

# Carboniferous Primitive Fusulinacea from the Hina Limestone in Okayama Prefecture, western Japan

Mutsumi FUJIMOTO\* and Kimiyoshi SADA

Faculty of Integrated Arts and Sciences,  
Hiroshima University, Higashi-Hiroshima 724, Japan

**Abstract :** In this paper the Carboniferous primitive fusulinacean zones of the Hina Limestone are established, which are in ascending order the *Endothyra-Mediocris* Zone, the *Eostaffella-Millerella* Zone and the *Pseudostaffella-Profusulinella* Zone. And here are illustrated the descriptions of *Millerella marblensis* Thompson, *M. toriyamai* Ota, *Eostaffella kanmerai* (Igo), *E. akiyoshiensis* Sada, *E. mosquensis* Vissarionova, *E. ikensis* Vissarionova, *E. paraprisca* Durkina, *E. etoi* Ota, *E. sp. A*, *Mediocris mediocris* (Vissarionova), *M. adducta* Durkina, *Ozawainella japonica* Sada, *Pseudostaffella minuta* Sada and *Nankinella yokoyamai* Sada.

**Key words :** Carboniferous, Primitive fusulinacea, *Millerella*, *Eostaffella*, *Mediocris*, *Ozawainella*, *Pseudostaffella*, *Nankinella*, Hina Limestone, Okayama Prefecture

## I. Introduction

The Hina Limestone in the southwestern part of Okayama Prefecture has been studied

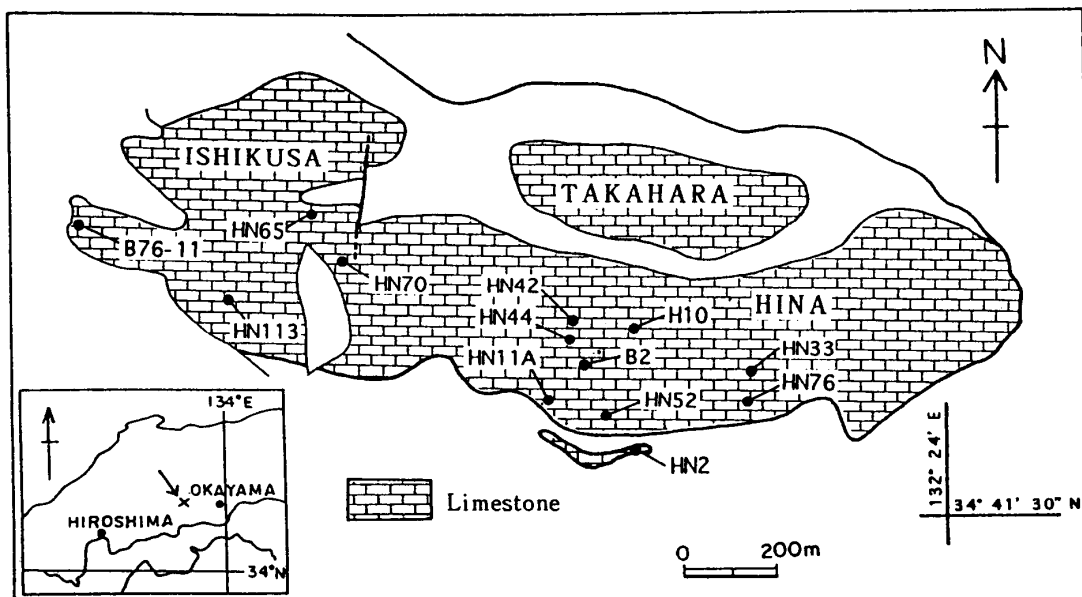


Figure 1. Map showing distribution of the Hina Limestone and representative localities of the primitive fusulinacean fossils.

Received August 31, 1994; Accepted September 29, 1994

\* Permanent address: Fukken Co., Ltd., Hikarimachi, Higashiku, Hiroshima 732, Japan

Species \ Zone	<i>Endothyra-Mediocris</i> Zone	<i>Eostaffella-Millerella</i> Zone	<i>Pseudostaffella-Profusulinella</i> Zone
<i>Endothyra similis</i>		.....	
<i>E. exilis</i>	————	.....	.....
<i>E. sp.</i>			.....
<i>Eoendothyanopsis</i> sp.	.....	————	
<i>Planoendothyra sigma</i>		.....	
<i>Zellerinella discoidea</i>			————
<i>Z. tortula</i>			.....
<i>Endothyranopsis</i> sp.	.....		
<i>Granuliferelloides</i> sp.	.....		
<i>Endostaffella</i> sp.A	.....	————	
<i>Mediocris mediocris</i>		————	
<i>M. adducta</i>	.....	————	
<i>M. sp.A</i>	————	.....	
<i>M. sp.</i>	.....	.....	
<i>Eostaffella ikensis</i>		.....	.....
<i>E. akiyoshiensis</i>		.....	.....
<i>E. paraprisca</i>		.....	.....
<i>E. exilis</i>		.....	.....
<i>E. kanmerai</i>		.....	.....
<i>E. mosquensis</i>		.....	
<i>E. etoi</i>		.....	————
<i>E. sp.A</i>		.....	.....
<i>E. sp.B</i>		.....	
<i>Millerella toriyamai</i>		.....	.....
<i>M. marblensis</i>		.....	.....
<i>Rectomillerella</i> sp.		.....	
<i>Ozawainella japonica</i>		.....	
<i>Pseudostaffella minuta</i>			.....
<i>Nankinella yokoyamai</i>			.....
<i>Profusulinella</i> sp.			.....

Figure 2. Stratigraphic distribution of foraminifers in the Hina Limestone.

stratigraphically and structurally by many workers such as Kobayashi (1950), Nakano (1952), Hase and Yokoyama (1975), Kobayashi and Hamada (1978), Sada et al. (1979), Otoh (1985) and Mizuno (1993). However, the fusulinacean species have never been described paleontologically from this limestone. We considered that the fusulinacean faunas should be described as the fundamental data and based on it the biostratigraphic zonation and the geologic folded structure of the Hina Limestone could be elucidated. For this reason, the Carboniferous primitive fusulinacean species are described in this paper, where the fourteen Carboniferous representative species are described and illustrated and on the basis of them the Hina Limestone is divided into three primitive fusulinacean zones.

Before going to the description, we wish to express our sincere thanks to the following persons who gave us their valuable help in various ways: Drs. Y. Oho, M. Fukuoka, H. Sato, M. Kaibori, S. Niko and Y. Hirayama of Hiroshima University.

## II. Carboniferous Primitive Fusulinacean Zone

The Carboniferous Hina Limestone is divided into three fusulinacean zones, namely, the *Endothyra-Mediocris* Zone, the *Eostaffella-Millerella* Zone and the *Pseudostaffella-Profusulinella* Zone in ascending order.

*Endothyra-Mediocris* Zone: The *Endothyra-Mediocris* Zone composed of biosparite and biomicrite, is characterized by *Mediocris mediocris*, *M. sp.*, *Endothyra similis*, *E. exilis*, *E. irinae*, *Endostaffella* sp. A, *Eoendothyranopsis* sp. and *Planoendothyra sigma*. The *Endothyra-Mediocris* Zone may be correlative with the *Mediocris breviscula* Zone of the Atetsu Limestone (Sada et al., 1992) and with the Middle Osagean to the Meramecian in North America, and with the Lower and Middle Visean in Russia.

*Eostaffella-Millerella* Zone: The *Eostaffella-Millerella* Zone made up mainly by biosparite and partly by biosparrudite, is composed of *Eostaffella ikensis*, *E. akiyoshiensis*, *E. kanmerai*, *E. parapriscia*, *E. mosquensis*, *E. postproikensis*, *E. exilis*, *E. sp.*, *Millerella toriyamai*, *M. marblensis*, *M. bigemmica* and *Zellerinella tortula*. This zone can be correlated with the *Eostaffella kanmerai-Zellerinella cf. designata* Zone to the lower half of the *Pseudostaffella minuta-Millerella marblensis* Zone of the Atetsu Limestone (Sada et al., 1992), and with the North American Chesterian-Lower Morrowan fusulinacean zones (Cooper, 1947; Zeller, 1950; D.N.Zeller, 1953; Ross, 1967; Mamet and Mason, 1968; Brenckle, 1973; Sada and Danner, 1973, 1974; Rich, 1980) and with the Russian Upper Visean-Serpukhovian fusulinacean zones (Aisenberg et al., 1963; Rozovskaya, 1961, 1963; Aisenberg et al., 1979; Semichatova et al., 1979; Groves, 1988).

*Pseudostaffella-Profusulinella* Zone: The *Pseudostaffella-Profusulinella* Zone composed of biosparite and bio-oosparite, consists of *Pseudostaffella minuta*, *Nankinella yokoyamai*, *N. sp.* and *Profusulinella* sp. This zone is compared with the Upper half of the *Pseudostaffella minuta-Millerella marblensis* Zone to the *Profusulinella toriyamai* Zone of the Atetsu Limestone (Sada et al., 1992), and also with the Upper Morrowan-Middle Atokan and the Russian Bashkirian fusulinacean zones.

### III. Systematic Description

Superfamily Fusulinacea von Moller, 1878

Family Ozawainellidae Thompson and Foster, 1937

Subfamily Ozawainellinae Thompson and Foster, 1937

Genus *Millerella* Thompson, 1942

*Millerella marblensis* Thompson

Figure 5-4—6

- Millerella marblensis* Thompson, 1942, p. 405-407, pl. 1, figs. 3-14.  
*Millerella marblensis*, Thompson, 1944, p. 420-423, pl. 1, figs. 1-9, pl. 2, figs. 1-15.  
*Millerella marblensis*, Thompson, 1948, p. 76, pl. 23, figs. 1-12, pl. 24, figs. 1-9.  
*Millerella marblensis*, Thompson, 1951, p. 118, pl. 13, figs. 14, 17, pl. 14, figs. 3-5.  
*Millerella marblensis*, Skinner and Wilde, 1954, p. 449, pl. 49, fig. 3.  
*Millerella* cf. *marblensis*, Igo, 1957, p. 178-179, pl. 1, figs. 13-14, 18-19.  
*Millerella marblensis*, Rich, 1961, pl. 142, figs. 1-9.  
*Millerella marblensis*, Moore, 1964, p. 298-305, pl. 47, figs. 1-24, pl. 48, figs. 1-23.  
*Millerella marblensis*, Ross and Sabins, 1965, p. 183-184, pl. 21, figs. 18-27.  
*Millerella marblensis*, Ross and Tyrrell, 1965, p. 621-622, pl. 76, figs. 38-42.  
*Millerella marblensis*, Pajic, 1965, p. 237, pl. 4, fig. 1.  
*Millerella marblensis*, Sada, 1967, p. 140-142, pl. 12, figs. 13-14, pl. 13, figs. 1-3, 9.  
*Millerella* aff. *marblensis*, Douglass, 1971, p. 5, pl. 2, figs. 2-3.  
*Millerella marblensis*, Kobayashi, 1973, p. 207-208, pl. 30, figs. 23-24.  
*Millerella marblensis*, Sada and Danner, 1974, p. 257-258, pl. 37, figs. 6-12, 14.  
*Millerella marblensis*, Sada, 1975b, p. 6-7, pl. 1, figs. 1-7, pl. 6, figs. 6-8.  
*Millerella marblensis*, Sada, 1975c, p. 33-35, pl. 8, figs. 6-9.  
*Millerella marblensis*, Zeller, 1977, pl. 1, fig. 19, pl. 2, figs. 1-2, 6, 17-18, 25-26, pl. 3, fig. 1.  
*Millerella marblensis*, Sada, 1980, p. 65-66, pl. 1, fig. 6.  
*Millerella marblensis*, Groves, 1983, p. 17-18, pl. 4, figs. 13-17, pl. 5, fig. 10 ?.  
*Millerella marblensis*, Rui Lin, 1983, pl. 1, figs. 18-19.  
*Millerella* cf. *marblensis*, Ginkel, 1983, p. 211, pl. 2, figs. 1-2.  
*Millerella marblensis*, Groves, 1984, pl. 6, figs. 15-17.  
*Millerella* aff. *marblensis*, Matsusue, 1986, pl. 6, fig. 17.  
*Millerella marblensis*, Rui Lin, 1987, p. 383, pl. 3, figs. 9-11.  
*Millerella marblensis*, Sada et al., 1992, p. 96-98, Fig. 3-19—27.

*Descriptive remarks.* — The shell of the illustrated specimen (Figure 5-5) is small and discoidal in shape. The outer one or two volutions are evolute. The shell of the three and half volutions is 0.122 mm in length and 0.538 mm in width, giving a form ratio of 0.23. In the evolute shell of the

Table 1. Measurements of *Millerella marblensis* Thompson (in mm).

Specimen	HN42-7b	HN42-15e
Figure	5-5	5-6
Length	0.122	0.101
Width	0.538	0.441
Form ratio	0.23	0.23
Proloculus	0.051	0.074
Diameter of whorl		
Vol.		
1	0.141	0.148
2	0.244	0.258
3	0.460	0.441
3 1/2	0.538	
Thickness of spirotheca		
0	0.020	0.023
1	0.018	0.021
2	0.022	0.016
3	0.021	0.018
3 1/2	0.031	

outer volution, the internal character and measured values of the shell, the illustrated specimens herein are referable to *Millerella marblensis* originally described by Thompson (1942) from the Lower Pennsylvanian Marble Fall Limestone in Texas.

*Occurrence.* — *Millerella marblensis* is common in the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are HN42 and HN52.

*Geological age.* — Morrowan (Late Serpukhovian to Early Bashkirian).

#### *Millerella toriyamai* Ota

Figure 5-1 – 3

*Millerella toriyamai* Ota, 1971, p. 67-68, pl. 13, figs. 15-19.

*Millerella toriyamai*, Matsusue, 1986, pl. 6, fig. 14.

*Millerella toriyamai*, Ueno, 1989, pl. 1, fig. 18.

*Descriptive remarks.* — The shell of *Millerella toriyamai* is small and discoidal in shape, having a subangular periphery and umbilicated poles. The shell of the illustrated specimen (Figure 5-2) is 0.102 mm in length and 0.360 mm in width, giving a form ratio of 0.28. The inner volution is involute or partially evolute. The proloculus is 0.021 mm in the outside diameter. In the general shell shape and measured values, the present species is agreeable to *Millerella toriyamai* described by Ota (1971) from the *Millerella yowarensis* Zone of the Akiyoshi Limestone.

*Occurrence.* — *Millerella toriyamai* is common in the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are HN11A, HN33 and HN44.

*Geological age.* — Morrowan (Late Serpukhovian to Early Bashkirian).

Table 2. Measurements of *Millerella toriyamai* Ota (in mm).

Specimen	HN33-f	H10-84.0a
Figure	5-1	5-2
Length	0.119	0.102
Width	0.356	0.360
Form ratio	0.33	0.28
Proloculus	0.029	0.021
Diameter of whorl		
Vol.		
1	0.095	0.055
2	0.156	0.176
3	0.272	0.288
3 1/2	0.356	0.360
Thickness of spirotheca		
0	0.004	0.005
1	0.010	0.005
2	0.006	0.009
3	0.013	0.009
3 1/2	0.013	0.016

Subfamily Pseudostaffellinae Putrya, 1959  
Genus *Eostaffella* Rauser-Chernousova, 1948

*Eostaffella kanmerai* (Igo)

Figure 4-6-9

- Millerella kanmerai* Igo, 1957, p. 175-177, pl. 1, figs. 20-26, pl. 2, fig. 14.  
*Eostaffella kanmerai*, Sada, 1964, p. 230-231, pl. 21, figs. 8, 16-17.  
*Eostaffella kanmerai*, Sada, 1967, p. 144-145, pl. 12, figs. 1-10.  
*Eostaffella kanmerai*, Sada, 1969, p. 120-121, pl. 12, figs. 1-13, pl. 13, figs. 1-2.  
*Eostaffella kanmerai*, Sada and Danner, 1974, p. 259-261, pl. 37, figs. 1-3, 5, 18-19.  
*Eostaffella kanmerai*, Sada, 1975c, p. 35-36, pl. 8, figs. 1-5.  
*Eostaffella kanmerai*, Niikawa, 1978, p. 538, pl. 1, figs. 11-12.  
*Eostaffella kanmerai*, Sada, 1980, p. 68-69, pl. 1, figs. 1-5, 11-13.  
*Eostaffella kanmerai*, Rich, 1980, p. 40-41, pl. 18, figs. 6, 8-12, 14 ?  
*Eostaffella kanmerai*, Sada et al., 1984, p. 390-391, pl. 75, figs. 1-8.  
*Eostaffella kanmerai*, Niko, 1987, p. 123, Fig. 4-H-J.  
*Eostaffella kanmerai*, Sada et al., 1992, Fig. 4-7-8.

*Descriptive Remarks.* — The shell of the present species is small and discoidal in shape with the subangular to rounded periphery and umbilicated poles. The illustrated specimen (Figure 4-6) is 0.240 mm long and 0.585 mm wide, giving a form ratio of 0.41. The inner volutions are involute and the outer ones are evolute to partially involute. The spirotheca consists of a tectum and inner

Table 3. Measurements of *Eostaffella kanmerai* (Igo) (in mm).

Specimen	HN42-18a	HN113-3a	HN113-8i
Figure	4-6	4-7	4-9
Length	0.240	0.218	0.168
Width	0.585	0.549	0.447
Form ratio	0.41	0.40	0.38
Proloculus	0.028	0.032	0.031
Diameter of whorl			
Vol.			
1	0.079	0.096	0.102
2	0.154	0.188	0.191
3	0.320	0.311	0.343
3 1/2			0.447
4	0.585	0.467	
4 1/2		0.549	
Thickness of spirotheca			
0	0.007	0.005	0.007
1	0.008	0.013	0.014
2	0.010	0.009	0.012
3	0.008	0.018	0.020
3 1/2			0.013
4	0.011	0.010	
4 1/2		0.013	

and outer tectoria. The chomata are low and asymmetrical.

The present species is referred to *Eostaffella kanmerai* originally described from the Ichinotani Formation (Igo, 1957) in Gifu Prefecture, from the lower part of the Atetsu Limestone (Sada, 1964; Sada et al., 1992) in Okayama Prefecture and from many other localities. *Eostaffella kanmerai* has been described by many workers from the Upper Onimaruan (Chesterian or Serpukhovian) and the Lower Kamitakaran (Lower Morrowan or Lower Bashkirian) in Japan.

*Occurrence.* — *Eostaffella kanmerai* is common in the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are HN42 and HN113.

*Geological age.* — Late Chesterian to Early Morrowan (Serpukhovian to Early Bashkirian).

#### *Eostaffella akiyoshiensis* Sada

Figure 3-10—13

*Eostaffella akiyoshiensis* Sada, 1975b, p. 9-10, pl. 1, figs. 15-23.

*Eostaffella akiyoshiensis*, Matsusue, 1986, pl. 6, fig. 9.

*Eostaffella akiyoshiensis*, Ueno, 1989, pl. 1, fig. 5.

*Eostaffella akiyoshiensis*, Sada et al., 1992, Fig. 4-1—6, 9—10.

*Descriptive remarks.* — The shell of the present species is discoidal, having a rounded periphery,

Table 4. Measurements of *Eostaffella akiyoshiensis* Sada (in mm).

Specimen	HN33-a	HN33-33b	HN33-31c
Figure	3-11	3-12	3-13
Length	0.122	0.115	0.151
Width	0.326	0.320	0.349
Form ratio	0.37	0.36	0.43
Proloculus	0.017	0.019	0.029
Diameter of whorl			
Vol.			
1	0.076	0.096	0.077
2	0.130	0.158	0.130
3	0.207	0.253	0.217
3 1/2		0.320	
4	0.326		0.349
Thickness of spirotheca			
0	0.006	0.004	0.005
1	0.007	0.005	0.006
2	0.006	0.007	0.007
3	0.009	0.008	0.009
3 1/2		0.016	
4	0.013		0.014

convex lateral slopes and umbilicated poles. The shell of the illustrated specimen (Figure 3-13) is 0.151 mm long and 0.349 mm wide, giving a form ratio of 0.43. The spirotheca is thin and is composed of a tectum and inner and outer tectoria. The chomata are primitive and asymmetrical.

The present species is agreeable in the measured values and the internal characteristics to *Eostaffella akiyoshiensis* originally described from the Akiyoshi Limestone (Sada, 1975b).

*Occurrence.* — *Eostaffella akiyoshiensis* is common in the *Eostaffella-Millerella* Zone to the lower part of the *Pseudostaffella-Profusulinella* Zone of the Hina Limestone. Representative localities are HN33, HN42 and HN44.

*Geological age.* — Chesterian to Late Morrowan (Late Viséan to Early Bashkirian).

#### *Eostaffella mosquensis* Vissarionova

Figure 4-2

*Eostaffella mosquensis* Vissarionova, 1948, p. 222, pl. 14, figs. 4-6.

*Eostaffella mosquensis*, Ganelina, 1951, p. 188-189, pl.2, figs.1-2.

*Eostaffella mosquensis*, Durkina, 1959, p. 196-197, pl.20, fig. 10.

*Eostaffella mosquensis*, Rozovskaya, 1963, p. 93-94, pl.16, figs. 16-17, pl. 17, figs.1-5.

? *Eostaffella mosquensis*, Ozawa, 1976, p. 121-123, pl. 22, figs. 1-15, 17-19.

*Eostaffella mosquensis*, Niikawa, 1978, p. 538, pl. 1, figs. 5-7, 15.

? *Eostaffella mosquensis*, Rich, 1980, p. 41, pl. 18, figs. 13, 15-16, 20, 25.



- Eostaffella mosquensis*, Wang Yujing et al., 1981, p. 17, pl. 1, figs. 4-5.  
*Eostaffella mosquensis*, Da Y. and Sun Q., 1983, p. 7, pl. 1, figs. 3-4.  
*Eostaffella mosquensis*, Zhao Zhixin et al., 1984, p. 55, pl. 1, figs. 1-4.  
*Eostaffella mosquensis*, Matsusue, 1986, pl. 6, figs. 1-2.  
*Eostaffella mosquensis*, Niko, 1987, p. 123, figs. 5-D, F, G, H.  
*Eostaffella mosquensis*, Rui Lin, 1987, p. 377-378, pl. 2, figs. 19-23.  
? *Eostaffella mosquensis*, Zhang Zuqi et al., 1987, p. 111, pl. 4, fig. 11.  
*Eostaffella mosquensis*, Ueno, 1989, pl.1, fig. 6.  
*Eostaffella mosquensis*, Ozawa and Kobayashi, 1990, pl. 1, figs. 16-18.

*Descriptive remarks.* — The shell of the present species is small and discoidal in shape with the rounded periphery and the convex lateral slopes. The specimen illustrated as Figure 4-2 is about 0.232 mm in length and 0.519 mm in width, showing a form ratio of 0.45. The spirotheca is fairly thick. The chomata are small and asymmetrical.

The present species resembles *Eostaffella mosquensis* described by Vissarionova (1948) and Ganelina (1951) in some respects. They may be regarded as the same species.

*Occurrence.* — The present species came from the upper part of the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are B2 and HN11A.

*Geological age.* — Late Chesterian to Early Morrowan (Serpukhovian).

#### *Eostaffella ikensis* Vissarionova

##### Figure 4-3

- Eostaffella ikensis* Vissarionova, 1948, p. 219-220, pl.13, figs. 8-10, pl. 14, fig. 1.  
*Eostaffella ikensis*, Grozdilova and Lebedeva, 1954, p. 123-124, pl. 13, figs. 17-18.  
*Eostaffella ikensis*, Durkina, 1959, p. 199, pl. 20, figs. 19-20.  
*Eostaffella ikensis*, Bogush and Yuferev, 1962, p. 173, pl. 6, fig. 28.  
*Eostaffella ikensis*, Rozovskaya, 1963, p. 95-97, pl. 17, figs. 10-19.  
*Millerella ikensis*, Ginkel, 1965, p. 50-51, pl. 14, figs. 62-67, pl. 15, figs. 1-10.  
*Eostaffella ikensis*, Han Jianxiu, 1980, p. 20, pl. 1, fig. 19.  
*Eostaffella aff. ikensis*, Sashida, 1981, p. 6, pl. 2, figs. 1-2.  
*Eostaffella ikensis*, Da Y. and Sun Q., 1983, p. 7, pl. 1, fig. 1 (non fig. 2).  
*Eostaffella ikensis*, Matsusue, 1986, pl. 6, fig. 7.  
*Eostaffella ikensis*, Zhang Zuqi et al., 1987, p. 117, pl. 3, fig. 6.

*Descriptive remarks.* — The shell of *Eostaffella ikensis* is small and discoidal in shape, having the rounded periphery and the convex lateral slopes. The shell of four volutions illustrated as Figure 4-3 is 0.271 mm in length and 0.629 mm in width, giving a form ratio of 0.43. The inner volutions are involute and the last one is involute to partially evolute. The proloculus is spherical and its outside diameter is 0.025 mm. The diameters of the whorls of the 1st to 4th volution are 0.099, 0.202, 0.351, and 0.629 mm, respectively. The chomata are low and asymmetrical.

The present species resembles closely *Eostaffella ikensis* described by Vissarionova (1948) in the shell shape, the measured values and the internal characteristics. The species can be referred to *Eostaffella ikensis* Vissarionova. The present species is similar to *Eostaffella mosquensis* in some respects, but differs from it in the rapid expansion of the whorls.

*Occurrence.*—*Eostaffella ikensis* is common in the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are B76-11, HN44 and HN11A.

*Geological age.*—Chesterian to Early Morrowan (Late Visean to Serpukhovian).

*Eostaffella paraprisc*a Durkina

Figure 3-16—17

*Eostaffella paraprisc*a Durkina, 1959, p. 189, pl. 19, fig. 10.

*Millerella bigemmicula*, Sada, 1975b, pl. 1, fig. 13.

*Eostaffella paraprisc*a, Matsusue, 1986, pl. 6, fig. 3.

*Eostaffella paraprisc*a, Ueno, 1989, pl. 1, fig. 9.

Table 5. Measurements of *Eostaffella paraprisc*a Durkina (in mm).

Specimen	HN44-7b	HN44-32h
Figure	3-16	3-17
Length	0.130	0.122
Width	0.334	0.292
Form ratio	0.39	0.42
Proloculus	0.030	0.026
Diameter of whorl		
Vol.		
1	0.084	0.110
2	0.158	0.219
2 1/2		0.292
3	0.263	
3 1/2	0.334	
Thickness of spirotheca		
0	0.009	0.008
1	0.009	0.014
2	0.017	0.018
2 1/2		0.020
3	0.018	
3 1/2	0.029	

*Descriptive remarks.*—The shell of *Eostaffella paraprisc*a Durkina is small for the genus and discoidal in shape. The inner and outer volutions are involute. The illustrated specimen (Figure 3-17) is 0.122 mm in length and 0.292 mm in width. The form ratio is 0.42. In the measured values and the internal biocharacters the present species can be referred to *Eostaffella paraprisc*a

(Durkina, 1959; Matsusue, 1986; Ueno, 1989).

*Occurrence.* — The present species is common in the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are H10, HN42 and HN44 .

*Geological age.* — Chesterian to Early Morrowan (Late Visean to Serpukhovian).

*Eostaffella etoi* Ota

Figure 4-13

*Eostaffella etoi* Ota, 1971, p. 69-70, pl. 13, figs. 16-33.

*Eostaffella etoi*, Sashida, 1981, p. 6-7, pl. 2, figs. 3-13.

*Eostaffella etoi*, Igo and Adachi, 1981, p. 113, pl. 4, figs. 2-12.

*Eostaffella etoi*, Matsusue, 1986, pl. 6, fig. 11.

*Eostaffella etoi*, Ueno, 1989, pl. 1, fig. 13.

*Descriptive remarks.* — The shell of *Eostaffella etoi* is small and discoidal in shape. The lateral slopes are convex to straight and the periphery is convex to straight and is subangular. The inner and outer volutions are involute. The shell of the illustrated specimens (Figure 4-13) is 0.178 mm in length and 0.509 mm in width, giving a form ratio of 0.35.

The present species is quite identical to *Eostaffella etoi* (Ota, 1971) from the Akiyoshi Limestone in the outline of shells, the internal biocharacters and measured values.

*Occurrence.* — *Eostaffella etoi* is rare in the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are HN2 and HN44.

*Geological age.* — Late Chesterian to Late Morrowan (Serpukhovian to Early Bashkirian).

Table 6. Measurements of *Eostaffella* sp. A (in mm).

Specimen	HN76-c	HN44-d
Figure	4-10	4-11
Length	0.082	0.085
Width	0.218	0.212
Form ratio	0.38	0.40
Proloculus	0.033	0.020
Diameter of whorl		
Vol.		
1	0.073	0.056
2	0.131	0.129
3	0.218	0.212
Thickness of spirotheca		
0	0.004	0.004
1	0.008	0.006
2	0.012	0.008
3	0.012	0.012

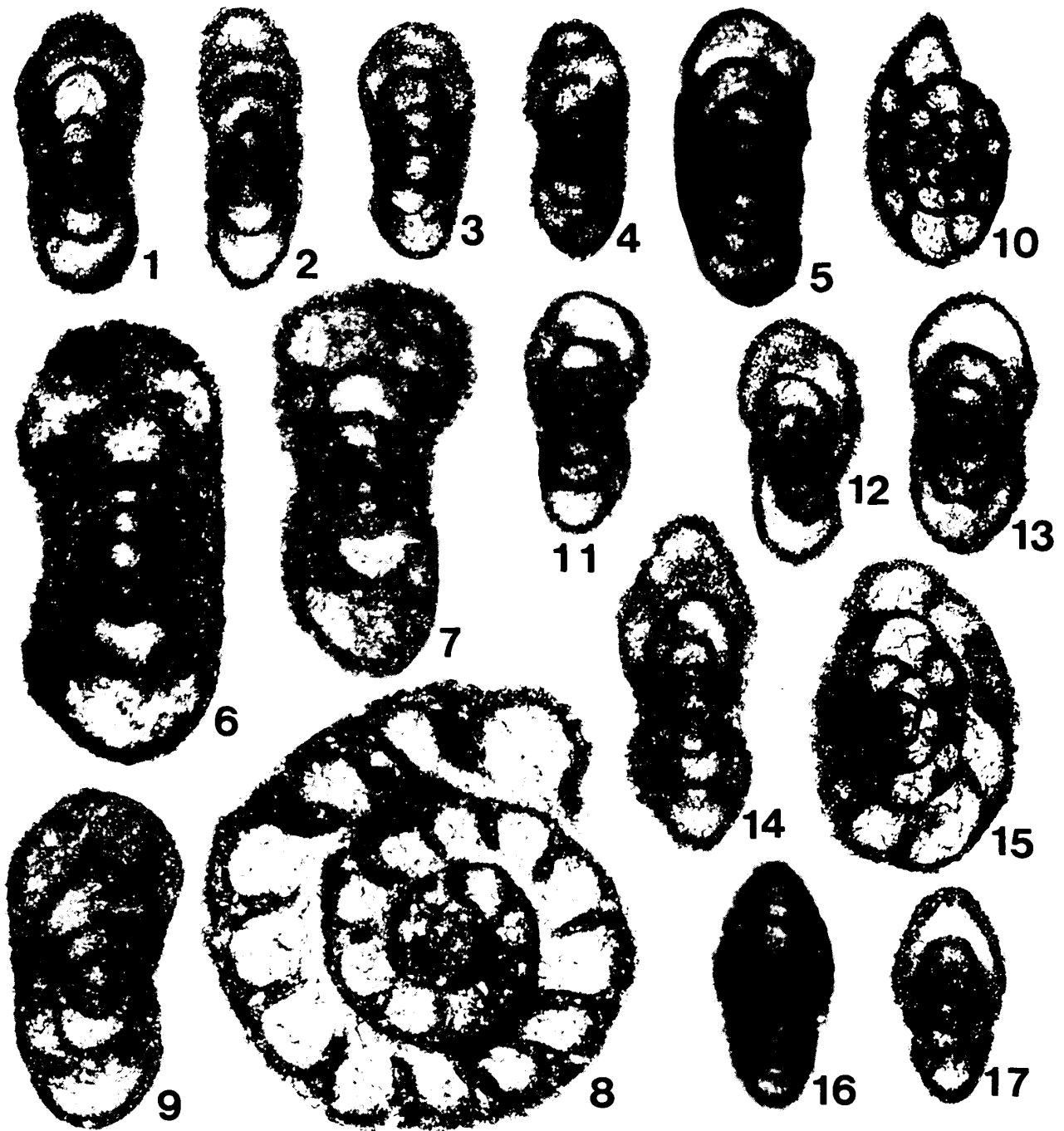


Figure 3. 1-5. *Mediocris mediocris* (Vissarionova), 1-5. Axial sections. Rg.No. HN42-8e, HN113-5a, HN113-10h, HN42-3d and HN70-a, respectively. 6-8. *Mediocris adducta* (Durkina), 6-7. Axial sections. Rg.No. HN65-30c and HN113-a, respectively, 8. Sagittal section. Rg.No. HN65-27c. 9. *Mediocris* sp., 9. Axial section. Rg. No. HN65-3a. 10-13. *Eostaffella akiyoshiensis* Sada, 10. Sagittal section. Rg.No. HN42-20b. 11-13. Axial sections. Rg.No. HN33-a, HN33-33b and HN33-31c, respectively. 14-15. *Eostaffella exilis* Grozdilova and Lebedeva, 14. Axial section. Rg.No. H10-98.9a. 15. Sagittal section. Rg.No. HN113-7a. 16-17. *Eostaffella parapriscia* Durkina, 16-17. Axial sections. Rg.No. HN44-7b and HN44-32h, respectively. All figures x100.

*Eostaffella* sp. A

Figure 4-10—11

*Descriptive remarks.* — The shell of *Eostaffella* sp. A is very small for the genus and discoidal in shape. The specimen illustrated as Figure 4-10 is 0.082 mm long and 0.218 mm wide, giving a form ratio of 0.38. The proloculus is spherical and its outside diameter is 0.033 mm. The diameters of the whorls of the 1st to the 3rd volution are 0.073, 0.131 and 0.218 mm, respectively. The spirotheca consists of a tectum and inner and outer tectoria.

The final identification of this species is to be postponed until more information of the species is obtained.

*Occurrence.* — *Eostaffella* sp. A is common in the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are HN42, HN44 and HN76.

*Geological age.* — Late Chesterian to Late Morrowan (Serpukhovian to Early Bashkirian).

Genus *Mediocris* Rozovskaya, 1961*Mediocris mediocris* (Vissarionova)

Figure 3-1—5

*Eostaffella mediocris* Vissarionova, 1948, p. 222-223, pl. 14, figs. 7-9.

*Eostaffella mediocris*, Durkina, 1959, p. 193, pl. 20, figs. 1-3 (non pl.19, fig. 17).

*Mediocris mediocris*, Rozovskaya, 1963, p. 103-104, pl. 18 figs. 26-33.

*Mediocris mediocris*, Bogush and Yuferev, 1962, p. 158, pl. 6, fig. 5.

? *Pseudoendothyra* ex gr. *spiroides*, Okimura, 1963, pl. 39, fig. 16.

*Mediocris mediocris*, Poyarkov, 1965, p. 96-98, pl. 1, figs. 8-10.

*Mediocris mediocris*, Mamet, 1973, p.118, pl. 7, figs. 17-18.

*Eostaffella kanmerai*, Sada and Danner, 1974, p. 259-261, pl. 37, fig. 1.

*Mediocris mediocris*, Ozawa, 1976, p. 124-126, pl. 24, figs. 1-14.

*Mediocris mediocris*, Sashida, 1981, p. 12, pl.1, figs. 8-10, 13- 18.

*Mediocris mediocris*, Bird and Mamet, 1983, p. 139-140, pl. 1, fig. 10.

*Mediocris mediocris*, Niko, 1985, p. 170, pl. 2, figs.1-10,14-17.

*Mediocris mediocris*, Adachi, 1985, p. 127, pl. 22, figs.10-12, 16-17 (non 13-15).

*Mediocris evolutis grandiosa*, Adachi, 1985, p. 129, pl. 22, figs. 21-23.

*Mediocris mediocris*, Matsusue, 1986, pl. 5, fig. 3.

*Mediocris mediocris*, Rui Lin, 1987, p. 382, pl. 3, figs. 21-22.

*Mediocris mediocris*, Ueno, 1989, pl. 1, fig. 1.

*Mediocris mediocris*, Ozawa and Kobayashi, 1990, pl. 1, figs. 9-10.

*Descriptive remarks.* — The shell of *Mediocris mediocris* is small and discoidal in shape, having the rounded periphery and the umbilicated poles. The inner volutions are involute and the last one is involute to partially evolute. The specimen (Figure 3-5) measures 0.171 mm long and 0.402 mm

Table 7. Measurements of *Mediocris mediocris* (Vissarionova) (in mm).

Specimen	HN42-8e	HN113-10h	HN70-a
Figure	3-1	3-3	3-5
Length	0.130	0.118	0.171
Width	0.372	0.321	0.402
Form ratio	0.35	0.37	0.43
Proloculus	0.035	0.041	0.038
Diameter of whorl			
Vol.			
1	0.088	0.106	0.114
2	0.173	0.203	0.192
3	0.307	0.321	0.284
3 1/2	0.372		0.402
Thickness of spirotheca			
0	0.007	0.010	0.010
1	0.006	0.008	0.008
2	0.009	0.009	0.010
3	0.011	0.013	0.013
3 1/2	0.018		0.014

wide, possessing a form ratio of 0.43. The proloculus is spherical and its outside diameter is 0.038 mm. The diameters of the whorls of the 1st to the first half of the 4th volution are 0.114, 0.192, 0.284 and 0.402 mm, respectively. The chomata are very primitive and asymmetrical.

The measured values and the internal modes of the present species are agreeable to those of *Mediocris mediocris* originally described by Vissarionova (1948). They may be considered to be of conspecific.

*Occurrence.* — *Mediocris mediocris* is common in the upper part of the *Endothyra-Mediocris* Zone and the lower part of the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are HN42, HN70 and HN113.

*Geological age.* — Late Meramecian to Chesterian (Late Visean to Early Serpukhovian).

#### *Mediocris adducta* Durkina

Figure 3-6—8

*Eostaffella adducta* Durkina, 1959, p. 194-195, pl. 20, figs. 6-7.

*Mediocris adducta*, Poyarkov, 1965, p. 198, Pl. 1, fig. 13.

*Mediocris adducta*, Matsusue, 1986, pl. 5, fig. 5.

*Descriptive remarks.* — The shell of *Mediocris adducta* is large for the genus and discoidal in shape. The periphery is subangular. The shell of the illustrated specimens (Figure 3-6) is 0.240 mm long and 0.605 mm wide. The form ratio is 0.40. The spirotheca is composed of a tectum and inner and outer tectoria. The proloculus is spherical and its outside diameter is 0.060 mm.

The present species closely resembles *Mediocris adducta* reported by Matsusue (1986) from

Table 8. Measurements of *Mediocris adducta* (Durkina) (in mm).

Specimen	HN65-30c	HN113-a
Figure	3-6	3-7
Length	0.240	0.189
Width	0.605	0.533
Form ratio	0.40	0.35
Proloculus	0.060	0.031
Diameter of whorl		
Vol.		
1	0.135	0.091
2	0.223	0.174
3	0.390	0.312
4	0.605	0.533
Thickness of spirotheca		
0	0.016	0.009
1	0.013	0.009
2	0.030	0.017
3	0.032	0.019
4	0.030	0.017

Akiyoshi in the general outline of the shell, the internal modes and the measured values. This is ascribable to *Mediocris adducta*.

*Occurrence.*—*Mediocris adducta* is common in the *Endothyra-Mediocris* Zone and the lower part of the *Eostaffella-Millerella* Zone of the Hina Limestone. Representative localities are HN65 and HN113.

*Geological age.*—Meramecian to Chesterian (Visean to Early Serpukhovian).

#### Genus *Ozawainella* Thompson, 1935

##### *Ozawainella japonica* Sada

Figure 5-7—9

*Ozawainella japonica* Sada, 1975b, p. 13-15, pl. 2, figs. 5-7, 12, pl. 3, figs. 1-13, pl. 4, figs. 1-11, pl. 6, fig. 3.

*Ozawainella japonica*, Igo and Adachi, 1981, p. 115-116, pl. 4, figs. 13-15, 17.

*Ozawainella japonica*, Matsusue, 1986, pl. 7, fig. 7.

*Ozawainella japonica*, Ozawa and Kobayashi, 1990, pl. 2, figs. 5-6.

*Descriptive remarks.*—The shell of *Ozawainella japonica* is discoidal and involute, having an angular periphery and straight to convex lateral slopes. The present specimen (Figure 5-9) measures 0.259 mm long and 0.645 mm wide, showing a form ratio of 0.40. The spirotheca consists of a tectum and inner and outer tectoria.

The present species can be referred to *Ozawainella japonica* described by Sada (1975b) from the Akiyoshi Limestone.



Figure 4. 1. *Mediocris* sp. A, 1. Axial section. Rg.No. HN113-4c. 2. *Eostaffella mosquensis* Vissarionova, 2. Axial section. Rg.No. B2-140.9d. 3. *Eostaffella ikensis* Vissarionova, 3. Axial section. Rg.No. B76-11-98.7a. 4-5. *Eostaffella* ? *kanmerai* (Igo), 4-5. Axial sections. Rg.No. HN33-7a and HN44-7a, respectively. 6-9. *Eostaffella kanmerai* (Igo), 6-9. Axial sections. Rg.No. HN42-18a, HN113-3a, HN42-19a and HN113-8i, respectively. 10-11. *Eostaffella* sp.A, 10-11. Axial sections. Rg.No. HN76-c and HN44-d, respectively. 12. *Eostaffella* sp.B, 12. Axial section. Rg.No. HN113-8e. 13. *Eostaffella etoi* Ota, 13. Axial section. Rg.No. HN44-11b. All figures x100.



Table 9. Measurements of *Ozawainella japonica* Sada (in mm).

Specimen	HN44-24c	HN33-13a	HN44-13b
Figure	5-7	5-8	5-9
Length	0.192	0.220	0.259
Width	0.471	0.692	0.645
Form ratio	0.41	0.32	0.40
Proloculus	0.023	0.040	0.030
Diameter of whorl			
Vol.			
1	0.072	0.078	0.095
2	0.132	0.140	0.136
3	0.231	0.249	0.293
4	0.375	0.396	0.482
4 1/2	0.471		0.645
5		0.544	
5 1/2		0.692	
Thickness of spirotheca			
0	0.007	0.014	0.006
1	0.007	0.015	0.010
2	0.009	0.024	0.009
3	0.014	0.027	0.016
4	0.013	0.028	0.020
4 1/2	0.014		0.019
5		0.037	
5 1/2		0.021	

*Occurrence.* — *Ozawainella japonica* is common in the upper part of the *Eostaffella-Millerella* Zone and the *Pseudostaffella-Profusulinella* Zone of the Hina Limestone. Representative localities are HN33 and HN44.

*Geological age.* — Chesterian to Early Atokan (Late Viséan to Bashkirian).

#### Genus *Pseudostaffella* Thompson, 1942

##### *Pseudostaffella minuta* Sada

Figure 5-11—14

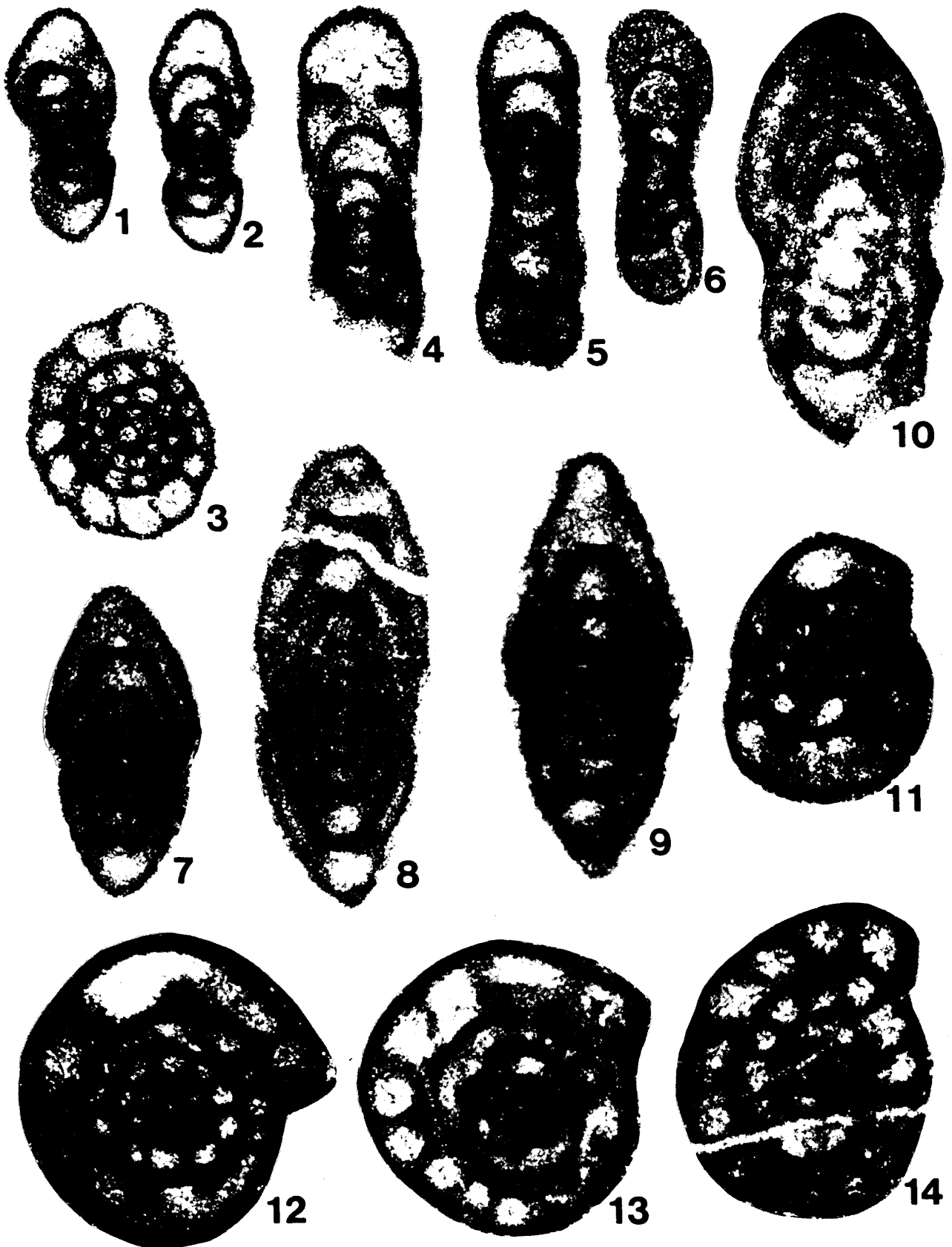
*Pseudostaffella minuta* Sada, 1975b, p. 21-22, pl. 7, figs. 6-9.

*Pseudostaffella minuta*, Matsusue, 1986, pl. 7, fig. 1.

? *Pseudostaffella (Semistaffella) variabilis*, Ozawa and Kobayashi, 1990, pl. 2, figs. 7-8.

*Remarks.* — The present specimens are identical with *Pseudostaffella minuta* described from the Taishaku Limestone (Sada, 1975a) and the Akiyoshi Limestone (Sada, 1975b) in the shell shape, the internal characters and measured values. They are considered to be conspecific.

*Occurrence.* — *Pseudostaffella minuta* is common in the *Pseudostaffella-Profusulinella* Zone of



the Hina Limestone. Representative localities are B2, HN33 and HN52.

*Geological age.* — Late Morrowan to Early Atokan (Bashkirian).

Family Staffellidae Miklukho-Maklay, 1949

Genus *Nankinella* Lee, 1931

*Nankinella yokoyamai* Sada

Figure 5-10.

*Nankinella yokoyamai* Sada, 1972, p. 441-443, pl. 52, fig. 22; pl. 53, figs. 1-2, 4-11.

*Nankinella yokoyamai*, Watanabe, 1974, p. 378-379, pl. 51, figs. 6-8.

*Nankinella yokoyamai*, Matsusue, 1986, pl. 7, fig. 5.

*Nankinella yokoyamai*, Ueno, 1989, pl. 1, fig. 20

*Remarks.* — In the general shell-shape, the internal characters and the measured values, the present specimen illustrated as Figure 5-10 can be identified with *Nankinella yokoyamai* originally described from the Taishaku Limestone (Sada, 1972).

*Occurrence.* — *Nankinella yokoyamai* is rare in the *Pseudostaffella-Profusulinella* Zone of the Hina Limestone. Representative localities are B2 and H10.

*Geological age.* — Early Atokan (Late Bashkirian).

---

←

Figure 5. 1-3. *Millerella toriyamai* Ota, 1-2. Axial sections. Rg.No. HN33-f and H10-84.0a, respectively. 3. Sagittal section. Rg.No. HN33-36g. 4-6. *Millerella marblensis* Thompson, 4-6. Axial sections. Rg.No. HN42-18d, HN42-7b and HN42-15e, respectively. 7-9. *Ozawainella japonica* Sada, 7-9. Axial sections. Rg.No. HN44-24c, HN33-13a and HN44-13b, respectively. 10. *Nankinella yokoyamai* Sada, 10. Axial section. Rg.No. H10-84.0h. 11-14. *Pseudostaffella minuta* Sada, 11-14. Sagittal sections. Rg.No. HN33-25b, HN33-23b, HN33-25c and HN33-25d, respectively. All figures x100.

## References

- Adachi, S. (1985): Smaller foraminifers of the Ichinotani Formation (Carboniferous-Permian), Hida Massif, central Japan. *Sci. Rep. Inst. Geosci., Univ. Tsukuba, Ser. B*, 6, 59-139, pls. 8-23.
- Aisenberg, D. E., Brazhnikova, N. E., Nnovik, K. O., Rotay, A. P. and Shulga, P. L. (1963): Stratigrafiya Kamennougol' nykh otlozhenii Donetskogo basseina. *Trudy Inst. Geol. Nauk, Ukr. SSR, ser. strat. i paleont.*, 37, 1-182 (in Russian).
- Aisenberg, D. E., Brazhnikova, N. E., Vassilyuk, N. P., Vdovenko, M. V., Gorak, S. V., Dunaeva, N. N., Zernetskaya, N. V., Poletaev, V. I., Potievskaya, P. D., Rotai, A. P. and Sergeeva, M. T. (1979): The Carboniferous sequence of the Donetz Basin. A standard section for the Carboniferous system. In Wagner, R. H., Higgins, A. C. and Meyen, S. V. eds., *The Carboniferous of the USSR, Yorkshire Geol. Soc., Occ. Pub.*, 4, 197-224.
- Bird, K. J. and Mamet, B. L. (1983): Carboniferous foraminifer *Mediocris*, first occurrence in northern Alaska. *Jour. Foram. Res.*, 13, 2, 134-143, pl. 1.
- Bogush, O. I. and Yuferev, O. V. (1962): Foraminifery i stratigrafiya kamennougol' nykh otlozhenii Karatau i Talasskogo Alatau. *Akad. Nauk. SSSR, Sibirskoe Otdel., Inst. Geol. i Geofiz.*, 1-234, pls.1-9 (in Russian).
- Brenckle, P. L. (1973): Smaller Mississippian and Lower Pennsylvanian calcareous foraminifers from Nevada. *Cushman Found. Foram. Research, Spec. Pub.*, 11, 1-82, pls. 1-10.
- Cooper, C. L. (1947): Upper Kinkaid (Mississippian) microfauna from Johnson County, Illinois. *Jour. Paleont.*, 21, 81-94, pls.19-23.
- Da Yingtai and Sun Qiaoli (1983): Order Fusulinida. In *Paleontological Atlas of Northwestern China, Xinjian (2), (Late Paleozoic)*, 7-113, pls. 1-30 (in Chinese).
- Douglass, R. C. (1971): Pennsylvanian fusulinids from southeastern Alaska. *U. S. Geol. Survey, Prof. Paper*, 706, 1-21, pls. 1-7.
- Durkina, A. V. (1959): Foraminifery nizhnkamennougol' nykh otlozhenii Timano-Pechorskoi provinsii. *Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. (VNIGRI) Trudy, Nov. Ser.*, 136, *Mikrofauna SSSR*, 10, 132-335, pls. 1-27 (in Russian).
- Ganelina, R. A. (1951): Eoshtaffelly i millerelly vizeiskogo i Namyurskogo yarusov nizhnego Karbona zapadnogokryla podmoskovnoi kotloviny. *Inst. (VNIGRI) Trudy, Nov. Ser.*, 56, *Mikrofauna SSSR*, 6, 179-210, pls. 1-3 (in Russian).
- Ginkel, A. C. van (1965): Carboniferous fusulinids from the Cantabrian Mountains (Spain). *Leidse Geol. Med.*, 34, 1-225, pls.1-53.
- Ginkel, A. C. van (1983): Carboniferous fusulinids in a coastal section near Pendueles (Asturias, Spain). *Ibid.*, 52, 2, 193-263, pls. 1-11.
- Groves, J. R. (1983): Calcareous foraminifers and algae from the type Morrowan (Lower Pennsylvanian) region of northeastern Oklahoma and northwestern Arkansas. *Bull. Oklahoma Geol. Survey*, 133, 1-65.
- Groves, J. R. (1984): Foraminifers and biostratigraphy of the Arco Hills, Bluebird Mountain, and

- lower Snaky Canyon Formations (Mid-Carboniferous) of east-central Idaho. *Jour. Foram. Research*, 14, 4, 282-302, pls. 1-8.
- Groves, J. R. (1988): Calcareous foraminifers from the Bashkirian stratotype (Middle Carboniferous, South Urals) and their significance for intercontinental correlations and the evolution of the Fusulinidae. *Jour. Paleont.*, 62, 3, 368-399.
- Grozdilova, L. P. and Lebedeva, N. S. (1954): Foraminifery nizhnego karbona Kolvo-Visherskogo kraja. *Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. (VNIGRI) Trudy*, 81, *Mikrofauna SSSR*, 7, 4-203, pls. 1-15 (in Russian).
- Han Jianxiu (1980): Phylum Protozoa, Fusulinida. In *Paleontological Atlas of Northeast China (1), Paleozoic volume*, 18-95, pls. 1-35 (in Chinese).
- Hase, A. and Yokoyama, M. (1975): Geological age and structure of the Hina Limestone, Okayama Prefecture, Southwest Japan. *Jour. Sci., Hiroshima Univ., Ser. C*, 7, 3, 167-182, pls. 16-18.
- Igo, H. (1957): Fusulinids of Fukuji, southeastern part of the Hida Massif, central Japan. *Sci. Rep. Tokyo Kyoiku Daigaku, Ser. C*, 5, 47, 153-246, pls. 1-15.
- Igo, H. and Adachi, S. (1981): Foraminiferal biostratigraphy of the Ichinotani Formation (Carboniferous-Permian), Hida Massif, central Japan. Part 1-Some foraminifers from the upper part of the Lower Member of the Ichinotani Formation. *Sci. Rep., Inst. Geosci., Univ. Tsukuba, Ser. B*, 2, 101-118, pls. 4-6.
- Kobayashi, F. (1973): Fusulinids of Nagaiwa Formation. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, 92, 200-219, pls. 30-31.
- Kobayashi, T. (1950): *Regional geology of Japan, Chugoku region*. Asakura Shoten, Tokyo (in Japanese).
- Kobayashi, T. and Hamada, T. (1978): On some Lower Carboniferous trilobites from the Hina Limestone, Okayama Prefecture, West Japan. *Proc. Japan Acad., Ser. B*, 54, 5-9.
- Mamet, B. L. (1973): Microfacies Viseens du Boulonnais (Nord, France). *Revue du Micropaleont.* 16, 2, 101-124.
- Mamet, B. L. and Mason, D. (1968): Foraminiferal zonation of the Lower Carboniferous Connor Lakes section, British Columbia. *Bull. Canadian Petroleum Geol.*, 16, 2, 147-166.
- Matsusue, K. (1986): Foraminiferal biostratigraphy of the lower part of the Akiyoshi Limestone Group. *Sci. Repts., Dept. Geol., Kyushu Univ.*, 14, 4, 163-185, pls. 2-7 (in Japanese with English abstract).
- Mizuno, Y. (1993): Biostratigraphy and correlation of the conodont faunas in the Hina Limestone, Okayama Prefecture. *Report on the boundary problem of the Carboniferous and Permian. Under the Grant in Aid for Scientific research from the Ministry of Education Science and Culture, Japan* (No.02304012), 154-166, pls. 1-2 (in Japanese).
- Moore, W. L. (1964): Note on the morphology and taxonomic position of the fusulinid *Millerella marblensis* Thompson. *Jour. Paleont.*, 38, 2, 294-305, pls. 47-48.
- Nakano, M. (1952): Geology of Kyowa-mura district, Shitsuki-gun, Okayama Prefecture, with special reference to the recent informations on the Paleozoic and Mesozoic. *Geol. Repts. Hiroshima Univ.*, 2, 15-30 (in Japanese with English abstract).

- Niikawa, I. (1978): Carboniferous and Permian fusulinids from Fukuji, central Japan. *Jour. Fac. Sci., Hokkaido Univ., Ser. 4*, 18, 4, 536-610, pls. 1-14.
- Niko, S. (1985): *Mediocris* (primitive fusulinacea) from the Ichinotani Formation, Fukuji District, central Japan. *Sci. Papers, Coll. Arts Sci., Univ. Tokyo*, 35, 2, 165-180. pls.1- 3.
- Niko, S. (1987): Early Carboniferous *Eostaffella* (primitive fusulinacea) from the Ichinotani Formation, Fukuji district, central Japan. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, 147, 117-130.
- Okimura, Y. (1963): Foraminiferal zones underlying the *Profusulinella beppensis* Zone of the Akiyoshi Limestone Group. *Geol. Repts. Hiroshima Univ.*, 15, 305-318, pl. 39 (in Japanese with English abstract).
- Ota, M. (1971): Faunas and correlation of the "Uzura" quarry limestone of Akiyoshi, Southwest Japan, Part 2, Fusulininan fauna. *Bull. Akiyoshi-dai Sci. Museum*, 7, 65-74, pls. 12-13.
- Otoh, S. (1985): Unconformity between the non-metamorphic Paleozoic strata and the Upper Triassic Nariwa Group in the Oga area, Okayama Prefecture. *Jour. Geol. Soc. Japan*, 91, 779-786 (in Japanese with English abstract).
- Ozawa, T. (1976): Late Visean *Eostaffella* (Fusulininan foraminifera) from West Malaysia. *GPSEA*, 17, 117-128, pls. 22-24.
- Ozawa, T. and Kobayashi, F. (1990): Carboniferous to Permian Akiyoshi Limestone Group. In *Organizing Committee Benthos '90 ed., Fossil and recent benthic foraminifera in some selected regions of Japan. Guidebook for field trips, 4th Intern. Symp. on Benthic Foraminifera, Sendai, 1990*, E1-E31, pls. 1-13.
- Pajic, V. (1965): The middle Carboniferous microfauna of western Serbia. *Bull. Inst. Geol. Geophys. Research (PROSVETA, Belgrade), Ser. A*, 21, 235-253.
- Poyarkov, B. V. (1965): Sistematika i filogenija roda *Mediocris* Rozovskaya, 1961. *Trudy Inst. Geol. Nauk Akad., SSSR, Voprosy Mikropaleontologii*, 9, 89-110, pl. 1 (in Russian).
- Rich, M. (1961): Stratigraphic section and fusulinids of the Bird Spring Formation near Lee Canyon, Clark County, Nevada. *Jour. Paleont.*, 35, 6, 1159-1180, pls. 142-146.
- Rich, M. (1980): Carboniferous calcareous foraminifera from northeastern Alabama, south-central Tennessee, and northwestern Georgia. *Contrib. Cushman Found. Foram. Research, Spec. Pub.*, 18, 1-62, pls. 1-22.
- Ross, C. A. (1967): Late Paleozoic fusulinacea from northern Yukon Territory. *Jour. Paleont.*, 41, 3, 709-725, pls.79-86.
- Ross, C. A. and Sabins, F. F. (1965): Early and Middle Pennsylvanian fusulinids from southeastern Arizona. *Ibid.*, 39, 2, 173-209, pls. 21-28.
- Ross, C. A. and Tyrrell, W. W. (1965): Pennsylvanian and Permian fusulinids from the Whetstone Mountains, Southeast Arizona. *Ibid.*, 39, 4, 615-635, pls. 75-78.
- Rozovskaya, S. E. (1961): Sistematike semeostv Endothyridae i Ozawainellidae. *Pal. Zurnal*, 3, 19-21 (in Russian).
- Rozovskaya, S. E. (1963): Drevneie predstaviteli fuzulinid i ikh predki. *Trudy Paleont. Inst. Nauk Akad., SSSR*, 97, 1-128, pls. 1-22 (in Russian).
- Rui Lin (1983): Fusulinacean fauna from the Quanwangtou Limestone (early Upper

- Carboniferous) in Jiawang coal-field, northern Jiangsu. *Acta Palaeont. Sinica*, 22, 2, 170-182, pls. 1-2 (in Chinese with English abstract).
- Rui Lin (1987): Fusulinaceans across Mid-Carboniferous boundary at Luosu of Luodian County, southern Guizhou. *Ibid.*, 26, 4, 367-391, pls. 1-3 (in Chinese with English abstract).
- Sada, K. (1964): Carboniferous and Lower Permian fusulinids of the Atetsu Limestone in West Japan. *Jour. Sci. Hiroshima Univ., Ser. C*, 4, 3, 225-269, pls. 21-28.
- Sada, K. (1967): Fusulinids of the *Millerella* Zone of the Taishaku Limestone (Studies of the stratigraphy and the microfossil faunas of the Carboniferous and Permian Taishaku Limestone in West Japan, No. 1). *Trans. Proc. Palaeont. Soc. Japan, N.S.*, 67, 139-147, pls. 12-13.
- Sada, K. (1969): Microfossils of the lowest part of the Taishaku Limestone (Ditto, No. 4). *Ibid.*, 75, 119-129, pls. 12-13.
- Sada, K. (1972): Fusulinids of the *Profusulinella* Zone of the Taishaku Limestone (Ditto, No. 2). *Ibid.* 87, 436-445, pls. 52-53.
- Sada, K. (1975a): Late Mississippian and Early Pennsylvanian fusulinid faunas of the Taishaku Limestone in West Japan. *Bull. Soc. belge Geol.*, 84, 1, 5-9.
- Sada, K. (1975b): Early and Middle Pennsylvanian fusulinacea from Akiyoshi. *Mem. Fac. Integrated Arts and Sci., Hiroshima Univ., Ser. IV*, 1, 1-29, pls. 1-7.
- Sada, K. (1975c): Early and Middle Pennsylvanian fusulinacea from the Omi Limestone in Japan. *Ibid.*, 1, 31-39, pl. 1.
- Sada, K. (1980): Primitive fusulinacea from the Nakamura Limestone in western Japan. *Jour. Paleont.*, 54, 1, 65-70, pl. 1.
- Sada, K. and Danner, W. R. (1973): Late Carboniferous *Eostaffella* and *Hexaphyllia* from central Oregon, U.S.A. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, 91, 151-160, pls. 23-24.
- Sada, K. and Danner, W. R. (1974): Early and Middle Pennsylvanian fusulinids from southern British Columbia, Canada and northwestern Washington, U.S.A. *Ibid.*, 93, 249-265, pls. 35 - 37.
- Sada, K., Hide, K. and Fujimoto, M. (1979): Preliminary report of the stratigraphy and the geologic structure of the Hina Limestone in Okayama Prefecture, Japan. *Mem. Fac. Integrated Arts and Sci. Hiroshima Univ., Ser. IV*, 4, 15-21 (in Japanese with English abstract).
- Sada, K., Nomura, K. and Oho, Y. (1984): Primitive fusulinacea from Dangyokei of Taishaku (Studies of the stratigraphy and the microfossil faunas of the Carboniferous and Permian Taishaku Limestone in West Japan, No. 5). *Trans. Proc. Palaeont. Soc. Japan, N. S.*, 134, 388-392, pl. 75.
- Sada, K., Tanaka, K., Fujimoto, M. and Oho, Y. (1992): Carboniferous primitive fusulinacean and endothyracean faunas in the lower part of the Atetsu Limestone. *Mem. Fac. Integrated Arts and Sci., Hiroshima Univ., Ser. IV*, 17, 91-109.
- Sashida, K. (1981): Primitive fusulinids from the Shishidedai area, northeastern Akiyoshi Plateau, Southwest Japan. *Sci. Rep., Inst. Geosci., Univ. Tsukuba, Ser. B*, 2, 1-16, pls. 1-3.
- Semichatova, S. V., Einor, O. L., Kireeva, G. D., Vassilyuk, N. P., Gubareva, V. S. and Potievskaya, P. D. (1979): The Bashkirian stage as a global stratigraphic unit. *In* Wagner, R.

- H., Higgins, A. C. and Meyen, S. V. eds., *The Carboniferous of the USSR, Yorkshire Geol. Soc., Occ. Pub.*, 4, 99-116.
- Skinner, J. W. and Wilde, G. L. (1954): Fusulinid wall structure. *Jour. Paleont.*, 28, 4, 445-451, pls. 46-52.
- Thompson, M. L. (1942): New genera of Pennsylvanian fusulinids. *Am. Jour. Sci.*, 240, 403-420, pls. 1-3.
- Thompson, M.L. (1944): Pennsylvanian Morrowan rocks and fusulinids of Kansas. *Bull. Kansas Geol. Survey*, 52, 409-431, pls. 1-2.
- Thompson, M. L. (1948): Studies of American fusulinids. *Univ. Kansas, Paleont. Contrib. Protozoa*, 1, 1-184, pls.1-38.
- Thompson, M. L. (1951): New genera of fusulinid foraminifera. *Contrib. Cushman Found. Foram. Research*, 2, 4, 115-119, pls. 12-13.
- Ueno, K. (1989): Carboniferous and Lower Permian foraminiferal biostratigraphy in the Akiyoshi Limestone Group. Studies of the Upper Paleozoic foraminifers in the Akiyoshi Limestone Group, Southwest Japan. Part 1. *Bull. Akiyoshi-dai Mus. Nat. Hist.*, 24, 1-39, pls. 1-8 (in Japanese with English abstract).
- Vissarionova, A. Ya (1948): Primitivnye fusulinidy iz nizhnego karbona Evropeiskoi chasti SSSR. *Akad. Nauk. SSSR, Inst. Geol. Nauk Trudy*, 62, *Geol. Ser.*, 19, 216-226, pls. 13-14 (in Russian).
- Wang Yujing, Sheng Jinzhang and Zhang Linxin (1981): Fusulinids from Xizang of China. *Ser. Sci. Exped. Qinghai-Xizang Plateau, Palaeont. of Xizang, Book 3*, 1-80 (in Chinese).
- Watanabe, K. (1974): *Profusulinella* assemblage in the Omi Limestone, Niigata Prefecture, central Japan. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, 92, 371-394, pls. 51-53.
- Zeller, D. N. (1953): Endothyroid foraminifera and ancestral fusulinids from the type Chesterian (Upper Mississippian). *Jour. Paleont.*, 27, 2, 183-199, pls. 26-28.
- Zeller, D. N. (1977): Microfauna from Chesterian (Mississippian) and Morrowan (Pennsylvanian) rocks in Washington County, Arkansas, and Adair and Muskogee Counties, Oklahoma. *Oklahoma Geological Survey Guidebook*, 18, 89-99, pls. 1-3.
- Zeller, E. J. (1950): Stratigraphic significance of Mississippian endothyroid foraminifera. *Univ. Kansas, Paleont. Contrib., Protozoa*, 4, 1-23, pls.1-6.
- Zhang Zuqi, Wang Hongbo and Xie Helin (1987): The Early Datangian Stage fusulinid fauna of Early Carboniferous from Liannan, Guangdong. *Spec. Paper Nation. Carb. Symp. China*, 93-149, pls.1-4 (in Chinese with English abstract).
- Zhao Zhixin, Han Jianxiu and Wang Zengji (1984): *The Carboniferous strata and its fauna from southwestern margin of Tarim Basin in Xinjiang*. Geol. Publ. House, 1-187, pls. 1-35 (in Chinese).