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Fusulinaceans Contained in Pebbles of the Intraformational Conglomerate of the Kanyo Formation, North of Itsukaichi, Southern Kwanto Mountains, Japan

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Abstract

The Kanyo Formation, distributed in the southern Kwanto Mountains, is the uppermost lithostratigraphic unit of the Middle Carboniferous to Lower Jurassic Nishitama Group. In north of Itsukaichi, this formation intercalates a remarkable intraformational conglomerate containing clasts of pebble- to boulder-size acidic to intermediate igneous rocks and prolific sedimentary rocks. The limestone clasts yield Moscovian to early Artinskian foraminifers, mostly of fusulinaceans. This paper describes the stratigraphy of this formation in north of Itsukaichi and two fusulinaceans: *Biwaella omiensis* Morikawa and Isomi and *Biwaella* sp. among the 52 listed foraminiferal species.

Key words: *Biwaella omiensis*, *Biwaella* sp., fusulinaceans, intraformational conglomerate, Kanyo Formation, Kwanto Mountains

Introduction

The conglomerate-bearing formations of pre-Cretaceous age in the Kwanto Mountains have been reported from the Kamiyoshida (Huzimoto, 1935), Okuchichibu (Ishii, 1962; Sato *et al.*, 1981, 1982), Shomaru (Morikawa, 1955) and Ome-Itsukaichi (Takagi, 1944; Sakagami, 1958; Ozawa, 1975; Ozawa and Kobayashi, 1986) areas. During the past 50 years, diverse views have been expressed as to the stratigraphy, geologic structure, sedimentary environment, geologic age and correlation of these formations. The Mesozoic radiolarian biostratigraphy and recent field mapping reveal that these formations are composed of Jurassic sandstone and shale enclosing pre-Jurassic exotic blocks, except for the Futamatao Formation (Ozawa, 1975) and the Kanyo Formation (Ozawa and Kobayashi, 1986), both of which are distributed in the Ome-Itsukaichi area.

The Nishitama Group, including the Futamatao and Kanyo Formations, is interpreted as originating from the Middle Carboniferous to Lower Jurassic shelf deposits accumulated on a microcontinent or island arcs which collided in Middle to Late Jurassic, on the basis of many lines of geologic evidence (Ozawa and Kobayashi, 1986). The stratigraphy and lithology of the conglomerate-bearing formations of the Nishitama Group are important supporting evidence for this view. Description of these formations in west of Ome by Ozawa and Kobayashi (1986) was nearly equal to that by Ozawa (1975), though the age and correlation of these formations were partly revised. However, much has not been mentioned regarding the Kanyo Formation distributed in north of Itsukaichi. In this formation, fossils rarely occur; however, Moscovian to early Artinskian fusulinaceans occur in limestone pebbles, cobbles and boulders of the intraformational conglomerate intercalated within the formation.

This paper describes the stratigraphy of the Kanyo Formation in north of Itsukaichi and two fusulinaceans: *Biwaella omiensis* Morikawa and

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Biwaella sp. among the 52 listed foraminiferal species.

All the illustrated specimens in this paper are stored in the collection of the Division of Earth Sciences, Museum of Nature and Human activities, Hyogo. Some, already described and illustrated in Kobayashi (1977), were registered in the collection of the Institute of Geology and Mineralogy, Tokyo University of Education. These have been transferred from the institute and are now kept in the museum under the newly labelled registration.

Geologic Setting

Pre-Cretaceous rocks in the mapped area (Fig. 1) are assignable to the Nishitama, Musashi and Takamizuyama Groups. The Nishitama Group consists of the Middle Carboniferous to Lower Jurassic shelf deposits, and is fault contact with the Musashi Group. The Musashi and Takamizuyama Groups are made up of the Lower to Middle Jurassic sandstone and shale, and exotic blocks of basaltic rocks, limestone, dolostone and chert, ranging in age from late Early Carboniferous to Late Triassic. Distribution, geologic structure and lithologic assemblages of the Takamizuyama Group indicate that the group forms a nappe overlying the Nishitama and Musashi Groups (Ozawa and Kobayashi, 1986).

The Kanyo Formation, as described below, is the uppermost lithostratigraphic unit of the Nishitama Group.

Stratigraphy of the Kanyo Formation

Designation: Ozawa and Kobayashi (1986).

Type area: Northeast of Kanyo, Hinode-machi, Nishitama-gun, Tokyo-to.

Distribution: In north of Itsukaichi, this formation exhibits complicated and isolated distribution, controlled by a major geologic structure with a NW-SE trend; it is exposed in Iwai, Kanyo, and other areas where the overlying nappe composed of the Takamizuyama Group is eroded.

Thickness: About 210m in the type section (B-B′), mostly less than 250m in north of Itsukaichi (Fig. 2). In west of Ome, this formation attains about 350 in thickness.

Lithology: This formation comprises massive sandstone, black shale and alternating beds of sandstone and shale, with intercalations of remarkable intraformational conglomerate at two to four horizons. The sandstone is greenish gray to dark gray in color, massive to thickly bedded, and mostly of feldspathic arenite. However, the sandstone which grades laterally and vertically into conglomerate tends to be more argilliceous, and contains poorly-sorted, medium- to coarse-grained lithic fragments of limestone, chert, mudstone and basaltic rocks.

The basal part of this formation in the Iwai area consists of poorly stratified, more than three units of upward thinning sandstone sequences. Each unit is 70 to 120cm thick. Grain size grades from granule at the base into medium-grained sandstone, showing distinct laminations, at the top. The coarse-grained sandstone of these units is classified into feldspathic arenite, consisting of quartz, potassium feldspar, albite, plagioclase, biotite and muscovite, with accessory lithic fragments of granite and andesite.

Intercalation of conglomerate is the most characteristic feature of this formation. However, it is not available for correlation. The conglomerate occurs at two to four horizons in the Kanyo area, but is poorly developed in the Iwai area. Its thickness varies from several tens of centimeters to 10m, and rather abruptly changes laterally as well as vertically into sandstone or black shale.

The conglomerate is ill-sorted, and mostly of subrounded to subangular pebbles to cobbles of abundant limestone and subordinate chert, sandstone, mudstone and basaltic rocks with accessory granite, grano-diorite, quartz-diorite, porphyrite and andesite. Roundness, diameter and composition are variable in places. Limestone boulders some-

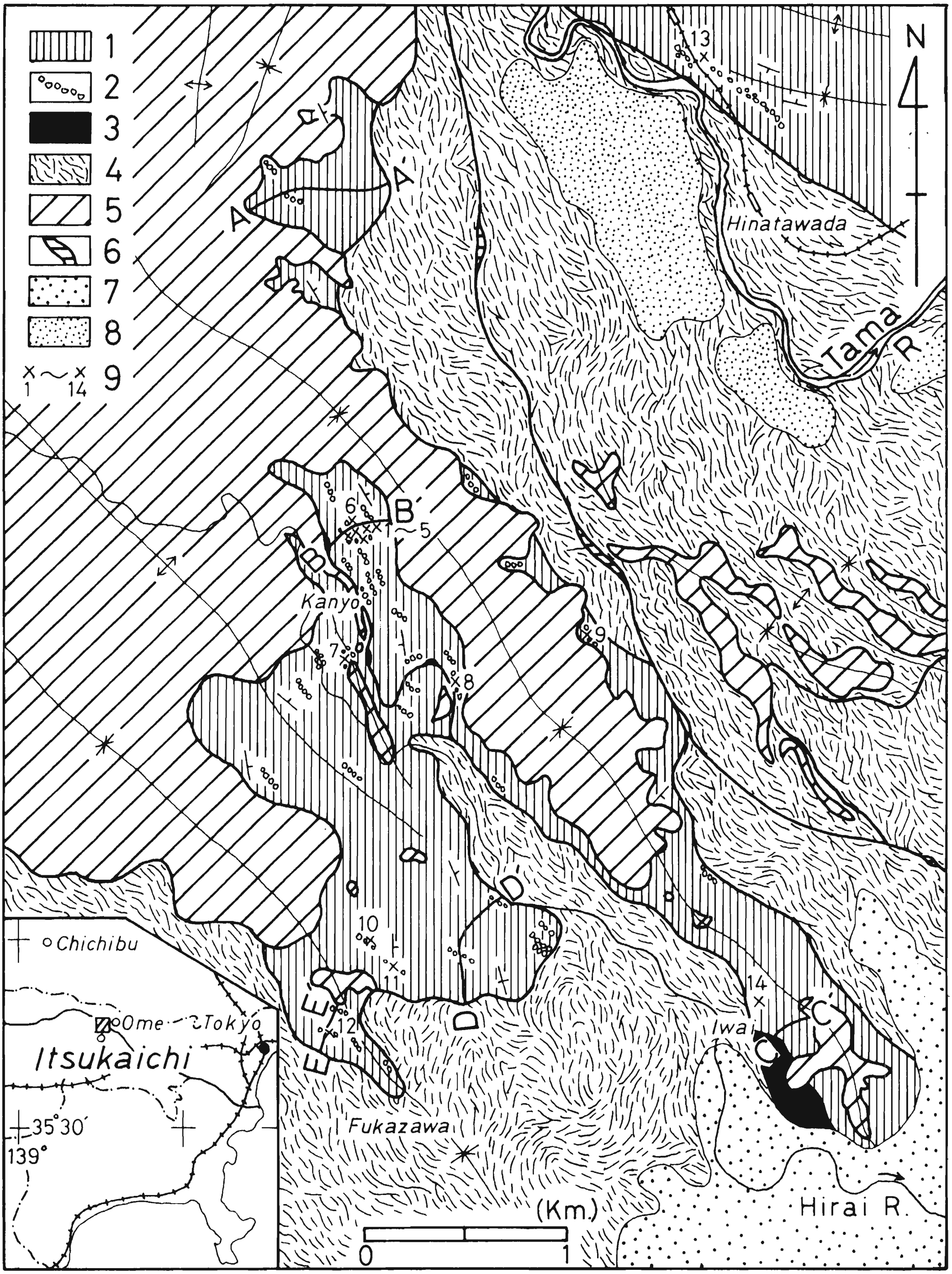

Fig. 1. Geologic map of north of Itsukaichi. 1. Kanyo Formation. 2. conglomerate of the Kanyo Formation. 3. Nishitama Group excluding the Kanyo Formation. 4. Musashi Group. 5. Takamizuyama Group. 6. serpentinite. 7. Tertiary formations. 8. terrace deposits. 9. fossil localities. Locs. 13 and 14 are adopted from Takagi (1944) and Zhang (1939), respectively.

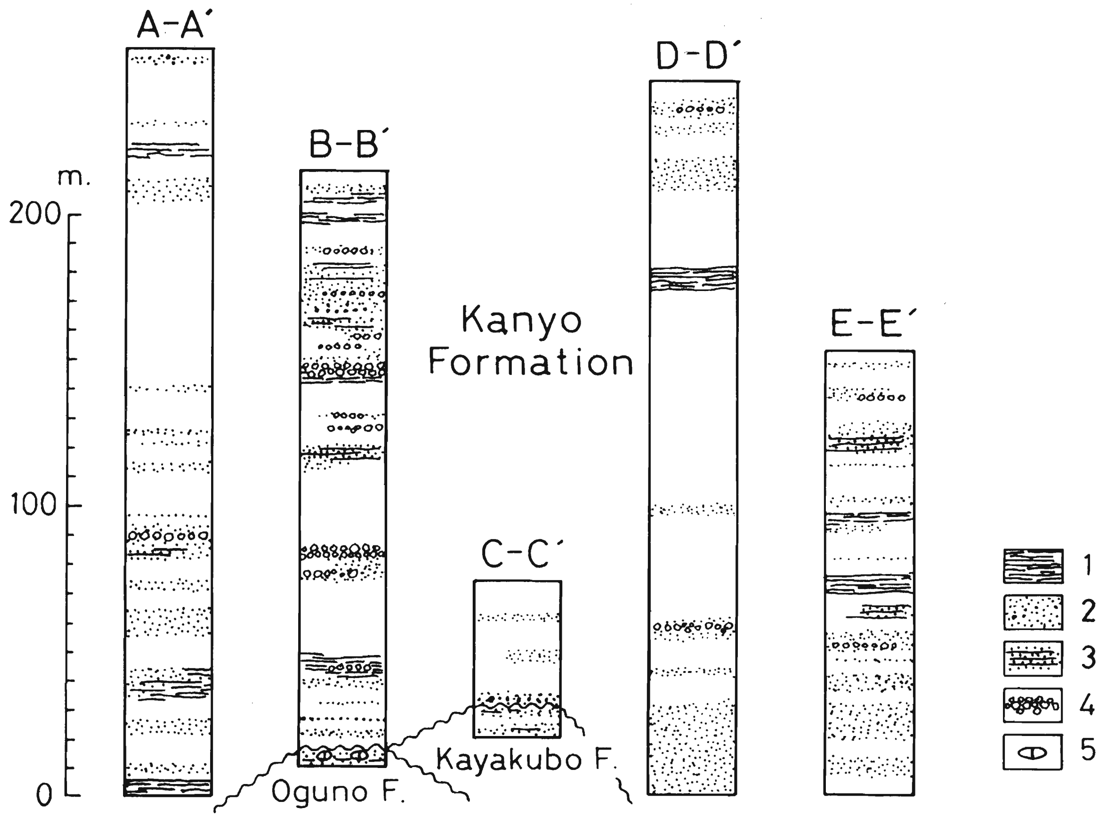

Fig. 2. Columnar sections of the Kanyo Formation in north of Itsukaichi. 1. shale. 2. sandstone. 3. alternating beds of sandstone and shale. 4. conglomerate. 5. limestone of the Oguno Formation. Location of each column is shown in Fig. 1.

times exceed 50cm in diameter. Igneous rock pebbles are generally well-sorted, and not always productive, but a rounded granite boulder is exposed at west of Kanyo. The matrix of the conglomerate is made up of lithic wacke, feldspathic wacke, argilliceous feldspathic arenite and mudstone.

Stratigraphic relationship: This formation rests unconformably upon the Norian Kayakubo Formation (Ozawa and Kobayashi, 1986). In the type area, this formation is considered to be unconformably lies above the Upper Permian Oguno Formation (Ozawa and Kobayashi, 1986), nevertheless there are no exposures between the two formations (Fig. 2).

Occurrence of fossils: A fragment of *Monotis* ? sp. from the micaceous fine-grained sandstone at north of Iwai by Zhang (1939), shown as Loc. 14 in Fig. 1, is the only record of fossil occurrence. In west of Ome, Takagi (1944) found *Monotis ochotica* Kayserling from the sandstone referable to this formation (Loc. 13 in Fig. 1). The Moscovian to Artinskian foraminifers listed in Table 1 occur in the limestone clasts of the intraformational conglomerate of this formation. Among these foraminifers, *Pamirina darvasica* Leven, *Misellina dyhrenfurthi* (Dutkevich) and *M.* sp. A are already described or illustrated in Kobayashi (1977).

Geologic age: The exact age of this formation has not yet been determined in the type area, but it is considered to be Late Triassic, ranging to Early Jurassic.

Appendix: The continued field surveying has revealed that the *Palaeofusulina*-bearing limestone erratic (Kobayashi, 1975) is derived from the lenticular limestone of the Oguno Formation and the Triassic conodont-bearing chert mentioned in Kobayashi (1975) is an erosional remnant of the nappe composed of the Takamizuyama Group.

Description of Species

Genus *Biwaella* Morikawa and Isomi, 1960

Biwaella omiensis Morikawa and Isomi

Plate 1, figs 26-28, 30.

Biwaella omiensis Morikawa and Isomi, 1960, p. 302-304, Pl. 54, figs. 1-5; Morikawa and Isomi, 1961, p.8, 9, Pl.1, figs. 1-16; Skinner and Wilde, 1965, p. 97, 99, Pl. 13, figs. 1-6; Ozawa, 1975, Pl.9, fig.6 (not described).

Oketaella takahashii Morikawa and Kobayashi, 1960, p. 308-310, Pl.55, figs.1-11.

Oketaella shiroishiensis Morikawa and Kobayashi, 1960, p.310-312, Pl.55, figs.12-19.

Schubertella haginoensis Suyari, 1962, p.6,7, Pl.2, figs.1,2, non. fig.3.

Schubertella haginoensis fusiformis Suyari, 1962, p.7,8, Pl.2, figs.4-6.

Schubertella kingi Dunbar and Skinner; Ishizaki, 1962, p.109,110, Pl.29, fig.3.

Biwaella sp. Leven, 1971, p.13, Pl.1, figs.3,4.

Biwaella sp. No. 1, Leven and Sherbovich, 1978, p.87, Pl.1, fig.14.

Biwaella ex. gr. *omiensis* Morikawa and Isomi; Leven and Sherbovich, 1978, p.87, Pl.1, fig.15.

Biwaella sp. No. 2, Leven and Sherbovich, 1978, p.88, Pl.1, fig.16.

non. *Triticiles omiensis* (Morikawa and Isomi); Han, 1975, p.148, Pl.4, figs.16-18.

Description: Shell small, fusiform in shape with straight to slightly irregular axis of coiling, broadly arched periphery, straight to slightly convexo-concave lateral slopes and rounded to bluntly pointed poles. Mature specimens of 4.5 to 5.5 volutions, 1.95 to 2.58 mm in axial length and 0.71 to 1.08mm in median width, giving form ratio 2.6 to 2.8.

Proloculus spherical to subspherical and 0.05 to 0.09 mm in longer diameter. One or one and a half volutions variable in shape, subspherical, oval or nautiloid, sometimes with shallowly depressed poles, and commonly coiled askew to the outer ones. The succeeding volutions becoming fusiform with pointed to bluntly pointed poles. Half length, radius vector and form ratio from the first to fifth volutions in specimen illustrated in Pl. 1, fig. 27; 0.05, 0.17, 0.46, 0.66 and 1.03mm; 0.07, 0.10, 0.16, 0.27 and 0.41mm; 0.8, 1.7, 3.0, 2.5 and 2.5, respectively.

Spirotheca very thin and undifferentiated in juvenile volutions, gradually thickened and composed of a tectum and translucent lower layer in the succeeding ones. The last and/or the preceding one volutions consist of a tectum and very fine alveolar keriotheca in most specimens. Alveolar keriotheca obscure in some specimens. Thickness of spirotheca 30 to 40μm in the last volution.

Septa unfluted throughout shell, and sometimes coated by calcareous materials. Septal counts from the first to fifth volutions, 7, 8, 9, 10 and 12, respectively. Chomata hook-like or node-like, asymmetrical and well developed in inner fusiform volutions, becoming discontinuous or absent in the outer ones. Tunnel wide, and half as high as chambers in outer ones. Tunnel angle varies from 40 to 75 degrees.

Remarks: The genus *Biwaella* was established from Early Permian (Asselian and Sakmarian) limestone blocks distributed in east of Lake Biwa, central Japan, designating *Biwaella omiensis* as the type species, by Morikawa and Isomi (1960). Skinner and Wilde (1965) recognized wide variation in size and shape of shell of this species after examination of topotype specimens, but proposed *Biwaella americana* Skinner and Wilde for the material from the Wolfcampian of New Mexico, based on differences in shell shape and tunnel angle. It seems to be very difficult to distinguish these two species on the basis of these differences.

Biwaella europanica Kochansky and Devidé, descibed from the *Pseudofusulina vulgaris* Subzone

Table 1. Late Paleozoic foraminifers from limestone pebbles of the intraformational conglomerate of the Kanyo Formation in north of Itsukaichi.

Species / Locality	1	2	3	4	5	6	7	8	9	10	11	12
Eotuberitina spp.	X			X	X		X	X	X	X	X	X
Tuberitina spp.											X	
Pseudoglomospina sp.	X		X				X	X			X	X
Eolasiodiscus sp.											X	
Lunucammina sp.					X							
Pachyphloia sp.							X	X				
Climacammina sp.A					X					X		
C. sp.B						X	X					
C. sp.C	X				X	X						
C. spp.	X				X		X				X	
Palaeotextulariidae gen. and sp. indet.			X		X	X	X		X			
Biseriella sp.											X	
Globivalvulina sp.	X				X		X	X		X	X	
Endothyra sp.A			X									
E sp.B										X	X	
Bradyina sp.A						X				X	X	
B sp.B					X	X						
Tetrataxis sp.A	X						X	X		X		
T sp.B			X							X		
Pamirina leveni Kobayashi		X										
P. darvasica Leven							X	X				
Mesoschubertella thompsoni Sakagami	X	X	X				X					X
Schubertella kingi Dunbar and Skinner	X				X	X	X		X			
Fusulinella bocki Möller				X	X						X	
F. pseudobocki Lee and Chan										X	X	
F. sp.					X							
Biwaella omiensis Morikawa and Isomi	X						X					
B. sp.						X						
Carbonoschwagerina minatoi (Kanmera)						X						
Chalaroschwagerina? sp.					X							
Daixina sokensis (Rauser–Chernousova)						X						
D.? sp.					X						X	
Pseudofusulina duplithecata Igo	X	X					X					
P. globosa (Schellwien)			X									
P. kraffti (Schellwien)			X									
P. vulgaris (Schellwien)							X					
P. muongthensis (Deprat)									X			
Rugosochusenella gregeriaeformis Rauser–Chernousova and Sherbovich						X						
R. shagoniensis Davydov						X						
Triticites sp.A					X				X			
T. sp.B	X				X		X					
T. sp.C					X							
Misellina dyhrenfurthi (Dutkevich)	X						X	X				
M. sp.A	X						X	X				
M. sp.B							X	X				X
Pseudoendothyra sp.A					X							
P. sp.B										X		
P. sp.C							X	X				X
Staffella sp.							X					
Agathammina sp.	X						X	X				X
Hemigordius? sp.	X											
Neohemigordius sp.								X				

of Montenegro, Yugoslavia (Kochansky-Devidé and Milanović, 1962) is closely allied to this species in many respects. This species may be synonymous with *B. omiensis.*

Triticites inopinatus, originally described from southern Croatia (Kochansky-Devidé, 1959), is characteristic in small subsylindrical shell with tightly coiled juvenile volutions and broadly spaced septa which are weakly fluted in polar regions. The Croatian species is referable to *Biwaella* based on these characters, but it is distinct from *Biwaella omiensis* by its weakly fluted septa in polar regions.

Overall shell characters of the two forms assigned to the genus *Oketaella* by Morikawa and Kobayashi (1960) from the Kwanto Mountains are identical with those of *Biwaella omiensis.* Also referable to the present species are three forms named as *Schubertella haginoensis* Suyari and *S. haginoenis fusiformis* Suyari by Suyari (1962) and *Schubertella kingi* Dunbar and Skinner by Ishizaki (1962). These three forms were described from the Chichibu Belt of Shikoku. However, the specimen illustrated in fig. 3 of Pl. 2 by Suyari (1962) is distinctive from the other two ones, and is referable to the genus *Schubertella* on the basis of thin spirotheca and more septa in outer volutions. Spirotheca of the present species thickens abruptly and significantly in outer one or two volutions, and consists of finely to very finely alveolar keriotheca. Alveolar keriotheca appears to be protheca or primatheca in unfavorable states of preservation.

Biwaella sp. No. 1, *B.* ex gr. omiensis and *B.* sp. No. 2 from the Asselian of Darvas (Leven and Sherbovich, 1978) seem to be dissimilar in size and shape of shell, as well as corresponding volutions, thickness of spirotheca and development of chomata in each other. These differences are considered to represent the variation of this species. Han (1975) described a primitive form of *Triticites* from the Upper Carboniferous of Inner Mongolia having a small shell with weak septal fluting in axial regions and obvious alveolar keriotheca in outer three volutions. Han thought that these characters were the same as those of *Biwaella omiensis*; nevertheless, he assigned *omiensis* to the genus *Triticites.* Han's materials should be distinguished from the present species by spirothecal structure, fluted septa and larger shell.

The genus *Biwaella* has been described from the various limestones of the Upper Carboniferous to Lower Permian of China. Although conclusion is reserved, the following species listed below may be synonymous with *Biwaella omiensis*:

Toriyamaia provecta Wang and Sun, 1973, p. 154, Pl. 3, figs. 9, 11; Sun, *et al.*, 1983, p. 8, 9, Pl. 2, fig. 23.
Biwaella provecta (Wang and Sun); Wang *et al.*, 1981, p.35, Pl. 8, figs. 8, 13, 14; Da and Sun, 1983, p. 80, Pl. 16, fig. 8.
Biwaella guizhouensis Liu, Xiao and Dong, 1978, p. 57, Pl. 11, figs. 6-8.
Toriyamaia laxiseptata Kanmera; Sun *et al.*, 1983, p. 9, Pl. 2, fig. 20.
Triticites planoseptus Chang; Da and Sun, 1983, p. 55, Pl. 9, fig. 16.
Biwaella tieliekensis Da, in Da and Sun, 1983, p. 80, Pl. 16, fig. 9.
Biwaella pulchra Da, in Da and Sun, 1983, p. 80, 81, Pl. 16, fig. 10.

Biwaella explicata Han and Zhao described from Tarim (Zhao *et al.*, 1984) differs from *B. omiensis* by weakly fluted septa.

Occurrence: Rare to common in Locs. 1 and 7, in association with *Pseudofusulina duplitheca* Igo, *Schubertella kingi* Skinner and Wilde and others.

Biwaella sp.

Pl. 1, fig. 29.

Remarks: Only one well-oriented specimen of this unnamed species is obtained in association with *Carbonoschwagerina minatoi* (Kanmera) and *Daixina sokensis* (Rauser-Chernousova) both of which are yielded restrictedly from the Gzhelian (e.g. Rauser-Chernousova, 1940; Rozovskaya, 1950, 1958; Davydov and Popov, 1986; Ozawa *et al.*, 1991). Diagnostic features of the present form are small elongate fusiform shell, minute proloculus, tightly coiled inner volutions, loosely coiled terminal one, essentially plane septa and thicker spirotheca in the last volution than in the preceding ones. Spirotheca of the outermost volution consists of thin tectum and inner translucent layer referable to protheca, and alveolar structure is obscure. These characters suggest the possibility of transitional form of the present species between Schubertellinae Skinner and Biwaellinae Davydov. Obscure alveolar structure and nearly plane septa of this species are discordant with diagnostic characters of the genus *Dutkevichites* established by Davydov (1984). This species is possibly included in the genus *Biwaella*, though its generic assignment is not definitely settled.

Species somewhat allied to *Biwaella* sp. are *Schubertella cylindrica* Sakagami and Omata from the Gzhelian limestone at Shiraiwa (Sakagami and Omata, 1957), about 3km north of the mapped area (Fig. 1), and *Schubertella baichengensis* Sun from the Upper Carboniferous limestone of Xinjiang Uygur Autonomous Region (Da and Sun, 1983).

Occurrence: Very rare in Loc.6. Associated fusulinaceans are *Carbonoschwagerina minatoi* (Kanmera), *Daixina sokensis* (Rauser-Chernousova), *Rugosochusenella gregariaeformis* (Rauser-Chernousova and Scherbovich), *Rugosochusenella shagoniensis* Davydov and *Schubertella kingi* Dunbar and Skinner.

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関東山地南部、五日市北方の肝要層層内礫岩産フズリナ化石

小　林　文　夫

関東山地南部に分布する肝要層は中部石炭系から下部ジュラ系陸棚相から成る西多摩層群の最上位の累層である。五日市北方の肝要層は堆積岩のほか、酸性～中性の火成岩の礫を含む層内礫岩を介在する。石灰岩礫はモスコヴィアンからアルティンスキアン前期の有孔虫類を産する。本文ではこれらをリストするとともに*Biwaella omiensis* Morikawa and Isomi, *Biwaella* sp. の２種のフズリナ化石を記載した。

Plate 1

fig. 1. *Climacammina* sp. A. lateral section, Loc. 10, D2-1155, ×40.
fig. 2. *Climacammina* sp. C. transverse section, Loc. 6, D2-1056, ×20.
fig. 3. *Neohemigordius* sp. transverse section, Loc. 8, D2-1145, ×40.
fig. 4. *Endothyra* sp. A. tangential section, Loc. 3, D2-1181, ×60.
fig. 5. *Agathammina* sp. lateral section, Loc. 7, D2-1030, ×40.
figs. 6, 7. *Bradyina* sp. A. lateral sections, 6: Loc. 6; D2-1099a; 7: Loc. 10; D2-1161a, ×25.
figs. 8, 9. *Bradyina* sp. B. 8: lateral section; D2-1119a; ×15; 9: axial section; D2-1110a, ×20, Loc. 6.
fig. 10. *Staffella* sp. axial section, Loc. 7, D2-1005, ×30.
fig. 11. *Pseudoendothyra* sp. B. tangential section, Loc. 10, D2-1148, ×40.
figs. 12-15. *Schubertella kingi* Dunbar and Skinner. 12: sagittal section; Loc. 6; 13-15: axial sections; Loc. 7; 12: D2-1115a; 13: D2-1045; 14: D2-1044; 15: D2-1023, 12, 15: ×40; 13, 14: ×30.
figs. 16, 17. *Fusulinella bocki* Möller. axial sections, Loc. 11, 16: D2-1050; 17: D2-1049, ×15.
figs. 18-23. *Fusulinella pseudobocki* Lee and Chen. 18-20: axial sections; 21-23: sagittal sections, Loc. 10, 18: D2-1159; 19: D2-1152; 20: D2-1156; 21: D2-1146; 22: D2-1169; 23: D2-1161b, ×15.
figs. 24, 25. *Carbonoschwagerina minatoi* (Kanmera). axial ections, Loc. 6, 24: D2-1093; 25: D2-1092, ×10.
figs. 26-28, 30. *Biwaella omiensis* Morikawa and Isomi. 26-28: axial sections; 30: sagittal section, Loc. 7, 26: D2-1020; 27: D2-1017; 28: D2-1026; 30: D2-1019, ×20.
fig. 29. *Biwaella* sp. axial section, Loc. 6, D2-1096, ×25.

Plate 2

figs. 1, 2. *Triticites* sp. A. 1: tangential section; D2-1174; 2: sagittal section; D2-1062, 1: Loc. 9; 2: Loc. 5, ×15.
figs. 3-6. *Daixina sokensis* (Rauser-Chernousova). 3, 4: axial sections; 5, 6: sagittal sections, Loc. 6, 3: D2-1101; 4: D2-1115b; 5: D2-1110b; 6: D2-1110c, ×10.
figs. 7, 8. *Rugosochusenella shagoniensis* Davydov. axial sections, Loc. 6, 7: D2-1119b; 8: D2-1099b, ×10.
figs. 9-12. *Rugosochusenella gregariaeformis* Rauser-Chernousova and Sherbovich. 9-11: axial sections; 12: parallel section, Loc. 6, 9: D2-1107; 10: D2-1100; 11: D2-1127; 12: D2-1103, ×10.
figs. 13-15. *Pseudofusulina globosa* (Schellwien). 13, 14: axial sections; 15: sagittal section, Loc. 3, 13: D2-1178; 14: D2-1179; 15: D2-1181, ×10.
figs. 16, 17. *Pseudofusulina kraffti* (Schellwien). 16: axial section; D2-1177; 17: sagittal section; D2-1180, Loc. 3, ×10.

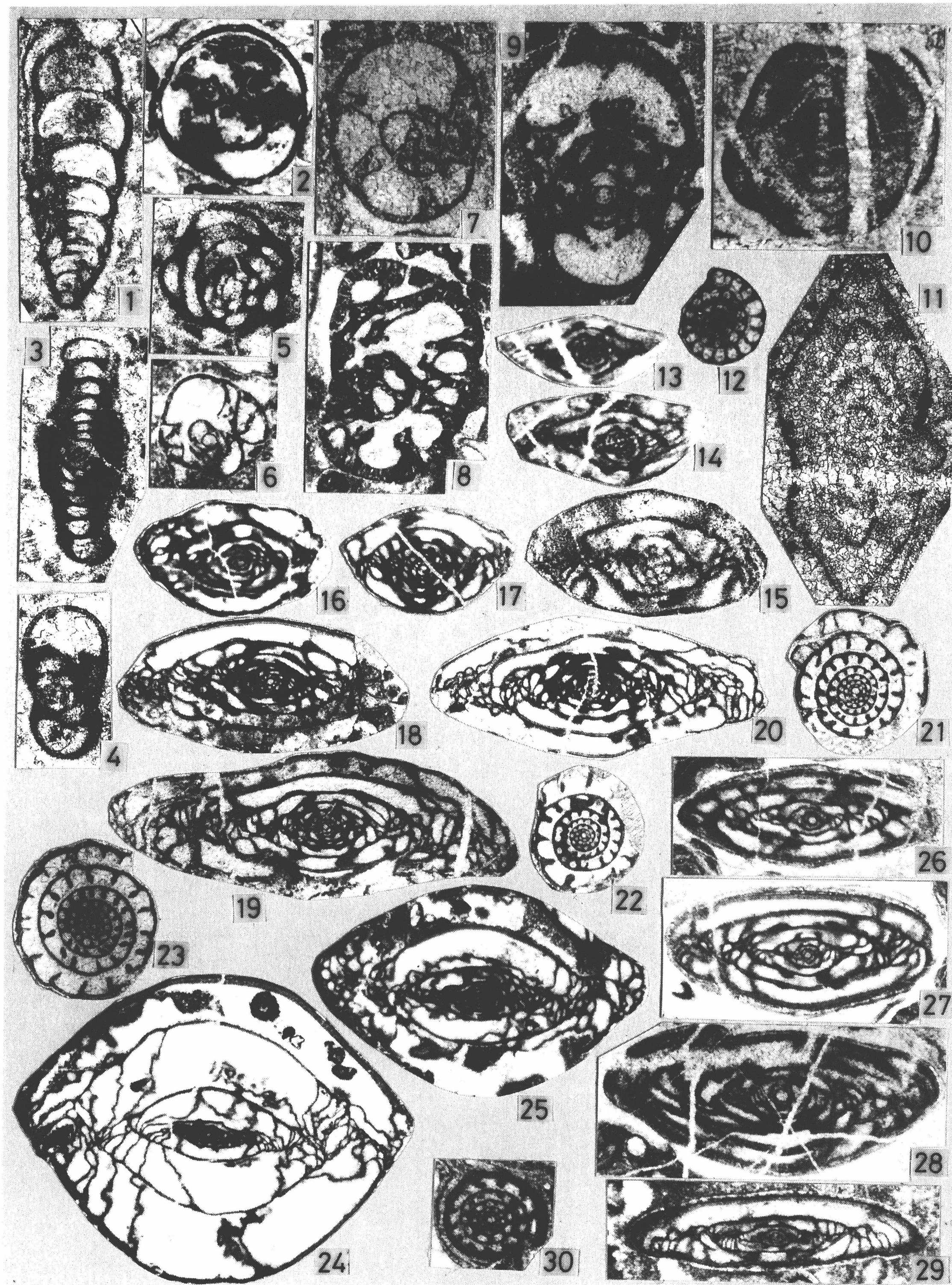
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Plate 1

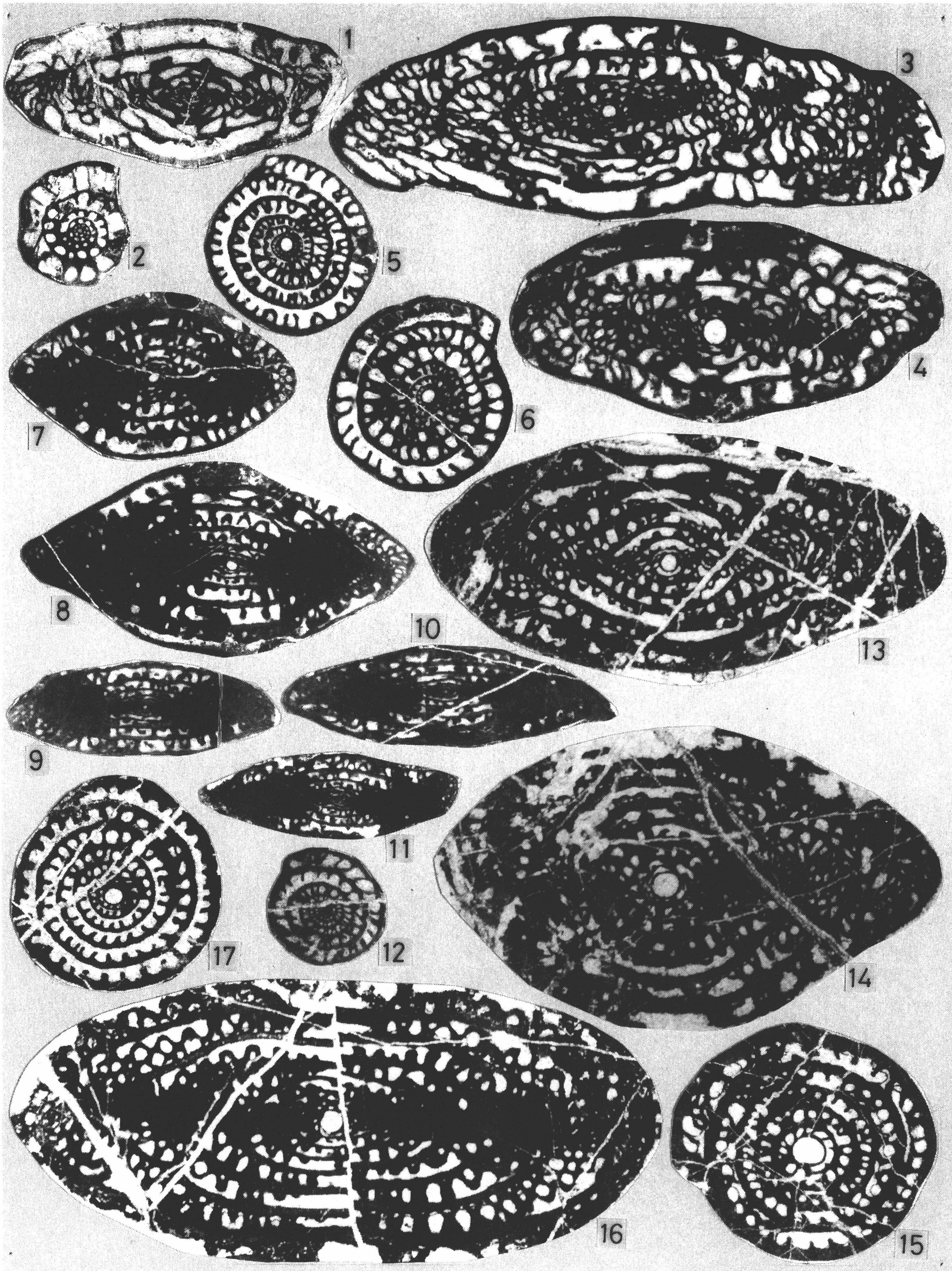

Plate 2