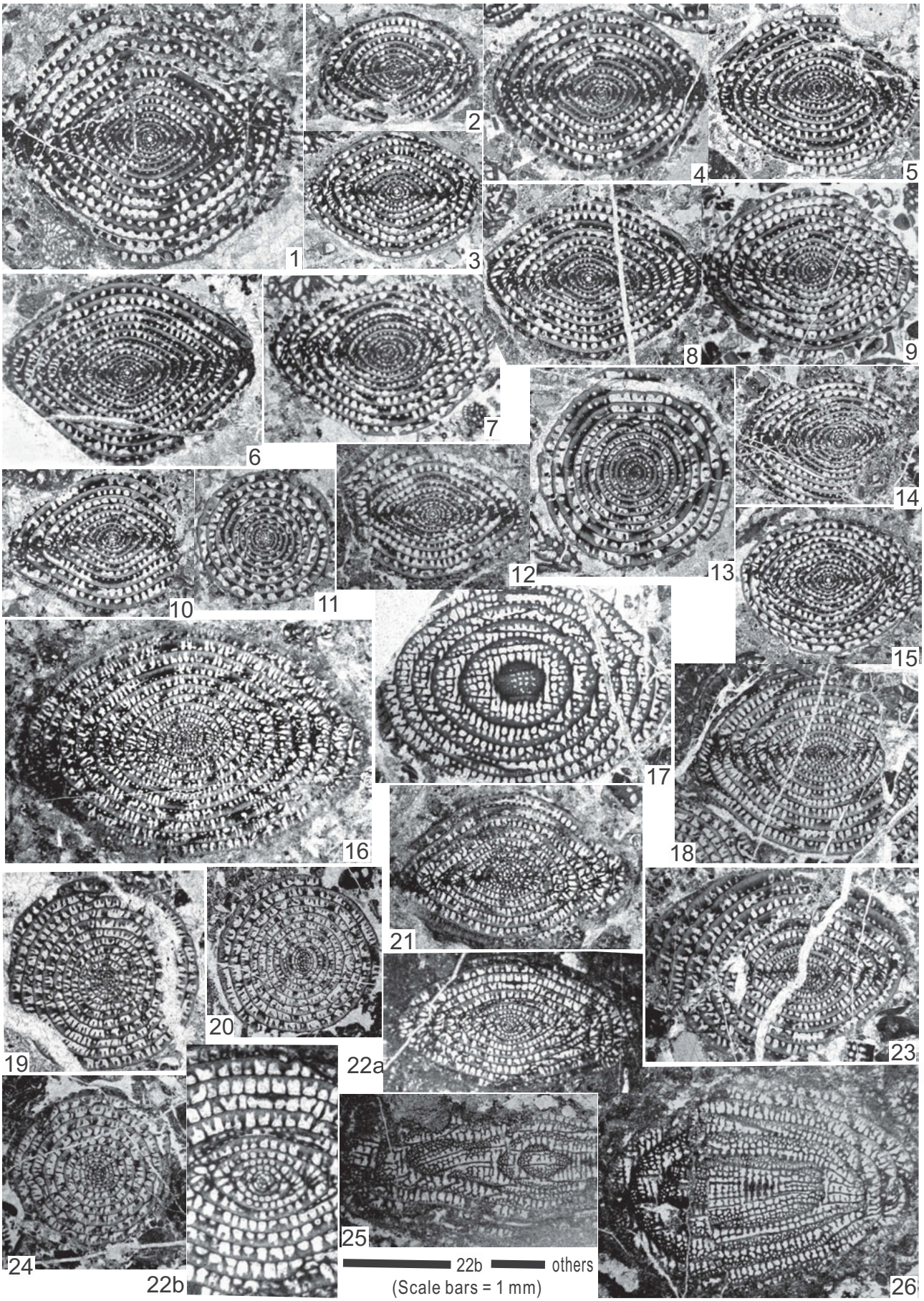
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紀伊半島西部由良町白崎石灰岩のペルム紀中期フズリナ類

小 林 文 夫

紀伊半島西部，和歌山県由良町西端に分布する南部秩父テレーンの異地性岩体，白崎石灰岩は古生物地理・生層序的見地から重要なフズリナ類を産する．白崎石灰岩のペルム紀中期フズリナ情報を充実させるため，識別されたフズリナ類 21 種のうち 12 種を記載し，それらとこれまでに図示された同時期のフズリナ類と比較・検討した．記載した 12 種は *Neofusulinella phairayensis*, *Parafusulina japonica*, *Parafusulina kinosakii*, *Parafusulina shimotsukensis*, *Parafusulina tochigiensis*, *Pseudodoliolina ozawai*, *Verbeekina verbeeki*, *Neoschwagerina craticulifera*, *Yabeina higoensis*, *Yabeina katoi*, *Yabeina* cf. *omurensis* と *Lepidolina*? sp. である．

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