人と自然　Humans and Nature 21: 79-91（2010）

Original article

Late Paleozoic foraminifers contained in limestone conglomerate of the Maizuru Group in the Oye area, Kyoto Prefecture, Japan

Fumio KOBAYASHI

Division of Natural History, Museum of Nature and Human Activities, Hyogo/Division of Earth Science, Institute of Natural and Environmental Sciences, University of Hyogo, Yayoigaoka 6, Sanda, Hyogo 669-1546, Japan

Abstract

Limestone conglomerate of the Permian Maizuru Group in the Oye area, Fukuchiyama City, Kyoto Prefecture is divided into two main types based on the difference of their matrices as well as that in other areas. Limestone conglomerate with a calcareous argillaceous matrix yields *Lepidolina kumaensis, L. takagamiensis,* and other foraminifers characteristic in the *Lepidolina kumaensis* fauna. Presence of *Colaniella parva* contained in this conglomerate as a bioclast indicates that the limestone conglomerate having the *Lepidolina kumaensis* fauna in the Middle and Upper formations of the Maizuru Group ranges into the Lopingian in age and is not restricted to the Capitanian (Midian) as previously thought. Pre-Capitanian fossils are exclusively found in limestone conglomerate with an arenaceous matrix in the Upper and Gujyo formations of the Maizuru Group. Various forms of foraminifers from the Early Carboniferous (Serpukhovian) to Early Permian (Artinskian) have been identified in the Oye area. Two species of *Lepidolina, L. kumaensis* and *L. takagamiensis,* are systematically described from the limestone conglomerate of calcareous argillaceous matrix.

Key words: Late Paleozoic foraminifers, limestone conglomerate, Maizuru Group, Oye area, *Lepidolina kumaensis* fauna

Introduction

The Maizuru Group in the Maizuru Terrane of SW Japan consists of four formations: Lower, Middle, Upper, and Gujyo formations in ascending order (Nakazawa and Nogami, 1958; Shimizu, 1962; Suzuki et al., 1987; Suzuki, 1987). Both limestone conglomerates with the *Lepidolina kumaensis* fauna in the Middle Formation and small limestone with the *Codonofusiella-Colaniella* fauna and the *Palaeofusulina-Colaniella* fauna in the Upper Formation have been thought to be conformable with the surrounding clastic rocks and important for distinguishing the Middle Formation from the Upper (e.g., Hayasaka, 1990). Based on these foraminiferal faunas the Middle Formation was referred to the Capitanian (late Middle Permian) and the Upper to the Wuchiapingian (early Late Permian) and Changhsingian (late Late Permian). On the other hand, radiolarians of both Middle and Upper formations indicate in age as late Middle to early Late Permian (Ishiga, 1984; Umeda et al., 1997).

Kobayashi (2003) revealed that (1) limestone conglomerate and small limestone of the Middle and Upper formations of the Maizuru Group are all exotic blocks that were redeposited on the deeper continental slope; (2) conglomerate is divided into two main types based on differences of the composition of their

matrices; (3) the *Lepidolina kumaensis* fauna is characteristic in the conglomerate of calcareous argillaceous matrix; (4) pre-Capitanian foraminifers are exclusively contained in the conglomerate of arenaceous to argillaceous matrix; (5) *Colaniella*, an index foraminifer genus of Late Permian, is also contained in the *Lepidolina kumensis-bearing* limestone conglomerate besides limestone blocks with *Palaeofusulina* and *Codonofusiella* in the Upper Formation, strongly suggesting that depositional age of the *Lepidolina*-bearing limestone conglomerate extends to the Late Permian.

Paleontologic description of foraminifers of the Maizuru Group was nearly confined to Nogami (1958, 1959) in the last century. Recently, I have published rich and diversified foraminifers of the *Lepidolina kumaensis* fauna from the Miharaiyama area (Kobayashi, 2006a) and Mikata area (Kobayashi, 2007), *Palaeofusulina-Colaniella* fauna from the Mikata area (Kobayashi, 2006b), and *Codonofusiella-Colaniella* fauna from Tatsuno area (Kobayashi, 2006c). In addition to geologic and paleontological data obtained in Hyogo Prefecture that were summarized in these papers, those from the Oye area of Kyoto Prefecture are also significant to discuss age and origin of conglomeratic rocks of the Maizuru Group (Kobayashi, 2003).

The purpose of this paper is (1) to announce the presence of *Colaniella parva* (Colani) in the conglomerate having *Lepidolina kumaensis* Kanmera in the Oye area; (2) to show the occurrence of two types of conglomerate mentioned above in the Upper Formation and the Gujyo Formation; and (3) to systematically describe two species of *Lepidolina, L. kumaensis* and *L. takagamiensis*. The report of *Colaniella* in the *Lepidolina*-bearing conglomerate in the Oye area is the second example continued from that in the Miharaiyama area (Kobayashi, 2006a). The presence of *Lepidolina takagamiensis* is the first in the Maizuru Terrane. Preceding these announcement and description, summarized are previous works on the stratigraphy and fusuline faunas of the Maizuru Group in the Oye area. All limestone thin sections used in this paper are stored in the Museum of Nature and Human Activities, Hyogo, Japan (Fumio Kobayashi Collection, MNHAM).

Stratigraphy and fusuline faunas of the Maizuru Group in the Oye area

In the Oye area, the subdivision and distribution of the Maizuru Group is more or less different among authors (Nakazawa and Nogami, 1958; Igi and Kuroda, 1965; Suzuki, 1987). Suzuki (1987) divided the group into the Lower, Middle, Upper, and Gujyo formations in ascending order.

The Lower Formation consists of basaltic rocks with subordinate mudstone. It is referable to a part of the Yakuno Complex by Nakazawa and Nogami (1958) and "schalestein" of the Maizuru Group by Igi and Kuroda (1965). The Middle Formation is made up of dominant mudstone accompanying muddy sandstone, conglomerate, turbidite, and seams of acidic tuff. The Upper Formation is more coarse-grained than the Middle (Suzuki, 1987). The Middle and Upper formations are not distinguished in Nakazawa and Nogami (1958) and Igi and Kuroda (1965). Radiolarians from Shimoamatsu of the Oye area show a Guadalupian age for the Upper Formation (Ishiga, 1984). The Gujyo Formation, originally defined by Nakazawa et al. (1951) and redefined by Nakazawa and Nogami (1958), is composed of sandstone, conglomerate, and mudstone yielding latest Permian mollusks and brachiopods (Nakazawa, 1959; 1960).

Nogami (1958) distinguished three different assemblages of fusulines in the Maizuru Group: (1) *Lepidolina-Yabeina*, (2) small fusulines, and (3) derived fusulines. They correspond respectively to (1) the *Lepidolina kumaensis* fauna from the conglomerate of calcareous argillaceous matrix in the Middle and Upper formations, (2) the *Palaeofusulina-Colaniella* and *Codonofusiella-Colaniella* faunas from exotic limestone blocks of the Upper Formation, and (3) pre-Capitanian foraminifers from the conglomerate of arenaceous to argillaceous matrix in the Middle and Upper formations in Kobayashi (2003).

In the Oye area, two different fusuline assemblages are listed by Nakazawa and Nogami (1958). One is referable to the *Lepidolina-Yabeina* assemblage (Nogami, 1958) consisting of *Codonofusiella cuniculata, Parafusulina?* sp., *Schwagerina* aff. *acris*, *Pseudodoliolina pseudolepida gravitesta, Yabeina columbiana, Y. yasubaensis, Y. gubleri, Lepidolina kumaensis, L. toriyamai, L.* cf. *toriyamai, Neoschwagerina* cf. *margaritae,* and *N.* sp. The other is corresponding to derived fusulines (Nogami, 1958; 1959) including *Neoschwagerina margaritae, N.* cf. *simplex, N. douvillei, N.* cf. *douvillei, N.* sp., *Sumatrina* sp., *Schwagerina* sp., *Pseudodoliolina* sp., and *Fusulinella* sp.

Among the illustrated 24 specimens of derived fusulines by Nogami (1959) from the Maizuru

Terrane, 20 were from Tadewara of the Oye area. Among fusulines belonging to *Lepidolina-Yabeina* and small fusuline assemblages described by Nogami (1958), *Neoschwagerina* cf. *margaritae* was from Gujyo of the Oye area. Others are unknown exactly in their derivation.

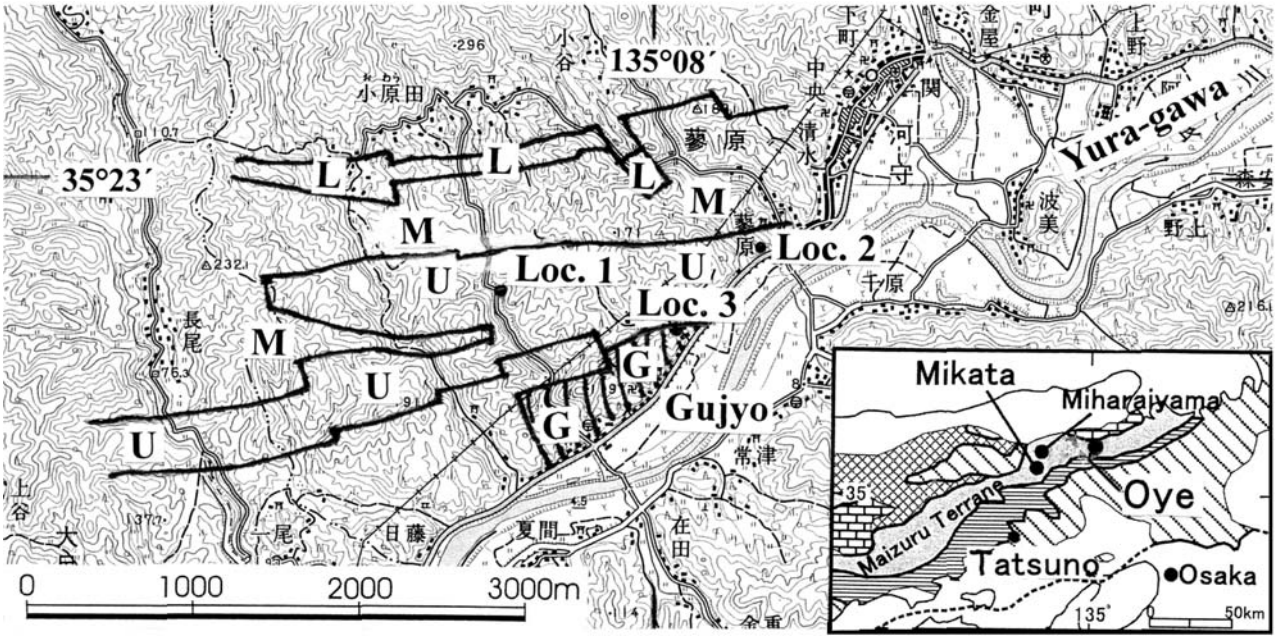


Figure 1. Distribution of the Maizuru Group (M: Middle Formation, U: Upper Formation, G: Gujyo Formation) and fossil localities of Late Paleozoic foraminigers (Loc. 1, Loc. 2, Loc. 3) in the Oye area. Topographic map is from 1:50,000 map "Oyeyama" of Geospatial Information Authority of Japan.

Material, Fauna and Age

Samples treated in this paper were collected at three localities of the Oye area (Figure 1).

Limestone conglomerate of the Upper Formation

The limestone conglomerate of the Upper Formation is subdivided into two. One has a calcareous argillaceous matrix and yields the *Lepidolina kumaensis* fauna, and the other has an arenaceous matrix and exclusively of pre-Capitanian fossils.

One sample collected as a float cobble at Loc. 1 (Owarada) consists of limestone granules and fossil fragments less than 1 cm densely packed with calcareous argillaceous materials (Figure 2). Foraminifers identified are *Lepidolina takagamiensis* (Chisaka), *Lepidolina kumaensis* Kanmera, *Metadoliolina gravitesta* (Kanmera), *Lantschites cuniculata* (Kanmera), *Kahlerina ussurica* (Sosnina), and others (Pls. 1, 2).

Lithology and fossils of this conglomerate in the Oye area are nearly the same as those of the Middle Formation of the Miharaiyama area (Kobayashi, 2006a), and of the Kuma Formation of Kyushu and its correlatives (Kobayashi, 2001). These limestone conglomerates are represented by the *Lepidolina kumaensis* fauna and largely different from the *Lepidolina shiraiwensis* fauna of the Permian Akiyoshi Terrane and the *Yabeina globosa* fauna of the Jurassic Chichibu and Mino terranes (Kobayashi, 1997). Smaller test-size in most fusulines of this Oye fauna compared with those from the Miharaiyama and Kuma is due to insufficient preservation of the Oye. They are somewhat different from those of the Mikata area (Kobayashi, 2007) in the absence of pebbles and cobbles of limestone in the Oye area. Especially important is the presence of *Colaniella parva* as a bioclast in the present material (Figure 2). This evidence reconfirms that the limestone conglomerate having the *Lepidolina kumaensis* fauna in the Middle and Upper formations of the Maizuru Group ranges into the Lopingian in age and not restricted to the Capitanian (Midian) as previously thought, as indicated by Kobayashi (2003, p. 308) based on the material from the Miharaiyama area.

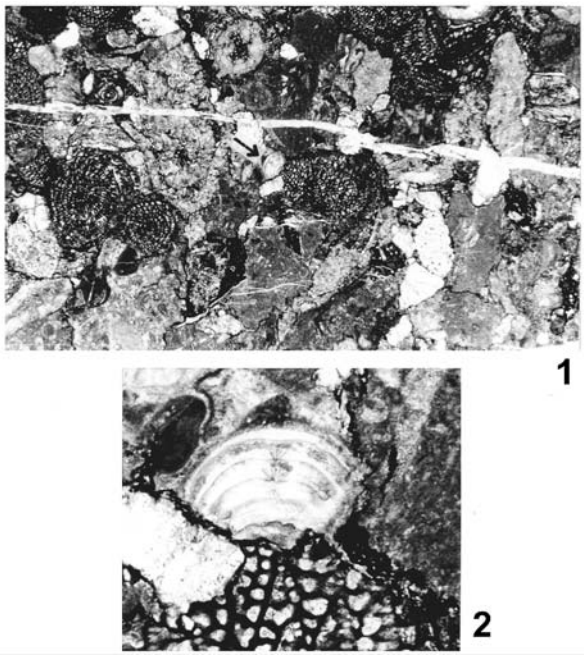


Figure 2. 1: Enlarged photograph of limestone conglomerate with calcareous argillaceous matrix containing many fragments of limestone and fossils including *Colaniella parva* indicated by the arrow in the central part, Owarada-40, ×5. 2: Enlarged photograph of the central part of Fig. 2-1, ×30

Eighteen samples collected as float fragments at Loc. 2 (Tadewara) consist of limestone pebbles and granules all with arenaceous matrices. Most of limestone conglomerates in this locality, the same as Nogami (1959)'s, were lost on account of road enlargement works and limestone fragments having such Wordian fusulines as described by Nogami (1959) were not obtained. Based on species and genera available for age determination, Upper Carboniferous (Bashkirian) to Lower Permian (Artinskian) limestone fragments have been discriminated (Figure 3).

Sample Tadewara-17 containing *Endothyra* sp., *Haplophragmella* sp. and *Tetrataxis* sp. might be Bashkirian in age, as well as Sample Tadewara 13 having *Planoendothyra* sp. Sample Tadewara-14 contains *Pseudofusulinella* sp. and *Bradyina* sp., and is probably Moscovian in age, though such large *Pseudofusulinella* as the former is not known from Japan. Moscovian, Kasimovian, and Gzhelian ages are labeled for Sample Tadewara-18, Tadewara-7, and Tadewara-4 based on the occurrence of *Fusulinella* sp. cf. *F. biconica* Hayasaka, *Montiparus* sp., and *Rauserites* sp., respectively. Sample Tadewara-10 is most fossiliferous among 18 samples and yields *Staffella yowarensis* Ozawa, *Schubertella melonica* Dunbar and Skinner, *Pseudofusulina* sp., *Hemigordius* sp., and others. It is probably Artinskian in age from the first species very characteristic in the *Pseudofusulina kraffti* Zone of the Akiyoshi Limestone (unpublished data by the author). There are other limestone granules and pebbles rich in bryozoans and crinoids and closely similar to bryozoan crinoidal grainstone/rudstone of the Carboniferous limestones in the Akiyoshi Terrane. Almost all of limestone fragments at this locality are thought to have been derived from the Akiyoshi Terrane.

Limestone conglomerate of the Gujyo Formation

Limestone conglomerate exposed at Loc. 3 (Gujyoshita) is 10 m or more in thickness and composed of granules and pebbles packed with arenaceous materials. It resembles lithologically the limestone conglomerate having arenaceous matrices of the Upper Formation. Among 40 limestone granules and pebbles examined, they are thought to be Carboniferous except for Sample Gujyoshita-A12 containing Early Permian *Pseudofusulina* sp. and *Pseudoendothyra* sp., and almost contemporaneous Gujyoshita-A24 with *Schubertella australis* Thompson and Miller, and *Hemigordius harltoni* Cushman and Water. Based on foraminifers (Figure 4), Carboniferous granules and pebbles are largely divided into three age groups. The first is possibly Serpukhovian ones of Gujyoshita-A6 having *Mediocris mediocris* (Vissarionova). The second is Bashkirian ones represented by Gujyoshita-A1 having *Eostaffella yowarensis* (Ota), *Eostaffella postmosquensis* Kireeva, and others; and by Gujyoshita-B2 having *Endothyra* sp. A, *Endothyra* sp. B, *Pseudostaffella* sp. A, and others. The third is Moscovian ones of Gujyoshita-A7 with *Fusulinella* sp. and Gujyoshita-A27 with *Pseudofusulinella?* sp.

In addition to these granules and pebbles having foraminifers, there are many limestone fragments of ooid grainstone, crinoidal grainstone/packstone, and crinoidal bryozoan oncolite. Although their age determination is difficult, they are closely similar lithologically to the Visean to Bashkirian limestones of the Akiyoshi Limestone. Almost all of these Carboniferous and Permian limestone fragments in the Gujyo Formation are thought to have been derived from the Akiyoshi Terrane based on their similar faunas and lithologies, as well as those with arenaceous matrices in the Upper Formation.

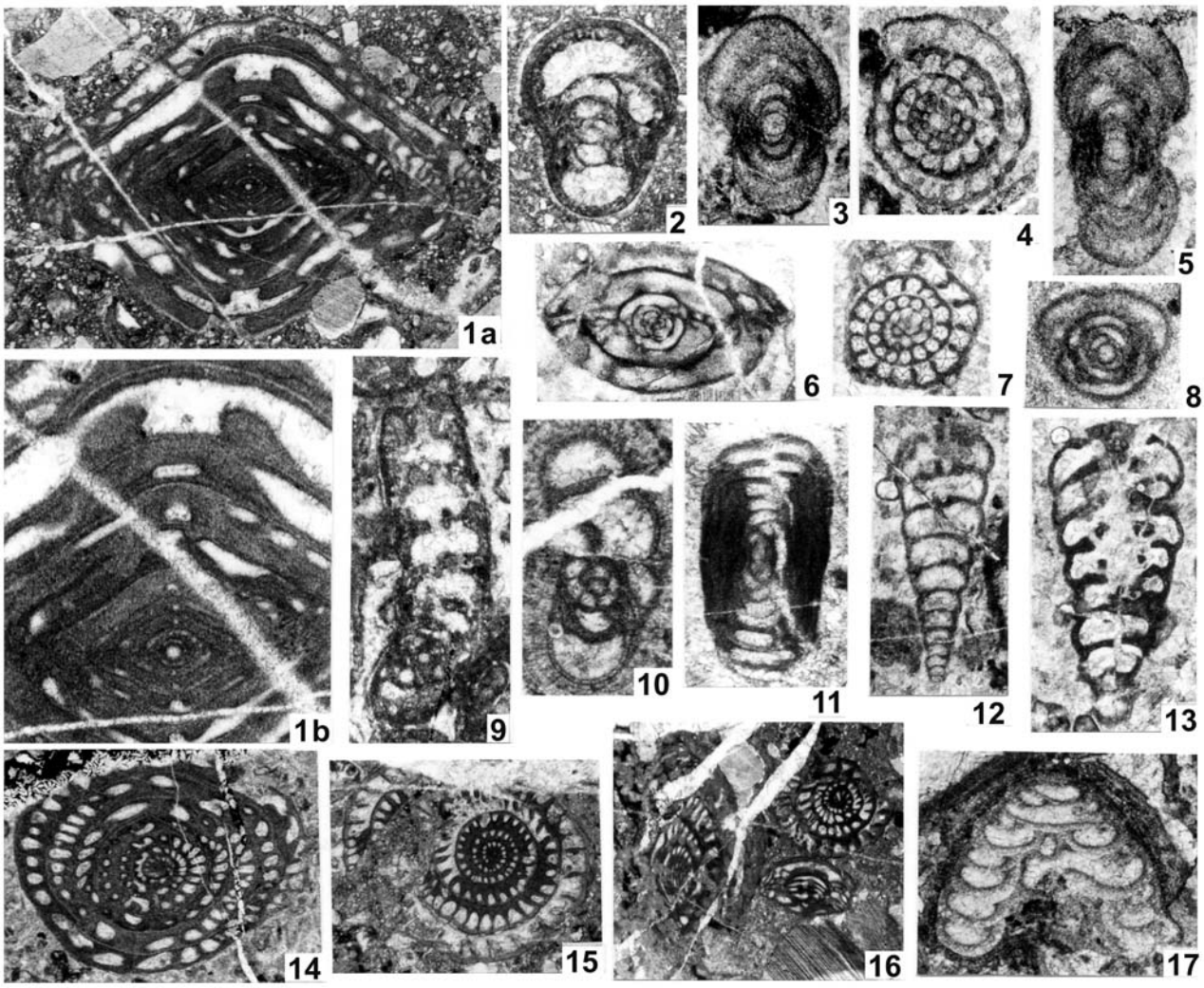


Figure 3. Late Carboniferous (Bashkirian) to Early Permian (Artinskian) foraminifers contained in limestone granules and pebbles of the conglomerate of the Upper Formation of the Maizuru Group. **1:** *Pseudofusulinella* sp., D2-023432, Tadewara-14, ×15. **2:** *Bradyina* sp., D2-023432, Tadewara-14, ×30. **3-5:** *Staffella yowarensis* Ozawa, 3, 4: D2-023413; 5: D2-023414, all Tadewara-10, ×30. **6, 7:** *Schubertella melonica* Dunbar and Skinner, 6: D2-023413; 7: D2-023415, both Tadewara-10, ×30. **8:** *Eoschubertella obscura* (Lee and Chen), D2-023443, Tadewara-18, ×40. **9:** *Haplophragmella* sp., D2-023440, Tadewara-17, ×40. **10:** *Planoendothyra* sp. A, D2-023428, Tadewara-13, ×50. **11:** *Hemigordius* sp., D2-023414, Tadewara-10, ×40. **12:** *Palaeotextularia* sp. A, D2-023411, Tadewara-10, ×20. **13:** *Palaeotextularia* sp. B, D2-023417, Tadewara-10, ×20. **14:** *Fusulinella* sp. cf. F. biconica Hayasaka, D2-023446, Tadewara-18, ×15. **15:** *Montiparus* sp., D2-023403, Tadewara-7, ×10. **16:** *Rauserites* sp., D2-023396, Tadewara-4, ×10. **17:** *Tetrataxis* sp., D2-023442, Tadewara-17, ×30.

Systematic Paleontology

Order FORAMINIFERIDA Eichwald, 1830

Suborder FUSULININA Wedekind, 1937

Superfamily Fusulinoidea von Möller, 1878

Family Neoschwagerinidae Dunbar and Condra, 1927

Subfamily Lepidolininae A. D. Miklukho-Maklay, 1958

Genus ***Lepidolina*** Lee, 1934 emend. Ozawa, 1970

Lepidolina kumaensis Kanmera, 1954

Plate 1, Figures 15-22, 27-30

Lepidolina kumaensis Kanmera, 1954, p. 22-24, pl. 5, figs. 1-13.

Lepidolina toriyamai Kanmera, 1954, p. 24-26, pl. 6, figs. 1-19.

Lepidolina kumaensis Kanmera. Nogami, 1958, p. 104, 105, pl. 2, figs. 8, 9.

Lepidolina toriyamai Kanmera. Nogami, 1958, p. 105, 106, pl. 1, figs. 1, 2.

Lepidolina kumaensis Kanmera. Kobayashi, 2001, p. 73, 74, pl. 6, figs. 1-29.

Lepidolina kumaensis Kanmera. Kobayashi, 2006a, pl. 1, figs. 1, 5-7.

Material.—Eight axial and four sagittal sections, all

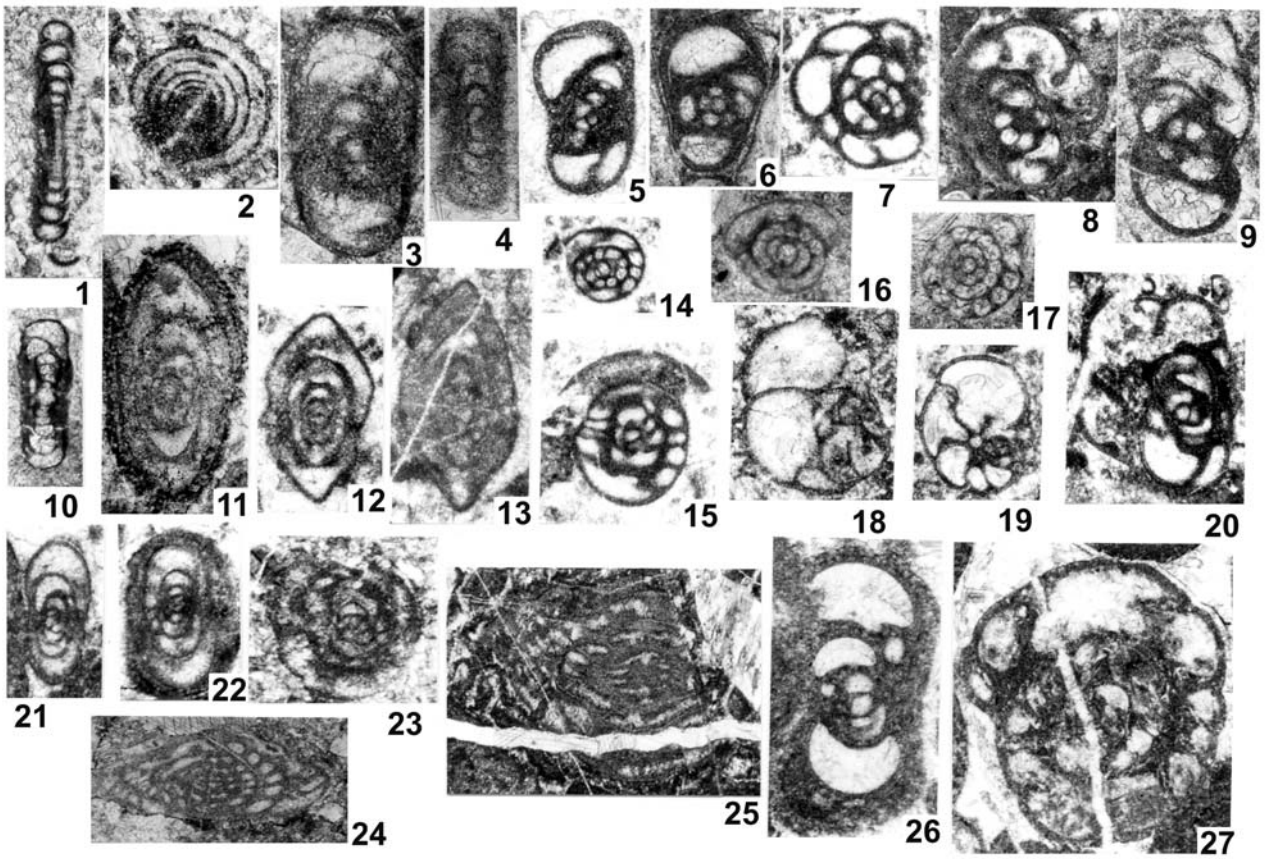


Figure 4. Early Carboniferous (Serpkhovian) to Early Permian foraminifers contained in limestone granules and pebbles of the conglomerate of the Gujyo Formation of the Maizuru Group. **1:** *Eolasiodiscu*s sp., D2-023376, Gujyoshita-B2, ×60. **2:** *Pseudoammodiscu*s sp., D2-023340, Gujyoshita-A21, ×40. **3:** *Mediocris mediocris* (Vissarionova), D2-023306, Gujyoshita-A6, ×75. **4:** *Mediocris breviscula* (Ganelina), D2-023289, Gujyoshita-A1, ×60. **5-7:** *Endothyra* sp. A, 5: D2-023381, Gujyoshita-B2, ×50; 6: D2-023310, Gujyoshita-A8, ×60; 7: D2-023377, Gujyoshita-B2, ×40. **8, 9, 20:** *Endothyra* sp. B, 8: D2-023310, Gujyoshita-A8, ×40; 9: D2-023376, Gujyoshita-B2, ×60; 20: D2-023376, Gujyoshita-B2, ×40. **10:** *Hemigordius harltoni* Cushman and Water, D2-023348, Gujyoshita-A24, ×60. **11:** *Eostaffella yowarensis* (Ota), D2-023288, Gujyoshita-A1, ×60. **12**: *Eostaffella* sp. D2-023378, Gujyoshita-B2, ×40. **13:** *Pseudoendothyra* sp., D2-023316, Gujyoshita-A12, ×30. **14, 15**: *Pseudostaffella* sp. A, 14: D2-023377; 15: D2-023380, both Gujyoshita-B2, ×40; **16, 17:** *Schubertella australis* Thompson and Miller, 16: D2-023348; 17: D2-023349, both Gujyoshita-A24, ×60. **18, 19:** *Globivalvulina* sp., 18: D2-023381; 19: D2-023380, both Gujyoshita-B2, ×40. **21, 22:** *Eostaffella postmosquensis* Kireeva, 21: D2-023292; 22: D2-023288, both Gujyoshita-A1, ×50. **23:** *Pseudostaffella* sp. B, D2-023363, Gujyoshita-A30,×50. **24:** *Pseudofusulinella?* sp., D2-023356, Gujyoshita-A27,×20. **25**: *Fusulinella* sp., D2-023309, Gujyoshita-A7, ×20. **26:** *Planoendothyra* sp. B, D2-023292, Gujyoshita-A1, ×20. **27:** *Globoendothyra?* sp., D2-023292, Gujyoshita-A1, ×30.

of which are incomplete due to abrasion of outer whorls.

Discussion.—This species is very characteristic in having a large elongate test, large proloculi in megalospheric forms, thin wall, and slender and short but numerous secondary transverse septula like in *Sumatrina* (Kobayashi et al., 2010). Junior synonymy of *Lepidolina toriyamai* with *L. kumaensis* is suggested by Kobayashi (2001) based on morphologic variation of topotypes from the Kuma Formation. These diagnostic characters of *L. kumaensis* well agree with those of the present specimens.

Length of the test is probably more than 10 mm, though it is not exactly known due to the abrasion of outer whorls and insufficient preservation in the Oye specimens. Approximate size of proloculi ranges from 0.35 to 0.65 mm and smaller than that of the types. Compared with most of other previously described ones identified with this species, the present specimens also have a smaller test. The Oye specimens are easily distinguished from other species of *Lepidolina* from the Maizuru Group such as *L. maizuruensis* Nogami from the Miharaiyama area (Kobayashi, 2006a) and Mikata (Kobayashi, 2007) by having

larger proloculus and more number of transverse septula, and *L. multiseptata* (Deprat, 1912) from Miharaiyama (Kobayashi, 2006a) by having a more elongate test and thinner septula.

Occurrence.—Common in the limestone conglomerate with a calcareous argillaceous matrix at Loc. 1.

Lepidolina takagamiensis (Chisaka, 1960) emend. Tazawa and Hasegawa, 2007

Plate 2, Figures 1-12

Yabeina columbiana (Dawson, 1879). Kanmera, 1954, p. 16-18, pl. 3, figs. 1-7.

Yabeina columbiana (Dawson, 1879). Nogami, 1958, p. 101, 102, pl. 9, fig. 9(?), 10.

Neoschwagerina takagamiensis Chisaka, 1960, p. 246-248, pl. 9, figs. 4-10.

Lepidolina? sp. Kobayashi, 2001, p. 74, pl. 4, figs.2-5.

Lepidolina takagamiensis (Chisaka, 1960). Tazawa and Hasegawa, 2007, p. 411, 412, Fig.3.1-3.8.

Material. — Six (megalospheric) and one (microspheric) axial sections, one sagittal, two tangential, and two oblique sections.

Diagnosis.—Small test, small proloculus, and fewer number of whorl for the genus, and secondary transverse septula first appeared in later ontogenetic stage than those of the known species of *Lepidolina*.

Description.—Test large, though small for the genus, fusiform to elongate fusiform with straight axis of coiling and bluntly pointed to rounded poles. Exact length, width, and the number of whorl of the test in the mature stage are uncertain on account of abrasion of outer whorls. However, the largest specimen with about 17 whorls attains about 8 mm in length, more than 3.5 mm in width giving ratio about 2.3.

Proloculus spherical to subspherical, 0.12 to 0.23 mm in megalospheric forms, and 0.016 mm in microspheric one. Inner one to three whorls are inflated fusiform with rounded poles, becoming fusiform to elongate fusiform with pointed to bluntly pointed poles outwardly, and finally with bluntly pointed to rounded poles in megalospheric forms. Inner two whorls coiled like *Eostaffella* with short axis of coiling in microspheric ones.

Wall thin to very thin compared with test size and composed of distinct tectum and fine alveolar keriotheca in outer whorls. Alveolar structure is more distinct in the joining portions between spiral wall and septula.

Septa numerous, approximately 30, in outer whorls of incomplete sagittal section. They are slender, and partially coated by dark calcareous materials in their tips and in contact with spiral wall.

Primary septula slender, long and well developed throughout whorls in megalospheric forms. They are partly in contact with parachomata and coated with dark calcareous materials in their tips. Distinct secondary transverse septula first appear in the fifth whorl. They are commonly one in inner whorls and one to two in outer whorls between adjacent primary transverse septula. Slender, short, two to four axial septula are inserted between the adjacent septa in outer whorls. Parachomata are low and massive in inner whorls, and slender and rather tall in outer whorls.

Discussion.—Chisaka (1960) thought that this species belongs to a primitive form of *Neoschwagerina* close to *Cancellina nipponica* (Ozawa) from its small test and development of septula. However, seven specimens including the holotype are all incomplete without outer whorls. Apparent secondary transverse septula first appear in the seventh whorl of the holotype. Thus it is quite different from *C. nipponica* and almost all species of *Neoschwagerina*. Based on the topotypes from the Takagami Conglomerate in the Choshi Peninsula that is correlatable to the conglomerate of the Upper Permian Kuma Formation (Kanmera, 1953), Tazawa and Hasegawa (2007) redefined this species and transferred it to the genus *Lepidolina*.

In the Capitanian *Lepidolina* faunas of Japan, Kobayashi (2001) pointed out the presence of forms having primitive morphologic features for the genus *Lepidolina* such as "*Yabeina columbiana*" from the Kuma Formation (Kanmera, 1954) and from the Maizuru Group (Nogami, 1958). Although these forms including *Lepidolina*? sp. from the Kuma Formation (Kobayashi, 2001) are different from the known species of *Lepidolina*, Kobayashi (2001) postponed his conclusion until reexamination of morphologic variation of topotypes of *Yabeina columbiana* and its allies from British Columbia.

Subsequently, Kobayashi et al. (2007) revealed that important test characters of topotypes of *Yabeina columbiana* are different from those of *Lepidolina*, though they are highly variable from population to population based on the Canadian materials. The reexamination by Kobayashi et al. (2007) strongly suggests that smaller forms of *Lepidolina* previously indicated by Kobayashi (2001) are distinguished from *Yabeina columbiana* from the type locality and most reasonably identified with the species *takagamiensis* that was redefined by Tazawa and Hasegawa (2007).

More or less different test characters such as form and size of the test, the number of whorl, size of proloculus, first appearance and development of secondary transverse septula are probably thought to represent the morphologic variation of *Lepidolina takagamiensis*. Moreover, smaller appearance of the test like the present Oye specimens is due to more conspicuous result of the abrasion of outer whorls than those of other materials.

Occurrence. — Common in the limestone conglomerate with calcareous argillaceous matrix at Loc. 1.

Acknowledgements

Thanks are due to Drs. K. Ueno and H. Furutani for their critical reading of the manuscript. A part of this study was financially supported by the Grant-in Aid for Scientific Research (C) of the Japan Ministry of Education, Science and Culture, 1999-2000 (Project No. 10640453).

References

Chisaka, T. (1960) On some Permian fusulinids from the Takagami Conglomerate, Choshi Peninsula, Chiba Prefecture, Japan. *Jour. Coll. Arts Sci., Chiba Univ.*, **3:** 235-253.

Dawson, G. M. (1879) On a new species of Loftusia from British Columbia. *Quart. Jour. Geol. Soc. London,* **35:** 69-75.

Deprat, J. (1912) Étude géologique du Yun-Nan Oriental. Étude des fusulinidés de Chine et d'Indochine et classification des calcaires à fusulines. *Mém. Surv. Géol. l'Indo-Chine,* **1:** 1-76.

Dunbar, C. O. and Condra, G. E. (1927) The Fusulinidae of the Pennsylvanian System in Nebraska. *Bull. Nebraska Geol. Survey, Ser.* 2, **2:** 1-135.

Eichwald, C. E. von (1830) *Zoologia Specialis pars Altera,* 323 pp., J. Zawadzki, Vilius.

Hayasaka, Y. (1990) Maizuru Terrane. In, Ichikawa, K., Mizutani, S., Hara, I., Hada, S., and Yao, A. (eds.), *Pre-Cretaceous Terranes of Japan.* Publ. IGCP Proj. 224, p. 81-95.

Igi, Y. and Kuroda, K. (1965) *Geology of the Oyeyama district.* With geological Sheet map at 1:50,000, Geological Survey of Japan, Kawasaki, 81 pp. (in Japanese with English abstract)

Ishiga, H. (1984) *Follicucullus* (Permian radiolarian) from Maizuru Group in Maizuru Belt, Southwest Japan. *Chikyu Kagaku (Earth Sci.)*, **38:** 427-434.

Kanmera, K. (1953) The Kuma Formation with special reference to the Upper Permian in Japan. *Jour. Geol. Soc. Japan,* **59:** 449-468. (in Japanese with English abstract)

Kanmera, K. (1954) Fusulinids from the Upper Permian Kuma Formation, Southern Kyushu, Japan, with special reference to the fusulinid zone in the Upper Permian of Japan. *Mem. Fac. Sci., Kyushu Univ., Ser. D,* **4:** 1-38.

Kobayashi, F. (1997) Middle Permian fusulinacean faunas and paleogeography of exotic terranes in the Circum-Pacific. In, Ross, C. A., Ross, J. R. P., and Brenckle, P. L. (eds.), *Late Paleozoic foraminifera: their biostratigraphy, evolution, and paleoecology; and the Mid-Carboniferous boundary,* Cushman Found. Foram. Res. Spec. Publ., no. 36: 77-80.

Kobayashi, F. (2001) Faunal analysis of Permian foraminifers of the Kuma Formation in the Kurosegawa Belt of west Kyushu, Southwest Japan. *News Osaka Micropaleontologists, Spec. vol.*, no. 11: 61-84.

Kobayashi, F. (2003) Paleogeographic constraints on the tectonic evolution of the Maizuru Terrane of Southwest Japan to the eastern continental margin of South China during Permian and Triassic. *Palaeogeogr., Palaeoclim. Palaeoecol.*, **195:** 299-317.

Kobayashi, F. (2006a) Late Middle Permian (Capitanian) foraminifers in the Miharaiyama area, Hyogo — Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan, Part 2—. *Nature and Human Activities,* **10:** 1-13.

Kobayashi, F. (2006b) Latest Permian (Changhsingian) foraminifers in the Mikata area, Hyogo—Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan, Part 3—. *Nature and Human Activities,* **10:** 15-24.

Kobayashi, F. (2006c) Early Late Permian (Wuchiapingian) foraminifers in the Tatsuno area, Hyogo—Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan, Part 4—. *Nature and Human Activities,* **10:** 25-33.

Kobayashi, F. (2007) Late Middle Permian (Capitanian) foraminifers in the Mikata area, Hyogo, with special reference to plasticity deformation of their test and their paleobiogeographic affinity with South China — Late Paleozoic and Early Mesozoic foraminifers of Hyogo, Japan, Part 5—. *Nature and Human Activities,* **11:** 17-28.

Kobayashi, F., Ross, C. A. and Ross, J. R. P. (2007) Age and generic assignment of *Yabeina columbiana* (Guadalupian Fusulinacea) in southern British Columbia. *Jour. Paleont.*, **81:** 238-253.

Kobayashi, F., Ross, C. A. and Ross, J. R. P. (2010) Classification , phylogeny, and paleobiogeography of the new Subfamily Gifuellinae and a revision of the Family Neoschwagerinidae (Superorder Fusulinoida); Guadalupian (Middle Permian). *Jour. Foram.Res.*, **40:** 283-300.

Lee, J. S. (1934) Taxonomic criteria of Fusulinidae with notes on seven new genera. *Mem. Nat. Res. Inst. Geol., Nanking (1933),* **14:** 1-32.

Miklukho-Maklay, A. D. (1958) Systematics of advanced fusulinids. *Vesnik Leningradskogo Universiteta, 1957, no. 12, Ser. Geol. Geograf.*, **2:** 5-14. (in Russian)

Möller, V. von (1878) Die spiral-gewunden Foraminiferen des russischen Kohlenkalkes. *Mém. l'Acad. Impér. Sci. St. P?tersbourg, Sér. 7,* **25:** 1-147.

Nakazawa, K. (1959) Permian and Eo-Triassic bakevellias from the Maizuru Zone, Southwest Japan. Mem. *Coll. Sci., Univ. Kyoto, Ser. B,* **25:** 193-213.

Nakazawa, K. (1960) Permian and Eo-Triassic Myophoriidae from the Maizuru Zone, Southwest Japan. *Jour. Geol*

Geogr., **29:** 49-62.

Nakazawa, K., Ichikawa, K. and Kambe, N. (1951) Triassic formations in the Maizuru and Yakuno areas, Kyoto Prefecture. In, *Triassic Stratigraphy of Japan,* Spec. no.: 34-48. Geol. Surv. Japan, Kawasaki. (in Japanese)

Nakazawa, K. and Nogami, Y. (1958) Paleozoic and Mesozoic formations in the vicinity of Kawanishi, Oye-cho, Kyoto Prefecture, Japan—A study on the stratigraphy and geological structure of the "Maizuru Zone" (Part 6). *Jour. Geol. Soc. Japan,* **64:** 68-77. (in Japanese with English abstract)

Nogami, Y. (1958) Fusulinids from the Maizuru Zone, Southwest Japan, Part 1. Ozawainellinae, Schubertellinae and Neoschwagerininae. *Mem. Coll. Sci., Univ. Kyoto, Ser. B,* **25:** 97-115.

Nogami, Y. (1959) Fusulinids from the Maizuru Zone, Southwest Japan, Part 2, Derived fusulinids. *Mem. Coll. Sci., Univ. Kyoto, Ser. B,* **26:** 67-83.

Ozawa, T. (1970) Notes on phylogeny and classification of the superfamily Verbeekinoidea. *Mem. Fac. Sci., Kyushu Univ., Ser. D,* **20:** 17-58.

Shimizu, D. (1962) The Permian Maizuru Group, its stratigraphy and syntectonic faunal succession through latest Permian orogeny. *Mem. Fac. Sci., Univ. Kyoto, Ser. B,* **28:** 571-609.

Suzuki, S. (1987) Sedimentary and tectonic history of the eastern part of the Maizuru Zone, Southwest Japan. *Geol. Rep., Hiroshima Univ.*, **27:** 1-54. (in Japanese with English abstract)

Suzuki, S., Sugita, M. and Mitsuno, C. (1987) Stratigraphy and geologic structure of the Maizuru Group in the Maizuru area, Southwest Japan. *Jour. Geol. Soc. Japan,* **88:** 835-848. (in Japanese with English abstract)

Tazawa, J. and Hasegawa, Y. (2007) Permian fusulinoideans from the Atagoyama Formation of Choshi, Chiba Prefecture, central Japan, and their tectonic significance. *Jour. Geol. Soc. Japan,* **113:** 406-416. (in Japanese with English abstract)

Umeda, M., Takemura, S., and Suzuki, S. (1997) Permian radiolarians from the Lower and Middle Formations of the Maizuru Group in the Oe area, northern part of Kyoto Prefecture, Southwest Japan. *News Osaka Micropaleontologists, Spec. vol.*, no. 10: 41-46. (in Japanese with English abstract)

Wedekind, P. R. (1937) *Einführung in die Grundlagen der historischen Geologie. Band, Mikrobiostratigraphie die Korallen- und Foraminiferenzeit.* 136 pp., Ferdinand Enke, Stuttgart.

(Received: Aug. 2, 2010)
(Accepted: Sept. 9, 2010)

Plate 1. *Lepidolina kumaensis* fauna contained in the limestone conglomerate with calcareous argillaceous matrix of the Upper Formation of the Maizuru at Loc 1 (1).

Fig. 1. *Climacammina* sp. D2-023269, ×16.

Figs. 2, 8. *Tetrataxis* sp. A. 2: D2-023278, ×25; 8: D2-023231, ×25.

Fig. 3. *Tetrataxis* sp. B. D2-023264, ×30.

Figs. 4, 5. *Hemigordius* sp. 4: D2-023281, ×30; 5: D2-023263, ×30.

Fig. 6. *Eolasiodiscus* sp. D2-023243, ×60.

Fig. 7. *Dunbarula* sp. D2-023287, ×40.

Fig. 9. *Globivalvulina?* sp. D2-023261, ×40.

Fig. 10. *Sichotenella* sp. D2-023271, ×40.

Figs. 11, 12. *Kahlerina ussurica* (Sosnina) 11: D2-023256, ×20; 12: D2-023278, ×30.

Figs. 13, 14. *Lantschites cuniculata* (Kanmera). 13: D2-023278, ×30; 14: D2-023263, ×20.

Figs. 15-22, 27-30. *Lepidolina kumaensis* Kanmera
15: D2-023260, 16: D2-023252, 17: D2-023254, 18: D2-023274, 19: D2-023247, 20: D2-023260, 21: D2-023241, 22: D3-023257, 27: D2-023257, 28: D2-023285, 29: D2-023250, 30: D2-023247, all ×10.

Figs. 23, 24. *Chusenella* sp. 23: D2-023242, ×10; 24: D2-023261, ×10.

Figs. 25, 26. *Parafusulina?* sp. 25: D2-023284, ×10; 26: D2-023283, ×10.

Plate 2. *Lepidolina kumaensis* fauna contained in the limestone conglomerate with calcareous argillaceous matrix of the Upper Formation of the Maizuru at Loc 1 (2).

Figs. 1-12. *Lepidolina takagamiensis* (Chisaka)
11: microspheric form, others: megalospheric forms. 1b, 2b, 11b: ×30; others: ×10. 1: D2-023287, 2: D2-023243, 3: D2-023282, 4: D2-023258, 5: D2-023286, 6: D2-023248, 7: D2-023245, 8: D2-023265, 9: D2-023275, 10: D2-023253, 11: D2-023271, 12: D2-023274.

Fig. 13. *Yabeina?* sp. D2-023285, ×10.

Fig. 14. *Neoschwagerina?* sp. D2-023267, ×10.

Figs. 15-19. *Metadoliolina gravitesta* (Kanmera)
15: D2-023270, 16: D2-023246, 17: D2-023264, 18: D2-023278, 19: D2-023278; 17b: ×30, others: ×10.

Plate 1

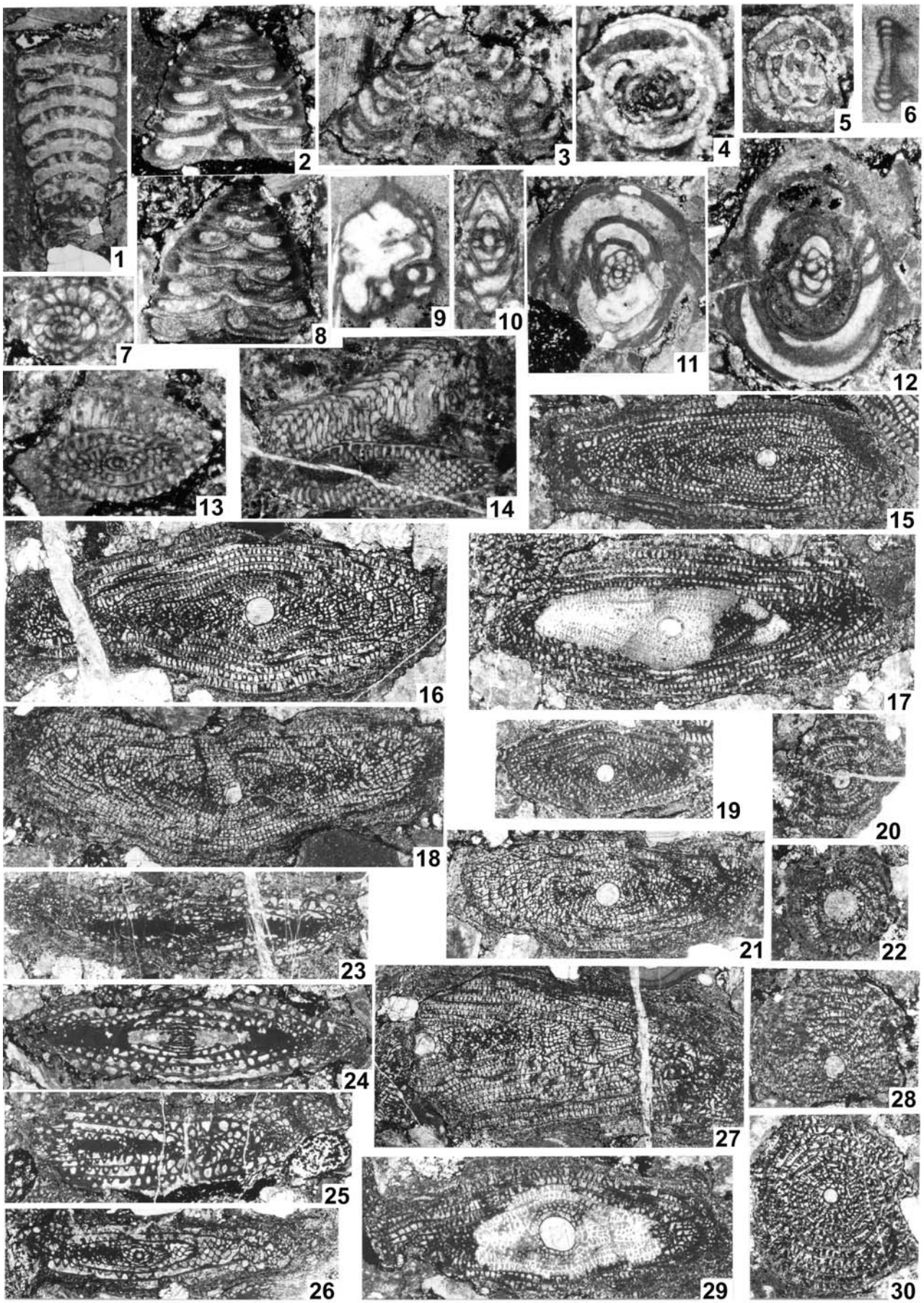
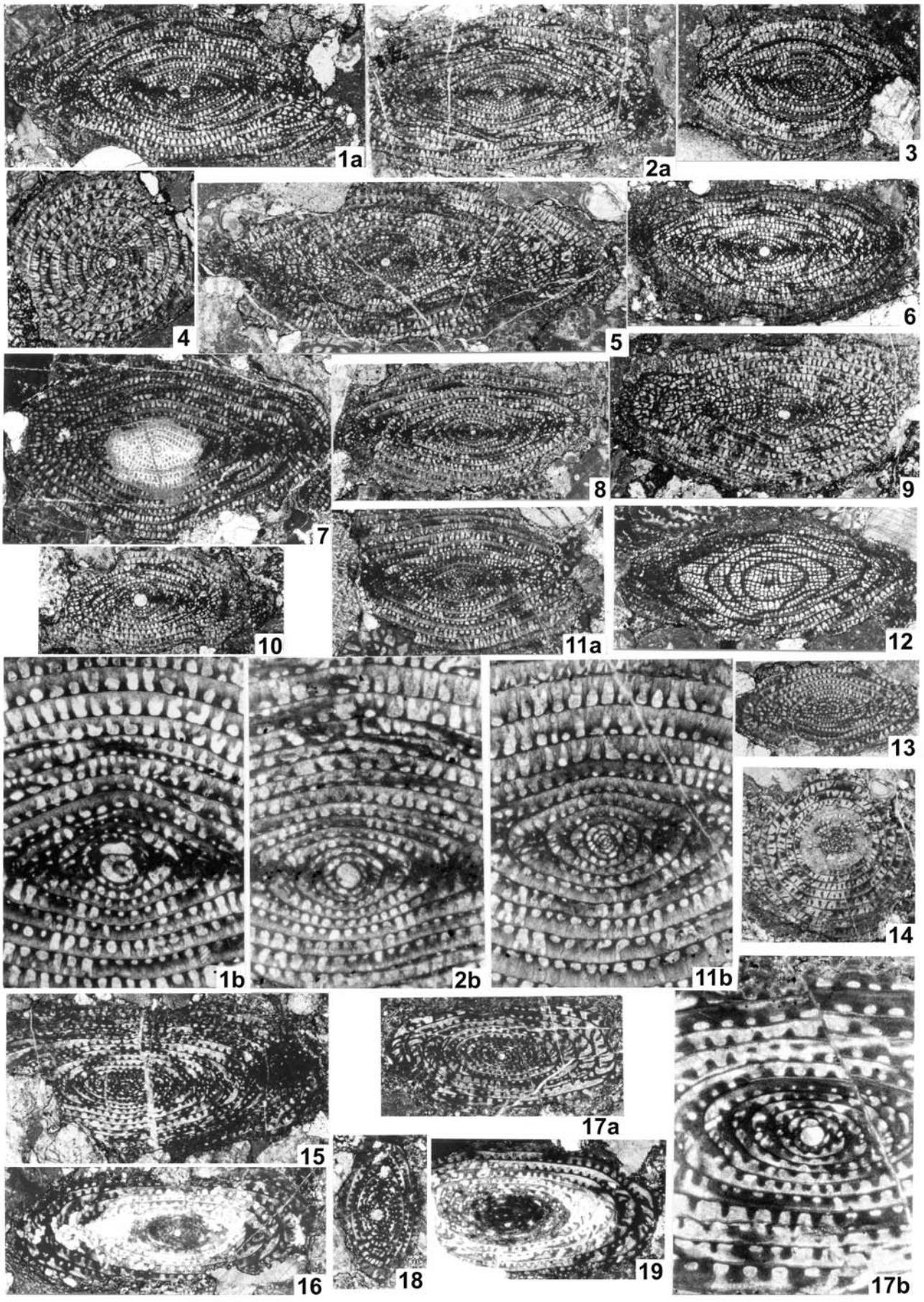

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

Plate 2



京都府大江地域舞鶴層群の石灰岩礫岩中の古生代後期有孔虫化石

小林文夫

京都府福知山市大江地域のペルム系舞鶴層群の石灰岩礫岩は他の地域のものと同様に基質の違いにより２大分される．石灰泥質基質の石灰岩礫岩は *Lepidolina kumaensis, L. takagamiensis* のような *Lepidolina kumaensis* フォーナに特徴的な有孔虫化石を産する．この礫岩に*Colaniella parva*が生砕片として含まれることは*Lepidolina kumaensis* フォーナを産する舞鶴層群中部層・上部層の石灰岩礫岩は，従来考えられていたCapitanian (Midian)に限定されるものではなく，Lopingianに及ぶことを示唆する．Capitanian以前の化石の産出は舞鶴層群上部層と公庄層の砂質基質の石灰岩礫岩に限られる．大江地域では石炭紀前期(Serpkhovian)からペルム紀前期(Artinskian)の多様な有孔虫類が同定された．石灰泥質基質の石灰岩礫岩から産する*Lepidolina*２種，*L. kumaensis*と *L. takagamiensis* を記載した．

(兵庫県立人と自然の博物館／兵庫県立大学自然・環境科学研究所)