

Late Early to Middle Permian foraminifers of the Akiyoshi Limestone (Japan)

Fumio KOBAYASHI

Suzukakedai 1-1-19, Sanda, Hyogo 669-1322, Japan. E-mail: fkoba1@outlook.jp; kobayasi@hitohaku.jp

Abstract

The late Early to Middle Permian fusuline faunas of the Akiyoshi Terrane (Permian accretionary complex) are represented by those of the Akiyoshi Limestone, Southwest Japan. They are faunistically heterogenous from those of the coeval limestone blocks in the Jurassic terranes of Japan. The upper Artinskian to Wordian of the Akiyoshi Limestone in the Kaerimizu area is biostratigraphically subdivided into nine zones in ascending order: *Paraleeina magana*, *Pamirina leveni*, *Misellina dyhrenfurthi*, *Misellina claudiae*, *Cancellina pamirica*, *Parafusulina kaerimizensis*, *Neoschwagerina craticulifera*, *Afghanella schencki*, and *Colania douvillei*. One-hundred and six species assignable to 58 genera of foraminifers are distinguished in the nine zones of the area. Among them, three are new: *Paraleeina akiyoshiensis*, *Neofusulinella uenoi*, and *Palaeostaffella subquadrata*. In addition to neoschwagerinids and verbeekinids to have been focussed on by previous workers, faunal composition and stratigraphic distribution of other fusuline taxa and non-fusuline foraminifers from the nine zones are described. Middle Permian fusulines of the Akiyoshi Limestone are closely implicative for the faunal provincialism in the global scale, and available for ancient tectonic evolution and amalgamation of East Asian and circum-Pacific terranes.

Keywords

Fusulines, Akiyoshi Limestone, upper Artinskian to Wordian, Biostratigraphy, Faunal analysis.

1. INTRODUCTION

The Akiyoshi Limestone in the Akiyoshi Terrane (Permian accretionary complex), Southwest Japan is famous worldwide for its fusuline biostratigraphy since Y. Ozawa (1923, 1925b), along with the Akasaka Limestone in the Mino Terrane (Jurassic accretionary complex) since Deprat (1914) and Y. Ozawa (1927). Among the various kinds of fossils, foraminifers especially of fusulines are most prolific and best available for chronologic calibration and paleobiogeography of the limestone. They have been studied biostratigraphically by many later workers (e.g., Toriyama, 1958; M. Ota, 1977; T. Ozawa & Kobayashi, 1990; Ueno, 1992b).

In these fifteen years, I have resumed the foraminiferal, especially fusuline biostratigraphy of the Akiyoshi Limestone. Fusuline faunas and their stratigraphic distribution from the Moscovian to Asselian of the limestone in the Wakatakeyama area were reexamined recently (Kobayashi, 2017) by cross-checking those previously presented by Ueno (1989), T. Ozawa & Kobayashi (1990), Watanabe (1991), and Y. Ota & M. Ota (1993).

The late Early to Middle Permian fusuline faunas are most satisfactorily preserved in the Kaerimizu area, a large doline located in the eastern part of the Akiyoshi Limestone Plateau (Akiyoshi-dai). They are important biogeographically concerning the global dispersion and isolation of characteristic fusuline faunas as demonstrated by Kobayashi (1997a, b), in which four biogeographic provinces were advocated in the global scale, and the Akiyoshi, Chichibu, and Kurosegawa faunas were discriminated in Japan. The Akiyoshi Fauna was established mainly based on the faunal analysis of middle Permian fusulines of the Akiyoshi Limestone (Kobayashi, 1997b).

The Kaerimizu fusuline faunas have been studied biostratigraphically and paleontologically by many workers (e.g., Y. Ozawa, 1925b; Toriyama, 1958; M. Ota, 1977; T. Ozawa & Kobayashi, 1990; Ueno, 1991b, 1992b, 1996b). Paleontologic works, however, were inclined to neoschwagerinid and verbeekinid fusulines in general. Details on the faunal composition and stratigraphic distribution of other fusulines of the Middle Permian have been left uncertain along with those of non-fusuline foraminifers.

The purpose of this paper is to clarify the whole aspects of late Early to Middle Permian foraminiferal faunas and their stratigraphic distribution in the Kaerimizu area, based on which the limestone in the area is biostratigraphically subdivided into nine zones. They are compared with previous works in the area and are inspected in relation to the paleobiogeographic implications of the Akiyoshi Fauna. Sixty-three species of fusulines and 43 species of nonfusuline foraminifers, including many taxa not have been reported by previous workers, were distinguished in this study. Among them, 38 species are described systematically. Newly proposed herein are *Paraleeina akiyoshiensis*, *Neofusulinella uenoi*, and *Palaeostaffella subquadrata*.

Besides as geographic proper nouns, Akiyoshi, Akiyoshi Plateau (Akiyoshi-dai) and Akiyoshi Limestone, the “Akiyoshi Limestone Group” has been traditionally used as a lithostratigraphic unit for the limestone sequence about 1,000 m thick with basaltic rocks in the basal part and acidic to intermediate tuff layers in the uppermost part. However, the “Akiyoshi Limestone Group” has not been subdivided into any lithostratigraphic units of lower categories (e.g., M. Ota, 1977; Kanmera *et al.*, 1990; Ueno, 1996b; Kobayashi, 2017). On the other hand, it has been subdivided biostratigraphically into more than 20 units (zones) by foraminifers, mostly of fusulines. Thus, the use of a term, “Akiyoshi Limestone Group” is not encouraged to contrast with the concept of the International Stratigraphic Guide. In this paper, the “Akiyoshi Limestone Group” is refrained from the description of lithostratigraphy, and the Akiyoshi Limestone is simply used as a huge limestone block of the Upper Paleozoic distributed in the Akiyoshi Terrane.

2. GEOLOGIC SETTING

The Akiyoshi Limestone situated in the central part of Yamaguchi Prefecture, west Japan is a huge limestone block approximately 7×15 km. It is isolated in the Akiyoshi Terrane consisting of the Permian non-metamorphic accretionary complex, as well as Taishaku, Atetsu, and Omi limestones. The upper Lower Carboniferous to Middle Permian non-calcareous oceanic rocks, Middle to lower Upper Permian trench-fill deposits, and Upper Triassic siliciclastic rocks are distributed around these huge limestone blocks in the Akiyoshi Terrane.

The Akiyoshi Limestone, more than 1,000 m thick, is composed of basaltic rocks in the basal part and overlying massive limestone (Toriyama, 1954; M. Ota, 1977; Kanmera *et al.*, 1990). Acidic to intermediate tuff layers are intercalated in the uppermost part. The limestone is in fault contact with the surrounding non-calcareous rock units (Fig. 1). These calcareous and non-calcareous formations (groups) are unconformably overlain by the Upper Triassic Mine Group showing the molasses facies (Toriyama, 1954; Tokuyama, 1958; Kanmera *et*

al., 1990; Kobayashi, 2012b). Historical changes about 70 millions year of the sedimentary environment and plate movement, sea-level fluctuation, and evolution of Late Paleozoic marine invertebrates in the mid-ocean realm of the Panthalassa are reconstructed from the lithologic, paleontologic, and geochemical analyses of the Akiyoshi Limestone.

On the other hand, nearly continuous original succession of the limestone is more or less disturbed by the accretion and post-accretion tectonics, as revealed by Kobayashi (2017) in the Wakatakeyama area. The Kaerimizu area is well-known among Japanese geologists by the overturned structure of the Akiyoshi Limestone as first noticed by Y. Ozawa (1923) and later ascertained on the basis of the fusuline biostratigraphy of the drilled cores by M. Ota *et al.* (1973).

The limestone in the Kaerimizu area is massive without showing distinct stratification as well as in other areas of the Akiyoshi Limestone. However, it is considered to be nearly horizontal and gently folded, and apparently overturned according to the lateral tracing of some limestone beds having marked fusuline genera and/or species, and the orientation of laminated parts of the limestone in the field.

3. BIOSTRATIGRAPHY, FAUNA AND CORRELATION

Before going into the description of the faunal composition and biostratigraphic units of the Kaerimizu area, the chronostratigraphy of the Upper Cisuralian and Guadalupian between the international stratotype regions and the standard Tethyan regions used in this paper is summarized for convenience. Fusulines are fewer and less diverse than those of the Asselian in the stratotypes of the Upper Cisuralian (Artinskian and Kungurian) in the South Urals where other marine biota are provincial and endemic, in contrast to rich and variable fusuline faunas in the coeval Yakhtashian, Bolorian, and lower part of Kubergandian in the Tethyan regions. Fusuline faunas are largely different between Texas and Tethyan regions in the Guadalupian. Under these circumstances, Leven (1980) comprehensively discussed on fusuline biostratigraphy and established the Tethyan chronostratigraphy in comparison with the international scale, which have been widely accepted by many fusuline specialists. Leven (2001, 2004) and Leven & Bogoslovskaya (2006) further argued the Tethyan chronostratigraphy and its international correlation, and pointed out some unresolved problems due to disaccordances of stage boundaries determined by ammonoids, conodonts, and fusulines. However, Permian biostratigraphic works of ammonoids and conodonts available for the international correlation are almost barren in the Akiyoshi Terrane along with other terranes of Japan.

Leven (2009) summarized and discussed the bio-

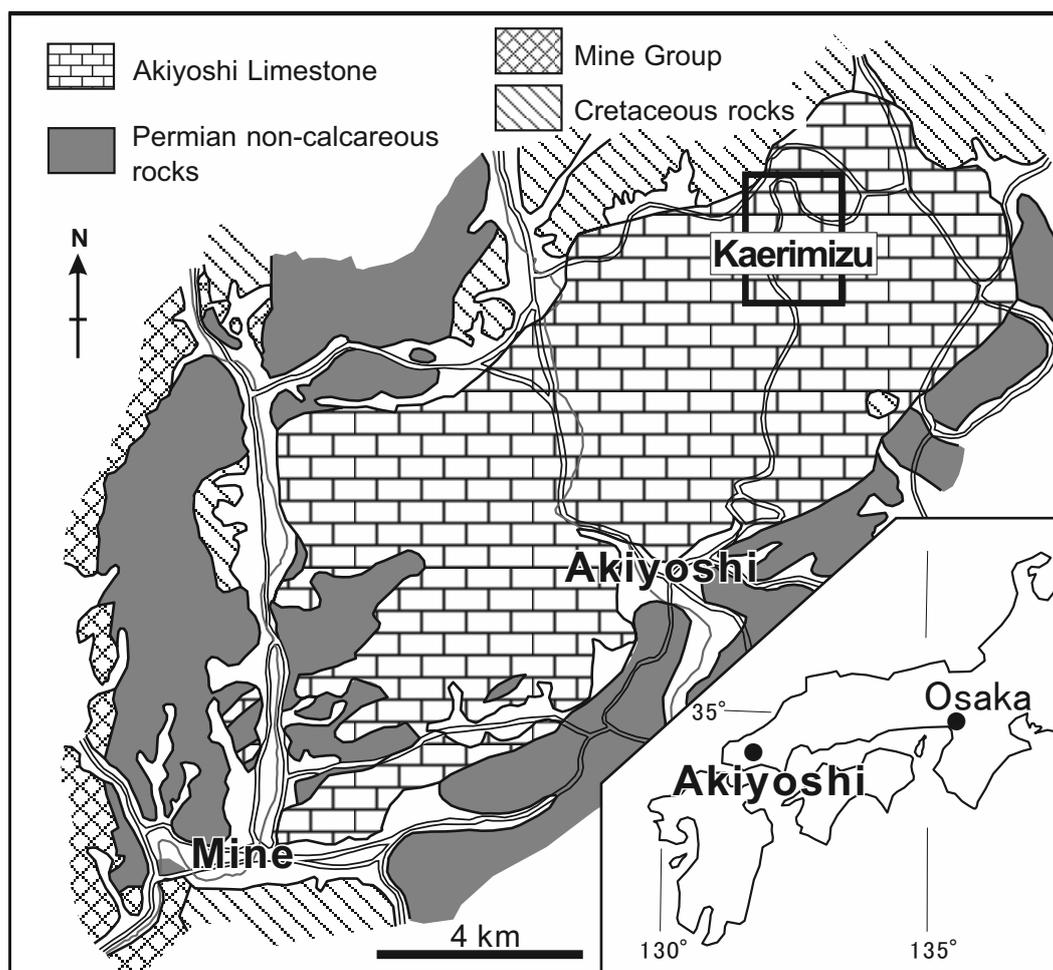


Fig. 1: Distribution of the Akiyoshi Limestone and the surrounding pre-Cretaceous rocks and the location of the Kaerimizu area.

stratigraphic distribution and faunal correlation of fusulines in the western Tethyan regions in detail. Concerning the chronostratigraphic subdivision and correlation, this paper follows fundamentally those presented by Leven & Bogoslovskaya (2006) and Leven (2001, 2004, 2009) with minor modifications. For example, the base of the Midian is drawn by the first occurrence of *Lepidolina* species or *Yabeina* species (Leven, 1980). Based on this definition, the *Colania douvillei* Zone in the Akiyoshi Terrane is correlated to the *Neoschwagerina margaritae* Zone assignable not to the Midian but to the upper Murgabian. Although the boundary of the Cisuralian-Guadalupian in the Tethyan by Leven (2009) is different from that of the international standard (Henderson *et al.*, 2012), it is provisionally demarcated in this paper between the *Misellina ovalis* Zone and the *Cancellina cutalensis* Zone. Both the former and the latter zones, however, are assigned to the Kubergandian in Leven (2009).

Based on the stratigraphic distribution of fusulines, the Akiyoshi Limestone in the Kaerimizu area is subdivided

into nine zones from lower to upper: (1) *Paraleeina magana*, (2) *Pamirina leveni*, (3) *Misellina dyhrenfurthi*, (4) *Misellina claudiae*, (5) *Cancellina pamirica*, (6) *Parafusulina kaerimizensis*, (7) *Neoschwagerina craticulifera*, (8) *Afghanella schencki*, and (9) *Colania douvillei* (Fig. 2). Among them, the *Parafusulina kaerimizensis* to the *Afghanella schencki* zones are, especially, well traceable laterally in the field on account of prolific occurrence, widespread distribution, and short stratigraphic range of the zonal species.

One-hundred and six species of foraminifers recognized in the Kaerimizu area are listed in Table 1. Tables 2, 3, and 4 show the taxonomic composition of non-fusuline and fusuline foraminifers contained in the selected samples from the *Paraleeina magna* Zone to the *Colania douvillei* Zone. Among the 106 species, biostratigraphic distribution of the selected 60 species is tabulated in Fig. 3. Fusuline biostratigraphic zonation and correlation of the upper Cisuralian and Guadalupian in the Akiyoshi Limestone are shown in Fig. 4, and those of the international are in Fig. 5.

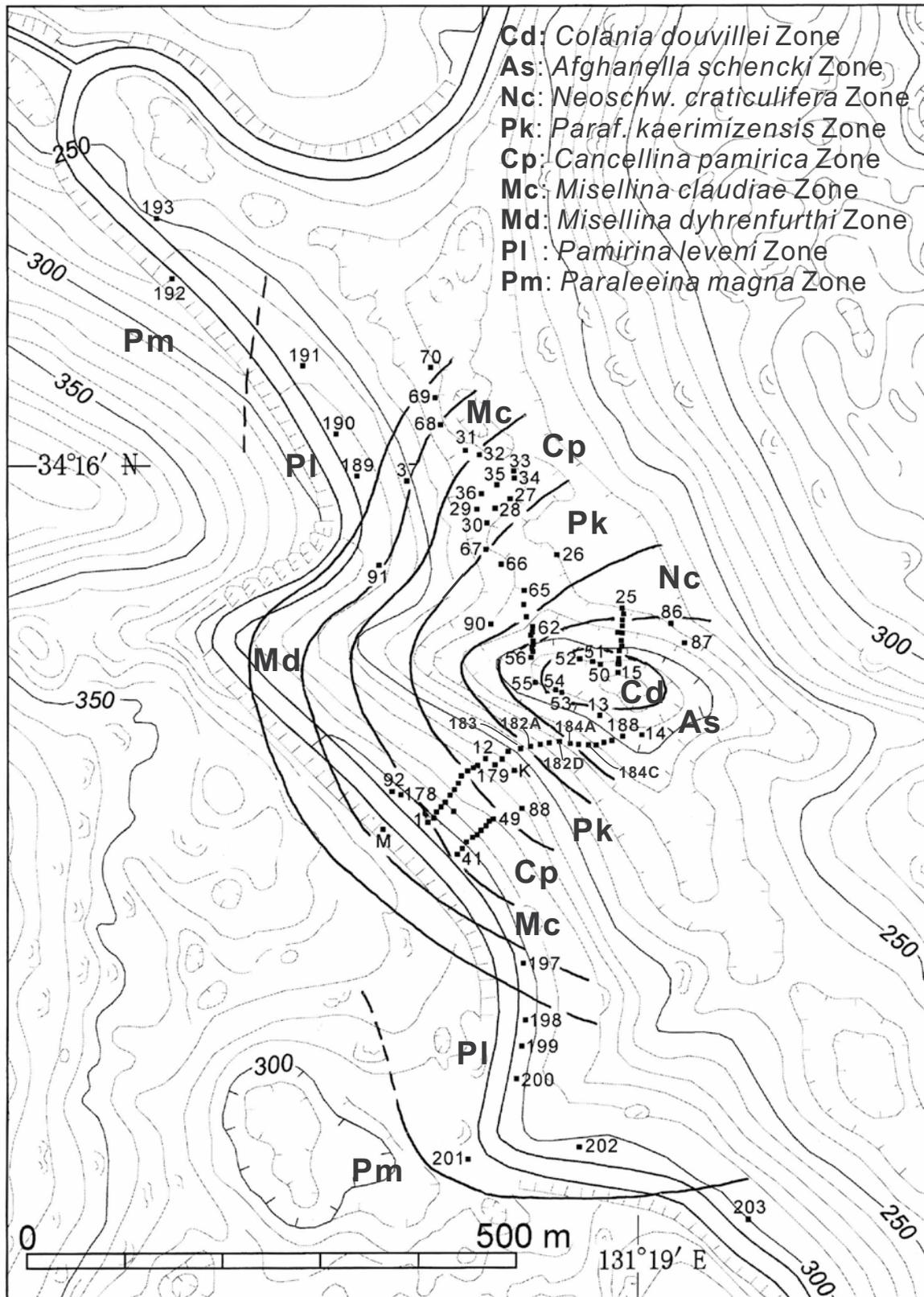


Fig. 2: Map of the studied area of the Kaerimizu Doline showing the biostratigraphic subdivision from the *Paraleeina magna* Zone (Artinskian) to the *Colania douvillei* Zone (Wordian) and sample localities. The first letter Ak is omitted for the sample number from 86 to 203, as well as that of Kz for other numbers and for M and K.

Age	Cisuralian				Guadalupian				
	Yakhtashian	Bolorian	Kubergandian	Murgabian					
Zone	Pm	Pl	Md	Mc	Cp	Pk	Nc	As	Cd
Thickness	>20 m	30 m	10-20 m	10-20 m	15-25 m	25-30 m	20 m	30 m	>10 m
<i>Paraleeina magna</i>	↔								
<i>Paraleeina akiyoshiensis</i>					↔				
<i>Pseudofusulina fusiformis</i>	↔								
<i>Cuniculinella vulgarisiformis</i>		↔							
<i>Pamirina leveni</i>		↔	→						
<i>Nagatoella orientis</i>				↔	→				
<i>Rauserella ellipsoidalis</i>							←		→
<i>Kahlerina</i> sp.								↔	→
<i>Nankinella nagatoensis</i>	←							→	
<i>Nankinellgana chanchiaoensis</i>									↔
<i>Pseudoreichelina darvasica</i>	←							→	
<i>Palaeostaffella subquadrata</i>	←	→							
<i>Palaeostaffella moelleri</i>		←		→					
<i>Palaeostaffella akudensis</i>	←			→					
<i>Toriyamaia laxiseptata</i>			↔						
<i>Schubertella melonica</i>		↔	↔	↔	→				
<i>Mesochubertella</i> sp.	↔								
<i>Yangchienia?</i> sp.					↔				
<i>Neofusulinella uenoi</i>					↔	→			
<i>Neofusulinella giraudi</i>					↔	→			
<i>Neofusulinella simplex</i>				↔	↔	→			
<i>Neofusulinella phairayensis</i>						↔	↔		
<i>Neofusulinella</i> sp. A			←		→				
<i>Minojapanella elongata</i>					↔	→			
<i>Dunbarula schubertellaeformis</i>					←	↔			→
<i>Dunbarula</i> aff. <i>tumida</i>							←	↔	
<i>Codonofusiella?</i> sp.								↔	
<i>Misellina dyhrenfurthi</i>			↔						
<i>Misellina parvicostata</i>			↔						
<i>Misellina claudiae</i>				↔	→				
<i>Misellina postclaudiae</i>				↔					
<i>Parafusulina</i> sp.					↔				
<i>Parafusulina kaerimizensis</i>						↔	→	↔	
<i>Rugosochusenella</i> sp. A					↔	→			
<i>Rugosochusenella</i> sp. B					↔	→			
<i>Chusenella conicocylindrica</i>						←	↔		→
<i>Chusenella schwagerinaeformis</i>						↔	↔		→
<i>Chusenella deprati</i>								↔	
<i>Laosella gigantea</i>								↔	→
<i>Laosella edoensis</i>								↔	→
<i>Armenina</i> cf. <i>pamirensis</i>					↔				
<i>Armenina salgirica</i>					↔	→			
<i>Pseudodoliolina ozawai</i>							↔		
<i>Pseudodoliolina pseudolepida</i>								↔	→
<i>Verbeekina verbeeki</i>								↔	→
<i>Verbeekina</i> cf. <i>douvillei</i>									↔
<i>Cancellina pamirica</i>					↔				
<i>Neoschwagerina craticulifera</i>							↔		
<i>Neoschwagerina haydeni</i>								↔	
<i>Presumatrina ozawai</i>						↔			
<i>Afghanella schencki</i>								↔	
<i>Colania douvillei</i>									↔
<i>Neendothyra hunanica</i>			←						→
<i>Abadehella regularis</i>	↔								
<i>Agathammina pusilla</i>							←		→
<i>Hemigordius decorus</i>			←					→	
<i>Hemigordius dvinensis</i>			↔						
<i>Hemigordiopsis?</i> sp.				↔					
<i>Neohemigordius japonicus</i>						←			→
<i>Dagmarita?</i> cf. <i>shahrezansis</i>									↔

Fig. 3: Stratigraphic distribution of the selected 60 species of foraminifers among 106 taxa.

Table 1: List of 43 species of non-fusuline foraminifers and 63 species of fusuline foraminifers in the Kaerimizu area.

Non-fusuline foraminifers	Fusulines except for verbeekiniids and neoschwageriniids	Verbeekiniid and neoschwageriniid fusulines
<i>Calcitornella</i> sp.	<i>Pseudoreichelina darvasica</i> Leven, 1970b	<i>Misellina claudiae</i> (Deprat, 1912)
<i>Endoteba controversa</i> Vachard & Razgallah, 1988	<i>Pseudoreichelina</i> sp.	<i>Misellina dyhrenfurthi</i> (Dutkevich in Likharev, 1939)
<i>Globivalvulina cyprica</i> Reichel, 1946	<i>Nankinella aktyoshiensis</i> (Toriyama, 1958)	<i>Misellina parvicostata</i> (Deprat, 1915)
<i>Retroseptellina</i> sp.	<i>Nankinella changanchaensis</i> (Sheng & Wang, 1962)	<i>Misellina postclaudiae</i> Ueno, 1991b
<i>Tetrataxis conica</i> Ehrenberg, 1854	<i>Nankinella nagatoensis</i> Toriyama, 1958	<i>Misellina</i> sp. A
<i>Tetrataxis</i> sp. A	<i>Palaeostafella moelleri</i> (Y. Ozawa, 1925b)	<i>Misellina</i> sp. B
<i>Tetrataxis</i> sp. B	<i>Palaeostafella akudensis</i> (Hh. Igo, 1996)	Misellinae? gen. and sp. indet.
<i>Polytaxis</i> sp.	<i>Palaeostafella subquadrata</i> n. sp.	<i>Pseudodoliolina ozawai</i> Yabe & Hanzawa, 1932
<i>Abadehella conformis</i> Okimura & Ishii in Okimura <i>et al.</i> , 1975	<i>Pamirina leveni</i> Kobayashi, 1977	<i>Pseudodoliolina pseudolepida</i> (Deprat, 1912)
<i>Abadehella regularis</i> Lin, Li & Sun, 1990	<i>Pamirina?</i> sp.	<i>Armenina salgirica</i> A. D. Miklukho-Maklay, 1955
<i>Dagmarita?</i> cf. <i>shahrezaensis</i> Mohtat-Aghai & Vachard, 2003	<i>Kahlerina</i> sp.	<i>Armenina</i> cf. <i>pamirensis</i> (Dutkevich, 1934)
<i>Deckerella tenuissima</i> Reitlinger, 1950	<i>Toriyamaia laxiseptata</i> Kanmera, 1956	<i>Verbeekina verbeeki</i> (Geinitz, 1876)
<i>Deckerella</i> sp.	<i>Rauserella ellipsoidalis</i> Sosnina, 1968	<i>Verbeekina</i> cf. <i>douvillei</i> (Deprat, 1912)
<i>Climacamina vavulinoides</i> Lange, 1925	<i>Schubertella melonica</i> Dunbar & Skinner, 1937	<i>Cancellina pamirica</i> Leven, 1967
<i>Cribrogenrina</i> sp.	<i>Schubertella?</i> <i>karasawensis</i> Kobayashi, 2006b	<i>Neoschwagerina craticulifera</i> (Schwager, 1883)
<i>Neoendothya hunatica</i> (Lin, 1978)	<i>Mesoschubertella</i> sp.	<i>Neoschwagerina haydeni</i> Dutkevich in D. & K., 1934
<i>Glomomidiella</i> spp.	<i>Yangchienia?</i> sp.	<i>Colania douvillei</i> (Y. Ozawa, 1922)
<i>Hemigordielina</i> sp.	<i>Minojapanella</i> sp.	<i>Presumatrina ozawai</i> (Hanzawa, 1954)
<i>Hemigordielina?</i> sp.	<i>Neofusulinella giraudi</i> Deprat, 1915	<i>Afghanella schencki</i> Thompson, 1946
<i>Neodiscus</i> sp. A	<i>Neofusulinella phairayensis</i> Colani, 1924	
<i>Neodiscus</i> sp. B	<i>Neofusulinella simplex</i> (Lange, 1925)	
<i>Neodiscus?</i> sp.	<i>Neofusulinella uenoi</i> , n. sp.	
<i>Graecodiscus</i> sp.	<i>Neofusulinella</i> sp. A	
<i>Agathammina pusilla</i> (Geinitz, 1876)	<i>Neofusulinella</i> sp. B	
<i>Hemigordius decorus</i> Lin, 1978	<i>Dunbarula schubertellaeformis</i> Sheng, 1958	
<i>Hemigordius divinensis</i> K. V. Miklukho-Maklay, 1968	<i>Dunbarula</i> aff. <i>tumida</i> Skinner, 1969	
<i>Hemigordius</i> sp.	<i>Codonofusilla</i> sp.	

Non-fusuline foraminifers	Fusulines except for verbeekinids and neoschwagerinids	Verbeekinid and neoschwagerinid fusulines
<p><i>Neohemigordius japonicus</i> (Y. Ozawa, 1925b)</p> <p><i>Neohemigordius</i> sp.</p> <p><i>Hemigordipsis?</i> sp.</p> <p>Hemigordipsidae gen. and sp. indet.</p> <p><i>Pachyphloia schwageri</i> Sellier de Civrieux & Dessauvage, 1965</p> <p><i>Pachyphloia robusta</i> K. V. Miklukho-Maklay, 1954</p> <p><i>Pachyphloia</i> sp.</p> <p><i>Pachyphloia?</i> sp.</p> <p><i>Ichtyofrondina</i> sp.</p> <p><i>Pseudolangella fragilis</i> Sellier de Civrieux & Dessauvage, 1965</p> <p><i>Pseudolangella</i> sp. A</p> <p><i>Pseudolangella</i> sp. B</p> <p><i>Nodosinelloides</i> sp.</p> <p><i>Protonodosaria</i> sp.</p> <p><i>Geinitzina postcarbonica</i> Spandel, 1901</p> <p><i>Geinitzina</i> sp. B</p> <p>43 species belonging to 27 genera</p>	<p>Fusulines except for verbeekinids and neoschwagerinids</p> <p><i>Cuniculinella vulgariformis</i> (Morikawa, 1952)</p> <p><i>Nagatoella orientis</i> (Y. Ozawa, 1925b)</p> <p><i>Pseudofusulina fusiformis</i> (Schellwien & Dyhrenfurth, 1909)</p> <p><i>Paraleeina magna</i> (Toriyama, 1958)</p> <p><i>Paraleeina akiyoshiensis</i> n. sp.</p> <p><i>Rugosohusenella</i> sp. A</p> <p><i>Rugosohusenella</i> sp. B</p> <p><i>Chusenella conicocylindrica</i> Chen, 1956</p> <p><i>Chusenella deprati</i> (Y. Ozawa, 1925b)</p> <p><i>Chusenella schwagerinaeformis</i> Sheng, 1963</p> <p><i>Chusenella</i> sp. A</p> <p><i>Chusenella</i> sp. B</p> <p><i>Parafusulina kaerimizensis</i> (Y. Ozawa, 1925b)</p> <p><i>Parafusulina</i> sp.</p> <p><i>Laosella edoensis</i> (Y. Ozawa, 1925b)</p> <p><i>Laosella gigantea</i> (Deprat, 1913)</p> <p>Schwagerinidae gen. and sp. indet.</p> <p>44 species belonging to 22 genera</p>	<p>Verbeekinid and neoschwagerinid fusulines</p> <p>19 species belonging to 9 genera</p>

Table 2: Taxonomic composition of non-fusuline foraminifers contained in 38 samples.

Zone	Pm	Pl	Md	Mc	Cp	Pk	Nc	As	Cd
Sample	AK-192	AK-201	AK-203	AK-92	Kz-3	Kz-10A-B	AK-182B-D	AK-184A-C	Kz-50
Species	AK-193	AK-198	Kz-69	Kz-68	Kz-7	Kz-10A-B	AK-88	AK-86	Kz-53
<i>Calcitormella</i> sp.		AK-191	Kz-37	AK-41	AK-92	AK-181	AK-88	AK-187	
<i>Endoteba controversa</i>		AK-189	Kz-70	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Neendothyra hunaica</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Globivalvulina cyprica</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Globivalvulina</i> spp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Retroseptellina</i> sp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Nodosinelloides</i> sp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Protonodosaria</i> sp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Dagmarita?</i> cf. <i>shahzezaensis</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Deckerella tenuissima</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Deckerella</i> sp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Climacammina valvulinoides</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Cribrogenina</i> sp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Palaeotaxurariidae</i> indet.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Tetrataxis conica</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Tetrataxis</i> sp. A		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Tetrataxis</i> sp. B		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Polytaxis</i> sp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Abadehella coniformis</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Abadehella regularis</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Geinitzina postcarbonica</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Geinitzina</i> sp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Agathammina pusilla</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Hemigordius decorus</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Hemigordius divinensis</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Hemigordius</i> sp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Neohemigordius japonicus</i>		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	
<i>Neohemigordius</i> sp.		AK-191	AK-202	Kz-41	Kz-46	AK-90	AK-88	AK-187	

Zone	Pm	Pl	Md	Mc	Cp	Pk	Nc	As	Cd
Sample	AK-192	AK-198	AK-37	AK-41	KZ-7	KZ-10A-B	AK-181	AK-187	KZ-50
Species	AK-193	AK-191	KZ-69	KZ-41	KZ-32	KZ-10A-B	AK-181	AK-187	KZ-50
	AK-203	AK-189	AK-91	AK-178	KZ-36	KZ-11A-B	AK-181	AK-187	KZ-50
<i>Hemigorditellina</i> sp.	×	×	×	×	?	×	×	×	×
<i>Hemigorditellina?</i> sp.		?	?		?	×	×	×	
<i>Hemigorditopsis?</i> sp.				×					
Hemigorditopsidae indet.	×	×		×		×	×	×	×
<i>Glomomitella</i> spp.	×	×	×	×	×	×	×	×	×
<i>Neodiscus</i> sp. A.		×	×	×	×	×	×	×	×
<i>Neodiscus</i> sp. B									
<i>Neodiscus?</i> sp.									
<i>Graecodiscus</i> sp.					×		×		
<i>Pseudolangella fragilis</i>									
<i>Pseudolangella</i> sp. A					×			×	
<i>Pseudolangella</i> sp. B					×			×	
<i>Pachyphloia ovata</i>					×			×	
<i>Pachyphloia robusta</i>								×	
<i>Pachyphloia schwageri</i>					×			×	×
<i>Pachyphloia</i> sp.		?						×	
<i>Pachyphloia?</i> sp.									
<i>Ichtyofrondina</i> sp.		×							

× illustrated × not illustrated ? questionable

Zone	Pm	PI	Md	Mc	Cp	Pk
Sample	AK-192	AK-189	AK-91	AK-178	KZ-2	AK-90
Species	AK-193	AK-191	KZ-37	KZ-68	KZ-3	AK-180
	AK-203	AK-198	AK-91	KZ-69	KZ-4	AK-181
		AK-200	KZ-37	KZ-92	KZ-5	AK-182A
		AK-201	KZ-37	AK-92	KZ-6	AK-183
		AK-202	KZ-37	AK-92	KZ-7	AK-183
<i>Nagabolla orientis</i>					KZ-8	AK-183
<i>Cuniculinella vulgarisiformis</i>					KZ-9	AK-183
<i>Pseudofusulina fusiformis</i>					KZ-10	AK-183
<i>Paraleeina akiyoshiensis</i> n. sp.					KZ-11	AK-183
<i>Paraleeina magna</i>					KZ-12	AK-183
<i>Parafusulina kaerimizensis</i>					KZ-13	AK-183
<i>Parafusulina</i> sp.					KZ-14	AK-183
Schwageritidae indet.					KZ-15	AK-183
<i>Misellina claudiae</i>					KZ-16	AK-183
<i>Misellina dyhrenfurthi</i>					KZ-17	AK-183
<i>Misellina parvicostata</i>					KZ-18	AK-183
<i>Misellina postclaudiae</i>					KZ-19	AK-183
<i>Misellina</i> sp. A					KZ-20	AK-183
<i>Misellina</i> sp. B					KZ-21	AK-183
<i>Misellinae?</i> indet.					KZ-22	AK-183
<i>Pseudodolotolina ozawai</i>					KZ-23	AK-183
<i>Armenina salgirica</i>					KZ-24	AK-183
<i>Armenina</i> cf. <i>pamirensis</i>					KZ-25	AK-183
<i>Cancellina pamirica</i>					KZ-26	AK-183
<i>Presumatrina ozawai</i>					KZ-27	AK-183

x illustrated × not illustrated ? questionable

Table 4: Taxonomic composition of fusulines contained in 23 samples from the *Neoschwagerina craticulifera* Zone to the *Colania douvillei* Zone.

Zone	Nc								As								Cd									
	Sample	Ak-88	Ak-182B	Ak-182C	Ak-182D	Kz-23	Kz-61	Kz-62	Kz-63	Ak-86	Ak-87	Ak-184A	Ak-184B	Ak-184C	Ak-185	Ak-186	Ak-187	Ak-188	Kz-13	Kz-14	Kz-21	Kz-57	Kz-16	Kz-18	Kz-52	Kz-53
<i>Kahlerina</i> sp.									x							x	x		x			x				
<i>Nankinella akiyoshiensis</i>		x											x		x		x			x				?		
<i>Nankinella changanchiaoensis</i>																							x		x	
<i>Nankinella nagatoensis</i>				?					x	x			x				x				x					
<i>Pseudoreichelina darvasica</i>	x		x						x																	
<i>Rausarella ellipsoidal</i>		x	x			x			x							x			x		x					
<i>Neofusulinella phairayensis</i>								x																		
<i>Dunbarula schubertellaeformis</i>						x	x	x		x						x					x				?	
<i>Dunbarula</i> aff. <i>tumida</i>						x		x		x			x			x	x									
<i>Codonofusiella?</i> sp.														?			x									
<i>Chusenella conicocylindrica</i>	x	x	x	x					x		x		x	x		x									x	x
<i>Chusenella deprati</i>											x	x	x			x	x									
<i>Chusenella schwagerinaeformis</i>				x				x		x								x		x	x					
<i>Chusenella</i> sp. A										x									x		x					
<i>Chusenella</i> sp. B					x	x																				
<i>Parafusulina kaerimizensis</i>	x	x	x	x	x		x	x												x						
<i>Laosella edoensis</i>										x		x	x			x	x									
<i>Laosella gigantea</i>											x	x	x	x		x	x		x	x	x					
Schwagerinidae indet.								x	x	x									x	x				x		x
<i>Pseudodoliolina ozawai</i>			x	x																						
<i>Pseudodoliolina pseudolepida</i>												x	x		x	x						x				
<i>Verbeekina verbeeki</i>									x		x	x	x			x	x					x				
<i>Verbeekina</i> cf. <i>douvillei</i>																										x
<i>Neoschwagerina craticulifera</i>	x	x	x	x	x	x	x																			
<i>Neoschwagerina haydeni</i>									x						x				x	x						
<i>Colania douvillei</i>																							x		x	x
<i>Afghanella schencki</i>											x	x	x	x		x	x					x				

x illustrated × not illustrated ? questionable

3.1. *Paraleeina magna* Zone

The limestone cropping out in the southeastern end of the mapped area (Ak-203) consisting of bioclastic grainstone/packstone contains abundant *Paraleeina magna* (Toriyama, 1958) and *Pseudofusulina fusiformis* (Schellwien & Dyhrenfurth, 1909), and no species of *Pamirina*. Similar limestone having many individuals of *P. magna* without *Pamirina* species is also recognized in the northern end of the mapped area (Ak-193). Although the lower and upper boundaries are not exactly demarcated, stratigraphic interval more than 20 m with *Paraleeina magna* and without *Pamirina* is provisionally designated as the *Paraleeina magna* Zone. Among

smaller fusulines, *Palaeostaffella subquadrata* n. sp. is the commonest in this zone and extends upward to the *Misellina dyhrenfurthi* Zone. *Schubertella melonica* Dunbar & Skinner, 1937 common to rare in this zone extends to the *Cancellina pamirica* Zone. *Abadehella regularis* Lin et al., 1990 is restricted to this zone.

This zone attains to more than 40 m thick and is widely distributed outside the mapped area. The zonal species is very common in the upper part of the Yakhtashian limestone in the Akiyoshi Terrane (e.g., Toriyama, 1958; Nogami, 1961a). This zone possibly corresponds to a part of the "*Pseudofusulina ambigua*" Zone by Toriyama (1958) and M. Ota (1977) overlying the stratigraphic interval with many specimens of *Chalartoschwagerina*

		Akiyoshi Limestone Group				
		Toriyama (1958)	M. Ota (1977)	T. Ozawa & Kobayashi (1990)	Ueno (1991b, 1992b)	Kobayashi (this paper)
Guadalupian	Midian	<i>Yabeina shiraiwensis</i>	<i>Lepidolina multiseptata shiraiwensis</i>	<i>Lepidolina shiraiwensis</i>	<i>Lepidolina shiraiwensis</i>	<i>Lepidolina shiraiwensis</i>
	Murgabian	<i>Neoschwagerina douvillei</i>	<i>Colania douvillei</i>	<i>Colania douvillei</i>	<i>Colania douvillei</i>	<i>Colania douvillei</i>
		<i>Verbeekina verbeeki</i>	<i>Verbeekina verbeeki</i>	<i>Neoschwagerina haydeni</i>	<i>Verbeekina verbeeki</i>	<i>Afghanella schencki</i>
		<i>Neoschwagerina craticulifera</i>	<i>Neoschwagerina craticulifera</i>	<i>Afgh. schencki-V. verbeeki</i>	<i>V. verbeeki-Afgh. schencki</i>	
				<i>Neoschwagerina craticulifera</i>	<i>Neoschw. craticulifera robusta</i>	<i>Neoschwagerina craticulifera</i>
	<i>Parafusulina kaerimizensis</i>	<i>Afghanella schencki</i>	<i>Parafusulina kaerimizensis</i>	<i>Afghanella ozawai</i>	<i>Parafusulina kaerimizensis</i>	
<i>Parafusulina kaerimizensis</i>	<i>Parafusulina kaerimizensis</i>	<i>Parafusulina grupperaensis</i>	<i>Parafusulina kaerimizensis</i>	<i>Parafusulina kaerimizensis</i>		
Cisuralian	Kubergandian	<i>Pseudofusulina ambigua</i>	<i>Misellina claudiae</i>	<i>Misellina claudiae</i>	<i>Misellina (M.) claudiae</i>	<i>Cancellina pamirica</i>
	Bolorian		<i>Misellina claudiae</i>	<i>Misellina parvicostata</i>	<i>Misellina (B.) dyhrenfurthi</i>	<i>Misellina dyhrenfurthi</i>
			<i>Pseudofusulina ambigua</i>	<i>Psf. fusiformis-M. dyhrenfurthi</i>	<i>Pamirina (Levenia) leveni</i>	<i>Pamirina leveni</i>
	Yakhtashian		<i>Pseudofusulina ambigua</i>	<i>Pseudofusulina krafftii</i>	<i>Pseudofusulina ex gr. krafftii</i>	<i>Paraleeina magna</i>

Fig. 4: Fusuline biostratigraphic zonation and correlation of the upper Cisuralian and Guadalupian in the Kaerimizu area.

vulgaris (Schellwien & Dyhrenfurth, 1909) in the Akiyoshi Limestone. It is correlated to the *Pseudofusulina* ex gr. *krafftii* Zone settled by Ueno (1991b) between the lower *Chalartoschwagerina vulgaris* Zone and the upper *Pamirina* (“*Levenia*”) *leveni* Zone in the Kaerimizu area.

3.2. *Pamirina leveni* Zone

Ueno (1991b) defined the *Pamirina* (“*Levenia*”) *leveni* Zone as the stratigraphic interval from the first occurrence of *P. (“L.”) leveni* Kobayashi, 1977 to that of *Misellina* (*Brevaxina*) *dyhrenfurthi otai* Sakaguchi & Sugano, 1966. However, I could not strictly determine the datum plane of *Pamirina leveni* on account of its sporadic occurrence in the Akiyoshi Limestone. Similarly, *Misellina* (*Brevaxina*) *nipponica* Ueno, 1991b and *Pamirina* (*Pamirina*) *darvasica* Leven, 1970a, reported from this zone by Ueno (1991b), could not be found out in the present study.

The stratigraphic interval of about 30 m thick yielding *Pamirina leveni* and intervened between the *Paraleeina magna* Zone and the *Misellina dyhrenfurthi* Zone in the Kaerimizu area is treated as the *Pamirina leveni* Zone. *Pamirina leveni* is, however, also distinguished from the *Misellina dyhrenfurthi* Zone in the area. The occurrence of *Cuniculinella vulgarisiformis* (Morikawa, 1952), *Schubertella melonica*, *Palaeastaffella subquadrata*, and *Palaeastaffella akudensis* (Hh. Igo, 1996) is noticeable, but subordinate, in this zone. These species are more characteristic in the upper Lower Permian in the Jurassic terranes of Japan (e.g., Kobayashi & Furutani, 2009).

This zone probably correspond to the *Pamirina* (“*Levenia*”) *leveni* Zone by Ueno (1991b), a part of the “*Pseudofusulina ambigua*” Zone by Toriyama (1958) and M. Ota (1977), and the lower part of the *Pseudofusulina fusiformis-Misellina dyhrenfurthi* Zone by T. Ozawa & Kobayashi (1990). In spite of insufficient paleontologic informations, this zone is correlated to the upper, possibly uppermost Yakhtashian based on the faunal compilation of *Pamirina leveni* and *Cuniculinella vulgarisiformis* by Leven (2001, 2009) in the Tethyan regions.

3.3. *Misellina dyhrenfurthi* Zone

This zone is defined by the stratigraphic interval of 10 to 20 m thick characterized by the occurrence of *Misellina dyhrenfurthi* (Dutkevich in Likharev, 1939). The upper boundary of this zone is designated by the first occurrence of *Misellina claudiae* (Deprat, 1912), corresponding to the level a few meters above the last occurrence of *M. dyhrenfurthi*. The lower boundary is not exactly determined on account of 5 to 10 m thick interval absent in both *Pamirina* and *Misellina*, and gradual lithologic change from the lower microbial limestone dominant facies to the upper algal micritic limestone facies. Fusulines confined to this zone are *Toriyamaia laxiseptata* Kanmera, 1956 and *Misellina parvicostata* (Deprat, 1915) in addition to the zonal species. Schwagerinids and staffellids are rare in this zone. This zone coincides with the *Misellina* (*Brevaxina*) *dyhrenfurthi otai* Zone of Ueno (1991b). The *Misellina*

parvicostata Zone by T. Ozawa & Kobayashi (1990) is not separated from this zone on account of co-existence of *M. dyhrenfurthi* and *M. parvicostata* in the upper part of this zone. Bolorian age of this zone is supported by the occurrence of these two species from the many Tethyan sections correlatable to the Bolorian of Darvas (Kalmykova, 1967; Leven, 2009). On the other hand, the correlation between the Kungurian Stage and the Bolorian Stage based on fusulines is almost impossible because of endemic and provincial fusuline composition or complete absence of fusulines in the stratotype region of the Kungurian in the South Urals.

3.4. *Misellina claudiae* Zone

This zone is defined by the stratigraphic interval of 10 to 20 m thick from the first occurrence of *Misellina claudiae* to that of *Yangchienia?* sp. Algal fusuline packstone/grainstone characteristically containing *Misellina claudiae* are well traceable laterally in the field. The zonal species does not continue to the upper boundary of this zone. *Misellina postclaudiae* Ueno, 1991b occurs in the uppermost part of this zone in the western slope of the Kaerimizu Doline. Besides these two species of *Misellina*, remarkable species in this zone are *Nagatoella orientis* (Y. Ozawa, 1925), *Neofusulinella giraudi* Deprat, 1915, and *Neofusulinella simplex* (Lange, 1925). The first species ranges up to the *Cancellina pamirica* Zone and the second and third species up to the *Parafusulina kaerimizensis* Zone. Moreover, schwagerinids indeterminable in their taxonomic assignment (Pl. V, fig. 42) occur in the *Misellina claudiae* Zone. *Hemigordiopsis?* sp. is confined to this zone.

Ueno (1991b) set up four datum planes of the five species belonging to *Misellina*, *Armenina*, *Maklaya*, and *Neoschwagerina* within his *Misellina claudiae* Zone that was defined by the stratigraphic interval from the first occurrence of *Misellina claudiae* to that of *Parafusulina kaerimizensis* (Y. Ozawa, 1925b) without any biostratigraphic subdivisions. This zone in the present paper is presumed to correspond to the lower part of Ueno's *M. claudiae* Zone. The *M. claudiae* Zone of M. Ota (1977) who first established this zone in the Akiyoshi Limestone is supposed to include the *Misellina dyhrenfurthi* Zone of later authors. The *Parafusulina nakamigawai* Zone free from any species of *Misellina* in Kuzu (Kobayashi, 2006a) and Akasaka (Kobayashi, 2011) is correlated to the *Misellina claudiae* Zone (Fig. 5) based on the faunal correlation done by Kobayashi (2011). Stratigraphic levels of *Nagatoella kobayashii* Thompson, 1936 (= *N. orientis*) in the Atetsu Limestone by Nogami (1961a, b) are supposed to be coeval with a part of the *Misellina claudiae* Zone of Akiyoshi, though they were included in the "*Pseudofusulina krafftii magna*" Subzone, where *Misellina* aff. *claudiae* occurs according to Nogami (1961a, b). Based on the comparison of the

Misellina faunas, the *Misellina claudiae* Zone is safely correlated to the lower part of the Kubergandian.

3.5. *Cancellina pamirica* Zone

The *Cancellina pamirica* Zone is introduced herein for the stratigraphic interval of 15 to 25 m thick from the first occurrence of *Yangchienia?* sp. to that of *Parafusulina kaerimizensis* in the western slope WSW of the bottom of the Kaerimizu Doline. Although biostratigraphic relationships of this zone between the lower and upper zones are the same between the western slope and NNW of the doline bottom (Fig. 2), species composition of fusulines is more or less different between these two locations (Table 3). The zonal species is contained in five samples of the micritic limestone in association with *Armenina salgirica* A. D. Miklukho-Maklay, 1955 and *A. cf. pamirensis* (Dutkevich, 1934) in the latter location. On the other hand, the occurrence of *Cancellina pamirica* Leven, 1967 is very rare in the former location, restricted to one sample (Kz-5), and questionable in two samples (Kz-4, 8). Species certainly assignable to *Armenina* have not been discovered in the the former location. Instead, some fusulines such as *Neofusulinella uenoi* n. sp. and *Yangchienia?* sp. very characteristic in the former location are barren in the latter location, as well as *Parafusulina* sp. only found in Kz-49. More noticeable fusulines in the field, though outer whorls of most of them are remarkably abraded, are *Paraleeina akiyoshiensis* n. sp. having large and not spherical proloculus, and well-developed axial fillings in the former location.

The *Cancellina pamirica* Zone corresponds to the upper part of the *Misellina claudiae* Zone of Ueno (1991b). This zone nearly coincides with the *Parafusulina grupperaensis* Zone of T. Ozawa and Kobayashi (1990). The specimens identified by T. Ozawa & Kobayashi (1990) with original species are different from the types from southern Mexico (Thompson & Miller, 1944) and should be attributed to *Paraleeina akiyoshiensis*. The *Cancellina pamirica* Zone is apparently correlated to the *Cancellina cutalensis* Zone of southeast Pamir (Leven, 1967) and its correlatives, and is late Kubergandian age of the Tethyan standard (Fig. 5).

Stratigraphic interval with *Cancellina nipponica* Y. Ozawa, 1927 in Akasaka (Kobayashi, 2011) and the limestone block with *Cancellina zarodensis* Sosnina, 1965 in the southern Kanto Mountains (Kobayashi, 2005a) are correlated to this zone (Fig. 5). Because these two species are considered to be almost coeval with *Cancellina pamirica* from the phylogenetic development of early groups of neoschwagerinids. The lower part of the *Parafusulina yabei* Zone in Kuzu (Kobayashi, 2006a) is also correlated to this zone in spite of absence of verbeekinids and neoschwagerinids.

		Province A (W Tethyan P.)			Province B (E Tethyan Province)			Province C (Panthalassan Province)												
(International)	Tethyan Realm (Leven & Bogoslovskaya, 2006; Leven, 2009)	Abadeh (Kobayashi & Ishii, 2003; Leven & Gorgji, 2008)		SE Pamir (Leven, 1967; 1980; 1993; 2009)		Thailand (Toriyama, 1975; Toriyama & Kanmera, 1979)		S China (Sheng, 1963; Sheng & Jin, 1994; Jin et al., 1994)		Akiyoshi (Akiyoshi Fauna) (this paper)		Kuma (Kurosegawa Fauna) (Kanmera, 1963; Kobayashi, 2001)		Akasaka (Chichibu Fauna) Kobayashi, 2011)		Kuzu (Chichibu Fauna) (Kobayashi, 1979; 2006a)		S Kanto (Chichibu Fauna) (Kobayashi, 2005a)		
		Midian	Yabeina Sumatrina	Chusenella abichi	Yabeina archaica		Lepidolina multiseptata	Lepidolina shiraiwensis												
		Wordian		Murgabian		Kubergandian		Kungurian		Artinskian										
Guadalupian	Tethyan Realm	Neoschw. haydeni	Neoschw. occidentalis	Neoschwagerina margaritae	Neoschw. haydeni	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae	Neoschw. margaritae
		Afghanella schencki	Afghanella schencki	Neoschwagerina craticulifera / Neoschw. schuberti	Af. schencki Neoschw. cf. kueichowensis	Neoschw. schuberti	Neoschw. craticulifera	Af. schencki Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera	Neoschw. craticulifera
Cisuralian	Tethyan Realm	Neoschw. haydeni	Neoschw. persica	Neoschwagerina simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex	Neoschw. simplex
		Armenina Misellina ovalis	Armenina cf. salgirica Misellina ovalis	Armenina salgirica Misellina ovalis	Can. pamirica Arm. sphaera	M. claudiae Misellina confragaspira	Misellina dyhrenfurthi	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae	Misellina claudiae
Cisuralian	Tethyan Realm	Misellina panvicosata	Darvasites ordinatus	Pamirina leveni	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi	Misellina dyhrenfurthi
		Misellina termieri	Misellina dyhrenfurthi	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis	Pamirina darvasica Cuniculinella vulgarisiformis

Fig. 5: Fusuline biostratigraphic zonation and correlation of the upper Cisuralian and Guadalupian of the standard Tethyan Realm and of some regions paleobiogeographically divided into the Province A (Western Tethyan Province), Province B (Eastern Tethyan Province), and Province C (Panthalassan Province). Note that the Permian Akiyoshi Terrane is contained to the Province B, and Jurassic terranes of Japan are to the Province C paleobiogeographically.

3.6. *Parafusulina kaerimizensis* Zone

This zone is defined by the 25 to 35 m thick stratigraphic interval from the first occurrence of *Parafusulina kaerimizensis* to that of *Neoschwagerina craticulifera* (Schwager, 1883). The zonal species ranges upward to the *Neoschwagerina craticulifera* Zone. Moreover, parafusulinids probably referable to *P. kaerimizensis* exceptionally occur in the *Afghanella schencki* Zone (Kz-21A, 21B). *Paraleeina akiyoshiensis* ranges up to the lower part of this zone. *Presumatrina ozawai* (Hanzawa, 1954) is very prolific in fusuline bioclastic grainstone of the upper part of this zone. *Pseudodoliolina ozawai* Yabe & Hanzawa, 1932 first occurs in the uppermost part of the zone and ranges up to the *N. craticulifera* Zone. Most species of *Neofusulinella* disappear by the middle part of this zone except for *N. phairayensis* Colani, 1924 ranging up to the *Neoschwagerina craticulifera* Zone. Instead, forms referable to *Chusenella* and *Dunbarula* become dominant from this zone.

The *Parafusulina kaerimizensis* Zone in this paper corresponds to *P. kaerimizensis* plus “*Afghanella schencki*” zones of M. Ota (1977) and *P. kaerimizensis* plus “*Afghanella*” *ozawai* zones of Ueno (1992b). Their “*Afghanella schencki*” (= *Presumatrina ozawai*) and “*Afghanella*” *ozawai* zones are better to be included into this zone from the stratigraphic distribution of *Parafusulina kaerimizensis*, *Presumatrina ozawai*, and *Neoschwagerina craticulifera* (Figs 3, 4).

The zonal species common in the huge limestone blocks of the Akiyoshi Terrane is almost barren in the Jurassic terranes of Japan. Although species composition of *Parafusulina* is considerably different between the Permian and Jurassic terranes of Japan, the *Parafusulina kaerimizensis* Zone is correlated to the *Neoschwagerina simplex* Zone or the upper part of the *Parafusulina yabei* Zone in the Jurassic terranes of Japan, as discussed by Kobayashi (2011). Accordingly, this zone is surely correlated to the lower part of the Murgabian corresponding to the upper Roadian (Fig. 5).

3.7. *Neoschwagerina craticulifera* Zone

Stratigraphic interval of 10 to 20 m thick from the first occurrence of *Neoschwagerina craticulifera* to that of *Afghanella schencki* Thomson, 1946 is defined by the *Neoschwagerina craticulifera* Zone. The zonal species, conspecific with *N. craticulifera robusta* Ueno, 1992b, is associated with *Parafusulina kaerimizensis* throughout the zone, and with *Pseudodoliolina ozawai* in the lower part. Though not confined to this zone and not prolific, *Dunbarula* aff. *tumida* Skinner, 1969 and *Rauserella ellipsoidalis* Sosnina, 1968 first occur in this zone. *Chusenella* is less common in this zone compared with in the *Afghanella schencki* Zone, along with non-fusuline foraminifers.

This zone is correlated to the middle Murgabian with *Neoschwagerina craticulifera* and its coeval species of *Neoschwagerina* widely distributed in the Tethyan regions (Fig. 5). In the Abadeh region, *Afghanella schencki* is more dominant than species of *Neoschwagerina* (Kobayashi & Ishii, 2003). In the Akiyoshi Terrane, *Afghanella* always occurs above the *N. craticulifera* Zone. The *Parafusulina tochiensis* Zone in Kuzu very poor in neoschwagerinids (Kobayashi, 2006a) and the stratigraphic interval having the primitive form of *Gifuella* in Akasaka (Kobayashi, 2011) are correlated to this zone.

3.8. *Afghanella schencki* Zone

This zone is designated for about 30 m thick limestone from the first occurrence of *Afghanella schencki* to that of *Colania douvillei* (Y. Ozawa, 1922). The lower boundary of this zone also coincides with the first occurrence of *Verbeekina verbeeki* (Geinitz, 1876). *Afghanella schencki* ranges up to the middle upper part of this zone, and *Verbeekina verbeeki* occurs also in the basal part of the *Colania douvillei* Zone. Both species are not found from the limestone having abundant *Neoschwagerina haydeni* Dutkevich in Dutkevich & Khabakov, 1934.

Diversity and abundance of both fusulines and non-fusuline foraminifers increase toward this zone except for the uppermost part barren in neoschwagerinids and verbeekinids. In addition to *A. schencki*, *V. verbeeki*, and *N. haydeni*, characteristic species in this zone are *Laosella gigantea* (Deprat, 1913), *Laosella edoensis* (Y. Ozawa, 1925b), *Chusenella deprati* (Y. Ozawa, 1925b), and *Pseudodoliolina pseudolepida* (Deprat, 1912). These four species are almost confined to this zone. *Codonofusiella?* sp. and *Kahlerina* sp. first occur in this zone. *Dunbarula schubertellaeformis* Sheng, 1958 and *D. aff. tumida* are common in this zone, though not restricted to this zone. Among non-fusuline foraminifers, *Neohemigordius japonicus* (Y. Ozawa, 1925b) and *Agathammina pusilla* (Geinitz in Geinitz & Gutbier, 1848) are almost confined to this zone.

Based on these faunas and their stratigraphic distribution, the *Afghanella schencki* Zone is correlated to the upper part of the middle Murgabian in the Tethyan regions. This zone corresponds to the *Afghanella schencki*-*Verbeekina verbeeki* Zone and *Neoschwagerina haydeni* Zone by T. Ozawa & Kobayashi (1990). It is equivalent to the three zones of Ueno (1992b), *V. verbeeki*-*A. schencki*, *Neoschwagerina fusiformis*, and *V. verbeeki* zones from lower to upper (Fig. 4). The *Afghanella schencki* Zone of Akiyoshi and other limestones with *A. schencki* in the Akiyoshi Terrane are correlated to the upper part of the *N. craticulifera* Zone in the Jurassic terranes of Japan, where *Afghanella* is completely absent.

3.9. *Colania douvillei* Zone

The lower boundary of this zone is defined by the first occurrence of the zonal species. The upper boundary, though not determined in the Kaerimizu area on account of no exposures of limestone, is defined by the first occurrence of *Lepidolina shiraiwensis* (Y. Ozawa, 1925b) in the western part of the Akiyoshi Limestone. *Colania douvillei* is recognized in four samples of Kaerimizu. Confined to this zone are *Verbeekina* cf. *douvillei* (Deprat, 1912) and *Nankinella chanchiaoensis* (Sheng & Wang, 1962), besides the zonal species. Fusulines ranging upward to this zone are *Verbeekina verbeeki*, *Chusenella conicocylindrica*, *Dunbarula schubertellaeformis*, *Rausserella ellipsoidalis*, and *Kahlerina* sp. Non-fusuline foraminifers are poor in this zone. *Dagmaria?* cf. *shahrezaensis* Mohtat-Aghai & Vachard, 2003 is only found in this zone.

Compared with the fusuline faunas of the *Lepidolina shiraiwensis* Zone of the Akiyoshi Limestone (Kobayashi, 2012a), genera *Lepidolina* and *Sumatrina*, *Parafusulina nagatoensis* Kobayashi, 2012a, *Chusenella atlinensis* (Ross, 1971), *Chusenella otai* (Nogami, 1961a), *Kahlerina ampla* Han, 1980, and *K. taishakuensis* Kobayashi, 2010 are not found out from the *Colania douvillei* Zone in Kaerimizu. *Sumatrina longissima* Deprat, 1914 and *S. annae* Volz, 1904 range from the *Colania douvillei* Zone to the *Lepidolina shiraiwensis* Zone in the limestone blocks of the Akiyoshi Terrane (Nogami, 1961b; Kobayashi, 1988a). Fusuline faunas of the *C. douvillei* Zone and coeval zones with heterogeneous elements in the Jurassic terranes of Japan (Fig. 5) are comparable to those of Tethyan regions assigned to the “early Midian” defined by Leven (2009). The boundary between Murgabian and Midian, and correlation between Midian and Capitanian have not been still definitely fixed internationally. The biostratigraphic boundary between *C. douvillei* and *L. shiraiwensis* zones is considered to be equal to the chronostratigraphic boundary between Murgabian and Midian in this paper as well as in other papers by the author (e.g., Kobayashi, 2011).

4. APPRAISAL OF THE AKIYOSHI FAUNA

Faunal provincialism is conspicuous in the Guadalpian neoschwagerinids and coeval schwagerinids in the global scale. Based on the spatiotemporal distribution of these fusuline faunas, Kobayashi (1997a, figs 2, 4, table 1) discriminated four faunal provinces: Province A (Western Tethyan Province), Province B (Eastern Tethyan Province), Province C (Panthalassan Province), and Province D (Cratonic North American Realm). The Akiyoshi Fauna is exceptionally belonged to the Province B in Japan (Kobayashi, 1997b) nevertheless its occurrence from the Panthalassan-originated seamount limestones. It is clearly distinguished from the coeval Chichibu Fauna as-

signable to Province C by the occurrence of *Afghanella* and *Sumartina*. These neoschwagerinids are completely absent in the Chichibu Fauna and almost barren in the Kurosegawa Fauna in spite of proximity of geographic distribution to the present Japanese Islands. The differences of the three faunas are inferred to be the result of their different paleogeographic and ancient plate tectonic settings, as done by Kobayashi (1997b), (1) the Akiyoshi Fauna originated in the Panthalassan-seamount limestones accreted in the Permian, (2) the Chichibu Fauna in those accreted in the Jurassic, and (3) the Kurosegawa Fauna originated in the Kurosegawa (Kurosegawa-South Kitakami) Microcontinent proximate to the Cathaysian Continent in the Permian time.

Other fusulines and their evolutionary, paleobiogeographic, and tectonic implications in the Panthalassan-originated terranes were subsequently demonstrated by Kobayashi (2005a, 2017) and Kobayashi *et al.* (2007, 2010). Against the presence of *Afghanella* and *Sumartina*, entirely lacking in the Akiyoshi Fauna are many species of *Yabeina* represented by *Y. globosa* (Yabe, 1906), *Lepidolina kumensis* Kanmera, 1954, *Metaoliolina gravitesta* (Kanmera, 1954), and genera *Gifuella* and *Gifuelloides*. These fusulines are characteristic in the upper Wordian and Capitanian limestones having the Chichibu or Kurosegawa Fauna (Kobayashi, 1986, 1988a, 2001, 2005a, b, 2006a, 2007, 2011; Kobayashi *et al.*, 2010).

Late Cisuralian and Guadalupian schwagerinid faunas are also more or less different between the Akiyoshi limestone and limestone blocks and fragments contained in the exotic terranes in and outside Japan. The occurrence of *Nagatoella* is almost confined to the Akiyoshi Terrane in Japan, and is also reported from the Nadanhada Range (Jilin, NE China) composed of the Mesozoic complex with ophiolitic rocks (Li *et al.*, 1979) and from the Baker Terrane of northeastern Oregon (Blome & Nestell, 1992). Five species and two subspecies erroneously assigned to *Nagatoella* from Hunan, South China by Zhou (1982) are attributed to *Darvasites*. *Acervoschwagerina* is an endemic form of inflated schwagerinids and commonly found in the Jurassic terranes of Japan and in the Lower Permian of the South Kitakami Terrane (Kanmera & Mikami, 1965). It is also reported from northeastern Oregon (Blome & Nestell, 1992), Koryak (Davydov *et al.*, 1996), and Sikhote-Alin (Sosnina, 1965). In the Tethyan regions, *Acervoschwagerina inusitata* Lin in Lin *et al.*, 1977 is exclusively reported from Guanxi of South China. This species is independent in its more strongly folded septa with more numerous chamberlets in the central part of the test than those of the known species of the genus. As well as *Acervoschwagerina ex gr. endoi* Hanzawa, 1949 from the Pamir by Rozovskaya (1975), as indicated by Kobayashi (2005a), specimens assigned to *Acervoschwagerina* illustrated from Darvas by Leven (1992) and Rauzer-Chernousova *et al.* (1996) are different from the typical *Acervoschwagerina* in their mode of septal folding and smaller test closer to those

of *Paraschwagerina* or *Liharevites*. The genus has been supposed to be confined to the Sakmarian, as assumed by Leven (2009). It ranges up to the Artinskian based on the fusuline faunal analysis in the Jurassic Mino Terrane (Kobayashi & Furutani, 2019). *Acervoschwagerina*, however, is completely absent in the Permian Akiyoshi Terrane.

The *Parafusulina kaerimizensis* fauna very common in the Permian Akiyoshi Terrane is faunistically replaced by the coeval *Parafusulina japonica* fauna in the Jurassic terranes of Japan (Kobayashi, 2005a, 2011). Taxonomic diversity of *Parafusulina* in the Roadian and early Wordian is higher in the Chichibu Fauna. Many species not reported from the Akiyoshi Fauna are characteristic and age-diagnostic in the Chichibu Fauna, e.g., *Parafusulina nakamigawai* Morikawa & Horiguchi, 1956 and *P. yabei* Hanzawa, 1942 (Kobayashi, 2006a, 2011). Moreover, giant *Parafusulina* such as *P. tomegansensis* Morikawa, 1958 and *P. shimotsukensis* Kobayashi, 2006a are entirely lacking in the Akiyoshi Fauna. On the contrary, *Laosella edoensis* (Y. Ozawa, 1925b) and *L. gigantea* (Deprat, 1913) common in the Wordian faunas of the Akiyoshi Fauna are very few or absent in the Jurassic terranes of Japan. All of these species of *Parafusulina* and *Laosella* are completely absent in the Kurosegawa Fauna of the South Kitakami Terrane, which is characterized by *Monodiexodina sutchanica* (Dutkevich in Likharev, 1939) and parafusulinids not known from the terranes with seamount-originated limestones in Japan (Kobayashi *et al.*, 2009). Occurrence of *Monodiexodina* is restricted to the terranes with continental affinities such as Kurosegawa and South Kitakami terranes in Japan.

In summary, the taxonomic composition of Middle Permian schwagerinid faunas is considerably different among the Akiyoshi, Chichibu, and Kurosegawa faunas, as well as neoschwagerinid faunas. Faunal similarities among Permian and Jurassic terranes of Japan, and some accreted terranes of the Circum Pacific regions having marked faunal affinities with Japan are paleobiogeographically and tectonically important. Spatiotemporal distribution of these fusulines is available for the faunal analysis of the late Early and Middle Permian provincialism and for the reconstruction of plate movement of the Panthalassan-originated seamounts and continental blocks, as outlined by Kobayashi (1997a, b) and more concretely demonstrated later by Kobayashi (2005a) and Kobayashi *et al.* (2010). Faunal similarities between Akiyoshi and peripheral regions of the Archean North China and the Proterozoic Hanka such as eastern Jilin and Primorye, are important for the paleobiogeographic changes and tectonic evolution and amalgamation of East Asia from late Paleozoic to early Mesozoic (Kobayashi, 2017).

5. SYSTEMATIC PALEONTOLOGY

Among 63 species of fusulines and 43 species of non-fusuline foraminifers, 31 species of fusulines and seven species of non-fusuline foraminifers are systematically described below. See also Fig. 3 and Table 2, 3, and 4 for more details on the biostratigraphic distribution of the described species and faunal composition of the selected samples in the Kaerimizu area. Limestone thin sections used in this paper are all stored in the Museum of Nature and Human Activities, Hyogo, Japan (Fumio Kobayashi Collection, MNHAH).

Order Foraminiferida Eichwald, 1830

Suborder Fusulinina Wedekind, 1937

Superfamily Fusulinoidea von Möller, 1878

Family Ozawainellidae Thompson & Foster, 1937

Genus *Pamirina* Leven, 1970a

Type species: *Pamirina darvasica* Leven, 1970a, p. 23.

Junior synonym:

Chinlingella Wang & Sun, 1973, p. 171 (type species, *Chinlingella chinlingensis* Wang & Sun, 1973).

Pamirina (*Pamirina*) Ueno, 1991a, p. 744 (name transferred).

Pamirina (*Levenia*) Ueno, 1991a, p. 745 (name invalidly proposed) [type species, *Pamirina leveni* Kobayashi, 1977].

Pamirina (*Levenella*) Ueno, 1994, p. 405 (name proposed to replace).

Remarks: *Pamirina* (*Levenella*) is inferred to be a junior synonym of *Pamirina* along with *Chinlingella* (Kobayashi, 2005c). *Pamirina* is considered to be the ancestor of verbeekinid fusulines and attributed to Ozawainellidae based on the wall structure and phylogenetic development from Ozawainellidae to Verbeekinidae (T. Ozawa, 1970; Kobayashi, 1977; Leven, 2010). On the other hand, Davydov (2011) presented that “*Levenella*, *Pamirina*, and *Misellina* are originating from Schubertellida” based on his idea on the phylogenetic relationship of *Schubertella* and related genera (Davydov, 2011, pp. 186-188, fig. 6), that is considerably different from the Leven’s (2010, fig. 5).

Pamirina leveni Kobayashi, 1977

Pl. III, figs 32, 38, 45-50

1960. *Staffella* sp. Kanuma, p. 57, pl. 12, figs 29-31.

1966. *Paramillerella*? sp. Takaoka, p. 5, pl. 1, figs 5-6.

1977. *Pamirina leveni* Kobayashi, pp. 11-14, pl. 1, figs 13-38.

1977. *Pamirina tethydis* Kobayashi, p. 11, pl. 1, figs 1-12.

1991a. *Pamirina* (*Levenia*) *leveni* Kobayashi.– Ueno, pp. 746-747, fig. 3.8-23.

1991a. *Pamirina* (*Levenia*) *evoluta* Sheng & Sun, 1975.– Ueno, pp. 747-748, fig. 4.1-8.

1991b. *Pamirina* (*Levenia*) *leveni* Kobayashi.– Ueno, fig. 6.6-10.

1991b. *Pamirina* (*Levenia*) *evoluta* Sheng & Sun.– Ueno, fig. 6.11-14.

Remarks: This species is characterized by thickly lenticular test with structureless single layer in inner whorls, and a tectum and translucent layer in outer whorls. These and other features of the test suggest its generic assignment to Ozawainellidae and the serial phyletic lineage from *Pamirina* to *Misellina* through *Brevaxina*-type *Misellina* (Kobayashi, 1977). *Pamirina tethydis* can not be separated from this species, as discussed by Kobayashi (2005c). From the examination of specimens from the Akiyoshi Limestone, “*Pamirina (Levenia) evoluta*” by Ueno (1991a, b) is supposed to be referable to an incomplete form of *Pamirina leveni* absent in the outermost whorl.

Pamirina? sp. (Pl. III, fig. 37) from sample Kz-6 (*Cancellina pamirica* Zone) is distinguished from this species by its thicker translucent layer of wall. It might be an incomplete specimen of *Cancellina pamirica* lacking middle and outer whorls. However, parachomata first appearing in the second to third whorl of *Cancellina pamirica* are absent in *Pamirina?* sp.

Occurrence and stratigraphic distribution: Rare in the *Pamirina leveni* Zone (Ak-198, 200, 202) and *Misellina dyrenfurthi* Zone (Kz-69).

Genus *Rauserella* Dunbar, 1944

Type species: *Rauserella erratica* Dunbar, 1944, p. 37.

***Rauserella ellipsoidalis* Sosnina, 1968**

Pl. IV, figs 11-16

1968. *Rauserella ellipsoidalis* Sosnina, pp. 116-117, pl. 28, fig. 8.

Remarks: This species was proposed by Sosnina (1968) from the lower Midian *Metadoliolina lepida* Zone of Sikhote-Alin based on the monotypic specimen. Although morphologic variation of this species is uncertain from the original description, Sosnina showed its difference from *R. breviscula* Sosnina, 1968 in size and shape of the test and inner whorls, and expansion of the test. Some specimens of the present material (e.g., Pl. IV, fig. 12) appear to be more similar to *R. breviscula* in their resemblance of inner whorls, but they are included in *Rauserella ellipsoidalis* herein.

Specimens probably referable to *R. ellipsoidalis* have been reported from the upper Murgabian limestones of Kuzu (Kobayashi, 2006b), and of the Midian limestones of Kaize (Kobayashi, 2006c) and Osakama (Kobayashi, 2007). The present Kaerimizu specimens are similar to these Japanese examples in the shape of periphery and lateral slopes of the test.

Occurrence and stratigraphic distribution: Rare in the *Neoschwagerina craticulifera* Zone (Ak-182B, 182C), *Afghanella schencki* Zone (Ak-86, 187; Kz-14, 57), and *Colania douvillei* Zone (Kz-53).

Genus *Kahlerina* Kochansky-Devidé & Ramovš, 1955
Type species: *Kahlerina pachythea* Kochansky-Devidé & Ramovš, 1955, p. 385.

***Kahlerina* sp.**

Pl. IV, figs 5-7, 8(?), 9

Remarks: Almost all species assigned into *Kahlerina* have nautiloid to subspherical test with form ratio less than 1.0, as those commonly found in the Capitanian (*Lepidolina shiraiwensis* Zone or *L. multiseptata* Zone) of the Akiyoshi Terrane (Kobayashi, 2010, 2012a, b) and coeval limestone blocks of Japan (e.g., Kobayashi, 1986, 2001). *Kahlerina globiformis* Sosnina, 1968 illustrated by Kobayashi (1988a) from the Omi Limestone has the largest form ratio of the test among the Japanese materials.

Along with *K. globiformis* and *K. circularis* Sosnina, 1968 proposed from the Capitanian of Sikhote-Alin (Sosnina, 1968), *Kahlerina globosa* Skinner, 1969 proposed from the upper Middle Permian of Turkey by Skinner (1969) has large form ratio of the test and is somewhat similar to the present material. However, the present unnamed species has smaller test and thinner wall than the Sosnina's and Skinner's species. *K. minutiosa* proposed by Han (1980) from the Nadanhada Range, NE China might be a form referable to *Kahlerina* having the largest form ratio of the test among the known species of the genus. It is easily distinguished from other species of the genus by its much smaller test.

The present unnamed forms with form ratio more than 1.3 might be a new species of *Kahlerina*, but its possibility is postponed on account of insufficient specimens in my hand.

Occurrence and stratigraphic distribution: Rare in the *Colania douvillei* Zone (Kz-16) and *Afghanella schencki* Zone (Ak-86, 187).

Family Staffellidae A. D. Miklukho-Maklay, 1949

Genus *Nankinella* Lee, 1934

Type species: *Staffella discoides* Lee, 1931, p. 286.

***Nankinella akiyoshiensis* (Toriyama, 1958)**

Pl. III, fig. 16

1958. *Ozawainella akiyoshiensis* Toriyama, pp. 64-65, pl. 6, figs 1-4 (1=3, 2=4).

Remarks: One illustrated and other few specimens having small, thickly lenticular, and weakly recrystallized test with angular periphery and straight lateral slopes are closely similar to those of “*Ozawainella*” *akiyoshiensis* proposed by Toriyama (1958) from the *Neoschwagerina craticulifera* Subzone of the Akiyoshi Limestone. This species is reassigned to *Nankinella*, because four-layered type wall of this species mentioned in Toriyama (1958) is doubtful. It is distinguished from *Nankinella*

changanchiaoensis, described below, by its smaller test with more angular periphery in middle and outer whorls.

Occurrence and stratigraphic distribution: Rare in the *Afghanella schencki* Zone (Ak-184C).

***Nankinella changanchiaoensis* (Sheng & Wang, 1962)**
Pl. III, figs 41-44

1958. *Reichelina?* *changanchiaoensis* Sheng & Wang, p. 184, pl. 1, figs 5-7.

Remarks: Four specimens illustrated are different from other forms of *Nankinella* in this paper in slenderer lenticular test of the former. They are probably identical with *Reichelina?* *changanchiaoensis* described by Sheng & Wang (1962) from the upper Maokouan of southern Kiangsu in association with *Metadoliolina multivoluta* (Sheng, 1963). Although the Chinese specimens were questionably assigned to *Reichelina* by the two-layered wall and absence of chomata, they are probably reassigned to *Nankinella*. Both “diaphanotheca”-like appearance and “alveolar” structure of wall are assumed to be a result of weakly recrystallized test in the types. These Akiyoshi and Kiangsu specimens are common in size and shape of the test with bluntly pointed periphery, and closely spaced septa inclined anteriorly. This species is different from *Nankinella akasakensis* Kobayashi, 2011 from the Akasaka Limestone by its smaller and slenderer test.

Occurrence and stratigraphic distribution: Rare in the *Colania douvillei* Zone (Kz-18, 53).

***Nankinella nagatoensis* Toriyama, 1958**

Pl. III, figs 21-30, 34-36

1958. *Nankinella nagatoensis* Toriyama, pp. 65-68, pl. 6, figs 5-13.

1958. *Nankinella* spp. Toriyama, pp. 68-69, pl. 6, figs 14-15.

2012b. *Nankinella nagatoensis* Toriyama.– Kobayashi, fig. 6.40-41, 52.

2017. *Nankinella nagatoensis* Toriyama.– Kobayashi, p. 33, pl. 1, figs 51-54.

Description: Test weakly recrystallized, subrhomboidal to thick lenticular with bluntly pointed periphery, straight to convex lateral slopes, and protruding poles with shallow umbilical cavities. Axis of coiling is straight. Mature test consists of six to seven whorls, 0.6 to 0.9 mm in length, 1.0 to 1.4 mm in width, and 0.5 to 0.7 in form ratio. Proloculus is nearly spherical and 35 to 120 microns in diameter. Inner two to three whorls are gradually increasing their length and width and the succeeding ones more rapidly increasing their chamber height.

Wall recrystallized and composed of a tectum and lower finely porous to finely mozaic calcite layer. Thickness and structure of the wall are variable depending on the

degree of secondary mineralization of the test. Septa closely spaced, planar, and curved anteriorly. 21 to 23 septa are counted in the last whorl. Tunnel is narrow and low, and its path nearly straight bordered by asymmetrical chomata. Low chomata unclearly present, but not found in specimens due to secondary mineralization.

Remarks: Although illustrated specimens are smaller than those from the Lower Permian of the Akiyoshi Limestone (Kobayashi, 2017) and from limestone fragments of the Tsunemori Formation (Kobayashi, 2012b), other test characters resemble each other, by which they are referable to *Nankinella nagatoensis*. This species differs from *Nankinella akiyoshiensis* in its thicker lenticular test with less sharply pointed periphery. Toriyama (1958) classified unnamed *Nankinella* into three forms. They are not easily distinguished from this species.

Nankinella kotakiensis (Fujimoto & Kawada, 1953), *N. kawadai* (Hy. Igo, 1956), and *N. kozakiensis* Kanmera, 1963 have larger test with more pointed periphery and more whorls than this species. The first and second species were assigned to *Hayasakaina* proposed by Fujimoto & Kawada (1953), a junior synonym with *Nankinella* according to Kobayashi (2011). The first was originally described from the Lower Permian of the Omi Limestone, the second from the Lower Permian pebbles in the Fukuji area, and the third from the Middle Permian Kozaki Formation in Kyushu. *Nankinella nagatoensis* is easily distinguished from the Early and Middle Permian *Nankinella*, e.g., *N. orbicularia* Lee, 1934 and *N. hunanensis* (Chen, 1956) from South China (e.g., Lee, 1934; Chen, 1934, 1956; Sheng, 1956) in having smaller test and fewer whorls.

Occurrence and stratigraphic distribution: Common to rare in the *Paraleeina magna* Zone (Ak-192, Ak-203), *Misellina dyhrenfurthi* Zone (Ak-91), *Cancellina pamirica* Zone (Kz-5), *Parafusulina kaerimizensis* Zone (Kz-11B), and *Afghanella schencki* Zone (Ak-86, 87, 184C).

Genus *Pseudoreichelina* Leven, 1970b

Type species: *Pseudoreichelina darvasica* Leven, 1970b, p. 19.

***Pseudoreichelina darvasica* Leven, 1970b**

Pl. III, figs 12-14, 15(?), 17-19

1970b. *Pseudoreichelina darvasica* Leven, pp. 19-20, pl. 1, figs 6-13.

1992a. *Pseudoreichelina darvasica* Leven.– Ueno, pp. 8, 10, fig. 5.1-16.

2017. *Pseudoreichelina darvasica* Leven.– Kobayashi, p. 34, pl. 1, figs 39-40, 42-43.

Remarks: The present specimens are assigned to *Pseudoreichelina* from the construction of the recrystallized test of early coiled part and later rectilinear

part. The number of whorls of early coiled part is variable within the same sample as well as by samples from different stratigraphic levels. These specimens are similar to and identified with the types of Leven (1970b) from the Artinskian of southwest Darvas in the size and construction of the test, as well as those from the *Paraleeina magna* Zone in the Wakatakeyama area (Kobayashi, 2017). They are different from *Pseudoreichelina slovenica* (Kochansky-Devidé, 1966) from Slovenia (Kochansky-Devidé, 1966) and the Akasaka Limestone (Kobayashi, 2011) in having thicker lenticular whorls in the coiled part of the test. One specimen of unnamed *Pseudoreichelina* (Pl. III, fig. 20) is separated from *P. darvasica* by its larger test with more chambers in the rectilinear part. It might be compared to *P. nevadaensis* proposed by Douglass & Nestell (1974) from the Leonardian of Nevada from its similar size and shape of the rectilinear part of the test.

In addition to *P. darvasica*, Ueno (1992a) recognized many forms of *Pseudoreichelina* and *Rectomillerella*? from the Kaerimizu area, and discussed on the taxonomic and phylogenetical problems of them. He subdivided *Pseudoreichelina* from Kaerimizu into six species including two new species, *P. discoidea* and *P. endothyroidea*, having well-developed, rectilinear, uniserial part of the test. These highly elongate forms were not found out in the present materials.

Occurrence and stratigraphic distribution: Rare in the *Paraleeina magna* Zone (Ak-203), *Cancellina pamirica* Zone (Kz-32), *Parafusulina kaerimizensis* Zone (Kz-K), *Neoschwagerina craticulifera* Zone (Ak-88, 182C), and *Afghanella schencki* Zone (Ak-86).

Genus *Palaeostaffella* Liêm, 1966

Type species: *Staffella moelleri* Y. Ozawa, 1925b, p. 19.

Diagnosis and age emended: Staffellids having less than seven whorls gradually expanding outward without tightly coiled inner whorls, thick wall composed of a tectum, thin upper layer, and thicker, less dense lower layer showing fibrous structure, and large proloculus for the test size. They are confined to middle to late Cisuralian.

Remarks: *Staffella moelleri*, proposed by Y. Ozawa (1925b) based on one axial section from the Akiyoshi Limestone, is considerably different from the type species of *Staffella*, *Fusulina sphaerica* Abich, 1859 (= *Staffella moellerana* Thompson, 1935), and most species of the genus in its absence of tightly coiled inner whorls, fewer whorls, and thicker wall and larger proloculus for the test size. This species was designated as the type species of *Palaeostaffella* by Liêm (1966).

Y. Ozawa (1925b) gave the Moscovian age for *Staffella moelleri*, though he did not show associated fusulines with this species. Toriyama (1958) regarded *S. moelleri* ranging from the Cm β (Moscovian) to the Pi β (Artinskian) in the Akiyoshi Limestone. However,

staffellids assignable to *Palaeostaffella* are confined to the *Paraleeina magna* Zone to the *Misellina claudiae* Zone (Fig. 3). *Palaeostaffella* has not been found from the Pennsylvanian and Asselian of the Akiyoshi Limestone (Kobayashi, 2017). Accordingly, Yakhtashian to early Kubergandian age is labeled to *Palaeostaffella* instead of Moscovian as assumed by Y. Ozawa (1925b) and Liêm (1966).

***Palaeostaffella moelleri* (Y. Ozawa, 1925b)**

Pl. IV, figs 29, 30, 32-34

1925b. *Staffella moelleri* Y. Ozawa, pp. 19-20, pl. 2, fig. 9.

1958. *Staffella moelleri* Y. Ozawa.– Toriyama, pp. 71-73, pl. 6, figs 29-34.

Remarks: Five specimens herein illustrated resemble original Y. Ozawa's one specimen reassigned to *Palaeostaffella*. Appearance of thinner wall in specimens of the present material is due to stronger recrystallization of the outer test. *Staffella yowarensis* Y. Ozawa, 1925b, described from presumably Artinskian of the Akiyoshi Limestone, is not easily distinguished from this species because of incomplete specimens absent in outer whorls in the original description by Y. Ozawa (1925b).

Occurrence and stratigraphic distribution: Rare in the *Pamirina leveni* Zone (Ak-189) and common in the *Misellina claudiae* Zone (Kz-68).

***Palaeostaffella akudensis* (Hh. Igo, 1996)**

Pl. IV, figs 26-28, 31

1996. *Sphaerulina akudensis* Hh. Igo, pp. 627-628, fig. 11.9-14.

2017. *Staffella?* sp. Kobayashi, p. 36, pl. 3, figs 24-31.

Remarks: The present, and the Wakatakeyama materials of Akiyoshi named as *Staffella?* sp. (Kobayashi, 2017) are identical with "*Sphaerulina*" *akudensis* described by Hh. Igo (1996) from the Lower Permian of Hachiman, Mino Terrane. These materials are common in their smaller test with fewer whorls and larger proloculus than *Palaeostaffella moelleri*. The Hachiman material is not assigned to *Sphaerulina* because of absence of tightly coiled lenticular inner whorls.

Occurrence and stratigraphic distribution: Common to rare in the *Pamirina leveni* Zone (Ak-202, Kz-70), *Misellina dyhrenfurthi* Zone (Kz-37), and *Misellina claudiae* Zone (Kz-68).

***Palaeostaffella subquadrata* n. sp.**

Pl. IV, figs 35-40

Etymology: From the subquadrata test.

Type specimens: Holotype D2-049787 (axial section, Pl. IV, fig. 40). Paratypes: three axial and two sagittal

sections illustrated in Pl. IV. Their register numbers are shown in the explanation of Pl. IV.

Type Locality: Outcrops (Ak-189, 203) along the Akiyoshi-dai Road running across the Kaerimizu area, Shuho-cho, Mine City, Yamaguchi Prefecture.

Diagnosis: Nearly quadrate test with obtuse edges and shallow umbilical cavities, large proloculus for the test, and weakly recrystallized thick wall and septa.

Description: Test nearly quadrate with obtuse edges and shallow umbilical cavities. Axis of coiling almost straight. Mature test is with six whorls, 1.0 to 1.5 mm in length, 1.3 to 1.5 mm in width, and 0.8 to 1.0 in form ratio. Proloculus spherical to subspherical, and 0.90 to 0.152 mm in longer diameter. Inner one to two whorls are subspherical and loosely coiled. The subsequent whorls nearly quadrate, and gradually increasing their length and width. Approximate length, width, and form ratio from the first to the sixth whorls in the holotype, though penetrated by veinlets, are 0.21, 0.35, 0.57, 0.80, 1.13, and 1.38 mm; 0.28, 0.41, 0.63, 0.85, 1.17, and 1.47 mm; and 0.76, 0.86, 0.89, 0.94, 0.97, and 0.94, respectively.

Septa thick and planar. Septal counts from the first to the fifth whorls in the paratype (Pl. IV, fig. 38) are 6, 12, 18, 18, and more than 15 (possibly 20). Wall thick, weakly recrystallized, and composed of a tectum, thin upper layer, and thicker, less dense lower layer showing fibrous structure. Discontinuous diaphanotheca-like layer is accompanied in the lower layer in outer whorls. Tunnel narrow and low, and its path roughly straight. Asymmetrical, low chomata developed in inner whorls. They are not discriminated in specimens due to secondary mineralization and micritization of the test.

Material examined: Six type and other incomplete specimens.

Remarks: This new species is assigned to *Palaeostaffella* rather than to *Sphaerulina* from its absence of tightly coiled inner lenticular whorls, fewer whorls, and thicker wall with finely fibrous structure. It is different from *Palaeostaffella moelleri* and *P. akudensis* by its larger test and thicker wall with more distinct fibrous structure. *Palaeostaffella subquadrata* is somewhat similar to *Sphaerulina croatica* established by Kochansky-Devidé (1965) from the lower Middle Permian of Croatia in shape and size of the test. However, the former is distinguished from the latter by having larger proloculus and fewer whorls. Moreover, the test is gradually expanding outward without distinct juvenile whorls in the former. By these test characters, this new species is similarly distinguished from *Staffella? ovalis* Hy. Igo, Ueno & Sashida, 1993 and *Sphaerulina* cf. *croatica* from the Lower Permian of northeast Thailand (Hy. Igo *et al.*, 1993). Subquadrate outline of both inner and outer whorls conspicuous to this new species resembles that of the *Staffella lacunose* Dunbar & Skinner, 1937 described from the type Leonardian in the Glass Mountains, Texas (Dunbar & Skinner, 1937). However, the present new species has thicker wall, larger proloculus, and fewer whorls than the Texas species.

Occurrence and stratigraphic distribution: Common to rare in the *Paraleeina magna* Zone (Ak-203) and *Pamirina leveni* Zone (Ak-189).

Family Schubertellidae Skinner, 1931

Subfamily Schubertellinae Skinner, 1931

Genus *Mesoschubertella* Kanuma & Sakagami, 1957

Type species: *Mesoschubertella thompsoni* Sakagami in Kanuma & Sakagami, 1957, p. 43.

Junior synonym:

Multialveoella Li, 1986, p. 82 (type species, *M. guangxiensis* Li, 1986).

Remarks: The “diaphanotheca” of the genus in the original description (Kanuma & Sakagami, 1957) seems to be not true diaphanotheca recognized in fusulines belonging to the Family Fusulinidae but less dense, finely granular translucent layer according to my observation of many materials of Japan (e.g., Kobayashi, 2005c). *Multialveoella* is considered to be a junior synonym of *Mesoschubertella* and four new species of *Multialveoella* by Li (1986) are conspecific, as suggested by Kobayashi (2005c).

***Mesoschubertella* sp.**

Pl. IV, fig. 21

Remarks: The illustrated specimen of thick fusiform test with broadly rounded poles is strictly discriminated from many species of *Neofusulinella* from the Kaerimizu area by its thicker wall composed of a tectum and distinct, finely granular, translucent layer, by which it is belonged to a species of *Mesoschubertella*. Although well-oriented specimens were not obtained, the Kaerimizu specimens closely resemble *M. thompsoni* from the eastern part of the Kanto Mountains showing broad intraspecific variation in many respects (Kobayashi, 2005c).

Two new species of *Mesoschubertella* were proposed by Ueno (1996a) from the middle and upper Cisuralian of Kaerimizu. *Mesoschubertella sakagamii* is similar to *M. thompsoni* but has smaller test and thinner wall, by which its reassignment might be needed. The other *Mesoschubertella akiyoshiensis* has smaller test and more distinct and more numbers of tightly coiled inner whorls than *M. sakagamii*.

Occurrence and stratigraphic distribution: Rare in the *Paraleeina magna* Zone (Ak-203).

Genus *Neofusulinella* Deprat, 1912

Type species: *Neofusulinella lantenoisi* Deprat, 1913, p. 41.

***Neofusulinella giraudi* Deprat, 1915**

Pl. V, figs 15-19, 21-22

1915. *Neofusulinella giraudi* Deprat, pp. 11-12, pl. 1, figs 6-11.

2011. *Neofusulinella giraudi* Deprat.– Kobayashi, pp. 464-465, pl. 5, figs 1-34.

Remarks: Size and shape of the test, almost planar septa, and relatively thick wall for the test size of the present material well resemble those of the original ones by Deprat (1915) from the Middle Permian of Laos. More or less depressed appearance of polar regions of the test in some specimens (Pl. V, figs 21-22) is due to the abrasion of a part of the outer test, as well as found in some specimens of this species described from the *Cancellina nipponica* and *Neoschwagerina simplex* zones of the Akasaka Limestone by Kobayashi (2011).

Occurrence and stratigraphic distribution: Common to rare in the *Misellina claudiae* Zone (Kz-M, Ak-92) and *Cancellina pamirica* Zone (Kz-46).

Neofusulinella phairayensis Colani, 1924

Pl. V, fig. 37

1924. *Neofusulinella phairayensis* Colani, pp. 104-105, pl. 16, figs 1-5, 7-10, 12-16, 20-22.
2011. *Neofusulinella phairayensis* Colani.– Kobayashi, p. 465, pl. 5, figs 35-54.

Remarks: Some specimens of *Neofusulinella* from the *Parafusulina kaerimizensis* and *Neoschwagerina craticulifera* zones are similar to *Neofusulinella giraudi* in their test construction, but length and width of corresponding whorls are greater than those of *N. giraudi*. Although well-oriented mature specimens are few, they are probably identical with *N. phairayensis* originally described by Colani (1924) from northern Viet-Nam and recently by Kobayashi (2011) from the lower and middle parts of the Middle Permian (*Cancellina nipponica* Zone to *Neoschwagerina craticulifera* Zone) of the Akasaka Limestone.

Occurrence and stratigraphic distribution: Rare in the *Neoschwagerina craticulifera* Zone (Kz-63) and *Parafusulina kaerimizensis* Zone.

Neofusulinella simplex (Lange, 1925)

Pl. V, figs 20, 23-24

1925. *Schubertella simplex* Lange, p. 254, pl. 3, figs 60a-c, 60d (?).
1988a. *Neofusulinella simplex* (Lange).– Kobayashi, p. 5, pl. 3, figs 10-13.

Remarks: Kobayashi (1988a) identified schubertellid specimens from the Omi Limestone with Lange's (1925) *Schubertella simplex* originally described from Padang (Sumatra) by their similar test size and incipient chomata. He reassigned the species to *Neofusulinella* on account of having relatively thick wall composed of a tectum and thicker transparent to translucent layer with mural pores. Detailed comparison between the present and the original

materials is difficult because of no axial sections in the latter. However, the present material closely resembles and identical with the Omi's material in size, shape and expansion of the test, and thickness and composition of wall.

Occurrence and stratigraphic distribution: Common to rare from the *Misellina claudiae* Zone (Kz-M) to the *Parafusulina kaerimizensis* Zone (Ak-182A).

Neofusulinella uenoi n. sp.

Pl. IV, figs 10, 17, 22-25; Pl. V, figs 1-5

Etymology: From Katsumi Ueno for his great contribution to fusuline works.

Type specimens: Holotype D2-056113 (axial section, Pl. V, fig. 2). Paratypes: two axial, two sagittal, three tangential, one parallel, and two oblique sections illustrated in Pl. IV and V. Their register numbers are shown in the explanation of Pl. IV and V.

Type Locality: Western slope of the Kaerimizu Doline (220 m WSW of the bottom of the doline), Shuho-cho, Mine City, Yamaguchi Prefecture.

Diagnosis: Medium-sized *Neofusulinella* characterized by closely spaced planar septa reaching to the base of chambers, and low, narrow, straight tunnel bordered by massive, almost symmetrical, node-like chomata a half to two-thirds as high as chambers.

Description: Test inflated fusiform with arched periphery and rounded poles. Mature test with 4.5 to 5.5 whorls, and length 0.75 to 1.02(?) mm, width 0.43 to 0.67 mm, and form ratio about 1.2 to 1.4. Proloculus spherical and 0.027 to 0.031 mm in diameter. Inner one and a half to two whorls eostaffelloid and tightly coiled and, with a sharp change of axis of coiling, succeeding whorls inflated fusiform to oval and expanding gradually outward.

Wall is rather thick for the test size, less than 0.01 mm in inner whorls and less than 0.03 mm in outer whorls. Partial appearance of 0.04 to 0.05 mm thick in the last one or two whorls is due to secondary coating of translucent calcareous materials. Wall is not differentiated in inner whorls, and consists of a tectum and underlying thicker, translucent, finely perforate layer in outer whorls.

Septa closely spaced, gently inclined anteriorly, and almost plane. Those of inner whorls reach to the base of chambers. Some septa in outer whorls also reaching to the base of chambers. Septal counts attain to 11 in the first whorl, and 18 to 21 in the last whorl. Tunnel is low, narrow, straight, and bordered by well-developed, massive, almost symmetrical, node-like chomata a half to two-thirds as high as chambers in outer whorls. Tunnel angle 15 to 20 degrees.

Remarks: This new species is proposed on the basis of massive chomata almost symmetrically arranged in both sides of low, narrow and straight tunnel. Node-like chomata do not extend to poleward. These features are seldom recognized in the known species of

Neofusulinella. This new species somewhat resembles *Yangchienia primaris* proposed from the Yakhtashian of Darvas (Leven in Leven *et al.*, 1992) and *Yangchienia compressaeformis* from the Bolorian of eastern Iran (Leven in Leven & Mohaddam, 2004) in well-developed massive chomata and the coiling pattern and size of the test. However, chomata of the former are taller and do not extend to poleward as those of the latter two. Moreover, wall structure is different between the present new and Darvas and Iranian species. Leven considered that the latter two species are the oldest and most primitive representatives of the genus *Yangchienia*.

Neofusulinella uenoi can not be assigned to *Yangchienia* by its smaller number of whorls, the mode of test expansion much more rapidly expanding in outer whorls, node-like chomata not extending to polewards, and wall structure lacking an apparent transparent layer comparable to diaphanotheca. It is discriminated from *Yangchienia?* sp. in this paper by its smaller test with fewer whorls, and thicker and more distinct perforated wall in outer whorls.

Occurrence and stratigraphic distribution: Common to rare in the *Cancellina pamirica* Zone (Kz-3, 5, 7, 8, 48).

Neofusulinella sp. A

Pl. V, figs 6-11

Description: Test fusiform to elongate fusiform with broadly arched periphery, nearly straight lateral slopes, and bluntly pointed poles. Mature test consists of four and a half to five and a half whorls, 0.85 to 1.31 mm in length, 0.40 to 0.63 mm in width, and 1.8 to 2.3 in approximate form ratio. Proloculus is spherical and less than 25 microns in diameter. Inner one or two whorls endothyroidly and tightly coiled and followed by the succeeding fusiform whorls with a sharp change of axis of coiling.

Wall is thin and as thick as 23 to 30 microns in the last two whorls. Wall is structureless in juvenile whorls, and consists of a tectum and underlying thicker, finely perforated, translucent layer. Septa almost plane throughout the test except for very weakly folded in polar regions of the last whorl in specimens. Tunnel narrow and its path roughly straight bordered by distinct chomata.

Remarks: Illustrated six and other specimens appear *Schubertella* in their shape and size of the test. However, they are eliminated from *Schubertella* and assigned to *Neofusulinella* on account of their wall structure with distinct perforation of the translucent layer. They are easily distinguished from the species of the genus described above by their elongate test, and not belonged to *Dunbarula* by their almost planar septa.

Occurrence and stratigraphic distribution: Rare in the *Misellina dyhrenfurthi* Zone (Kz-37), *Misellina claudiae* Zone (Ak-92), and *Cancellina pamirica* Zone (Kz-5, 7).

Neofusulinella sp. B

Pl. V, fig. 32

Remarks: Among the various forms of *Neofusulinella* described above, *Neofusulinella* sp. B is more or less similar to *N. giraudi* and *N. sp. A*. Although the outermost part of the test is worn, it is distinguished from the former by more slowly and gradually expanding whorls, thicker wall, and possibly more pointed poles in outer whorls, and done from the latter by its more inflated fusiform test and thicker wall.

Occurrence and stratigraphic distribution: Rare in the *Cancellina pamirica* Zone (Kz-46).

Genus *Schubertella* Staff & Wedekind, 1910

Type species: *Schubertella transitoria* Staff & Wedekind, 1910, p. 112.

Schubertella melonica Dunbar & Skinner, 1937

Pl. V, figs 12-14

1937. *Schubertella melonica* Dunbar & Skinner, pp. 611-613, pl. 57, figs 10-14.

2007. *Schubertella melonica* Dunbar & Skinner.– Kobayashi & Adachi, p. 25, pl. 2, figs 13-22.

2012b. *Schubertella melonica* Dunbar & Skinner.– Kobayashi, fig. 7.7, 9-15.

Remarks: This species was proposed from the Leonardian of southernmost Mexico (Dunbar & Skinner, 1937) and was distinguished from *Schubertella kingi* Dunbar & Skinner, 1937 by its inflated fusiform test and thicker wall. In Japan, specimens identified with this species are reported from limestone fragments of the Lower Cretaceous Sasayama Group (Kobayashi & Adachi, 2007) and those of the Permian Tsunemori Formation (Kobayashi, 2012b). These limestone fragments are considered to have been derived from the Akiyoshi Terrane (Kobayashi & Adachi, 2007) and the Akiyoshi Limestone (Kobayashi, 2012b), respectively. Along with Sasayama and Tsunemori materials, the Kaerimizu specimens are identified with the types, though having smaller proloculus and somewhat smaller test.

This species is not assigned to *Neofusulinella* but to *Schubertella* on account of its thinner wall and its wall structure without distinct perforation of the translucent layer. It is similar to *Schubertella mullerriedi* Thompson & Miller, 1944 from the Leonardian of southernmost Mexico. However, the latter has much larger test and more whorls than the former.

Occurrence and stratigraphic distribution: Rare in the *Pamirina leveni* Zone (Ak-191), *Misellina dyhrenfurthi* Zone (Ak-91), and *Cancellina pamirica* Zone (Kz-7).

***Schubertella? karasawensis* Kobayashi, 2006b**

Pl. III, figs 39-40

2006b. *Schubertella? karasawensis* Kobayashi, pp. 67, 71, fig. 8.16-25.2011. *Schubertella? karasawensis* Kobayashi.– Kobayashi, p. 466, pl. 3, figs 52-53.

Remarks: Small and subspherical schubertellids of the present materials agree well with the Kuzu (Kobayashi, 2006b) and Akasaka (Kobayashi, 2011) ones in their subspherical test, chamber arrangement, and wall structure composed of very thin tectum and underlying much thicker translucent layer. Sizes of corresponding whorls and proloculus of this species are considerably smaller than those of associated fusulines as well as in the Kuzu and Akasaka materials.

They resemble “*Schuberterina circuli* Marshall, 1969” reexamined closely by Davydov (2011) and four species of *Semistaffella* described by Kobayashi (2019), both of which are early Pennsylvanian in age, in their small and subspherical test with relatively large proloculus, few whorls, and irregularly changeable axis of coiling. In this paper, however, they are also questionably assigned to *Schubertella* because of their thicker wall than that of “*Schubertellina*” and *Semistaffella*.

Occurrence and stratigraphic distribution: Rare in the *Pamirina leveni* Zone (Ak-200, 201).

Genus *Toriyamaia* Kanmera, 1956

Type species: *Toriyamaia laxiseptata* Kanmera, 1956, p. 252.

***Toriyamaia laxiseptata* Kanmera, 1956**

Pl. IV, figs 1-4

1956. *Toriyamaia laxiseptata* Kanmera, pp. 252-255, pl. 36, figs 1-14.2005c. *Toriyamaia laxiseptata* Kanmera.– Kobayashi, p. 16, pl. 2, figs 12-13.2011. *Toriyamaia laxiseptata* Kanmera.– Kobayashi, p. 467, pl. 3, figs 1-5, 10-12, 14-15.

Remarks: The illustrated specimens are undoubtedly identified with types from Uminoura, Kyushu by Kanmera (1956). This species is distinguished from *Rauserella ellipsoidalis*, described above, in having fewer and rounded juvenile whorls. In Japan, *Toriyamaia* is common in the upper Cisuralian limestones in the Jurassic terranes. The present report of the occurrence of *Toriyamaia* is the first from the Permian terranes of Japan.

Occurrence and stratigraphic distribution: Rare in the *Misellina dyhrenfurthi* Zone (Kz-37, Ak-91).

Genus *Yangchienia* Lee, 1934

Type species: *Yangchienia iniqua* Lee, 1934, p. 14.

Yangchienia? sp.

Pl. IV, figs 18-20

Remarks: More than 15 specimens of schubertellids with six to seven whorls are distinguished, though well-oriented sections are few. They are supposed better to be included in *Yangchienia* rather than in *Neofusulinella* from the development pattern of chomata extending poleward. However, mode of the test expansion of them is different from that of the known species of *Yangchienia*, and length and height of the last one to two whorls are more rapidly increasing than those of the preceding whorls. These specimens, accordingly, are questionably belonged into *Yangchienia*.

Occurrence and stratigraphic distribution: Rare in the *Cancellina pamirica* Zone (Kz-2, 3, 7).

Subfamily Boultoniinae Skinner & Wilde, 1954

Genus *Codonofusiella* Dunbar & Skinner, 1937

Type species: *Codonofusiella paradoxica* Dunbar & Skinner, 1937, p. 606.

Codonofusiella? sp.

Pl. V, fig. 38

2012b. *Codonofusiella* sp. B Kobayashi, fig. 7.24-25, 27-28, 31-32.

Remarks: Only one well-oriented specimen and others questionably assigned to *Codonofusiella* were obtained in association with *Afghanella schencki* and others. They might be conspecific with six specimens named as *Codonofusiella* B illustrated in Kobayashi (2012b) without description from the limestone fragments of the Tsunemori Formation. These specimens from Kaerimizu and Tsunemori are common in their elongate fusiform to subellipsoidal test with obscure uncoiled terminal whorl.

Occurrence and stratigraphic distribution: Rare in the *Afghanella schencki* Zone (Ak-188).

Genus *Dunbarula* Ciry, 1948

Type species: *Dunbarula mathieui* Ciry, 1948, p. 108.

***Dunbarula schubertellaeformis* Sheng, 1958**

Pl. V, figs 25-31, 33-34

1958. *Dunbarula schubertellaeformis* Sheng, p. 283, pl. 1, figs 8-12; pl. 4, fig. 6.2006b. *Dunbarula schubertellaeformis* Sheng.– Kobayashi, fig. 7.16-39.2010. *Dunbarula schubertellaeformis* Sheng.– Kobayashi, fig. 5.4-6.2012b. *Dunbarula schubertellaeformis* Sheng.– Kobayashi, fig. 7.24-25, 27-28, 31-32.

Remarks: This species was originally described from the Maokou Limestone in Qinghai in association with *Neoschwagerina cheni* and *Afghanella schencki* (Sheng,

1958). It is also reported from the Wordian (Kobayashi, 2006b, 2012b) and Capitanian (Kobayashi, 2010) limestone blocks and fragments in Japan. Although axial and tangential sections illustrated herein are incomplete due to abrasion of outer test, they are identical with the Qinghai and three materials of Japan from the similarities of their shape and size of the test and corresponding whorls, and the mode of septal folding.

Occurrence and stratigraphic distribution: Rare in the *Afghanella schencki* Zone (Kz-57; Ak-86, 187), *Neoschwagerina craticulifera* Zone (Kz-24, 63), *Parafusulina kaerimizensis* Zone (Ak-180), and *Cancellina pamirica* Zone (Kz-49).

***Dunbarula aff. tumida* Skinner, 1969**

Pl. V, figs 35-36, 39-40, 44-46

Related to:

1969. *Dunbarula tumida* Skinner, p. 7, pl. 9, figs 2-7; pl. 10, figs 1-7; pl. 11, figs 1-3.

Remarks: Seven specimens illustrated herein are easily distinguished from the previously reported forms of *Dunbarula* from the Japanese Middle Permian in their larger test and more strongly folded septa. They are related to *Dunbarula tumida* from the upper Middle Permian of Turkey (Skinner, 1969) in their common morphologic features of shape, size, and mode of expansion of the test, and intensity of septal folding. *Dunbarula tumida* is similar to *Dunbarula mathieui*, but is different in its smaller test, fewer and more rapidly expanding outer whorls, and weaker septal folding.

Occurrence and stratigraphic distribution: Common to rare in the *Afghanella schencki* Zone (Ak-184C, 187, 188) and rare in the *Neoschwagerina craticulifera* Zone (Kz-62).

Genus *Minojapanella* Fujimoto & Kanuma, 1953

Type species: *Minojapanella elongata* Fujimoto & Kanuma, 1953, p. 150.

***Minojapanella elongata* Fujimoto & Kanuma, 1953**

Pl. III, figs 31, 33

1953. *Minojapanella elongata* Fujimoto & Kanuma, pp. 150-152, pl. 19, figs 1-11

1988a. *Minojapanella elongata* Fujimoto & Kanuma.– Kobayashi, p. 6, pl. 3, figs 17-22.

Remarks: Although specimens obtained in this study are all fragmented and excentered, they are assigned to *Minojapanella elongata* by their subcylindrical test with thin translucent wall partly showing hyaline appearance, and closely spaced and intensely folded septa. In Japan, *Minojapanella* is characteristic in the upper Lower to lower Middle Permian limestone blocks of the Jurassic terranes. Though rare, its distribution extends to the South Kitakami Terrane (Kanmera & Mikami, 1965) and the Akiyoshi Terrane (Kobayashi, 1988a).

Occurrence and stratigraphic distribution: Rare in the upper part of the *Misellina claudiae* Zone and the uppermost part of the *Cancellina pamirica* Zone (Kz-49).

Family Schwagerinidae Dunbar & Henbest, 1930

Genus *Chusenella* Hsu, 1942

Type species: *Chusenella ishanensis*, Hsu, 1942, p. 175.

***Chusenella conicocylindrica* Chen, 1956**

Pl. VII, figs 3, 5-16, 18, 20-25, 34-35

1956. *Chusenella conicocylindrica* Chen, pp. 42-43, pl. 4, figs 7-8.

1990. *Chusenella* sp. B, T. Ozawa & Kobayashi, pl. 10, figs 9-10.

par 2012b. *Chusenella conicocylindrica* Chen.– Kobayashi, fig. 10.6-8, [non fig. 10.2-3 = *Chusenella deprati* (Y. Ozawa, 1925b)].

Description: Test fusiform with broadly arched to almost straight periphery, nearly straight lateral slopes, and bluntly pointed poles. Mature test with seven to eight whorls, 5.85 to 6.8? mm in length, 2.3? to 2.69 mm in width, and about 2.3 to 2.6 in form ratio.

Proloculus is spherical and 0.11 to 0.20 mm in diameter. Inner two to three whorls are tightly coiled and later ones gradually increasing their length and width. Form ratio gradually increases from the first to third or fourth whorl, then decreasing outwards in most specimens. Poles are sharply pointed in inner and middle whorls.

Septa planar in the first to second whorls, moderately folded in the following two to three whorls, and intensely and rather regularly folded in further outer whorls. Septal counts from the first to seventh whorls 6, 10 or 11, 14 or 15, 15, 16 or 17, 22? or 23, and 23, respectively in the illustrated two sections shown in Pl. VII, figs 20, 22.

Wall very thin and not differentiated in the initial two whorls, then consisting of a tectum and alveolar keriotheca and gradually thickening outwards, and 0.08 to 0.10 mm in its thickest part of the outer whorl. It becomes partly thicker than the actual due to secondary coatings of calcareous materials. Wall gently corrugated partly in middle and outer whorls in specimens. Rudimentary chomata present on proloculus and in inner fusiform whorls where narrow and low tunnel present. Axial fillings well developed.

Remarks: This species established by Chen (1956) from the Middle Permian of Hunan, South China was distinguished from *C. deprati* (Y. Ozawa, 1925b) by having larger test, more whorls, and more intensely folded septa. These two species are assumed to be related each other, and not easily distinguished based on slight differences of those test characters, as Chen (1956) supposed a conspecific possibility of them. However, the former has more well-developed axial fillings than the latter. By these features, *Chusenella* sp. B illustrated by T. Ozawa & Kobayashi is supposed to be identical

with *C. conicocylindrica* rather than with *C. deprati*. Specimens with relatively large test with large proloculus in this species are similar to *Chusenella crassa* (Deprat, 1913), originally described from the “Upper Permian” of Pong-oua, Laos (Deprat, 1913), except for their more tightly coiled inner whorls.

Smaller specimens of the present material appear to be separated from this species and better to be identified with smaller and more elongate forms of the genus such as *C. tieni* (Chen, 1956). However, they are not eliminated from *C. conicocylindrica*, since smaller appearance of them is due to the abrasion of outer test or immature individuals of this species. This species is different from *Chusenella atlinensis* (Ross, 1971) from the Capitanian of British Columbia (Ross, 1971) and also reported from the Capitanian of the Akiyoshi Limestone (Kobayashi, 2012a) in its not so tightly coiled inner whorls and weaker development of axial fillings.

Two specimens among five illustrated by Kobayashi (2012b) as *Chusenella conicocylindrica* are herein transferred to *C. deprati* because of their weaker development of axial fillings. These five specimens are associated with *Colania douvillei* in limestone fragments of the Tsunemori Formation.

Occurrence and stratigraphic distribution: Common to rare in the *Parafusulina kaerimizensis* Zone (Ak-90, 180, 181, 182A), *Neoschwagerina craticulifera* Zone (Ak-88, 182B, 182D), and *Afghanella schencki* Zone (Ak-86, 184A, 184B, 184C, 187).

***Chusenella deprati* (Y. Ozawa, 1925b)**

Pl. VII, figs 1-2, 4, 17, 19

1912. *Fusulina exilis* Schwager, 1883.– Deprat, p. 24, pl. 7, fig. 16; pl. 8, figs 13-14.

1925b. *Schellwienia deprati* Y. Ozawa, pp. 34-35, pl. 5, figs 6-7.

? 1956. *Chusenella deprati* (Y. Ozawa).– Chen, pp. 42-43, pl. 2, figs 16-18.

par 2012b. *Chusenella conicocylindrica* Chen.– Kobayashi, fig. 10.2-3 (non fig. 10.6-8 = *Chusenella conicocylindrica*).

Remarks: This species was proposed by Y. Ozawa (1925b) based on specimens described as *Fusulina exilis* from Tonkin (Hanoi) by Deprat (1912) not from Akasaka (Japan) by Deprat (1914), and additional Akiyoshi specimens by Y. Ozawa (1925b). These two materials from Tonkin and Akiyoshi are probably conspecific by their similarities of test expansion of middle and outer whorls, poorly developed to almost absent axial fillings, and mode of septal folding. This species was reassigned to *Chusenella* by Chen (1956) due to tightly coiled inner whorls. Some specimens of *Chusenella conicocylindrica* illustrated by Kobayashi (2012b) are reassigned to *C. deprati*, as mentioned above.

Occurrence and stratigraphic distribution: Common to rare in the *Afghanella schencki* Zone (Ak-184A, 184B, 184C, 188).

***Chusenella schwagerinaeformis* Sheng, 1963**

Pl. VI, figs 7, 15-19

1963. *Chusenella schwagerinaeformis* Sheng, pp. 81-82, 211, pl. 23, figs 1-6.

Remarks: Six specimens illustrated are identified with *Chusenella schwagerinaeformis* by many similarities between them and the types from the Maokouan Stage (Wordian) of Guangxi (Sheng, 1963) in the mode of test expansion and septal folding, and the degree of development of chomata. Although some are more inflated than the types, they are also included in this species. Compared with the named species of Akiyoshi in this paper, they are distinguished from *C. deprati* by their more developed axial fillings, and from *C. conicocylindrica* by their larger proloculus and not so tightly coiled inner whorls, taking wide morphologic variations of these three species into account.

Chusenella sp. A in this paper (Pl. VI, fig. 20) differs from this species in its more inflated test with distinct concave lateral sides and protruding poles in outer whorls. *Chusenella* sp. B (Pl. VI, fig. 21) is separated from this species by its larger test and stronger axial fillings.

Occurrence and stratigraphic distribution: Common to rare in the *Parafusulina kaerimizensis* Zone (Ak-180), *Neoschwagerina craticulifera* Zone (Ak-182D), and *Afghanella schencki* Zone (Kz-13, 21A, 21B).

Genus *Cuniculinella* Skinner & Wilde, 1965b

Type species: *Cuniculinella tumida* Skinner & Wilde, 1965b, p. 84.

Junior synonym:

Chalaroschwagerina (*Cuniculina*) Leven in Leven & Mohaddam, 2004 (type species, *Parafusulina? vulgarisiformis* Morikawa, 1952).

Remarks: *Chalaroschwagerina* (*Cuniculina*) proposed by Leven in Leven & Mohaddam (2004) was distinguished from *Chalaroschwagerina* (*Chalaroschwagerina*) by the presence of cuniculi based on the Iranian material. It might be better to be treated as a junior synonym of the genus *Cuniculinella*, established by Skinner & Wilde (1965b), rather than to be done as an independent subgenus of *Chalaroschwagerina*. *Cuniculinella* and *Chalaroschwagerina* (*Cuniculina*) are common in the mode of septal folding producing cuniculi and the coiling pattern of the test, and not strictly differentiated in generic and/or subgeneric level despite of more or less dissimilarities of other test characters.

***Cuniculinella vulgarisiformis* (Morikawa, 1952)**

Pl. VI, figs 1

1936. *Pseudofusulina vulgaris* (Schellwien & Dyhrenfurth, 1909).—Huzimoto, pp. 75-77, pl. 11, figs 1-7.
 1952. *Parafusulina? vulgarisiformis* Morikawa, pp. 31-32, pl. 1, figs 1-4.
 1962. *Pseudofusulina globosa* (Deprat, 1912).—Ishizaki, pp. 149-150, pl. 8, fig. 6.
 2004. *Chalaroschwagerina* (*Cuniculina*) *vulgarisiformis* (Morikawa).—Leven in Leven & Mohaddam, p. 452, pl. 2, figs 2-6.
 2009. *Cuniculinella vulgarisiformis* (Morikawa).—Kobayashi in Kobayashi & Furutani, pp. 33-34, pl. 4, figs 20-22.

Remarks: The illustrated oblique axial and other oblique sections are similar to more well-oriented sections of *Cuniculinella vulgarisiformis* described by Kobayashi in Kobayashi & Furutani (2009) from the Lower Permian of Mt. Ryozen, Jurassic Mino Terrane in the mode of septal folding, though the present Kaerimizu specimens have smaller test and thinner wall in comparison with the Ryozen specimens. This species was originally assigned questionably to *Parafusulina* by Morikawa (1952) because of the presence of cuniculi. Although other diagnostic morphologic features are not definitely discernible from the Morikawa's (1952) types, Leven (1967) recognized the taxonomic validity of this species. As mentioned by Kobayashi in Kobayashi & Furutani (2009), the species to have been described from the Jurassic terranes of Japan as listed above are referable to *Cuniculinella vulgarisiformis*.

Occurrence and stratigraphic distribution: Rare in the *Pamirina leveni* Zone (Kz-70).

Genus *Laosella* Leven, 1997

Type species: *Fusulina gigantea* Deprat, 1912, p. 29.

Remarks: Kobayashi (1988b) showed that "*Parafusulina*" *gigantea* from the southern Kanto Mountains is largely different from the typical *Parafusulina* in its thicker wall and septa. However, he assigned it provisionally to *Parafusulina*. Leven (1997) proposed *Laosella* for schwagerinids with much thicker wall, much larger proloculus, and rather regularly folded septa than those of other schwagerinids, designating *Fusulina gigantea* as type species of the genus.

Schwagerinids referable to *Laosella* are common in the Middle Permian of the middle to eastern Tethyan regions (e.g., Deprat, 1913; Gubler, 1935; Sheng, 1963; Leven, 1967; Toriyama & Kanmera, 1979) and the Akiyoshi area (Toriyama, 1958; Kobayashi, 2012b). Kobayashi (1988b) pointed out that *Schwagerina ibukiensis* M. Kobayashi, 1957 from the Mino Terrane and *Schwagerina chiapasensis* Thompson & Miller, 1944 from southernmost Mexico are allied to "*Parafusulina*" *gigantea*. Reassignment of these two species to either *Laosella* or other genus would be postponed until another opportunity.

***Laosella edoensis* (Y. Ozawa, 1925b)**

Pl. XIII, figs 3, 5, 11-12

- par 1925b. *Schellwienia edoensis* Y. Ozawa, pp. 30-31, pl. 6, figs 2-3. (non pl. 6, fig. 1b = *Paraleeina akiyoshiensis*, n. sp.)
 1958. *Parafusulina edoensis* (Y. Ozawa).—Toriyama, pp. 197-200, pl. 33, figs 1-7; pl. 34, figs 1-6; pl. 35, figs 1-9; pl. 36, fig. 1.
 ? 1961. *Parafusulina edoensis* (Y. Ozawa).—Kawano, pp. 103-105, pl. 10, figs 4-7.
 non 1961a. *Pseudofusulina* aff. *edoensis* (Y. Ozawa).—Nogami, pp. 224-225, pl. 7, figs 7-9 (= indeterminate *Paraleeina*).
 non 1962. *Parafusulina edoensis* (Y. Ozawa).—Suyari, p. 30, pl. 9, fig. 6 (= indeterminate schwagerinid).
 non 1962. *Parafusulina edoensis* (Y. Ozawa).—Sheng, p. 428, pl. 1, figs 1-7.
 non 1963. *Parafusulina edoensis* (Y. Ozawa).—Sakaguchi, p. 108, pl. 9, fig. 3 [= *Parafusulina japonica* (Gümbel, 1874)].
 ? 1967. *Parafusulina edoensis* (Y. Ozawa).—Leven, p. 160, pl. 17, fig. 2.
 2012a. *Laosella edoensis* (Y. Ozawa).—Kobayashi, fig. 3.1
 2012b. *Laosella edoensis* (Y. Ozawa).—Kobayashi, p. 239, fig. 10.10-12, 15, 23.

Remarks: Y. Ozawa (1925b) presumed that this species is independent from similar species such as *Schellwienia gigantea* by its slenderer test and other features. This species, reassigned to *Parafusulina* since Toriyama (1958), might be a typical species of *Laosella* characterized by thick wall, large proloculus, and rather regularly folded septa. Toriyama (1958) designated the lectotype of this species for the specimen illustrated on pl. 6, fig. 2 in Y. Ozawa (1925b). *Laosella edoensis* has denser axial fillings than *L. gigantea* in all axial and oblique sections illustrated by Toriyama (1958) and in four axial sections by Kobayashi (2012b).

Identification of four specimens with the types by Kawano (1961) from the Ikadaba Formation in the Akiyoshi Terrane is doubtful from their thinner wall. Nogami's (1961a) specimens, thought to be allied to this species from the *Pseudofusulina kraffii magna* Subzone of the Atetu Limestone, are different from the types in having weaker septal folding and thinner wall. *Parafusulina edoensis*, in association with unnamed species of *Misellina*, described by Suyari (1962) from the Jurassic Chichibu Terrane of Shikoku is also not identical with the types of the Akiyoshi on account of its smaller test and smaller proloculus, thinner wall, and mode of test expansion. Sheng's (1962) seven specimens in association with *Misellina ovalis* (Deprat, 1915) from the Chihshian Stage (Kungurian) of northern Hebei are different from the topotypes of this species by its slower expansion of the test, smaller proloculus, thinner wall, and more regularly folded septa. Sakaguchi's (1963) specimen in association with

Neoschwagerina craticulifera from the Jurassic Tamba Terrane is also eliminated from this species in its thinner wall and probably transferred to *Parafusulina japonica* (Gümbel). Leven's (1967) specimen from the Murgabian of southeast Pamir somewhat resembles the specimens with short fusiform test of this species. However, it has weaker axial fillings and smaller proloculus. *Parafusulina nagatoensis* Kobayashi, 2012a in association with *Lepidolina shiraiwensis* is distinguished from both *Laosella edoensis* and *L. gigantea* in its smaller length and width of corresponding whorls, thinner wall, and weaker septal folding.

Occurrence and stratigraphic distribution: Common to rare in the *Afghanella schencki* Zone (Ak-184C, 187, 188).

Laosella gigantea (Deprat, 1913)

Pl. XIII, figs 1-2, 4, 6-10, 13

1913. *Fusulina gigantea* Deprat, pp. 29-30, pl. 1, figs 1-6.
 ? 1925b. *Schellwienia gigantea* (Deprat).— Y. Ozawa, pp. 32-33, pl. 4, fig. 9.
 1935. *Pseudofusulina gigantea* (Deprat).— Gubler, pp. 91-92, pl. 2, figs 4-5, 8-9; pl. 3, fig. 4.
 ? 1958. *Parafusulina gigantea* (Deprat).— Toriyama, pp. 200-203, pl. 36, figs 2-11.
 1963. *Parafusulina gigantea* (Deprat).— Sheng, p. 201, pl. 20, figs 1-5, 9, 11.
 1988b. "*Parafusulina*" *gigantea* (Deprat).— Kobayashi, pp. 439, 441, fig. 4.18.
 1990. *Parafusulina gigantea* (Deprat).— T. Ozawa & Kobayashi, pl. 10, figs 15-16.

Description: Test elongate fusiform to subcylindrical with bluntly to broadly rounded poles. Periphery and lateral slopes slightly convex to nearly straight. Axis of coiling is straight. Fully grown specimen illustrated in Pl. XIII, fig. 1 has 6.5 whorls, about 14.3 mm in length, 5.07 mm in width, and about 2.8 in form ratio.

Proloculus subspherical to short ellipsoidal and 0.44 to 0.69 mm in longer diameter. Inner one or two whorls subspherical to fusiform and succeeded by gradually expanding outer fusiform whorls. The number of whorl is few in comparison with large test. Approximate length, width, and form ratio from the first to sixth whorl of the specimen shown in Pl. XIII, fig. 1 are 1.4, 2.8, 4.3, 6.4, 9.3, and 12.7 mm; 0.94, 1.51, 2.16, 3.00, 3.88, and 4.69 mm; and 1.5, 1.9, 2.0, 2.1, 2.4, and 2.7, respectively. Length and width per a whorl are considerably variable from specimen to specimen depending on the proloculus size and the orientation of an axial section.

Septa closely spaced, and strongly folded throughout the test especially in polar regions. Septal loops narrow, as high as one fourth to three fourth of chamber heights in tunnel regions, and some loops reaching to the roof of chambers. Septal counts 6 to 10, 18 to 20, 24 to 30, 33 or 34, and 36? or 40 from the first to fifth whorl in three specimens. Wall relatively thin in the first to second

whorl, then thickend rather abruptly, and consists of a tectum and coarse alveolar keriotheca in middle and outer whorls.

Chomata rudimentarily present only on proloculus. Tunnel is narrow, and its path up to 35 degrees in outer whorls. Axial fillings are absent or restricted to inner whorls.

Remarks: Diagnostic characters of the types by Deprat (1913) are large proloculus, thick wall with coarse alveolar keriotheca throughout the test, and almost absence of axial fillings. On the other hand, Gubler (1935) included forms both with and without axial fillings into this species. Axial fillings are absent in the Sheng's (1963) all specimens illustrated from South China.

Among the materials illustrated from Japan, specimens from the southern Kanto Mountains (Kobayashi, 1988b) are the closest to the types, though their form ratio is smaller and the outermost whorl is abraded. The Akiyoshi specimens have not so regularly folded septa, thinner wall of inner few whorls, and poorly developed axial fillings in comparison with the types from the upper Middle Permian of Laos. This species is distinguished from *Laosella edoensis* by its absence or weaker development of axial fillings.

Occurrence and stratigraphic distribution: Common to rare in the *Afghanella schencki* Zone (Ak-184B, 184C, 185, 187, 188).

Genus *Nagatoella* Thompson, 1936

Type species: *Schellwienia ellipsoidalalis* Staff, 1912 var. *orientis* Y. Ozawa, 1925b, p. 22.

Remarks: *Nagatoella* is considered to have been derived from *Darvasites* A. D. Miklukho-Maklay, 1959 from its short ellipsoidal test, regularly folded septa, larger test with more whorls. It is distinguished from *Darvasites* by its absence of chomata in outer whorls in addition to larger test with more whorls. *Nagatoella kobayashii* Thompson, 1936 is supposed to be conspecific with *N. orientis*.

Three new species assigned to the genus *Nagatoella* were proposed from the Lower and lower Middle Permian of Japan: *N. fujimotoi* Morikawa, 1951 from the Chichibu Terrane of the Kanto Mountains, *N. ikenoensis* Morikawa & Isomi, 1961 from the Mino Terrane, and *N. minatoi* Kanmera & Mikami, 1965 from the South Kitakami Terrane. The first species is different from the type species in much smaller test, and smaller length and width of corresponding whorls, and is considered to be an independent species of the genus. The second and third species should be reassigned to *Darvasites*, as discussed by Kobayashi in Kobayashi & Furutani (2009). *Nagatoella* sp. by Kanmera (1963) from the Kozaki Formation of Kyushu and *Nagatoella? parva* Sheng, 1963 from the Chihisia Limestone in Guizhou (Sheng, 1963) are excluded from the genus and also included into *Darvasites*. In Japan, *Nagatoella* is almost restricted

to the Permian Akiyoshi Terrane but for an exceptional occurrence of *N. fujimotoi* from the Jurassic Chichibu Terrane of the Kanto Mountains.

***Nagatoella orientis* (Y. Ozawa, 1925b)**

Pl. V, fig. 41; Pl. VI, figs 10-14

- 1925b. *Schellwienia ellipsoidalis* Staff, 1912 var. *orientis* Y. Ozawa, pp. 22-23, pl. 6, fig. 1a; pl. 8, figs 3, 5.
 1936. *Nagatoella orientis* (Y. Ozawa).– Thompson, pp. 198-200, pl. 2, fig. 1 (= fig. 2).
 par 1936. *Nagatoella kobayashii* Thompson, pp. 200-202, pl. 2, figs 4-6.
 1958. *Nagatoella kobayashii* Thompson.– Toriyama, pp. 162-163, pl. 20, figs 6-9.
 1961. *Nagatoella kobayashii* Thompson.– Kawano, pp. 100-101, pl. 8, fig. 10.
 1961a. *Nagatoella kobayashii* Thompson.– Nogami, pp. 205-206, pl. 10, figs 9-11.
 1979. *Nagatoella orientis* (Y. Ozawa).– Li *et al.*, pl. 2, fig. 1.
 1985. *Nagatoella orientis* (Y. Ozawa).– Han, pl. 1, figs 9-11. (fig. 9 = pl. 2, fig. 1 by Li *et al.*, 1979)
 1990. *Nagatoella orientis* (Y. Ozawa).– T. Ozawa & Kobayashi, pl. 9, figs 7-9.
 1992. *Nagatoella* cf. *orientis* (Y. Ozawa).– Blome & Nestell, pl. 3, fig. 2.

Description: Test ellipsoidal with about 12 whorls, straight to broadly arched periphery, bluntly convex lateral slopes, broadly rounded poles, and straight axis of coiling. Approximate length, width, and form ratio are 7.7 to 7.9 mm, 3.2 to 4.2 mm, and 2.0 to 2.5, respectively. Proloculus nearly spherical and 0.21 to 0.28 mm in diameter. Inner few whorls relatively tightly coiled and succeeded by gradually expanding outer whorls. Septa regularly folded and coated by dense calcareous materials. Septal loops are regularly arranged, and about a half as high as chambers in the tunnel regions and become gradually higher laterally toward poles. Septal counts from the second to the eleventh whorl are 12>, 16, 18, 22, 20, 22, 26, 25, 27, and 29?, respectively. Wall less than 15 microns in its thickness and not differentiated in inner tightly coiled whorls, and consists of a tectum and alveolar keriotheca gradually thickening outward, attaining to 70 to 80 microns in outer few whorls. Tunnel straight, low, narrow with angles of about 20 degrees, and bordered by symmetrical chomata in inner and middle whorls. Tunnel path becomes broader and irregular, and chomata are not developed in outer whorls.

Remarks: The test of some specimens is more or less micritized and densely filled with dark calcareous materials. The specimen (Y. Ozawa, 1925b, pl. 6, fig. 1a) designated as the lectotype of “*N. kobayashii*” by Thompson (1936) is associated with a schwagerinid (Y. Ozawa, 1925b, pl. 6, fig. 1b). This schwagerinid was named as *Schellwienia edoensis* by Y. Ozawa (1925b) and *Parafusulina? edoensis* by Thompson (1936). It can

not be identified with the lectotype of *Laosella edoensis* designated by Toriyama (1958) and is probably referable to an incomplete, abraded specimen of *Paraleeina akiyoshiensis* n. sp., described below. Though incomplete, the specimen rarely yielded from Kz-4 (Pl. V, fig. 41) is also referable to *N. orientis*.

Nagatoella kobayashii is hardly distinguished from *N. orientis* by slight differences such as higher and narrower septal loops, less dense secondary deposits, and more slowly expanding outer whorls of the former than those of the latter, as pointed out by Thompson (1936) and Toriyama (1958). Kawano’s (1961) and Nogami’s (1961a) specimens named as *N. kobayashii* are also conspecific with *N. orientis*. The former was described from the Handa Limestone of the Akiyoshi Terrane and the latter from the Atetsu Limestone of the terrane. Most specimens previously assigned to *Nagatoella* reported from the Jurassic terranes of Japan should be eliminated from *Nagatoella* and included into *Darvasites* except for *N. fujimotoi*, as mentioned above.

Outside Japan, schwagerinids identical with *Nagatoella orientis* are reported from the Nandan Range, Northeast China (Li *et al.*, 1979; Han, 1985) and from the Baker Terrane, Oregon (Blome & Nestell, 1992).

Occurrence and stratigraphic distribution: Rare to common in the *Misellina claudiae* Zone (Kz-M, Ak-92) and rare in the *Cancellina pamirica* Zone (Kz-4).

Genus *Parafusulina* Dunbar & Skinner, 1931

Type species: *Parafusulina wordensis* Dunbar & Skinner, 1931, p. 258.

***Parafusulina kaerimizensis* (Y. Ozawa, 1925b)**

Pl. IX, figs 1-11; Pl. X, figs 1-20; Pl. XI, figs 1-14;
 Pl. XII, figs 1(?), 2-11

- 1925b. *Schellwienia kaerimizensis* Y. Ozawa, pp. 31-32, pl. 4, figs 6-7; pl. 6, fig. 5. (non pl. 4, fig. 5 = *Parafusulina yabei* Hanzawa, 1942)
 1925b. *Schellwienia granum-avenae* Roemer, 1880.– Y. Ozawa, pp. 29-30, pl. 6, fig. 6.
 non 1936. *Pseudofusulina kaerimizensis* (Y. Ozawa).– Huzimoto, pp. 65-67, pl. 7, figs 6-8; pl. 8, figs 1-4.
 non 1955. *Parafusulina kaerimizensis* (Y. Ozawa).– Morikawa, pp. 107-108, pl. 15, figs 11-13.
 non 1957. *Parafusulina kaerimizensis* (Y. Ozawa).– M. Kobayashi, p. 291, pl. 7, fig. 1.
 1958. *Parafusulina kaerimizensis* (Y. Ozawa).– Toriyama, pp. 194-197, pl. 30, figs 6-12; pl. 31, figs 1-8; pl. 32, figs 1-9.
 non 1959. *Parafusulina kaerimizensis* (Y. Ozawa).– Kanuma, pp. 81-82, pl. 9, figs 1-3.
 1961a. *Parafusulina kaerimizensis* (Y. Ozawa).– Nogami, pp. 207-208, pl. 8, figs 1-5.
 non 1962. *Parafusulina kaerimizensis* (Y. Ozawa).– Suyari, pp. 28-29, pl. 9, fig. 5.
 ? 1963. *Parafusulina* (*Parafusulina*) *kaerimizensis* (Y. Ozawa).– Kanmera, pp. 101-102, pl. 16, figs 6-7; pl. 17, figs 5-7; pl. 18, figs 5-8.

- non 1964. *Parafusulina kaerimizensis* (Y. Ozawa).– Hy. Igo, pp. 18-19, pl. 8, figs 1-5; pl. 9, figs 1-5.
 1977. *Parafusulina kaerimizensis* (Y. Ozawa).– M. Ota, pl. 1, figs 9-10.
 1988a. *Parafusulina* cf. *kaerimizensis* (Y. Ozawa).– Kobayashi, p. 7, pl. 3, figs 34-35; pl. 4, figs 1-13.
 1990. *Parafusulina kaerimizensis* (Y. Ozawa).– T. Ozawa & Kobayashi, pl. 9, figs 15-17.
 ? 2005a. *Parafusulina kaerimizensis* (Y. Ozawa).– Kobayashi, fig. 7.17-19.
 2012b. *Parafusulina kaerimizensis* (Y. Ozawa).– Kobayashi, pp. 237, 239, fig. 9.11-17.

Description: Test elongate fusiform to subcylindrical with straight to slightly concave periphery, straight to slightly convex lateral slopes, and bluntly pointed poles. Axis of coiling straight to slightly arcuate. Mature test with eight to nine, rarely ten whorls. Length is 7.1? to 14.63 mm, width 2.1? to 3.82? mm, and form ratio 3.2? to 4.6? in 21 axial and 10 sagittal sections.

Proloculus spherical to subspherical, 0.17 to 0.39 mm in diameter, averaging 0.27 mm in 56 specimens. Test tightly coiled in inner few whorls, then gradually increasing length and width. In 21 axial sections, length from the first to tenth whorls 0.38 to 0.98?, 0.92? to 2.1?, 1.37? to 3.5?, 2.20? to 4.92, 3.48? to 6.60, 3.9? to 8.36, 5.3? to 10.73, 6.8? to 13.78, 10.32 to 14.20, and 13.0? to 15.0? mm, though exactly uncertain on account of dense axial fillings in middle whorls of most specimens. In 31 axial and sagittal sections, width from the first to tenth whorls 0.25 to 0.51, 0.36 to 0.72, 0.50 to 1.02, 0.70 to 1.37, 1.01 to 1.82, 1.39 to 2.44, 1.78 to 2.80, 2.2? to 3.22, 2.73 to 3.56, and 3.39 mm.

Septa weakly folded in inner few whorls, and intensely and rather regularly folded in outer whorls resulting distinct cuniculi. Septal folds rather regular, about a half or more as high as chambers in the tunnel regions, gradually become higher laterally toward poles, and partly reaching the roof of chambers. Septal counts from the first to the ninth whorls 8 or 9, 14 to 19, 18 to 27, 23 to 30, 23 to 32, 28 to 37, 29 to 41, 34 to 41, 37 to 40 or more in ten sections.

Wall thin and alveolar structure is obscure in tightly coiled inner whorls. Its thickness is 10 to 30 microns in inner tightly coiled whorls and mostly about 80 to 95 microns in the thickest part of outer whorls. Rudimentary chomata present on proloculus and in the first to second whorls. Tunnel is relatively well discernible and its angle is as wide as 30 degrees in middle and outer whorls. Prenotheca not present throughout the test. Axial fillings well developed in middle whorls. They become less dense in outer one to three whorls. Degree and manner of their decrease are variable from specimen to specimen.

Remarks: The lectotype of this species was designated by Toriyama (1958) for the specimen illustrated by Y. Ozawa (1925b) on pl. 8, fig. 8. The specimen illustrated on pl. 4, fig. 5 in Y. Ozawa (1925b) from the Kuzu area is excluded from this species (Kobayashi, 1988a) and is

referable to an elongate form of *Parafusulina yabei*, as pointed out by Kobayashi (2012b). Y. Ozawa (1925b) described *P. kaerimizensis* based on only one sample from Kaerimizu, but later authors revealed that parafusulines referable to this species are abundant almost throughout the *Parafusulina kaerimizensis* Zone and range up to the *Neoschwagerina craticulifera* Zone. Toriyama (1958) showed many illustrations of this species, but most of them are incomplete without outermost whorl. Most specimens abundant in fusuline grainstones of the *Parafusulina kaerimizensis* Zone are incomplete due to the abrasion of outer test, as well as those compared to this species by Kobayashi (1988a) from the Omi Limestone on account of somewhat thicker wall in outer whorls. Y. Ozawa (1925b, p. 32) mentioned that this species is an intermediate form between *Parafusulina japonica* (Gümbel, 1883) and *P. lutugini* (Schellwien, 1908). However, *P. kaerimizensis* is largely different from the topotypes of *P. japonica* from the Akasaka Limestone (Kobayashi, 2011).

Many specimens of *Parafusulina* (*Parafusulina*) *kaerimizensis* described by Kanmera (1963) from the Kozaki Formation in Kyushu have thicker wall in inner corresponding whorls in comparison with the types. They have larger height in the corresponding outer whorls than the types and Nogami's (1961a) three axial sections from the Atetsu Limestone. Kanmera (1963) presumed that these differences fall within the intraspecific variation of this species. However, tightly coiled inner few whorls with thin wall characteristic in the types of Akiyoshi are indistinct in the Kozaki's specimens as well in Kobayashi's (2005a) from southern Kanto Mountains. Therefore, it is doubtful that these two examples are certainly identical with *P. kaerimizensis*. Specimens from the Kozaki and southern Kanto might be an ally of *Parafusulina* sp. A (Kobayashi, 2011, p. 477, pl. 14, fig. 11) from the Akasaka Limestone.

Toriyama (1958), Nogami (1961a), and Kanmera (1963) indicated the erroneous identification with *P. kaerimizensis* or its possibility for parafusulinids described from the Jurassic terranes of Japan by Huzimoto (1936), Morikawa (1955), M. Kobayashi (1957), Kanuma (1959), and Suyari (1962). Hy. Igo's (1964) material from the Nabeyama Formation in the Kuzu area is also separated from this species, as indicated by Kobayashi (2006a). Thus, in Japan, parafusulinids certainly identical with *P. kaerimizensis* are confined to those from the Permian Akiyoshi Terrane.

Occurrence and stratigraphic distribution: Abundant in many samples from the *Parafusulina kaerimizensis* Zone (Ak-180, 181, 182A; Kz-K, 10A, 12, 26) and *Neoschwagerina craticulifera* Zone (Ak-182B, 182C, 182D; Kz-62). Forms questionably referable to this species commonly occur in the *Afghanella schencki* Zone (Kz-21A, 21B).

***Parafusulina* sp.**

Pl. VIII, figs 17-22

- 1925b. *Schellwienia lutugini* (Schellwien, 1908).— Y. Ozawa, pp. 28-29, pl. 6, fig. 4.
 1958. *Parafusulina lutugini* (Schellwien).— Toriyama, pp. 192-194, pl. 30, figs 1 (= Y. Ozawa, 1925b, pl. 6, fig. 4), 2-5.

Description: Test subcylindrical to elongate fusiform, almost straight periphery, straight to slightly convex lateral slopes, rounded poles, and straight axis of coiling. Mature test with six whorls. Length 8.3? to 9.5? mm, width 1.8? to 2.33 mm, and approximate form ratio 3.8 to 4.4. Proloculus spherical to subspherical, 0.25 to 0.33 mm in diameter. The first whorl short fusiform to subspherical, and later ones gradually increasing length and width.

Septa closely spaced, rather regularly folded, and some septal loops reach the roof of chambers. Septal counts from the first to the fifth whorls 9, 17, 23, 25, and 31. Wall thin in inner few whorls and is 45 to 70 microns thick in outer whorls. Rudimentary chomata present on proloculus. Tunnel angle is as wide as 25 degrees in middle whorls. Axial fillings developed in polar regions of inner and middle whorls.

Remarks: Parafusulinids yielded only from the upper part of the *Cancellina pamirica* Zone are similar to *P. kaerimizensis*. However, they are different from the species by their smaller and more elongate test, more loosely coiled inner whorls, larger length and width of the corresponding whorls, and less developed axial fillings. These features well resemble those of the specimens described as *Schellwienia lutugini* by Y. Ozawa (1925b) and his unpublished four other specimens that were later reproduced by Toriyama (1958). These specimens were obtained from Kaerimizu, though the stratigraphic level of them is uncertain. *Fusulina lutugini*, originally described from the *Schwagerina* limestone (Asselian and/or Sakmarian) of the Ural regions (Schellwien, 1908), is age-diagnostic in the Artinskian of the Southern Urals and Carnic Alps (e.g., Kahler & Krainer, 1993; Krainer & Davydov, 1998) and the Timan region (Grozdilova & Lebedeva, 1961). The Akiyoshi specimens are largely different from and can not be identified with the original and other European specimens having larger and more elongate cylindrical test.

This unnamed *Parafusulina* resembles *Parafusulina tomoozawai* proposed by Kobayashi (2011) from the *Parafusulina nakamigawai* Zone of the Akasaka Limestone, correlatable to the *Misellina claudiae* Zone of Akiyoshi. However, the latter has more regularly folded septa, larger and slenderer test with smaller length and width in the corresponding whorls. The illustrated specimens herein are somewhat similar to *Schwagerina hupehensis* proposed by Chen (1956) from the Wuhsueh Limestone in Guangxi, South China. But, the former is

not so elongate as the latter and has more developed axial fillings.

Occurrence and stratigraphic distribution: Common in the upper part of the *Cancellina pamirica* Zone (Kz-49).

Genus *Paraleeina* Leven in Leven & Mohaddam, 2004
Type species: *Parafusuulina postkrafftii* Leven, 1967, p. 157.

Remarks: *Paraleeina* proposed by Leven in Leven & Mohaddam (2004) was distinguished from *Parafusulina* and *Skinnerella* by its less regularly folded septa and presence of massive secondary deposits. Leven did not discuss on its differences from some evolved forms of schwagerinids such as *Laosella* that is characterized by thick wall, large proloculus, and rather regular septal folds. Although morphologic differences of the type species of *Laosella* and *Paraleeina* are definite, some taxonomic problems seem to be remained uncertain. For example, Leven in Leven & Mohaddam (2004) reassigned “*Parafusulina*” *edoensis* to *Paraleeina*. However, the species, as described above, is considered to be transferred to *Laosella*. *Paraleeina* is supposed to be independent and probably distinguished from *Laosella* by its shorter fusiform test and more irregularly and more weakly folded septa in my opinion.

***Paraleeina magna* (Toriyama, 1958)**

Pl. VI, figs 5-6, 8-9

1958. *Pseudofusulina krafftii* var. *magna* Toriyama, pp. 178-181, pl. 25, figs 1-10; pl. 26, figs 1-15.
 1961a. *Pseudofusulina krafftii magna* Toriyama.— Nogami, pp. 216-217, pl. 10, figs 1-4.
 ? 1967. *Pseudofusulina magna* (Toriyama).— Leven, p. 149, pl. 11, fig. 5 [= *Praeskinnerella magna*, Leven (2009, p. 139, pl. 24, fig. 3)], fig. 6.
 1990. *Pseudofusulina krafftii magna* Toriyama.— T. Ozawa & Kobayashi, pl. 8, figs 8-9.
 2017. *Paraleeina magna* (Toriyama).— Kobayashi, pp. 144, 146, pl. 49, figs 24-29.

Remarks: Generic assignment of this species to *Pseudofusulina* is doubtful, as Leven (2009) included it to *Praeskinnerella* Bensch, 1987. This species, reassigned to *Paraleeina* by Kobayashi (2017), is very common in the upper Lower Permian (Artinskian) limestone in the Akiyoshi Terrane (e.g., Toriyama, 1958; Nogami, 1961a; Kobayashi, 2017). These specimens illustrated are surely identified with this species showing broad morphologic variations, as easily understood from the specimens illustrated by Toriyama (1958). This species is abundant in bioclastic grainstone, but it is not so widespread in the mapped area (Fig. 2) as in other areas of the Akiyoshi Limestone.

Occurrence and stratigraphic distribution: Common in the *Paraleeina magna* Zone (Ak-203).

***Paraleeina akiyoshiensis* n. sp.**

Pl. VIII, figs 1-16

- par 1925b. *Schellwienia edoensis* Y. Ozawa, pp. 30-31, pl. 6, fig. 1b (non figs 2-3 = *Laosella edoensis*).
1979. *Pseudofusulina japonica constricta* (Deprat, 1914).— Li *et al.*, pl. 2, fig. 11.
1979. *Parafusulina* sp. Li *et al.*, pl. 2, fig. 12.
1990. *Parafusulina grupperaensis* (Thompson & Miller, 1944).— T. Ozawa & Kobayashi, pl. 9, fig. 14.

Etymology: From the geographic name, Akiyoshi.

Type specimens: Holotype D2-056210 (axial section, Pl. VIII, fig. 2). Paratypes: Nine axial, four sagittal, and two tangential sections illustrated in Pl. VIII. Their register numbers are shown in the explanation of Pl. VIII.

Type Locality: Western slope of the Kaerimizu Doline (230 m southwest of the bottom of the doline), Shuhochi, Mine City, Yamaguchi Prefecture.

Diagnosis: Inflated fusiform test with broadly rounded poles. Proloculus large and irregularly subspherical. The number of whorls few for the size of test. Septa intensely and rather regularly folded resulting cuniculi. Axial fillings well developed especially in the axial regions of inner and middle whorls.

Description: Test inflated fusiform with rounded to broadly rounded periphery, almost straight to slightly convex lateral slopes, broadly round poles, and straight axis of coiling. Mature test with seven to seven and a half whorls. Length is about 8 to 9 mm, width about 4 to 5 mm, and form ratio about 1.6 to 1.8, but exactly unknown due to abrasion of the test in most specimens. Proloculus irregularly subspherical and 0.54 to 0.83 mm in longer diameter. The first whorl irregularly subspherical, highly variable in its shape and size depended on a cutting plane of the section, and followed by gradually and regularly expanding outer whorls. In the holotype, the first to six whorls 1.12, 1.90, 2.77, 3.87, 5.10, and 6.96 mm in length; and 1.15, 1.56, 2.12, 2.73, 3.41, and 4.25? mm in width.

Septa closely spaced, and intensely and rather regularly folded resulting cuniculi. Some of septa are coated by secondary calcareous materials. Septal folds more than a half as high as chambers and partly reaching the roof of chambers. Septal counts from the first to the fourth whorls 8 or 10, 18 to 24, 27 to 32, 31 to 37(?). Those in further outer whorls are uncertain due to the abrasion of the test.

Wall thin for the length and width in the first whorl and gradually thickened in the succeeding whorls, and attains to more than 0.1 mm in the thickest part of outer two whorls. It consists of a tectum and alveolar keriotheca and alveolar structure is distinct in outer whorls. Rudimentary chomata present only on proloculus. Tunnel is low and narrow, and its path not straight. Axial fillings well developed especially in the axial regions of inner and middle whorls.

Remarks: This new species somewhat resembles *Parafusulina quasigrupperaensis* Sheng, 1958 from the Maokou Limestone of Guangxi and Guizhou of South China (Sheng, 1958) in rounded large test and irregular-shaped large proloculus and mode of the test expansion. It has, however, much stronger axial fillings, thicker wall, and more strongly folded septa.

A part of “*Schellwienia edoensis*” illustrated in association with *Nagatoella orientis* by Y. Ozawa (1925b) corresponds to an abraded specimen of this new species. *Parafusulina grupperaensis* illustrated from Kaerimizu by T. Ozawa & Kobayashi (1990) is considered to be also an incomplete specimen of this new species. The specimen has thicker wall and more intense axial fillings than the original ones described from southern Mexico by Thompson & Miller (1944).

Pseudofusulina japonica constricta and *Parafusulina* sp. illustrated by Li *et al.* (1979) from the “Lower Permian” of the Nandanghada Range, Jilin are the closest to this new species. Axial fillings, mode of septal folding, and thickness of wall are closely similar each other. These Nandanghada specimens, though uncertain in their detailed age, are considered to be conspecific with *Paraleeina akiyoshiensis*.

Occurrence and stratigraphic distribution: Abundant in the lower part of the *Parafusulina kaerimizensis* Zone (Kz-11B). Incomplete specimens lacking outer test commonly occur also in the middle and upper parts of the *Cancellina pamirica* Zone (e.g., Kz-48).

Genus *Pseudofusulina* Dunbar & Skinner, 1931

Type species: *Pseudofusulina huecoensis* Dunbar & Skinner, 1931, p. 252.

***Pseudofusulina fusiformis* (Schellwien & Dyhrenfurth, 1909)**

Pl. VI, figs 2-4

1909. *Fusulina vulgaris* var. *fusiformis* Schellwien & Dyhrenfurth, pp. 165-168, pl. 15, figs 1-4.
1963. *Pseudofusulina fusiformis* (Schellwien & Dyhrenfurth).— Sheng, pp. 192-193, pl. 16, figs 19-21.
1967. *Pseudofusulina fusiformis* (Schellwien & Dyhrenfurth).— Kalmykova, pp. 181-182, pl. 9, figs 1-5.
1990. *Pseudofusulina fusiformis* (Schellwien & Dyhrenfurth).— T. Ozawa & Kobayashi, pl. 8, fig. 14.
2009. *Pseudofusulina fusiformis* (Schellwien & Dyhrenfurth).— Kobayashi in Kobayashi & Furutani, p. 35, pl. 5, figs 14-17.

Remarks: This species was originally described as a variety of *Fusulina vulgaris* (Schellwien & Dyhrenfurth, 1909), and its specific diagnosis was clarified by Kalmykova (1967) based on the material from the Kungurian of Darvas. Illustrated specimens herein are well agree with those from Darvas (Schellwien & Dyhrenfurth, 1909; Kalmykova, 1967), South China (e.g., Sheng, 1963), and Japan (e.g., Kobayashi in Kobayashi & Furutani, 2009).

Occurrence and stratigraphic distribution: Common in the *Paraleeina magna* Zone (Ak-203).

Genus *Rugosochusenella* Skinner & Wilde, 1965a

Type species: *Rugosochusenella zelleri* Skinner & Wilde, 1965a, p. 102.

***Rugosochusenella* sp. A**

Pl. V, figs 47, 49-50

Remarks: Kobayashi (2017) distinguished three named and two unnamed species of *Rugosochusenella* from the middle Gzhelian to the lower Asselian in the Akiyoshi Limestone of the Wakatakeyama area. Detailed comparison with the Wakatakeyama species is difficult on account of abraded test of almost all forms possibly referable to *Rugosochusenella* characteristic in the *Cancellina pamirica* Zone of the Kaerimizu area. However, the forms of *Rugosochusenella* from the Kaerimizu area are different from those from the Wakatakeyama area by more tightly coiled and more numerous inner whorls and more irregularly folded septa. They are divided into two. *Rugosochusenella* sp. A, more dominant than *R. sp. B* (Pl. V, figs 48, 51), has a minute proloculus and very tightly coiled inner four whorls with very thin wall. Axial fillings are well developed and septa are irregularly folded in outer whorls. It is also distinguished from *Rugosochusenella* sp. B in its smaller proloculus and more tightly coiled inner whorls.

Occurrence and stratigraphic distribution: Common to rare in the *Cancellina pamirica* Zone (Kz-5, 7, 48).

Family Verbeekiniidae Staff & Wedekind, 1910

Subfamily Miselliniinae A. D. Miklukho-Maklay, 1958

Genus *Misellina* Schenck & Thompson, 1940

Type species: *Doliolina ovalis* Deprat, 1915, p. 15.

***Misellina claudiae* (Deprat, 1912)**

Pl. XVI, figs 33-51; Pl. XVII, figs 1-19

1912. *Doliolina claudiae* Deprat, pp. 44-45, pl. 4, figs 5-9.

1925b. *Verbeekina claudiae* (Deprat).— Y. Ozawa, pp. 52-53; pl. 11, figs 9-11.

1958. *Misellina claudiae* (Deprat).— Toriyama, pp. 208-211; pl. 39, figs 1-19.

non 1963. *Misellina claudiae* (Deprat).— Hanzawa & Murata, pl. 6, figs 7-8 (= indeterminate *Armenina*).

1977. *Misellina claudiae* (Deprat).— M. Ota, pl. 2, figs 3-4.

1990. *Misellina claudiae* (Deprat).— T. Ozawa & Kobayashi, pl. 9, figs 5-6.

1991b. *Misellina (Misellina) claudiae* (Deprat).— Ueno, pp. 984-985, fig. 8.1-13.

Description: Test short ellipsoidal to thick fusiform, broadly rounded periphery, convex lateral slopes, and broadly rounded poles with shallow umbilicated cavities.

Mature test consists of 7.5 to 9.5, rarely 10 whorls, 2.1? to 3.02 mm in length, 1.62 to 2.36 mm in width, and 1.2? to 1.34 in form ratio in specimens from sample Kz-M. The test of specimens from sample Ak-92 is with 7 to 9.3 whorls, 2.2? to 2.7? mm in length, 1.65 to 2.23 mm in width, and 1.2? to 1.4? in form ratio.

Proloculus spherical and its diameter ranging from 0.06 to 0.22 mm. The first one to three whorls discoidal to subspherical with umbilicated poles. In forms with discoidal juvenilium, axis of coiling is at large angles to that of outer whorls. Succeeding whorls short ellipsoidal to inflated fusiform and mostly with shallowly depressed poles. Their length and width gradually increase outwards. Length from the first to ninth whorls 0.09 to 0.38, 0.28 to 0.97, 0.54 to 1.12, 0.76 to 1.46, 1.09 to 1.87, 1.43 to 2.28?, 1.75 to 2.38, 2.11 to 2.7?, and 3.02 mm, respectively. Width from the first to tenth whorls 0.12 to 0.34, 0.20 to 0.48, 0.31 to 0.63, 0.44 to 0.84, 0.63 to 1.09, 0.84 to 1.37, 1.10 to 1.65, 1.51 to 1.87, 1.80 to 2.27, and 2.36 mm, respectively.

Wall consists of a tectum and thin translucent layer or not differentiated in inner whorls, and of a tectum and alveolar keriotheca in middle and outer whorls. Its thickness less than 15 microns in inner whorls, and varies approximately from 40 to 60 microns in the outer whorls, but not exactly measured and appears to be thicker than the actual due to secondary covers in specimens. In addition to these secondary covers, wall is partly in contact with parachomata in specimens on account of partial downward protrusions of lower surface of wall.

Septa planar, elongate wedge-shaped, inclined anteriorly, and consist of downward deflections of a tectum, on both sides of which keriotheca is extending. Some are in contact with parachomata. Septal counts from the first to ninth whorls 4? to 7, 9 to 13, 11 to 16, 12 to 20, 17 to 22?, 18 to 23, 18 to 25, 22 to 29, and 27 to 29, respectively.

Parachomata are dome-shaped to subtriangular, well developed throughout whorls except for in discoidal inner whorls. They are one-fourth to a half as high as chambers and also present even on the proloculus in specimens having subspherical first whorl and relatively large proloculus.

Remarks: Highly variable morphologies are remarkable especially in the juvenile whorls. Different shape of juvenile whorls either elongate eostaffelloid or subspherical eostaffelloid and different size of proloculus led an erroneous interpretation of a dimorphism of this species in Kobayashi (1977). They should be considered to represent a part of intraspecific variations of this species, because they change continuously and gradually from specimen to specimen. However, specimens with minute proloculus succeeded by very tightly coiled inner few whorls (e.g., Pl. XVI, fig. 41; Pl. XVII, figs 5, 16) are inferred to represent the microspheric form of this species. Gradual and continuous changes are also recognized in other test characters such as the number of whorls, and size and shape of the test. The degree and

magnitude of their changes are also variable in specimens from different stratigraphic levels. On the other hand, it is true that there are significant differences about the interpretation of morphologic variations of this and other species, and the classification of *Misellina* by authors.

This species resembles *Misellina (Misellina) postclaudiae* Ueno, 1991b and *M. (M.)? ventricosa* Ueno, 1991b in many respects, but the former has larger proloculus and thinner wall than the latter two. Moreover, ontogenetic change from tightly coiled inner whorls to later whorls is less conspicuous in the former than in the latter two.

Occurrence and stratigraphic distribution: Abundant in the *Misellina claudiae* Zone in the western part of the Kaerimizu Doline (Kz-M; Ak-92), and common in the zone northern part of the doline (Kz-31, 68).

***Misellina dyhrenfurthi* (Dutkevich in Likharev, 1939)**

Pl. XVI, figs 1-22

1939. *Doliolina dyhrenfurthi* Dutkevich in Likharev, p. 42, pl. 4, figs 3-5.
 1966. *Misellina otai* Sakaguchi & Sugano, pp. 145-147, pl. 1, figs 1-12.
 1967. *Brevaxina dyhrenfurthi* (Dutkevich).— Kalmykova, pp. 216-217, pl. 30, figs 1-8.
 1990. *Misellina dyhrenfurthi* (Dutkevich).— T. Ozawa & Kobayashi, pl. 9, figs 1-2.
 1991b. *Misellina (Brevaxina) dyhrenfurthi otai* Sakaguchi & Sugano.— Ueno, pp. 981, 983-984, fig. 7.13-25.

Description: Test subspherical with shallowly umbilicated cavities. Mature test with five to seven whorls, 0.83 to 1.08 mm in length, 0.75 to 1.18 mm in width, and 0.82 to 1.03 in form ratio. Proloculus spherical and 0.04 to 0.09 mm in diameter. The first two to three whorls discoidal and succeeded by subspherical later whorls with shallow but distinct depressed poles. Form ratio of most of middle and outer whorls is mostly less than 1.0. Length from the first to sixth whorls 0.04 to 0.12, 0.12 to 0.21, 0.20 to 0.34, 0.29 to 0.34, 0.46 to 0.73, and 0.73 to 1.01 mm, respectively. Width from the first to seventh whorls 0.09 to 0.17, 0.13 to 0.26, 0.22 to 0.41, 0.33 to 0.57, 0.51 to 0.81, 0.71 to 1.10, and 0.97 or 1.01 mm.

Wall less than 15 microns and consists of a tectum and thin translucent layer or not differentiated in inner tightly coiled whorls. It consists of a tectum and finely to very finely alveolar keriotheca gradually increasing thickness outwards, and is 35 to 45 microns in the thickest part of the outer whorls. Septa planar, elongate wedge-shaped. Septal counts from the first to sixth whorls 5, 7 or 8, 8 to 11, 11 to 13, 13 to 16, 13 to 17. Parachomata small, dome-shaped to subtriangular, not developed in discoidal inner whorls, poorly developed in middle whorls, and moderately in outer whorls.

Remarks: The specimens illustrated are variable in size and shape of the test and in those of corresponding whorls, and in the degree of development of parachomata. They are similar to the original three specimens from

the upper Lower Permian of Darvas by Dutkevich in Likharev (1939) and later six additional specimens from Darvas by Kalmykova (1967). This species resembles *Misellina aliciae* (Deprat, 1912) in shape of the test and development of parachomata, but has larger test.

Two new species, *Misellina otai* and *Misellina (Brevaxina) nipponica*, were proposed from Kaerimizu. The former by Sakaguchi & Sugano (1966) is supposed to belong to an advanced form of *M. dyhrenfurthi* because of having well-developed parachomata. The latter, though not found out in this study, was distinguished by Ueno (1991b) from this species in its weaker development of parachomata and its occurrence from the top of the Ueno's *Pamirina (Levenia) leveni* Zone.

Occurrence and stratigraphic distribution: Common in the *Misellina dyhrenfurthi* Zone (Ak-91, Kz-37).

***Misellina parvicostata* (Deprat, 1915)**

Pl. XVI, figs 23-32

1915. *Doliolina parvicostata* Deprat, p. 16, pl. 3, figs 7-9.
 1990. *Misellina parvicostata* (Deprat).— T. Ozawa & Kobayashi, pl. 9, figs 3-4.

Description: Test subspherical with shallow umbilicated cavities. Mature test with 5.5 to 7.3 whorls, 0.70 to 1.38? mm in length, 0.75 to 1.49 mm in width, and 0.72 to 1.03? in form ratio. Proloculus spherical and 0.04 to 0.09 mm in diameter. Length from the first to seventh whorls 0.04 to 0.15, 0.12 to 0.27, 0.20 to 0.41, 0.29 to 0.63, 0.46 to 0.85, 0.73 to 1.06, and 0.83 to 1.38? mm. Width from the first to seventh whorls 0.09 to 0.18, 0.13 to 0.29, 0.22 to 0.43, 0.33 to 0.62, 0.51 to 0.90, 0.71 to 1.26, and 1.01 to 1.49 mm.

Wall consists of a tectum and thin translucent layer or not differentiated in inner whorls, and a tectum and finely alveolar keriotheca in middle and outer whorls. Its thickness less than 15 microns in inner whorls, increases gradually, and varies from 35 to 50 microns in the thickest part of the outer whorls.

Septa planar and elongate wedge-shaped. Septal counts from the first to seventh whorls 4 to 7, 9 to 10, 10 to 12, 12 to 16, 13 to 16, 13 to 17, and 17. Parachomata are small, dome-shaped to subconical, one-sixth to one-fourth as high as chambers in middle and outer whorls, and not developed in discoidal inner whorls.

Remarks: In the *Misellina dyhrenfurthi* Zone, specimens having larger width in outer whorls and more developed parachomata are separated from *Misellina dyhrenfurthi*, and are named as *M. parvicostata*. The strict distinction between these two species needs more type materials of *M. parvicostata* from the upper Lower Permian of Laos (Deprat, 1915).

Some specimens (ex.gr. Pl. XVI, fig. 30) should better be separated from this species and assigned to *Brevaxina* Schenck & Thompson, 1940 than to *Misellina*. However, these specimens with relatively smaller form ratio of

the test are assumed to merely represent morphologic variations of this species in the Kaerimizu material. *Misellina* sp. A (Pl. XVIII, fig. 2) and *M. sp. B* (Pl. XVIII, fig. 3) contained in sample Kz-37 are somewhat similar to *Misellina parvicostata* in their shape and size of the test. However, the former is eliminated from this species by its larger proloculus and indistinct juvenile whorls, and the latter by its more rapidly expanding outer whorls. **Occurrence and stratigraphic distribution:** Common to rare in the *Misellina dyhrenfurthi* Zone (Ak-91, Kz-37).

***Misellina postclaudiae* Ueno, 1991b**

Pl. XVII, figs 20-32

- 1991b. *Misellina (Misellina) postclaudiae* Ueno, pp. 985, 987-988; fig. 8.15-18.
 1991b. *Misellina (Misellina)? ventricosa* Ueno, pp. 989-990, fig. 8.19-24.
 1991b. *Armenina cf. asiatica* Leven, 1967.– Ueno, p. 993, fig. 9.16.

Description: Test subspherical with broadly rounded periphery, rounded poles partly with shallow umbilical cavities, and straight axis of coiling. Mature specimens with 9 to 10 or more whorls, about 2.1 to 2.7 mm in length and about 1.9 to 2.6 mm in width, giving approximate form ratio 1.1 to 1.3.

Proloculus is spherical and 0.03 to 0.10 mm in diameter. Inner two to three whorls thick lenticular to subspherical. With slight changes of axis of coiling, later whorls become short ellipsoidal to subspherical gradually increasing their length and width outward. Form ratio, roundness of poles and expansion of whorls are considerably variable by specimens. Length from the first to ninth whorls 0.06 to 0.17, 0.11 to 0.26, 0.21 to 0.46, 0.46 to 0.70, 0.68 to 0.98, 0.98 to 1.32, 1.32 to 1.77, 1.65 to 2.20, and 1.90 to 2.56 mm, respectively. Width from the first to tenth whorls 0.09 to 0.17, 0.18 to 0.27, 0.26 to 0.41, 0.39 to 0.61, 0.57 to 0.84, 0.78 to 1.11, 1.03 to 1.44, 1.34 to 1.8?, 1.68 to 2.2?, and 2.2? mm, respectively.

Thickness of wall is about 10 to 20 microns in juvenile whorls, 20 to 40 microns in the next two, and 50 to 80 microns in further outer whorls, where wall consists of a tectum and distinct alveolar keriotheca. Septa closely spaced. Septal counts from the first to tenth whorls, 5 or 6, 8, 11 or 12, 12 or 13, 13 or 16, 18 or 19, 21, 25, 25 or 27, and 26, respectively.

Rudimentary downward protrusions of wall, appearing to be the primary transverse septula, partly present in middle and outer whorls. They are short, broad, fan-shaped, and partly in contact with parachomata. Partitions referable to axial septula are not recognized. Parachomata well developed except for inner lenticular whorls, massive, circular to triangle, and less than one-third as high as chambers.

Remarks: Size and shape of the test, size and the

number of inner tightly coiled whorls, presence or absence of rudimentary downward protrusions of wall, and development of parachomata are considerably variable from specimen to specimen. These differences among specimens are considered to represent the broad intraspecific variations. Largely different appearance of smaller specimens (Pl. XVII, figs 20, 21) is only due to an incomplete specimen without outer whorls.

All the illustrated specimens are probably identified with *Misellina postclaudiae* proposed from Kaerimizu by Ueno (1991b). He showed rudimentary protrusions of wall of this species, and discriminated them from primary transverse septula. These protrusions, considered to be the incipient structure of primary transverse septula, are also recognized in some specimens of *Misellina claudiae* (e.g., Pl. XVI, fig. 35; Pl. XVII, fig. 13). More distinct and more frequent appearances of these protrusions, better to be referable to primary transverse septula, are discriminated in primitive forms of *Cancellina* (e.g., *C. cutalensis* Leven, 1967). These protrusions strongly suggest an intimate phylogenetic relationship between *M. claudiae* and a primitive short-ellipsoidal species of *Cancellina* through *M. postclaudiae*, taking other test characters of these species into account.

In addition to *M. postclaudiae*, Ueno (1991b) subdivided primitive forms of verbeekiniids into many taxa that occur beneath the Ueno's *Parafusulina kaerimizensis* Zone. Among them, *Misellina (Misellina)? ventricosa* is considered to be conspecific with *M. postclaudiae* from many common features such as shape and size of the test, proloculus size, ontogenetic change from tightly coiled inner whorls to later whorls, development of parachomata, and thickness of wall. *Armenina cf. asiatica* by Ueno (1991b) is assumed to merely represent an incomplete specimen of *M. postclaudiae* with poorly developed parachomata. One specimen described by Ueno (1991b) as *Misellina (Misellina) spinosa* Han, 1976 is inferred to be separated from the genus *Misellina*. In my opinion, "fine alveolar keriotheca" in outer whorls and "rudimental parachomata" in the specimen illustrated by Ueno (1991b) are different from those of *Misellina* and the specimen might be referable to a rounded form questionably belonging to *Neofusulinella*.

Occurrence and stratigraphic distribution: Common in the uppermost part of the *Misellina claudiae* Zone (Ak-178).

Genus *Pseudodoliolina* Yabe & Hanzawa, 1932

Type species: *Pseudodoliolina ozawai* Yabe & Hanzawa, 1932, p. 40.

***Pseudodoliolina pseudolepida* (Deprat, 1912)**

Pl. VII, figs 28-33

1912. *Doliolina pseudolepida* Deprat, p. 46, pl. 5, figs 6-9; pl. 6, fig. 4.
 par 1927. *Doliolina lepida* (Schwager).– Y. Ozawa, pp. 152-

- 153, pl. 45, figs 1, 2 (?) [non pl. 37, figs 1c, 7b, 8b, 9b = *Pseudodoliolina ozawai* Yabe & Hanzawa].
1937. *Pseudodoliolina pseudolepida* (Deprat).– Thompson & Foster, pp. 141-142, pl. 25, figs 2-4.
1958. *Pseudodoliolina pseudolepida* (Deprat).– Toriyama, pp. 211-212, pl. 39, figs 20-25.
- 1988a. *Pseudodoliolina pseudolepida* (Deprat).– Kobayashi, p. 10, pl. 5, figs 18-21; pl. 6, fig. 18.
- 1988b. *Pseudodoliolina pseudolepida* (Deprat).– Kobayashi, pp. 443, 445, fig. 6.1-8.
1990. *Pseudodoliolina pseudolepida* (Deprat).– T. Ozawa & Kobayashi, pl. 10, fig. 8.
- 1992b. *Pseudodoliolina pseudolepida* (Deprat).– Ueno, pp. 1049, 1051, fig. 7.1-10.

Remarks: Differences between *Doliolina lepida* (Schwager, 1883) and *D. pseudolepida* are not clear in the Deprat's (1912) original description and subsequent ones (e.g., Y. Ozawa, 1925b, 1927). Thompson & Foster (1937) made clear the taxonomic validity of *pseudolepida* based on the historical review of *Pseudodoliolina* and the materials from South China (see Thompson & Foster, 1937, pp. 138-142).

Among seven specimens described and illustrated by Y. Ozawa (1925b, 1927), only one specimen in Y. Ozawa (1927, pl. 45, fig. 1) from Akiyoshi is certainly identical with *P. pseudolepida*. Those from Akasaka (Y. Ozawa, 1927, pl. 37, figs 1c, 7b, 8b, 9b) are referable to *Pseudodoliolina ozawai*, as pointed out by Kobayashi (2011). The other one from the *Neoschwagerina craticulifera* Zone of Akiyoshi (Y. Ozawa, 1925b, pl. 2, fig. 8b) is presumably reassigned to *P. ozawai*.

Smaller test appearance of most specimens in this paper than of those by Deprat (1912) and Thompson & Foster (1937) is due to the abrasion of outer whorls in the present material. The illustrated two specimens (Pl. VII, figs 26-27) from samples Ak-182A and Ak-182D and few other from Ak-182C are identical with *Pseudodoliolina ozawai*, though incomplete. They have smaller test, smaller proloculus, and fewer number of whorls than *P. pseudolepida*.

Occurrence and stratigraphic distribution: Common in the *Afghanella schencki* Zone (Ak-184B, 184C, 186, 187; Kz-57).

Subfamily Verbeekiniinae Staff & Wedekind, 1910

Genus *Armenina* A. D. Miklukho-Maklay, 1955

Type species: *Armenina karinae* A. D. Miklukho-Maklay, 1955, p. 576.

***Armenina salgirica* A. D. Miklukho-Maklay, 1955**

Pl. XVIII, figs 24-27

1955. *Armenina salgirica* A. D. Miklukho-Maklay, fig. 1.
1957. *Armenina salgirica* A. D. Miklukho-Maklay.– A. D. Miklukho-Maklay, p. 120, pl. 4, fig. 3 (= A. D. Miklukho-Maklay, 1955, fig. 1).
1965. *Armenina salgirica* A. D. Miklukho-Maklay.– Leven, p. 141, pl. 4, fig. 3; pl. 6, figs 1-3.

1967. *Armenina salgirica* A. D. Miklukho-Maklay.– Leven, p. 203, pl. 35, figs 2-3; pl. 38, figs 2, 6; pl. 39, fig. 4.
- 1991b. *Armenina salgirica* A. D. Miklukho-Maklay.– Ueno, pp. 991, 993, fig. 7.26-29.
2013. *Armenina salgirica* A. D. Miklukho-Maklay.– Vachard & Moix, fig. 13.9-12.

Remarks: Spherical to subspherical verbeekiniids occur in association with *Cancellina pamirica* Leven, 1967. Both are closely similar each other in many respects except for absence of primary transverse septula in the former that are poorly developed in the latter. These verbeekiniids are probably identical with *Armenina salgirica*, originally included into the Subfamily Neoschwageriniinae, described by A. D. Miklukho-Maklay (1955) from the “Upper Permian” of Crimea and subsequently by Leven (1965, 1967) from the *Neoschwagerina simplex* Zone of middle and southeast Pamir. Among these materials, the Kaerimizu ones are most alike to Leven's (1967) in spite of having somewhat thinner wall.

Occurrence and stratigraphic distribution: Common to rare in the *Cancellina pamirica* Zone (Kz-33, 34).

***Armenina cf. pamirensis* (Dutkevich, 1934)**

Pl. XVIII, figs 4-6

Compare:

1934. *Doliolina termieri* Deprat, 1915 var. *pamirensis* Dutkevich, p. 83, pl. 1, fig. 10.
1997. *Armenina pamirensis* (Dutkevich).– Leven, p. 203, pl. 75, pl. 21, figs 1-3.
2014. *Armenina cf. pamirensis* (Dutkevich).– Gaetani & Leven, pl. 3, fig. 15.

Remarks: Three illustrated and other few specimens are characterized by spherical to subspherical test with 2.0? to 2.4 mm in length and width, eight to ten whorls, and well-developed parachomata. They are considered to be assigned to *Armenina* rather than to *Misellina* from the mode of test expansion and more number of parachomata per a whorl in outer test.

These morphologic features are similar to those of the spherical “*Doliolina*” described by Dutkevich (1934) from the Lower Permian of Kuberganda area of Tajikistan as a variety of *Doliolina termieri* Deprat, 1915. Although Dutkevich showed many similarities between *pamirensis* and *termieri* (*s.s.*) from the basal part of the “Upper Permian” of Cammon, Laos (Deprat, 1915), he pointed out about two times or more larger test and corresponding whorls of the former than those of the latter. The present specimens are compared to the Tajikistan material that might belong to a primitive form of *Armenina*, as did by Leven (1997) based on the Afghanistan material. They resemble also the specimen compared to this species illustrated from the Kubergandian Staghar Formation of Sinkiang (China) by Gaetani & Leven (2014). Further comparison is difficult due to only one tangential section illustrated in the original description of Dutkevich (1934).

Occurrence and stratigraphic distribution: Common in the lower part of the *Cancellina pamirica* Zone (Kz-32).

Genus *Verbeekina* Staff, 1909

Type species: *Fusulina verbeeki* Geinitz, 1876, p. 399.

***Verbeekina verbeeki* (Geinitz, 1876)**

Pl. VII, fig. 36; Pl. XIV, figs 1-13; Pl. XV, figs 1-11

1876. *Fusulina verbeeki* Geinitz, pp. 399-400.

1925b. *Verbeekina verbeeki* (Geinitz).— Y. Ozawa, pp. 48-51, pl. 10, figs 6-7.

1958. *Verbeekina verbeeki* (Geinitz).— Toriyama, pp. 205-208, pl. 37, figs 1-6; pl. 38, figs 1-6.

1977. *Verbeekina verbeeki* (Geinitz).— M. Ota, pl. 1, figs 5-6.

1986. *Verbeekina verbeeki* (Geinitz).— Kobayashi, p. 145, pl. 4, fig. 8; pl. 9, fig. 6.

par 1988a. *Verbeekina verbeeki* (Geinitz).— Kobayashi, p. 8, pl. 11, figs 11, 13, [non pl. 11, figs 10, 12, 14 = *Verbeekina douvillei*]

1988b. *Verbeekina verbeeki* (Geinitz).— Kobayashi, p. 443, fig. 5.3-4.

1990. *Verbeekina verbeeki* (Geinitz).— T. Ozawa & Kobayashi, pl. 10, fig. 11.

1992b. *Verbeekina verbeeki* (Geinitz).— Ueno, pp. 1045, 1047-1049, fig. 5.1-6; fig. 6.1-5.

Description: Test almost spherical. Mature specimens with 13 to 16 whorls, 4.95? to 5.98 mm in length, 5.05? to 6.5? mm in width, and 0.9? to 1.1? in form ratio.

Proloculus very small and 0.01 to 0.04 mm in diameter. Inner three to five whorls eostaffelloid and tightly coiled. With the slight change of axis of coiling, the next few whorls become spherical with shallow umbilicus and are succeeded by outer whorls gradually increasing length and width. Length from the first to sixteenth whorls 0.03? to 0.08, 0.10 to 0.15, 0.18 to 0.31, 0.32 to 0.61, 0.54 to 1.01, 0.89 to 1.52, 1.20 to 2.22, 1.63 to 2.82, 2.27 to 3.52, 2.51 to 4.21, 3.00 to 4.80, 3.63 to 5.5?, 4.25 to 5.98, 4.87 to 5.83, 6.1?, and 6.5 mm, respectively. Width from the first to sixteenth whorls 0.03 to 0.10, 0.08 to 0.18, 0.20 to 0.35, 0.33 to 0.56, 0.53 to 0.90, 0.91 to 1.43, 1.27 to 2.00, 1.70 to 2.63, 2.17 to 3.37, 2.69 to 4.07, 3.20 to 4.75, 3.81 to 5.3?, 4.49 to 5.95, 5.0? to 5.78, 5.86, and 6.38 mm, respectively.

Wall very thin less than 10 microns, structureless in inner few whorls, and also very thin up to 25 microns in the next few whorls consisting a tectum and translucent layer. Beyond these inner whorls, wall of outer whorls consists of a tectum and very finely to finely alveolar keriotheca. Wall thickness of whorls with alveolar keriotheca varies 25 to 40 microns in inner part and 50 to 90 microns in outer part.

Septa planar, slender, and inclined anteriorly in inner and middle whorls, and thickened in outer whorls. Septal counts from the second to fifteenth whorls, 6 or 6?, 6?

to 10, 8 to 10, 8 to 13, 8 to 12, 7 to 10, 10 to 13, 12 to 18, 16 to 23, 21 to 30, 24 to 30?, 27 to 31?, 29, 34?, and 34?, respectively. Parachomata small and semicircular to triangular in cross sections. They are absent or sporadic, less than one fifth as high as chambers in inner spherical whorls, and become more distinct in outer three to five whorls where they are still sporadic.

Remarks: Appearance of *Verbeekina* is more or less different in samples from the *Afghanella schencki* Zone between the northern and southwestern parts of the bottom of the Kaerimizu Doline. Almost all specimens in the southwestern part are less well preserved because of abrasion and partial destruction of the test in various degrees. Whereas, they are relatively well preserved in the northern part in general. The difference of the state of reservation results an appearance of smaller test and thinner wall and septa in the materials from the southwestern part than from the northern part. Four specimens illustrated (Pl. XIV, figs 3, 6, 9, 12) are examples of relatively well-preserved specimens in the southwestern part.

Taking these secondary modifications of the test morphologies into account, specimens assigned to *Verbeekina* in the studied area are almost all identical with *V. verbeeki*, very common in the Middle Permian of the Tethyan regions.

This species differs from *Verbeekina douvillei* described by Kobayashi (2012a) and illustrated by T. Ozawa & Kobayashi (1990) from the *Lepidolina shiraiwensis* Zone of the top of the Akiyoshi Limestone in its smaller test, thicker wall, and more developed parachomata. Kobayashi (1988a) showed the differences in the sizes of the test and proloculus, numbers of whorls and tightly coiled juvenile whorls in the *Verbeekina* specimens between the *Neoschwagerina margaritae* and *Lepidolina shiraiwensis* zones in the Omi Limestone. Although he thought both of them as conspecific and identical with *V. verbeeki*, those from the *Lepidolina shiraiwensis* Zone are reassigned herein to *V. douvillei*.

Occurrence and stratigraphic distribution: Abundant to common in the *Afghanella schencki* Zone (Ak-86, 184A, 184B, 188; Kz-57), and rare in the *Colania douvillei* Zone (Kz-53).

***Verbeekina cf. douvillei* (Deprat, 1912)**

Pl. XV, fig. 12

Compare:

1912. *Schwagerina douvillei* Deprat, pp. 38-40, pl. 1, figs 4-6.

par 1988a. *Verbeekina verbeeki* (Geinitz).— Kobayashi, p. 8, pl. 11, figs 10, 12, 14 (non pl. 11, figs 11, 13 = *Verbeekina verbeeki*).

1990. *Verbeekina douvillei* (Deprat).— T. Ozawa & Kobayashi, pl. 11, fig. 10.

2012a. *Verbeekina douvillei* (Deprat).— Kobayashi, p. 93, fig. 11.1-3, 7-8, 10.

Remarks: Exact size of the test of verbeekiniid specimens, contained only in sample Kz-53, is uncertain on account of the abrasion of the outer test. These specimens are dissimilar to *Verbeekina verbeeki* in their thinner wall, poorer development of parachomata, and larger length and width of the middle and outer whorls. By these features of the test, they are compared to *V. douvillei*.

Occurrence and stratigraphic distribution: Rare in the *Colania douvillei* Zone (Kz-53).

Family Neoschwagerinidae Dunbar & Condra, 1927
Subfamily Lepidolininae A. D. Miklukho-Maklay, 1958

Remarks: This subfamily consists of three genera: *Cancellina*, *Colania*, and *Lepidolina*. Kobayashi *et al.* (2010) accepted the T. Ozawa's (1970) view that *Colania* represents an important segment of a branch of the Neoschwagerinidae and is placed near the middle of the Lepidolininae evolutionary lineage. However, they recognized *Maklaya* as a junior synonym of *Cancellina*, and *Gifuella* Honjo, 1959 as an independent genus of the Gifuellinae proposed by Kobayashi *et al.* (2010). On the other hand, T. Ozawa (1970) assigned *Maklaya* into the Neoschwagerininae as a valid genus and treated *Gifuella* synonymous with *Colania*.

Genus *Cancellina* Hayden, 1909

Type species: *Fusulina (Neoschwagerina) primigena* Hayden, 1909.

Junior synonym:

Neoschwagerina (Minoella) Honjo, 1959, p. 124 [type species, *Neoschwagerina (Cancellina) nipponica* Y. Ozawa, 1927].

Maklaya Kanmera & Toriyama, 1968, p. 33 (type species, *Cancellina pamirica* Leven, 1967).

Shengella Yang, 1985, p. 334 (type species, *Shengella datieguanensis* Yang, 1985).

Remarks: *Cancellina* and its synonyms are discussed in Kobayashi (2011, pp. 506, 508). As Kobayashi *et al.* (2010) concluded, *Cancellina* is considered to be the most variable genus among the Family Neoschwagerinidae and to be the ancestral stock not only for the Lepidolininae but also for other subfamilies of Neoschwagerinidae.

***Cancellina pamirica* Leven, 1967**

Pl. XVIII, figs 7-23

1967. *Cancellina pamirica* Leven, pp. 186-187, pl. 32, figs 1, 3.

1968. *Maklaya pamirica* (Leven).– Kanmera & Toriyama, pp. 34-37, pl. 4, figs 1-16.

1990. *Maklaya pamirica* (Leven).– T. Ozawa & Kobayashi, pl. 9, figs 10-11.

1991b. *Maklaya pamirica* (Leven).– Ueno, pp. 994-995, fig. 9.5-10.

1991b. *Maklaya saraburiensis* Kanmera & Toriyama, 1968.– Ueno, pp. 993-994, fig. 9.1-4.

1991b. *Maklaya* sp. Ueno, p. 995, fig. 9.14.

2005a. *Maklaya* sp. Kobayashi, pp. 427, 429, fig. 9.12.

Description: Test subspherical to almost spherical, with broadly rounded periphery, rounded poles partly with shallow umbilical cavities. Axis of coiling is straight. Mature specimens with 10 to 11 or more whorls, about 2.7 to 3.5 mm in length, about 2.4 to 2.8 mm in width, and approximate form ratio 1.0 to 1.2, rarely 1.3?.

Proloculus is spherical and 0.06 to 0.10 mm in diameter. Inner two to three whorls lenticular to subspherical and relatively tightly coiled. The succeeding four to six whorls are short ellipsoidal, thick fusiform, or subspherical, gradually increasing their length and width, and finally becoming subspherical to almost spherical in outermost few whorls. Length from the first to eleventh whorls 0.83 to 0.13, 0.15 to 0.27, 0.36 to 0.47, 0.60 to 0.74, 0.88 to 1.07, 1.22 to 1.38, 1.57 to 1.82, 1.97 to 2.22, 2.31 to 2.59, 2.66 to 3.00, and 3.43 mm. Width from the first to eleventh whorls 0.11 to 0.23, 0.20 to 0.31, 0.32 to 0.46, 0.40 to 0.64, 0.67 to 0.87, 0.93 to 1.21, 1.27 to 1.62, 1.58 to 2.05, 1.93 to 2.45, 2.23 to 2.76, and 3.15? mm, respectively.

Wall 10 to 25 microns in inner whorls, about 25 to 55 in the next four to six, and about 40 to 60 in further outer whorls. Wall consists of a tectum and finely alveolar keriotheca except for juvenile whorls. Septal counts from the first to tenth whorls are, 5 or 6, 7 to 11, 10 to 12, 12 to 14, 14 or 15, 16 to 18, 17 or 20, 19 to 23, 23 or 24, and 27, respectively.

Primary transverse septula short, broad, fan-shaped, and partly in contact with parachomata. They are absent in inner whorls, and poorly developed in middle and outer whorls. Axial septula are absent except for incipient ones in few specimens. Parachomata massive, circular to triangular, and well developed except for juvenile whorls.

Remarks: Degree of development of primary transverse septula and parachomata is variable from specimen to specimen even in the same sample. Axial and tangential sections illustrated herein are closely similar to and identified with those of the types of *Cancellina pamirica* established by Leven (1967) from the Kubergandian of southeast Pamir in size and shape of the test, and development of transverse septula. Most specimens identified to this species by Ueno (1991b) from Kaerimizu are insufficient probably due to the abrasion of outer test. *Maklaya* sp. described by Kobayashi (2005a), from one of limestone breccias containing many fusulines of various ages in the southern Kanto Mountains, is similar to this species in its subspherical test and poorly developed primary transverse septula.

"*Neoschwagerina simplex*" by Ueno (1991b) somewhat resembles *Cancellina pamirica*, but primary transverse septula are more developed in the former. Twelve specimens of Ueno's (1991b) *N. simplex* are different from three specimens from the Tunemori Formation (Kobayashi, 2012b) and 17 specimens from the

Omi Limestone (Kobayashi, 1988a) identified with *N. simplex*, and the topotypes of the species from the Akasaka Limestone (Kobayashi, 2011). Development of primary transverse septula are poorer and axial septula are almost absent in the Ueno's in comparison with the latter three. Moreover, the test is more spherical and the number of whorls is fewer. Therefore, Ueno's (1991b) *N. simplex* is inferred to be transferred to *Cancellina akiyoshiensis* (Y. Ota, 2005), proposed as a new species of *Maklaya* from Kaerimizu by Y. Ota (2005). Because the shape and size of the test, degree of development of primary transverse septula, and almost absence of axial septula are common in both materials of Ueno's (1991b) and Y. Ota's (2005).

Occurrence and stratigraphic distribution: Common to rare in the *Cancellina pamirica* Zone (Kz-32-34, 36) in NNW of the bottom of Kaerimizu Doline. Incomplete specimens (Kz-5) and doubtful ones (Kz-4, 8) from the zone are rarely found in WSW of the bottom of the doline.

Genus *Colania* Lee, 1934 emend. T. Ozawa, 1970

Type species: *Colania kwangsiana* Lee, 1934, p. 20.

Remarks: T. Ozawa (1970) redefined the genus based on his review of the morphology of various species that had been assigned to *Colania* or other genera from East and Southeast Asia. Kobayashi *et al.* (2010) accepted the Ozawa's view that *Colania* is a distinct genus placed near the middle of the Lepidolininae evolutionary lineage.

Colania douvillei (Y. Ozawa, 1922)

Pl. XXII, figs 22-26

1906. *Neoschwagerina globosa* (Yabe, 1906).– Douvillé, p. 182, pl. 17; pl. 18, figs 1-2.
 1912. *Neoschwagerina globosa* (Yabe).– Deprat, p. 51, pl. 4, figs 1-4.
 1922. *Neoschwagerina douvillei* Y. Ozawa, pp. 368-372.
 1925a. *Neoschwagerina douvillei* Y. Ozawa.– Y. Ozawa, pl. 3, fig. 6; pl. 4, fig. 5.
 1925b. *Neoschwagerina douvillei* Y. Ozawa.– Y. Ozawa, pp. 55-57, pl. 11, figs 5-7.
 1958. *Neoschwagerina douvillei* Y. Ozawa.– Toriyama, pp. 223-227, pl. 41, figs 9-13; pl. 42, figs 1-6.
 1961b. *Neoschwagerina douvillei* Y. Ozawa.– Nogami, pp. 180-183, pl. 5, figs 1-5.
 1961b. *Neoschwagerina* sp. A. Nogami, pp. 183-184, pl. 3, fig. 7.
 1961b. *Neoschwagerina* sp. B. Nogami, pp. 184-185, pl. 5, fig. 8.
 1961b. *Neoschwagerina* sp. C. Nogami, pp. 185-186, pl. 5, fig. 6-7.
 1970. *Colania douvillei* (Y. Ozawa).– T. Ozawa, pl. 7, figs 8-10.
 1977. *Colania douvillei* (Y. Ozawa).– M. Ota, pl. 1, figs 3-4.
 1988a. *Colania douvillei* (Y. Ozawa).– Kobayashi, p. 13, pl. 7, figs 7-9; pl. 8, figs 1-8.
 1990. *Colania douvillei* (Y. Ozawa).– T. Ozawa & Kobayashi, pl. 11, figs 1-2.

1992b. *Colania douvillei* (Y. Ozawa) [not “Y. Ozawa, 1925” but Y. Ozawa, 1922].– Ueno, pp. 1057, 1059, fig. 7.11-12.

2012b. *Colania douvillei* (Y. Ozawa).– Kobayashi, fig. 11.14-15.

Remarks: Specimens of insufficiently preserved *Colania* occur around the bottom of the Kaerimizu Doline. They have more than 12 whorls, long and slender septa, primary transverse septula well developed throughout the test, secondary transverse septula not present in inner and middle whorls, a few short axial septula between adjacent septa, and low and slender parachomata in all whorls. From these characters, they are certainly identified with *Colania douvillei*. Since well-oriented specimens of the mature stage are few in the Kaerimizu material, the species from the Tsunemori Formation are illustrated in Fig. 6 for the sake of better understanding of this species from Akiyoshi whose definition is more or less different among authors, and comparison of the Akiyoshi materials with those from other important localities in and outside the Akiyoshi Terrane.

Historically, a part of the taxonomic confusion of this species as well as the genus *Colania* is connected with the insufficient description and illustration of “*Neoschwagerina globosa*” from the Akasaka Limestone by Yabe (1906) and of *Colania kwangsiana*, type species of *Colania* from Guangxi (Lee, 1934). *Yabeina inouyei* Deprat, 1914 is a junior synonym of *Yabeina globosa* (Yabe, 1906). *Colania douvillei* was newly introduced by Y. Ozawa (1922) based on the Akiyoshi material described and illustrated later by Y. Ozawa (1925a, b) so as to distinguish the Southeast Asian neoschwagerinids named as “*Neoschwagerina globosa*” by Douvillé (1906) and Deprat (1912).

C. douvillei and *C. kwangsiana* are similar each other and closely related so far as the description and illustrations by Sheng (1963), but the former has somewhat larger test and proloculus, and thicker wall. Three unnamed species of “*Neoschwagerina*” and “*N.*” *douvillei* from the Atetsu Limestone (Nogami, 1961b) are conspecific. Their considerably different appearances are due to the morphologic variation, dimorphism, and partial deformation and abrasion of the test in the Atetsu materials. Along with specimens illustrated from Kaerimizu, those from the Tsunemori (Fig. 6) have smaller test and proloculus as a whole than those from Atetsu (Nogami, 1961b) and Omi (Kobayashi, 1988a). It is inferred that these differences by localities are derived both from the morphologic variation of this species and from different stratigraphic levels of an examined material.

Occurrence and stratigraphic distribution: Common in the *Colania douvillei* Zone (Kz-16) and rare in the zone (Kz-52, 53).

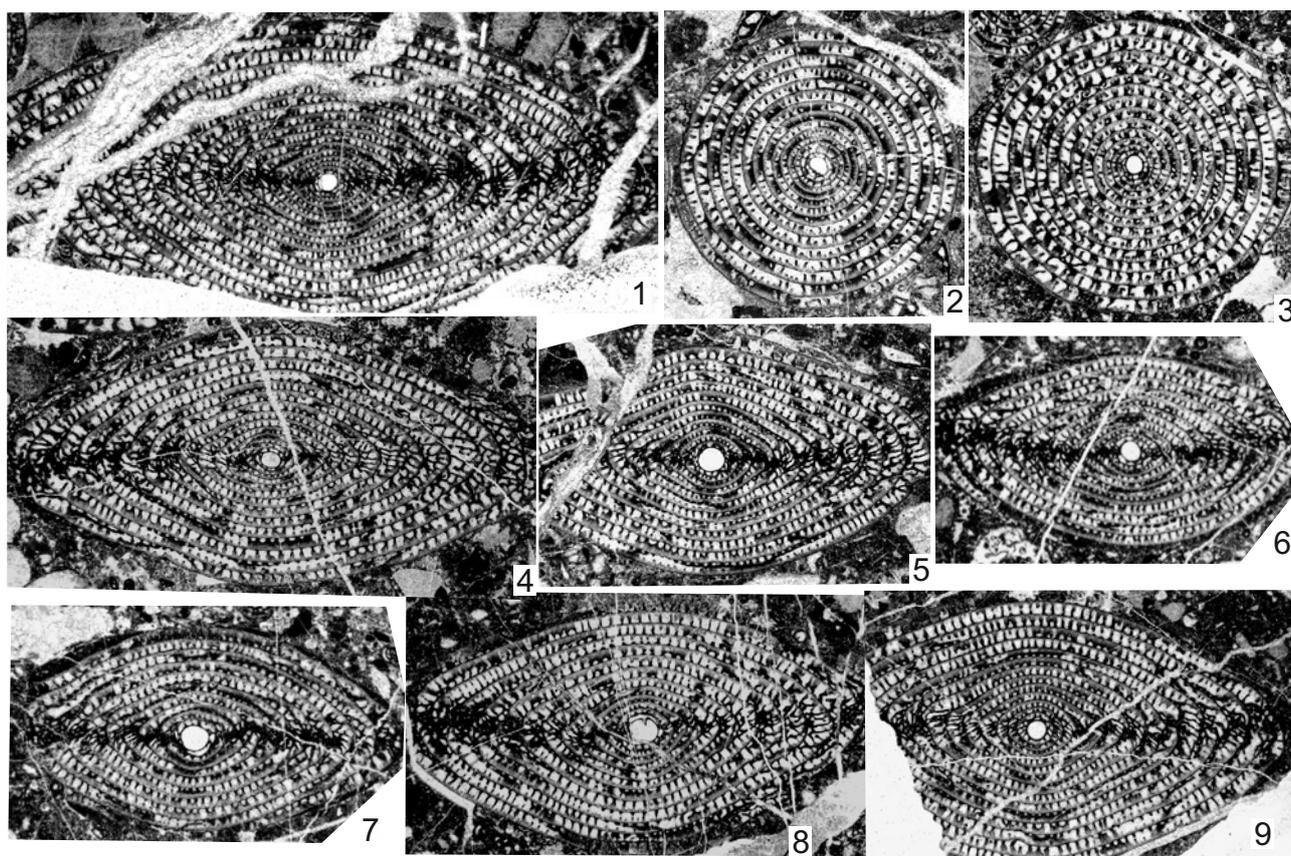


Fig. 6: *Colania douvillei* contained in sample Mine 83B collected from the limestone block contained in the Permian Tsunemori Formation cropping out west of the Akiyoshi Limestone (Kobayashi, 2012b). 1: D2-0487477, 2: D2-048767, 3: D2-048748, 4: D2-048796, 5: D2-048755, 6: D2-048793, 7: D2-048778, 8: D2-048746, 9: D2-048759. All $\times 10$.

Subfamily Neoschwagerininae Dunbar & Condra, 1927
Genus *Neoschwagerina* Yabe, 1903

Type species: *Schwagerina craticulifera* Schwager, 1883, p. 140.

***Neoschwagerina craticulifera* (Schwager, 1883)**

Pl. XX, figs 1-23

1883. *Schwagerina craticulifera* Schwager, p. 140, pl. 18, figs 15-25.
1925b. *Neoschwagerina craticulifera* (Schwager).— Y. Ozawa, pp. 54-55, pl. 2, fig. 8c; pl. 11, fig. 4.
1958. *Neoschwagerina craticulifera* (Schwager).— Toriyama, pp. 215-220, pl. 40, figs 1-9, 10 (= Deprat, 1914, pl. 6, fig. 4 from Akasaka), 11-22; pl. 41, figs 1-5.
1961b. *Neoschwagerina cheni* Sheng, 1958.— Nogami, pp. 174-177, pl. 8, figs 1-6.
1979. *Neoschwagerina cheni* Sheng.— Kobayashi, pl. 4, figs 1-5.
1979. *Neoschwagerina craticulifera* (Schwager).— Kobayashi, pl. 4, figs 6-8.
1988b. *Neoschwagerina craticulifera*.— Kobayashi, p. 445, fig. 6.13-16, 18-19; fig. 7.1.
1990. *Neoschwagerina craticulifera*.— T. Ozawa & Kobayashi, pl. 10, figs 3-4.

1992b. *Neoschwagerina craticulifera robusta* Ueno, pp. 1053-1055, fig. 8.1-10, fig. 10.6-11.

Description: Test fusiform to inflated fusiform, with broadly rounded periphery, almost straight lateral slopes, bluntly pointed poles, and straight axis of coiling. Mature specimens with 15 to 17 whorls, about 4.7 to 5.7 mm in length, about 3.3 to 4.6 mm in width, and form ratio about 1.2 to 1.4 in 11 axial sections illustrated.

Proloculus is spherical and 20 to 80 microns in diameter. Inner two to three whorls are lenticular to subspherical to short fusiform and tightly coiled, then changing to short fusiform increasing length and width gradually outward. Poles are more pointed in inner fusiform whorls than in outer whorls. Length from the first to 17th whorls 0.03 to 0.13, 0.07 to 0.32, 0.21 to 0.54, 0.39 to 0.85, 0.56 to 1.08, 0.87 to 1.44, 1.12 to 1.78, 1.45 to 2.39, 1.71 to 2.57, 2.04 to 2.96, 2.37 to 3.40, 2.81 to 3.8?, 3.16 to 4.07, 3.55 to 4.48, 3.93 to 4.98, 4.35 to 5.3?, and 4.8? to 5.6? mm in illustrated 11 specimens. Width from the first to 17th whorls 0.08 to 0.17, 0.12 to 0.26, 0.19 to 0.39, 0.30 to 0.55, 0.39 to 0.72, 0.55 to 0.93, 0.71 to 1.15, 0.93 to 1.43, 1.15 to 1.67, 1.41 to 2.03, 1.70 to 2.39, 2.04 to 2.76, 2.40

to 3.15, 2.76 to 3.56, 3.12 to 3.95, 3.47 to 4.37, and 3.83 to 4.16 mm in 11 axial and three sagittal sections.

Wall rather thick and about 40 to 70 microns in the thicker part of outer whorls, and composed of a tectum and finely alveolar keriotheca. Septa long, thick, closely spaced, and gently inclined anteriorly. Septal counts from the second to 16th whorls in three sagittal sections are 5? or 6?, 8 or 9, 12 to 14, 13 to 16, 15 to 18, 17 to 19, 17 to 20, 20 to 22, 20 to 23, 23 to 25, 22 to 24, 24 to 27, 26? to 29, 30, and 32, respectively.

Primary transverse septula elongate triangular to fan-shaped and well developed except for inner lenticular to subspherical whorls. Secondary transverse septula rudimentarily present only in outer whorls in specimens, but almost absent in most specimens. Axial septula absent in inner four to five whorls, poorly developed in the subsequent few whorls, and more developed in further outer whorls. One to three of them occur between

adjacent septa in outer whorls. Parachomata are massive, node-like, and commonly in contact with the lower end of the primary transverse septula. They are well developed even in inner fusiform whorls.

Remarks: Ueno (1992b) proposed *Neoschwagerina craticulifera robusta* from Kaerimizu and distinguished it from *N. craticulifera* (*s.s.*) based on its larger and more inflated test, and more whorls. The test characters of the illustrated specimens herein without conspicuous abrasion of outer whorls are almost the same as those of Ueno (1992b). Forms referable to *N. craticulifera* (*s.l.*) having larger form ratio than these Akiyoshi specimens, like the specimen illustrated by Deprat (1914, pl. 6, fig. 4), are not recognized in the Akiyoshi material. Taxonomic placement of *N. craticulifera* and its similar forms has been diverse among authors in relation to how to understand the morphologic variation of Schwager's (1883) types. In this paper, *N. craticulifera robusta* is

Plate I

- Fig. 1: *Calcitornella* sp. D2-049371. Locality: Ak-184B (As). $\times 30$.
 Fig. 2: *Endoteba controversa* Vachard & Razgallah. D2-056075. Locality Kz-3 (Cp). $\times 40$.
 Figs 3-9: *Globivalvulina cyprica* Reichel. 3: D2-056124, 4: D2-056121, 5: D2-030159, 6: D2-030150, 7: D2-043241, 8: D2-043212, 9: D2-049507. Locality 3-4: Kz-6 (Cp), 5-6: Kz-M (Mc), 7-8: Ak-92 (Mc), 9: Ak-184C (As). 3-4, 7-9: $\times 40$; 5-6: $\times 30$.
 Fig. 10: *Retroseptellina* sp. D2-049253. Locality Ak-181 (Pk). $\times 50$.
 Figs 11-12: *Dagmarita?* cf. *shahrezaensis* Mohtat-Aghai & Vachard. 11: D2-053608, 12: D2-053609. Locality both Kz-16 (Cd). Both $\times 40$.
 Fig. 13: *Deckerella* sp. D2-049521. Locality Ak-184C (As). $\times 20$.
 Figs 14-17: *Deckerella tenuissima* Reitlinger. 14: D2-049617, 15: D2-049462, 16: D2-049236, 17: D2-049387. Locality 14: Ak-188 (As), 15: Ak-184A (As), 16: Ak-181 (Pk), 17: Ak-182B (Nc). 14-15: $\times 30$, 16: $\times 40$, 17: $\times 20$.
 Fig. 18: *Cribrogenerina* sp. D2-059755. Locality Kz-49 (Cp). $\times 15$.
 Figs 19-26: *Climacammina valvulinoides* Lange. 19: D2-056491, 20: D2-059738, 21: D2-049377, 22: D2-056213, 23: D2-059857, 24: D2-059751, 25: D2-049424, 26: D2-049407. Locality 19: Kz-32 (Cp), 20: Kz-48 (Cp), 21: Ak-182B (Nc), 22: Kz-12 (Pk), 23: Kz-57 (As), 24-25: Kz-49 (Cp), 26: Ak-182C (Nc). 19-22: $\times 20$, 23, 25: $\times 30$, 24: $\times 15$, 26: $\times 25$.
 Fig. 27: *Hemigordiellina* sp. D2-049567. Locality Ak-187(As). $\times 50$.
 Figs 28-35: *Glomomidiella* spp. 28-29, 31: D2-059775, 30: D2-049563, 32: D-056116, 33: D2-059845, 34: D2-043232, 35: D2-049643. Locality 28-29, 31: Kz-50 (Cd), 30: Ak-187(As), 32: Kz-5 (Cp), 33: Kz-57 (As), 34: Ak-92 (Mc), 35: Ak-191 (Pl). 28-29, 31-32, 34-35: $\times 40$, 30, 33: $\times 50$.
 Fig. 36: Hemigordiopsidae gen. and sp. indet. D2-049156. Locality Ak-178 (Mc). $\times 40$.
 Figs 37-39: *Neodiscus* sp. A. 37: D2-049631, 38: D2-059724, 39: D2-049462. Locality 37: Ak-189 (Pl), 38: Kz-48 (Cp), 39: Ak-184A (As). All $\times 40$.
 Figs 40-41: *Neodiscus* sp. B. 40: D2-049751, 41: D2-056099. Locality 40: Ak-202 (Pl), 41: Kz-4 (Cp). Both $\times 40$.
 Figs 42-43, 45-46: *Tetrataxis conica* Ehrenberg. 42: D2-056276, 43: D2-043089, 45: D2-043029, 46: D2-043094. Locality 42: Kz-14 (As), 43, 46: Ak-87 (As), 45: Ak-86 (As). 42, 45: $\times 30$, 43: $\times 40$, 46: $\times 50$.
 Fig. 44: *Tetrataxis* sp. A. D2-049720. Locality Ak-198 (Pl). $\times 30$.
 Figs 47, 49: *Tetrataxis* sp. B. 47: D2-056497, 49: D2-049762. Locality 47: Kz-32 (Cp), 49: Ak-202 (Pl), 47: $\times 40$, 49: $\times 30$.
 Fig. 48: *Polytaxis* sp. D2-056478. Locality Kz-32 (Cp). $\times 20$.
 Figs 50-51: *Abadehella coniformis* Okimura & Ishii. 50: D2-049610, 51: D-056343. Locality 50: Ak-188 (As), 51: Kz-20 (As). Both $\times 40$.
 Fig. 52: *Abadehella regularis* Lin, Li & Sun. D2-049663. Locality Ak-193 (Pm). $\times 20$.

Symbols of the biostratigraphic units (Pm, Pl, Md, Mc, Cp, Pk, Nc, As, Cd) used in the explanation of plates are the same as those shown in Fig. 2 (Pm: *Paraleeina magna* Zone, Pl: *Pamirina leveni* Zone, Md: *Misellina dyhrenfurthi* Zone, Mc: *Misellina claudiae* Zone, Cp: *Cancellina pamirica* Zone, Pk: *Parafusulina kaerimizensis* Zone, Nc: *Neoschwagerina craticulifera* Zone, As: *Afghanella schencki* Zone, and Cd: *Colania douvillei* Zone).



inferred to be a form of *N. craticulifera* (*s.l.*) without subspecific subdivisions based on the number of whorls of the mature test, and shape and degree of development of primary and secondary transverse septula and axial septula. *N. craticulifera* from Akiyoshi closely resembles *N. cheni* Sheng, 1958 described by Nogami (1961b) from the Atetsu Limestone and illustrated by Kobayashi (1979) from the Kuzu area. Although periphery and poles of the test of the latter are more rounded than those of the former, they are considered to be conspecific.

Occurrence and stratigraphic distribution: Abundant to common in the *Neoschwagerina craticulifera* Zone (Ak-88, 182B, 182C, 182D; Kz-23).

***Neoschwagerina haydeni* Dutkevich in
Dutkevich & Khabakov, 1934**

Pl. XXI, figs 1-27

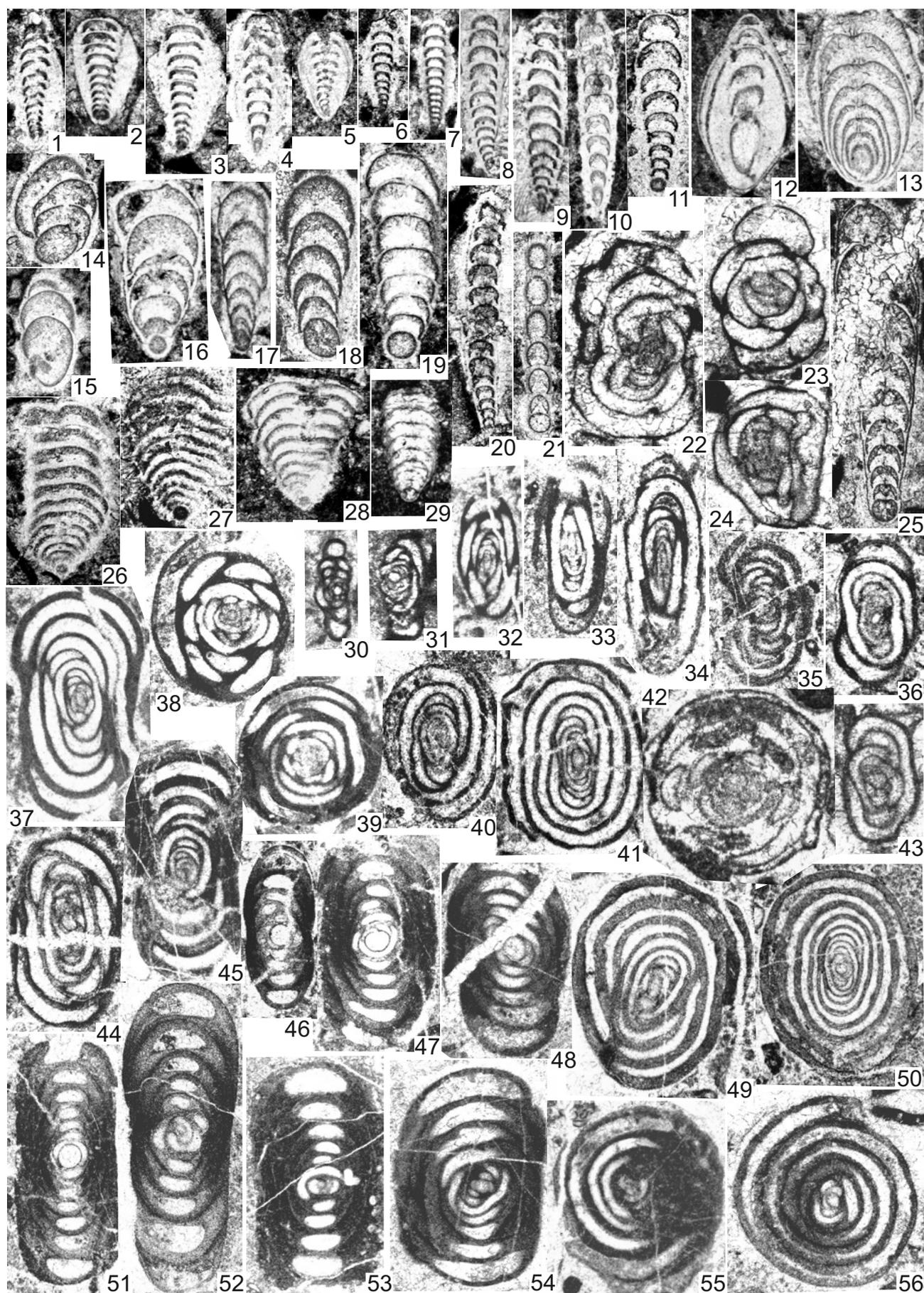
1909. *Neoschwagerina craticulifera* (Schwager).—
Hayden, pp. 248-249, pl. 21, fig. 1-7.
1934. *Neoschwagerina craticulifera* var. *haydeni*

- Dutkevich in Dutkevich & Khabakov, pp. 94-99,
pl. 2, fig. 6-8; pl. 3, figs 1-2.
non 1946. *Neoschwagerina craticulifera haydeni* Dutkevich
& Khabakov.—Thompson, pp. 155-156, pl. 23,
fig. 12-13.
1958. *Neoschwagerina craticulifera haydeni* Dutkevich
& Khabakov.—Toriyama, pp. 220-223, pl. 41,
figs 6(?), 7(?), 8.
1988b. *Neoschwagerina haydeni* Dutkevich & Khabakov.—
Kobayashi, pp. 445, 447, fig. 7.2-11.
1990. *Neoschwagerina haydeni* Dutkevich & Khabakov.—
T. Ozawa & Kobayashi, pl. 10, figs 12-14.
1992b. *Neoschwagerina haydeni* Dutkevich & Khabakov.—
Ueno, pp. 1055, 1057, fig. 10.1-5.
1992b. *Neoschwagerina fusiformis* Skinner & Wilde,
1967.—Ueno, pp. 1053, 1055; fig. 9.1-14.

Description: Test fusiform, with broadly rounded periphery, almost straight lateral slopes, bluntly pointed poles, and straight axis of coiling. Mature specimens with more than 15 whorls, more than 5.5 mm in length, more than 3.5 mm in width, and about 1.5 to 1.7 in form ratio, though exactly unknown due to abrasion of outer test.

Plate II

- Figs 1-5: *Pachyphloia ovata* Lange. 1: D2-049467, 2: D2-049596, 3: D2-049475, 4: D2-049488, 5: D2-049572. Locality 1, 3: Ak-184A (As); 2: Ak-188 (As), 4: Ak-184B (As), 5: Ak-187 (As). 1-3: $\times 50$, 4-5: $\times 40$.
Figs 6-7: *Pachyphloia* sp. 6: D2-049465, 7: D2-049579. Locality 6: Ak-184A (As), 7: Ak-187 (As). Both $\times 50$.
Figs 8-11: *Pachyphloia schwageri* Sellier de Civrieux & Dessauvagine. 8: D2-059858, 9: D2-059904, 10: D2-056525, 11: D2-049611. Locality 8: Kz-57 (As), 9: Kz-62 (Nc), 10: Kz-34 (Cp), 11: Ka-188 (As). 8: $\times 50$, 9-10: $\times 30$, 11: $\times 40$.
Fig. 12: *Pachyphloia robusta* K. V. Miklukho-Maklay. D2-059859. Locality Kz-57 (As). $\times 50$.
Fig. 13: *Pachyphloia?* sp. D2-059952. Locality Kz-65 (Pk). $\times 40$.
Fig. 14-15: *Ichtyofrondina* sp. 14: D2-049151, 15: D2-049725. Locality 14: Ak-178 (Mc), 15: Ak-198 (Pl). Both $\times 30$.
Figs 16-18: *Pseudolangella* sp. A. 16: D2-049622, 17: D2-056280, 18: D2-056477. Locality 16: Ak-188 (As), 17: Kz-14 (As), 18: Kz-32 (Cp). 16, 18: $\times 40$; 17: $\times 50$.
Fig. 19: *Pseudolangella fragilis* Sellier de Civrieux & Dessauvagine. D2-049584. Locality Ak-187 (As). $\times 40$.
Fig. 20: *Nodosinelloides* sp. D2-049639. Locality Ak-191 (Pl). $\times 40$.
Fig. 21: *Protonodosaria* sp. D2-049172. Locality Ak-178 (Mc). $\times 25$.
Figs 22-24: *Hemigordiellina?* sp. 22: D2-043000, 23: D2-049584, 24: D2-056215. Locality 22: Ak-86 (As), 23: Ak-187 (As), 24: Kz-12 (Pk). 22-23: $\times 50$, 24: $\times 40$.
Fig. 25: *Pseudolangella* sp. B. D2-049608. Locality Ak-188 (As). $\times 40$.
Figs 26-28: *Geinitzina postcarbonica* Spandel. 26: D2-049406, 27: D2-049467, 28: D2-043121. Locality 26: Ak-188 (As), 27: Ak-184A (As), 28: Ak-88 (Pk). 26: $\times 40$, 27-28: $\times 50$.
Fig. 29: *Geinitzina* sp. D2-059677. Locality Kz-42 (Cp). $\times 30$.
Figs 30-31: *Graecodiscus* sp. 30: D2-056551, 31: D2-059683. Locality 30: Kz-36 (Cp), 31: Kz-42 (Cp). Both $\times 50$.
Figs 32-34: *Agathammina pusilla* (Geinitz). 32: D2-049575, 33: D2-049585, 34: D2-043007. Locality 32-33: Ak-187 (As), 34: Ak-86 (As). 32-33: $\times 40$, 34: $\times 30$.
Figs 35-36, 43-44: *Hemigordius* sp. 35: D2-049752, 36: D2-049751, 43: D2-059771, 44: D2-049760. Locality 35: Ak-201 (Pl), 36: Ak-202 (Pl), 43: Kz-50 (Cd), 44: Ak-202 (Pl). 35: $\times 30$; 36, 44: $\times 40$; 43: $\times 50$.
Figs 37-39: *Hemigordius decorus* Lin. 37: D2-056574, 38: D2-043168, 39: D2-056125. Locality 37: Kz-37 (Md), 38: Ak-90 (Pk), 39: Kz-7 (Cp). 37: $\times 30$, 38-39: $\times 40$.
Figs 40-41: *Hemigordius dvinensis* K. V. Miklukho-Maklay. 40: D2-049748, 41: D2-056575. Locality 40: Ak-201 (Pl), 41: Kz-37 (Md). Both $\times 30$.
Fig. 42: *Neodiscus?* sp. D2-059719. Locality Kz-46 (Cp). $\times 40$.
Fig. 45: *Neohemigordius* sp. D2-049782. Locality Ak-203 (Pm). $\times 30$.
Figs 46-48, 51-56: *Neohemigordius japonicus* (Y. Ozawa). 46: D2-043155, 47: D2-043148, 48: D2-049601, 51: D2-043163, 52: D2-043158, 53: D2-043039, 54: D2-049518, 55: D2-049574, 56: D2-043161. Locality 46: Ak-87 (As); 47, 51-52, 56: Ak-90 (Pk); 48: Ak-188 (As); 53: Ak-86 (As); 54: Ak-184C (As); 55: Ak-187 (As). All $\times 30$.
Figs 49-50: *Hemigordiopsis?* sp. 49: D2-059990, 50: D2-059988. Locality both Kz-68 (Mc). 49: $\times 30$, 50: $\times 20$.



Proloculus is spherical and 25 to 70 microns in diameter. Inner two to three whorls are lenticular to subspherical to short fusiform, and tightly coiled. The succeeding whorls become to fusiform gradually increasing their length and width outward. Length from the first to 16th whorls 0.06 to 0.19, 0.17 to 0.33, 0.34 to 0.51, 0.53 to 0.70, 0.74 to 1.04, 1.04 to 1.43, 1.32 to 1.85, 1.75 to 2.24, 2.22 to 2.72, 2.77 to 3.14, 3.18 to 3.65, 3.6? to 4.2?, 4.25? to 4.7?, 4.98? to 5.2?, 5.5?, and 5.4? mm, respectively in the illustrated seven specimens. Width from the first to 16th whorls 0.08 to 0.17, 0.14 to 0.30, 0.24 to 0.38, 0.35 to 0.47, 0.47 to 0.62, 0.64 to 0.80, 0.82 to 1.03, 1.01 to 1.26, 1.24 to 1.56, 1.49 to 1.95, 1.75 to 2.32, 1.99 to 2.97, 2.26 to 3.15?, 2.53 to 3.23, 2.85 to 3.55?, and 3.24 to 3.58? mm in the illustrated seven axial and three sagittal sections.

Wall thin for the genus and composed of a tectum and finely alveolar keriotheca in fusiform whorls. Thickness of wall about 25 to 35 microns in outer whorls. Septa slender and gently inclined anteriorly. Septal counts from the first to 14th whorls in the illustrated three specimen are 6 or 7, 7 to 9, 9? to 11, 10? or 12, 11 to 14, 14 or 16, 17 to 18, 17 to 21, 18 to 20, 20 to 23, 22 to 25, 24 to 27, 26 or 28, and 27 or 29?, respectively.

Primary transverse septula slender for the genus and well developed except for inner lenticular to subspherical whorls. Secondary transverse septula poorly developed in outer whorls in most specimens. Axial septula absent in inner four whorls, poorly developed in the subsequent few whorls, and more developed in further outer whorls.

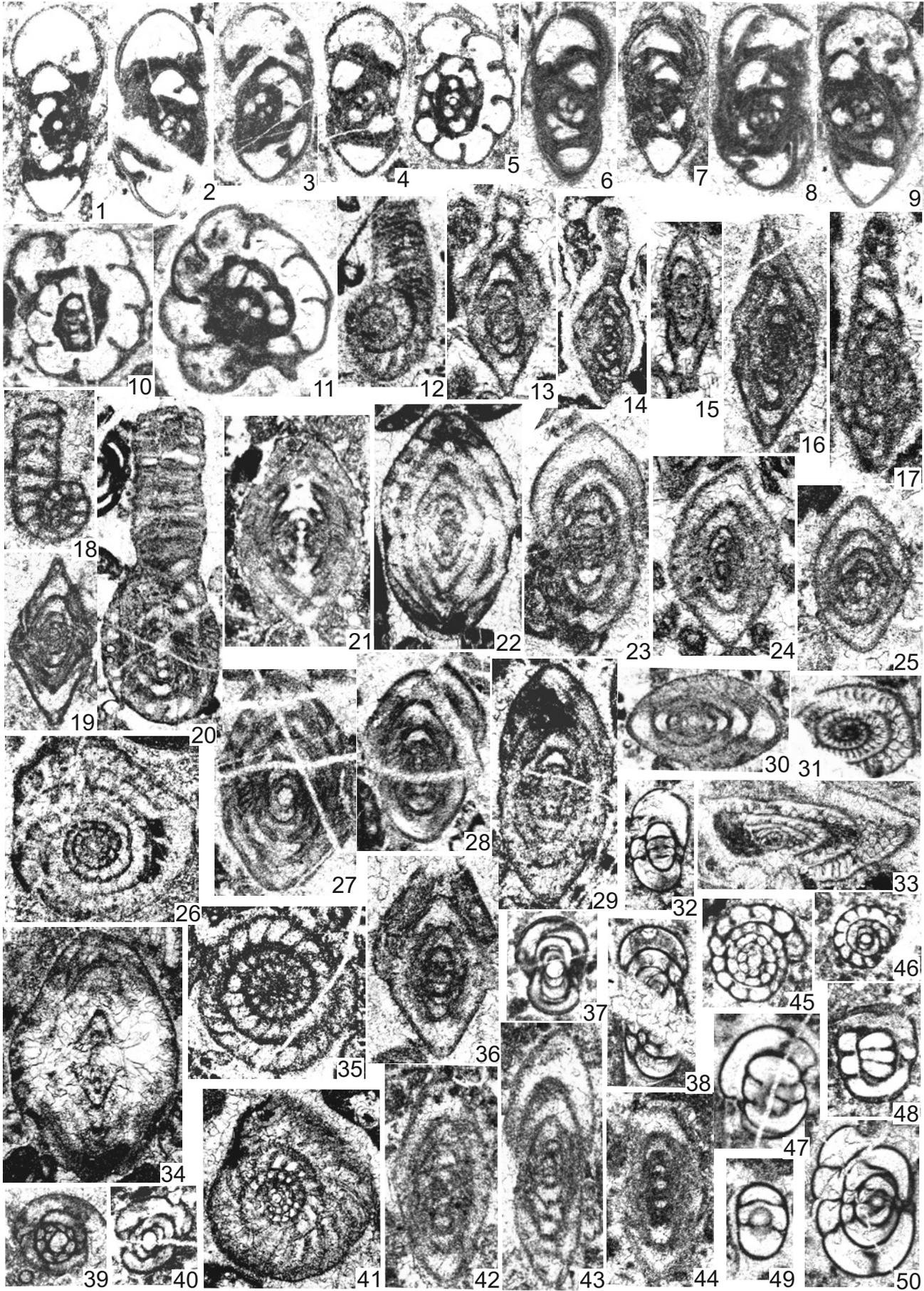
One to three axial septula are inserted between adjacent septa in outer whorls. Parachomata are narrow and high, and commonly in contact with the lower end of the primary transverse septula.

Remarks: In the Akiyoshi Limestone, neoschwagerinids having relatively thinner wall, and slenderer septa, septula and parachomata than other species were identified with *Neoschwagrina craticulifera haydeni* by Toriyama (1958), *N. haydeni* by T. Ozawa & Kobayashi (1990) and by Ueno (1992b), and with *N. fusiformis* by Ueno (1992b). The types of *Neoschwagerina haydeni* from eastern Pamir, Tajikistan (Dutkevich in Dutkevich & Khabakov, 1934) were distinguished from *N. craticulifera* (s.s.) by their thinner primary and secondary transverse septula in outer whorls. By these features of this species, Thompson's (1946) axial section from the Bamian Limestone, Afghanistan is separated from this species and reassigned to *N. craticulifera*. Axial septula are more developed in the Akiyoshi specimens in comparison with the types.

Fourteen specimens identified by Ueno (1992b) with *Neoschwagerina fusiformis* can not be distinguished from the Ueno's *N. haydeni*. These two species described by Ueno (1992b) are supposed to be conspecific. Though having fusiform to elongate fusiform test with relatively thin wall and slender septa, septula, and parachomata, *N. fusiformis* proposed just beneath the Capitanian limestone of Tunisia (Skinner & Wilde, 1967) is assumed to be phylogenetically unrelated to the species of *Neoschwagerina* reported from Japan.

Plate III

- Figs 1-11: *Neoendothyra hunai* (Lin). 1: D2-030249, 2: D2-059855, 3: D2-049488, 4: D2-049618, 5: D2-059926, 6: D2-043145, 7: D2-056155, 8: D2-056333, 9: D2-049592, 10: D2-056080, 11: D2-056188. Locality 1: Kz-K (Pk), 2: Kz-57 (As), 3: Ak-184B (As), 4, 9: Ak-188 (As), 5: Kz-63 (Nc), 6: Ak-90 (Pk), 7: Kz-9 (Pk), 8: Kz-18 (As), 10: Kz-3 (Cp), 11: Kz-11A (Pk). 1, 4, 6-11: $\times 50$; 2-3, 5: $\times 40$.
- Figs 12-14, 15(?), 17-19: *Pseudoreichelina darvasica* Leven. 12: D2-056487, 13: D2-043019, 14: D2-049424, 15: D2-043028, 17: D2-0430868, 18: D2-049783, 19: D2-049618. Locality 12: Kz-32 (Cp), 13, 15, 17: Ak-86 (As), 14: Ak-182C (Nc), 18: Ak-203 (Pm), 19: Ak-88 (Pk). 12, 14: $\times 30$; 13, 15, 17: $\times 50$; 18-19: $\times 40$.
- Figs 16: *Nankinella akiyoshiensis* (Toriyama). D2-049497. Locality Ak-184C (As). $\times 40$.
- Fig. 20: *Pseudoreichelina* sp. D2-049754. Locality Ak-202 (Pl). $\times 30$.
- Figs 21-30, 34-36: *Nankinella nagatoensis* Toriyama. 21: D2-056113, 22: D2-056208, 23: D2-049773, 24: D2-043033, 25: D2-049784, 26: D2-043100, 27: D2-049651, 28: D2-043180, 29: D2-049789, 30: D2-043207, 34: D2-043087, 35: D2-049789, 36: D2-049498. Locality 21: Kz-5 (Cp), 22: Kz-11B (Pk), 23, 25, 29, 35: Ak-203 (Pm), 24: Ak-86 (As), 26, 34: Ak-87 (As), 27: Ak-192 (Pm), 28, 30: Ak-91 (Md), 36: Ak-184C (As). 21-22, 26-27, 35: $\times 30$; 23-25, 28-30, 34, 36: $\times 40$.
- Figs 31, 33: *Minojapanella elongata* Fujimoto & Kanuma. 31: D2-059766, 33: D2-059761. Locality both Kz-49 (Cp). Both $\times 30$.
- Figs 32, 38, 45-50: *Pamirina leveni* Kobayashi. 32: D2-049766, 38: D2-059999, 45: D2-049768, 46: D2-049738, 47: D2-049726, 48: D2-049740, 49: D2-049724, 50: D2-049764. Locality 32, 45, 50: Ak-202 (Pl); 38: Kz-69 (Md); 46, 48: Ak-200 (Pl); 47, 49: Ak-198 (Pl). 32, 50: $\times 40$; others: $\times 50$.
- Fig. 37: *Pamirina?* sp. D2-056119. Locality Kz-6 (Cp). $\times 50$.
- Figs 39-40: *Schubertella?* *karasawensis* Kobayashi. 39: D2-049745, 40: D2-049743. Locality 39: Ak-201 (Pl), 40: Ak-200 (Pl). 39: $\times 40$, 40: $\times 50$.
- Figs 41-44: *Nankinella changanchiaoensis* (Sheng & Wang). 41: D2-056326, 42: D2-059803, 43: D2-059811, 44: D2-0800. Locality 41: Kz-18 (Cd), 42-44: Kz-53 (Cd). 41: $\times 30$, 42-44: $\times 40$.



Occurrence and stratigraphic distribution: Abundant exclusively in the middle part of the *Afghanella schencki* Zone (Ak-87, 186; Kz-13, 14), though not well traceable laterally in the field.

Subfamily Sumatrininae Silvestri, 1933

Genus *Afghanella* Thompson, 1946

Type species: *Afghanella schencki* Thompson, 1946, p. 153.

***Afghanella schencki* Thompson, 1946**

Pl. XXII, figs 1-21

- 1925a. *Neoschwagerina (Yabeina) schellwieni* (Deprat, 1913).— Y. Ozawa, pl. 2, figs 8-10.
 1925b. *Yabeina schellwieni* (Deprat).— Y. Ozawa, pp. 60-61, pl. 10, figs 3a, 4.
 1946. *Afghanella schencki* Thompson, pp. 153-155, pl. 25, figs 1-12.
 1958. *Afghanella schencki* Thompson.— Toriyama, pp. 250-251, pl. 48, figs 1, 2(?), 3, 4(?), 5(?), 6-9, 10(?).
 non 1977. *Afghanella schencki* Thompson.— M. Ota, pl. 2, figs 1-2 [= *Presumatrina ozawai* (Hanzawa, 1954)].
 1990. *Afghanella schencki* Thompson.— T. Ozawa & Kobayashi, pl. 10, figs 5-7.
 1992b. *Afghanella schencki* Thompson.— Ueno, pp. 1061-1063, fig. 12.1-11.
 1992b. *Afghanella* cf. *sumatrinaeformis* (Gubler, 1935).— Ueno, pp. 1063-1064, fig. 12.12-16.

Description: Test fusiform, with broadly rounded periphery, almost straight to slightly convex lateral slopes, bluntly pointed poles, and straight axis of coiling. Mature specimens with nine to twelve whorls, about 3.0 to 3.9 mm in length, about 1.47 to 2.25 mm in width, and form ratio about 1.7 to 2.1.

Proloculus is nearly spherical and 0.09 to 0.15 mm in

diameter. The first whorl short fusiform to subspherical and succeeded by later fusiform to elongate fusiform whorls gradually increasing length and width outwards. Length from the first to 11th whorls 0.14 to 0.27, 0.29 to 0.48, 0.47 to 0.83, 0.71 to 1.20?, 0.96 to 1.37, 1.27 to 1.76, 1.69 to 2.17, 2.18 to 2.72, 2.60 to 3.15, 3.0? to 3.57?, and 3.63? mm, respectively. Width from the first to 11th whorls 0.12 to 0.22, 0.19 to 0.30, 0.26 to 0.41, 0.36 to 0.56, 0.45 to 0.73, 0.64 to 0.96, 0.80 to 1.20, 1.01 to 1.49, 1.23 to 1.73, 1.4? to 1.97?, and 1.89 mm.

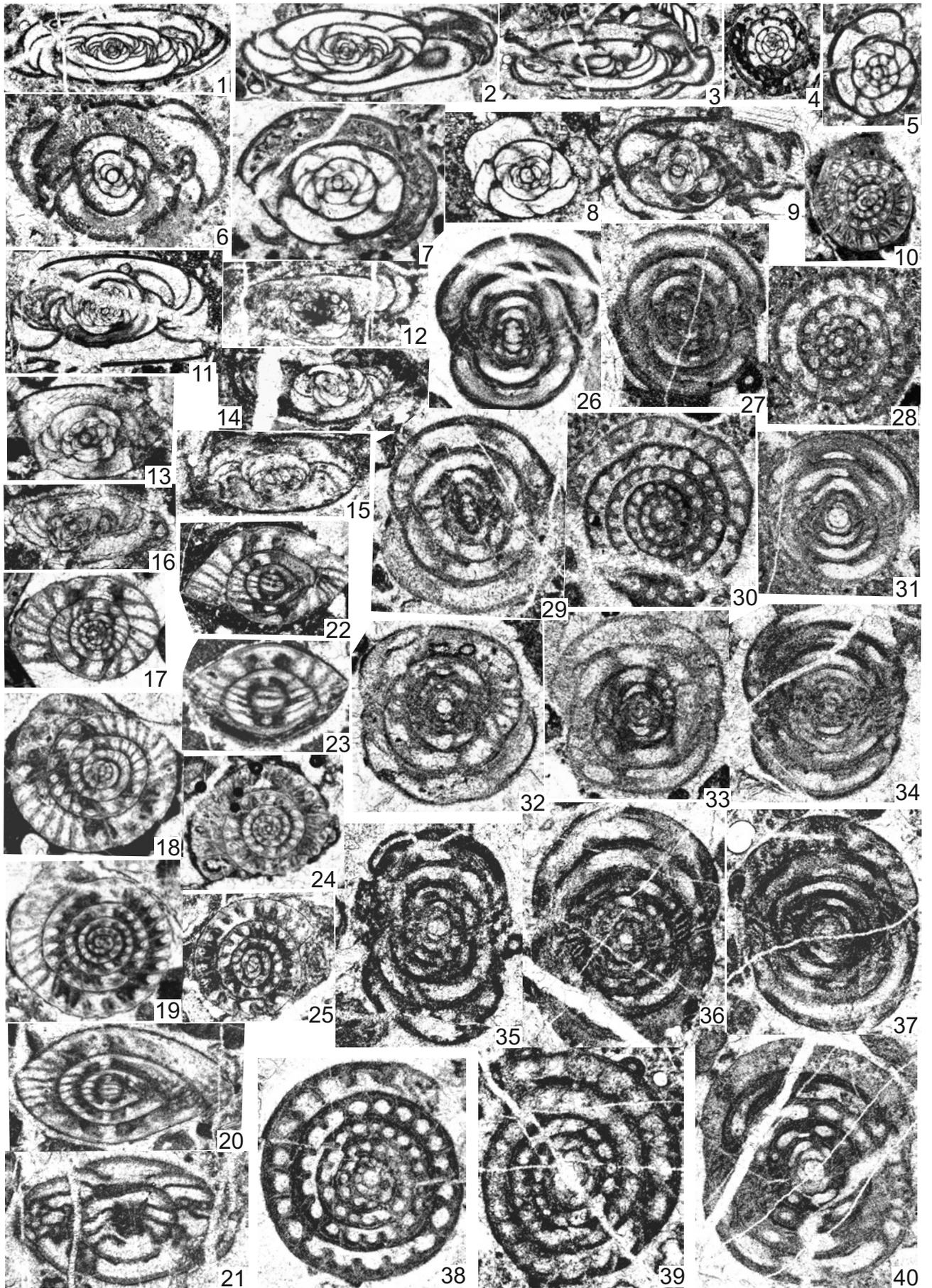
Wall thin and about 20 to 25 microns in outer whorls, and composed of a tectum and finely alveolar keriotheca. Septa slender, and inclined anteriorly. Septal counts from the first to 11th whorls in one sagittal section illustrated are 4, 11, 14, 15, 17, 19, 20, 25, 26, 29, and more than 32, respectively.

Primary transverse septula slender, developed throughout the test, and in contact with slender parachomata. Secondary transverse septula first appear in the fifth whorl, shorter than the primary ones, and well developed in outer whorls. Commonly one, partly two secondary transverse septula occur between the adjacent primary transverse septula in outer whorls. Axial septula first appear in the fourth whorl, and commonly two axial septula are counted between the adjacent septa in outer whorls.

Remarks: The present Akiyoshi specimens are safely identical with the types from the Bamian Limestone of Afghanistan (Thompson, 1946), though proloculus is somewhat smaller in the former. Y. Ozawa's (1925a, b) specimens from Akiyoshi are undoubtedly reassigned to *Afghanella*. His assignment to *Neoschwagerina (Yabeina)* or *Yabeina* at those days is considered to be due to well development of both primary and secondary transverse septula in spite of having smaller test and larger

Plate IV

- Figs 1-4: *Toriyamaia laxiseptata* Kanmera. 1: D2-056560, 2: D2-056558, 3: D2-043175, 4: D2-056568. Locality 3: Ak-91 (Md), others: Kz-37 (Md). All $\times 20$.
 Figs 5-7, 8(?), 9: *Kahlerina* sp. 5: D2-056316, 6: D2-056319, 7: 049566, 8: D2-043062, 9: D2-043083. Locality 5-6: Kz-16 (Cd), 7: Ak-187 (As), 8-9: Ak-86 (As). All $\times 30$.
 Figs 10, 17, 22-25: *Neofusulinella uenoi* n. sp. 10: D2-056132, 17: D2-059740, 22: D2-056114, 23: D2-056129, 24: D2-056112, 25: D2-056068. Locality 10, 23: Kz-7 (Cp); 17: Kz-48 (Cp); 22, 24: Kz-5 (Cp); 25: Kz-3 (Cp). 22: $\times 30$, others: $\times 40$.
 Figs 11-16: *Rauserella ellipsoidalis* Sosnina. 11: D2-059860, 12: D2-049584, 13: D2-056279, 14: D2-056290, 15: D2-049383, 16: D2-056261. Locality 11: Kz-57(As); 12: Ak-187 (As); 13-14, 16: Kz-14 (As); 15: Ak-182B (Nc). 11, 14: $\times 30$; others: $\times 40$.
 Figs 18-20: *Yangchienia?* sp. 18: D2-056128, 19: D2-056059, 20: D2-056069. Locality 18: Kz-7 (Cp), 19: Kz-2 (Cp), 20: Kz-3 (Cp). 18-19: $\times 40$, 20: $\times 30$.
 Fig. 21: *Moschubertella* sp. D2-049771. Locality Ak-203 (Pm). $\times 30$.
 Figs 26-28, 31: *Palaeostaffella akudensis* (Hh. Igo). 26: D2-049754, 27: D2-056568, 28: D2-060004, 31: D2-059981. Locality 26: Ak-202 (Pl), 27: Kz-37 (Md), 28: Kz-70 (Pl), 31: Kz-68 (Mc). 28: $\times 40$, others: $\times 30$.
 Figs 29-30, 32-34: *Palaeostaffella moelleri* (Y. Ozawa). 29: D2-059992, 30: D2-059991, 32: D2-059989, 33: D2-059987, 34: D2-049628. Locality 29-30, 32-33: Kz-68 (Mc); 34: Ak-189 (Pl). All $\times 30$.
 Figs 35-40: *Palaeostaffella subquadrata* n. sp. 35: D2-049627, 36: D2-049779, 37: D2-049785, 38: D2-049783, 39: D2-049775, 40: D2-049787 (holotype). Locality 35: Ak-189 (Pl), 36-40: Ak-203 (Pm). 39: $\times 40$, others: $\times 30$.



proloculus than in the typical *Yabeina*. However, they are not identical with Deprat's (1913) original *schellwieni*, later designated as the type species of *Presumatrina* by Tumanskaya (1950), in more well-developed secondary transverse septula, though outer whorls of the test are abraded as well as those of most specimens in the present material. Thus, Y. Ozawa's *Y. schellwieni* should be renamed as *Afghanella schencki*.

It is uncertain that the incomplete, not well oriented specimens illustrated by Toriyama (1958) are all identical with this species or not. Five specimens compared by Ueno (1992b) with *Afghanella sumatrinaeformis* are different from the types of Gubler (1935). The latter has more developed secondary transverse septula and axial septula, thinner wall and septula, and much larger proloculus. Larger appearance of the five specimens than his eleven specimens named *A. schencki* is supposed to be due to lower degree of abrasion of the outer test in the former than in the latter. They occur in the same stratigraphic levels according to Ueno (1992b, fig. 4). These five specimens of Ueno's are transferred to *A. schencki* herein, since no significant differences are recognized between the two, taking the test abrasion into account.

Occurrence and stratigraphic distribution: Common in the *Afghanella schencki* Zone (Ak-184B, 184C, 184D, 187, 188; Kz-57).

Genus *Presumatrina* Tumanskaya, 1950
Type species: *Doliolina schellwieni* Deprat, 1913, p. 51.

***Presumatrina ozawai* (Hanzawa, 1954)**

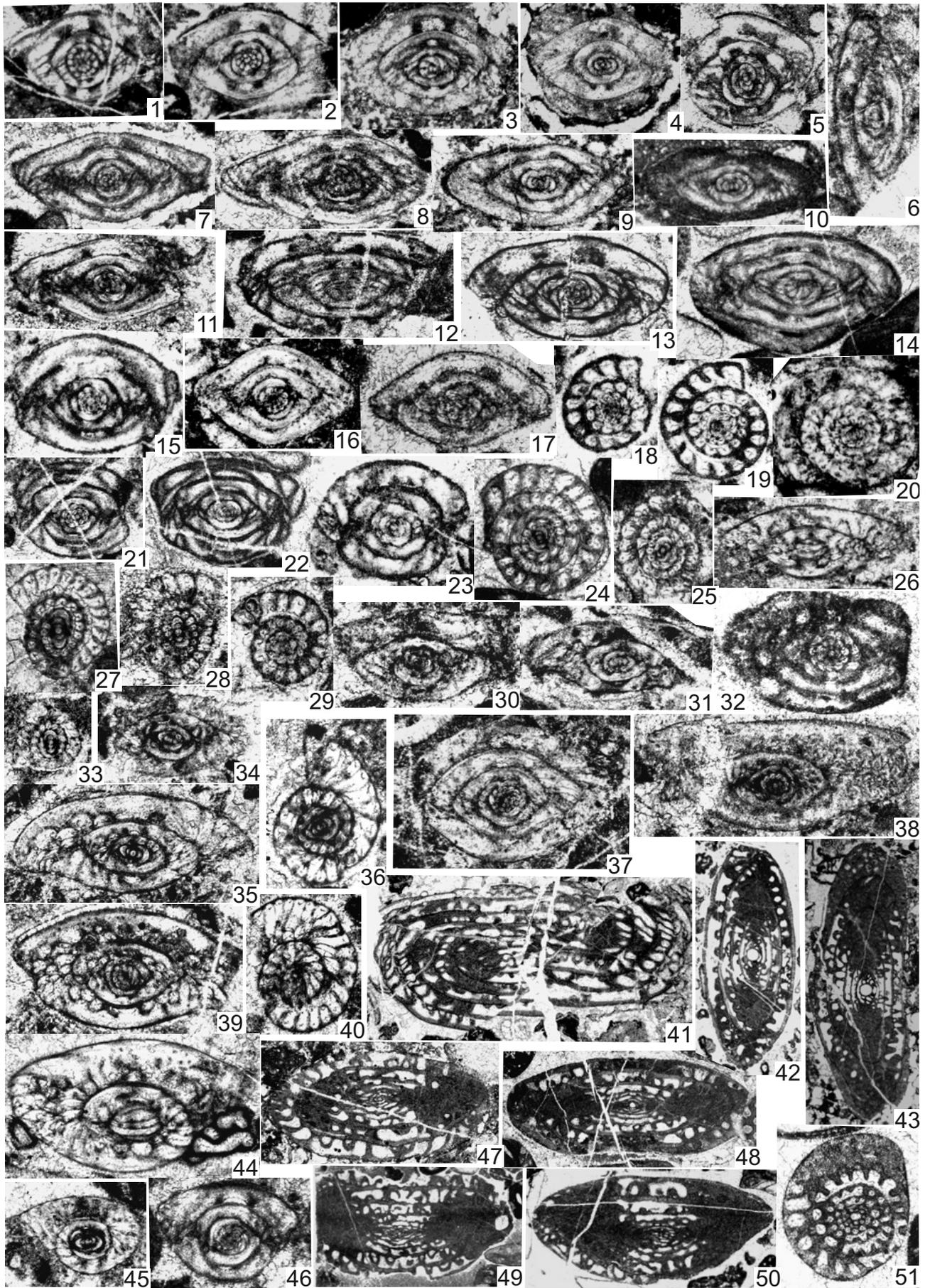
Pl. XIX, figs 1-29

1954. *Afghanella ozawai* Hanzawa, pp. 3-7, pl. 1, figs 1-6; pl. 2, figs 1-4.
 par 1958. *Afghanella ozawai* Hanzawa.— Toriyama, pp. 252-254, pl. 48, figs 11, 13, non fig. 12 (possibly *Afghanella schencki*), non 14-17 (indeterminable *Afghanella*).
 1958. *Afghanella schencki* var. *megaspherica* Sheng, pp. 290-291, pl. 4, figs 1-4.
 1977. *Afghanella schencki* Thompson.— M. Ota, pl. 2, figs 1-2.
 1990. *Afghanella ozawai* Hanzawa.— T. Ozawa & Kobayashi, pl. 10, figs 1-2.
 1992b. *Afghanella ozawai* Hanzawa.— Ueno, pp. 1059, 1061, fig. 11.1-17.
 1992b. *Afghanella* sp. Ueno, p. 1064, fig. 11.18-20.

Description: Test inflated fusiform to fusiform, with broadly rounded periphery, and bluntly pointed poles. Axis of coiling is straight. Mature specimens of megalospheric forms with 7 to 9 whorls, about 2.9 to 4.1 mm in length, 1.67? to 2.24 mm in width, giving approximate form ratio 1.5 to 1.9 in fourteen axial and four sagittal sections illustrated.

Plate V

- Figs 1-5: *Neofusulinella uenoi* n. sp. 1: D2-056145, 2: D2-056113 (holotype), 3: D2-056116, 4: D2-056115, 5: D2-056074. Locality 1: Kz-8 (Cp), 2-4: Kz-5 (Cp), 5: Kz-3 (Cp). All $\times 40$.
 Figs 6-11: *Neofusulinella* sp. A. 6: D2-056570, 7: D2-056129, 8: D2-043234, 9: D2-056103, 10: D2-056137, 11: D2-043219. Locality 6: Kz-37 (Md); 7, 10: Kz-7 (Cp); 8, 11: Ak-92 (Mc); 9: Kz-5 (Cp). All $\times 40$.
 Figs 12-14: *Schubertella melonica* Dunbar & Skinner. 12: D2-049645, 13: D2-043191, 14: D2-056138. Locality 12: Ak-191 (Pl), 13: Ak-91 (Md), 14: Kz-7 (Cp). 12: $\times 30$, 13-14: $\times 40$.
 Figs 15-19, 21-22: *Neofusulinella giraudi* Deprat. 15: D2-030147, 16: D2-030263, 17: D2-030263, 18: D2-030160, 19: D2-030148, 21: D2-043227, 22: D2-043223. Locality: 15-16, 18-19: Kz-M (Mc); 17: Kz-46 (Cp); 21-22: Ak-92 (Mc). 15-16, 18-19, 22: $\times 40$; 17: $\times 50$; 21: $\times 30$.
 Figs 20, 23-24: *Neofusulinella simplex* (Lange). 20: D2-030143, 23: D2-030154, 24: D2-049346. Locality 20, 23: Kz-M (Mc); 24: Ak-182A (Pk). 20: $\times 50$, 23-24: $\times 40$.
 Figs 25-31, 33-34: *Dunbarula schubertellaformis* Sheng. 25: D2-059752, 26: D2-059847, 27: D2-059859, 28: D2-042994, 29: D2-043023, 30: D2-043052, 31: D2-042985, 33: D2-049206, 34: D2-049579. Locality 25: Kz-49 (Cp), 26-27: Kz-57 (As), 28-31: Ak-86 (As), 33: Ak-180 (Pk), 34: Ak-187 (As). 25, 28-31, 33-34: $\times 40$; 26: $\times 30$; 27: $\times 50$.
 Fig. 32: *Neofusulinella* sp. B. D2-059714. Locality Kz-46 (Cp). $\times 40$.
 Figs 35-36, 39-40, 44-46: *Dunbarula* aff. *tumida* Skinner. 35: D2-049622; 36, 40: D2-049511; 39: D2-049620; 44: D2-049518; 45: D2-049582; 46: D2-059906. Locality 35, 39: Ak-188 (As); 36, 40, 44: Ak-184C (As); 45: Ak-187 (As); 46: Kz-62 (Nc). 46: $\times 50$, others: $\times 40$.
 Fig. 37: *Neofusulinella phairayensis* Colani. D2-059931. Locality Kz-63 (Nc). $\times 40$.
 Fig. 38: *Codonofusiella?* sp. D2-049615. Locality Ak-188 (As). $\times 40$.
 Fig. 41: *Nagatoella orientis* (Y. Ozawa). D2-056081. Locality Kz-4 (Cp). $\times 10$.
 Figs 42-43: Schwagerinidae gen. and sp. indet. 42: D2-059989, 43: D2-059954. Locality 42: Kz-68 (Mc), 43: Kz-65 (Pk). Both $\times 10$.
 Figs 47, 49-50: *Rugosochusenella* sp. A. 47: D2-056105, 49: D2-056141, 50: D2-059749. Locality 47: Kz-5 (Cp), 49: Kz-7 (Cp), 50: Kz-48 (Cp). 47, 50: $\times 15$; 49: $\times 10$.
 Figs 48, 51: *Rugosochusenella* sp. B. 48: D2-056194, 51: D2-059741. Locality 48: Kz-11B (Pk), 51: Kz-48 (Cp). 48: $\times 10$, 51: $\times 20$.



Proloculus spherical to subspherical, 0.15 to 0.61 mm, averaging 0.25 mm in the 23 illustrated specimens of megalospheric forms, and 0.02 or 0.03 mm in two microspheric forms illustrated. The first whorl short fusiform to subspherical and succeeded by later fusiform whorls gradually increasing length and width in megalospheric forms. Length from the first to ninth whorls 0.29 to 0.64, 0.47 to 1.07, 0.75 to 1.45, 1.03 to 1.87, 1.43 to 2.30, 1.85 to 2.8?, 2.25 to 3.1?, 2.63? to 3.65, and 3.23? to 4.1? mm, respectively in illustrated 19 megalospheric axial sections. Width from the first to ninth whorls 0.22 to 0.89, 0.30 to 1.14, 0.42 to 1.43, 0.57 to 1.17, 0.74 to 1.47, 0.98 to 1.8?, 1.26 to 2.0?, 1.55 to 2.24, 1.80? to 2.2? mm, respectively in illustrated 19 axial and four sagittal sections of megalospheric forms. Wall thin and about 30 to 75 microns in thickness in outer whorls, and composed of a tectum and finely alveolar keriotheca. Septa slender, and inclined anteriorly. Septal counts from the first to seventh whorls in four sagittal sections illustrated are 8 to 12, 15 to 21, 19 to 25, 20 to 22, 23 or 24, 24 to 27, and 28?, respectively.

Primary transverse septula long and developed throughout the test. Secondary transverse septula first appear in the fifth to sixth whorl, and developed in most specimens beyond the sixth whorl. Axial septula first appear in the third whorl, and one or two axial septula are inserted between the adjacent septa in outer whorls. Parachomata node-like and variable in their height, and some are in contact with primary transverse septula.

Remarks: This species to have been assigned to *Afghanella* in Akiyoshi is reassigned to *Presumatrina* on account of its poorer development of secondary transverse septula and smaller number of axial septula between adjacent septa. In addition to these features, it is easily distinguished from *Afghanella schencki* by its larger proloculus, thicker wall, fewer whorls, and stouter septula and parachomata. Furthermore, secondary transverse septula and axial septula first appear in later ontogenetic stage of the test growth in the former.

Based on these features characteristic in *Presumatrina ozawai*, M. Ota's (1977) two specimens are separated

from *A. schencki* and reassigned to this species. At least some of Toriyama's (1958) specimens included into *Afghanella ozawai* should be eliminated from this species and reassigned to *A. schencki*, and some others to indeterminate *Afghanella* by these features despite incomplete thin sections of Toriyama's (1958). Three excentered sections named as *Afghanella* sp. in Ueno (1992b) are considered to represent the microspheric forms of this species based on the test size, degree of development of primary and secondary transverse septula, and parachomata. These morphologic features of "*Afghanella* sp." are more similar to those of microspheric forms of *Presumatrina ozawai* than of *Afghanella schencki*.

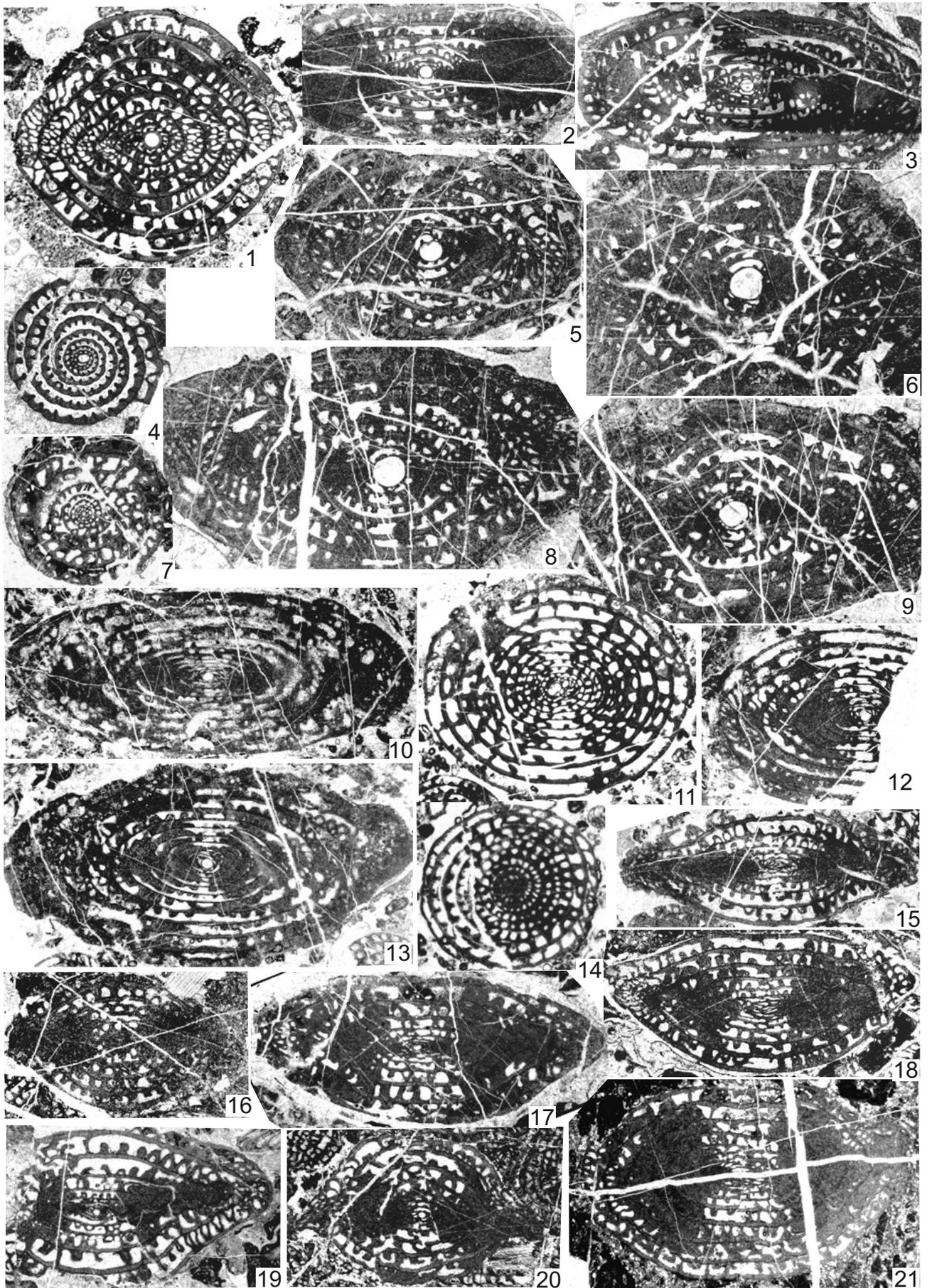
Afghanella schencki var. *megaspherica* proposed by Sheng (1958) from the Maokou Limestone of Qinghai is removed to *Presumatrina ozawai* on account of its number of whorls, proloculus size, and degree of development of secondary transverse septula. Samely, based on morphologic features variable from specimen to specimen of this species, *Praesumatrina grandis* introduced by Leven (1967) from the Murgabian of southeast Pamir is supposed to be a junior synonym of this species. Two new species, included or questionably included into *Praesumatrina* by Sosnina (1965), *P. turgida* and *P. (?) taudemica*, from the *Metadoliolina lepida* Zone of Schikote-Alin, are assumed to be excluded from *Presumatrina*. However, their taxonomic assignment can not be closely discussed on account of absence of outer whorls of the test. Nevertheless, the former has more developed secondary transverse septula, compared to those in the corresponding whorls of a species of *Presumatrina*. The latter might be an incomplete specimen referable to a species of *Lepidolina*.

Occurrence and stratigraphic distribution: Abundant in the upper part of the *Parafusulina kaerimizensis* Zone (Ak-90, 180, 181, 183).

Superfamily Palaeotextularioidea Galloway, 1933
Family Biseriamminidae Chernysheva, 1941
Subfamily Dagmaritinae Bozorgnia, 1973

Plate VI

- Fig. 1: *Cuniculinella vulgarisiformis* (Morikawa). D2-060003. Locality Kz-70 (Pl). $\times 10$.
Figs 2-4: *Pseudofusulina fusiformis* (Schellwien & Dyhrenfurth). 2: D2-049781, 3: D2-049777, 4: D2-049774. Locality all Ak-203 (Pm). All $\times 10$.
Figs 5-6, 8-9: *Paraleeina magna* (Toriyama). 5: D2-049773, 6: D2-049784, 8: D2-049786, 9: D2-049772. Locality all Ak-203 (Pm). All $\times 10$.
Figs 7, 15-19: *Chusenella schwagerinaeformis* Sheng. 7: D2-056347, 15: D2-049206, 16: D2-056249, 17: D2-056348, 18: D2-049440, 19: D2-056376. Locality 7, 17: Kz-21A (As); 15: Ak-180 (Pk); 16: Kz-13 (As); 18: Ak-182D (Nc); 19: Kz-21B (As). All $\times 10$.
Figs 10-14: *Nagatoella orientis* (Y. Ozawa). 10: D2-043234, 11: D2-030157, 12: D2-043235, 13: D2-043238, 14: D2-030155. Locality 10, 12-13: Ak-92 (Mc); 11, 14: Kz-M (Mc). All $\times 10$.
Fig. 20: *Chusenella* sp. A. D2-056288. Locality Kz-14 (As). $\times 10$.
Fig. 21: *Chusenella* sp. B. D2-059903. Locality Kz-61 (Nc). $\times 10$.



Genus *Dagmarita* Reitlinger, 1965

Type species: *Dagmarita chanakchiensis* Reitlinger, 1965, p. 62.

***Dagmarita?* cf. *shahrezaensis* Mohtat-Aghai &**

Vachard, 2003

Pl. I, figs 11-12

Compare:

2003. *Dagmarita shahrezaensis* Mohtat-Aghai & Vachard, pp. 38, 40, 42, pl. 1, figs 1-13, 14?.

Description: Test small, flattened-cuneate in section, and consisting of more than five pairs of chambers biserially arranged. Chambers gradually increasing width and height, rounded without thornlike projections at their peripheral margins common in the species of *Dagmarita*. Adjacent chambers overlapping and bending sharply at the simple aperture. Wall thin, dark, microgranular, not differentiated at the peripheral margins, and thickened toward the chamber junctions showing three-layered structure by intervening of light layer between thin dark layers.

Remarks: Inner stage of the test in the present material is uncertain. However, the size of the test, chamber arrangement, absence of thornlike projections, and wall structure of the paired chambers of the present material are similar and compared to those of *Dagmarita shahrezaensis* described by Mohtat-Aghai & Vachard (2003) from the Wuchiapingian of central Iran. The most important test character of this species is the absence of thornlike projections, by which Mohtat-Aghai & Vachard interpreted that the species is a transitional form phylogenetically from *Dagmarita* to *Paradagmarita*. In this paper, this species is, however, questionably assigned to *Dagmarita* on account of absence of thornlike projections characteristic in the genus.

The test size and chamber arrangement of the present

material are similar to *Dagmarita cuneata* and *D. elegans*, both of which were proposed by Sosnina (1977) from the Capitanian (*Metadoliolina lepida* Zone) of Primorye. However, thornlike projections well developed in the two species of Primorye are absent in the present material.

Occurrence and stratigraphic distribution: Rare in the *Colania douvillei* Zone (Kz-16).

Superfamily Endothyroidea Brady, 1884

Family Endothyridae Brady, 1884

Genus *Neoendothyra* Reitlinger, 1965

Type species: *Neoendothyra reicheli* Reitlinger, 1965, p. 61.

***Neoendothyra hunanica* (Lin, 1978)**

Pl. III, figs 1-11

1978. *Endothyra hunanica* Lin, p. 31, pl. 6, figs 2-3.

2012b. *Neoendothyra hunanica* (Lin).— Kobayashi, p. 233, fig. 5.11, 15, 20-21.

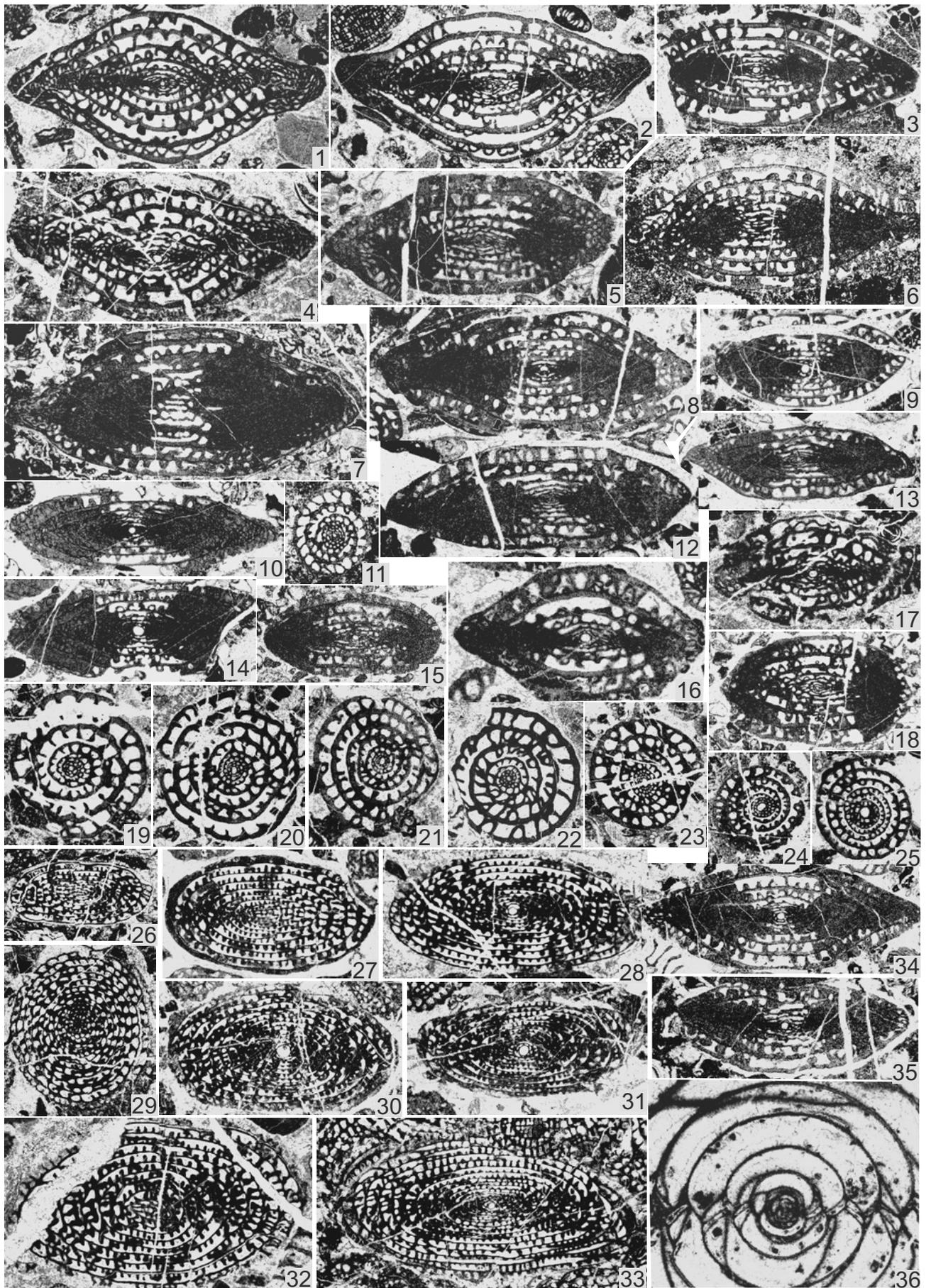
Description: Test involute, lenticular to discoidal, consisting of 4 to 4.5 whorls, with rounded to bluntly pointed peripheral margin and shallow umbilical cavities. Axis of coiling variably changes in inner two to three whorls, and is gently displaced in the terminal whorl. Length 0.21 to 0.38 mm, width 0.58 to 0.97 mm and form ratio about 0.30 to 0.47. Proloculus spherical and 31 to 36 microns in diameter. Width rather abruptly increases in the terminal whorl.

Wall not differentiated in inner whorls and consist of thin, discontinuous, distinct upper layer, and thicker, microgranular, calcareous lower layer. Its thickness about 28 to 34 microns in outer whorls. Septa gently curved and inclined anteriorly. Septal counts 8 to 10 in the terminal whorl. Inner whorls and umbilical parts of the test are filled with calcareous materials.

Remarks: Test outline, thickness of wall, spacing of the

Plate VII

- Figs 1, 2, 4, 17, 19: *Chusenella deprati* (Y. Ozawa). 1: D2-049506, 2: 49493, 4: D2-049610, 17: D2-049508, 19: D2-049613. Locality 1: Ak-184A (As); 2: Ak-184B (As); 4, 19: Ak-188 (As); 17: Ak-184C (As). All $\times 10$.
- Figs 3, 5-16, 18, 20-25, 34-35: *Chusenella conicocylindrica* Chen. 3: D2-049202, 5: D2-043021, 6: D2-043126, 7: D2-049377, 8: D2-049258, 9: D2-043137, 10: D2-043157, 11: D2-043051, 12: D2-049248, 13: D2-049345, 14: D2-043170, 15: D2-043028, 16: D2-049501, 18: D2-043060, 20: D2-049465, 21: D2-049512, 22: D2-049497, 23: D2-049577, 24: D2-043136, 25: D2-043154, 34: D2-049248, 35: D2-049431. Locality 3: Ak-180 (Pk); 5, 11, 15, 18: Ak-86 (As); 6: Ak-88 (Nc); 7: Ak-182B (Nc); 8, 12, 34: Ak-181 (Pk); 9-10, 14, 24-25: Ak-90 (Pk); 13: Ak-182A (Pk); 16, 21-22: Ak-184C (As); 20: Ak-184A (As); 23: Ak-187 (As); 35: Ak-182D (Nc). 16: $\times 15$, others: $\times 10$.
- Figs 26-27: *Pseudodoliolina ozawai* Yabe & Hanzawa. 26: D2-049434, 27: D2-049310. Locality 26: Ak-182D (Nc), 27: Ak-182A (Pk). Both $\times 10$.
- Figs 28-33: *Pseudodoliolina pseudolepida* (Deprat). 28: D2-049500, 29: D2-049490, 30: D2-049547, 31: D2-049559, 32: D2-049512, 33: D2-049542. Locality 28, 32: Ak-184C (As); 29: Ak-184B (As); 30-31, 33: Ak-186 (As). All $\times 10$.
- Fig. 36: *Verbeekina verbeeki* (Geinitz). D2-043046. Locality Ak-86 (As). $\times 20$. (= Plate XIV, fig. 7).



septa, and degree of development of calcareous materials vary from specimen to specimen. The present specimens are presumably identical with the original ones of *Neoendothyra hunanica* proposed by Lin (1978) from the Maokou Limestone in Hunan of South China in their similarities in size and outline of the test with rounded to bluntly pointed peripheral margin, the mode of the change of axis of coiling, and dense calcareous materials. These similar test characters are also recognized in specimens identified with this species by Kobayashi (2012b) from the Tsunemori Formation.

Occurrence and stratigraphic distribution: Rare in the *Cancellina pamirica* Zone (Kz-3), *Parafusulina kaerimizensis* Zone (Kz-K, Kz-9, 11; Ak-90) and *Neoschwagerina craticulifera* Zone (Kz-63), and rare to common in the *Afghanella schencki* Zone (Ak-184B, 188; Kz-18, 57).

Superfamily Tetrataxioidea Galloway, 1933
Family Abadehellidae Loeblich & Tappan, 1984
Genus *Abadehella* Okimura & Ishii in
Okimura *et al.*, 1975

Type species: *Abadehella tarazi* Okimura & Ishii in Okimura *et al.*, 1975, p. 41.

***Abadehella regularis* Lin, Li, & Sun, 1990**

Pl. I, fig. 52

1990. *Abadehella regularis* Lin, Li & Sun, p. 161, pl. 10, figs 35-38.
1990. *Abadehella regularisaeformis* Lin, Li & Sun, p. 161, pl. 11, fig. 4.
1996. *Abadehella* sp. A Kobayashi, p. 96, fig. 9.33-34.
2012c. *Abadehella regularis* Lin, Li & Sun.— Kobayashi, p. 161, pl. 10, figs 35-38.

Remarks: Kobayashi (2012c) supposed that *A. regularis* and *A. regularisaeformis*, both of which were proposed from the Cisuralian of Guangxi, are synonymous based on thick wall, large test, and the development pattern of platy partitions. The Akasaka specimens identified with these Chinese forms have somewhat smaller test with fewer whorls (Kobayashi, 2012c) than the types. The illustrated Kaerimizu specimen closely resembles Chinese ones in size and construction of the test, though its features in the early stage are uncertain on account of

the excentered section. The Chinese, Akasaka, and the present Kaerimizu forms are common in the absence of secondary platy partitions and having shorter, thicker, and poorly developed primary platy partitions and thicker wall than those of other species of the genus. *Abadehella* sp. A, though incomplete, illustrated by Kobayashi (1996) from the *Neoschwagerina simplex* Zone of Funabuseyama (Mino Terrane) is probably assigned to this species by its thick wall and absence of secondary platy partitions. Unnamed species of *Abadehella* from the lower Wordian of Kuzu described by Kobayashi (2006b) also resembles *A. regularis* except for poorly developed secondary platy partitions.

Occurrence and stratigraphic distribution: Rare only in the *Paraleeina magna* Zone (Ak-193).

Suborder Miliolina Delange & Hérouard, 1896
Superfamily Cornuspiroidea Schultze, 1854
Family Hemigordiopsidae Nikitina, 1969
Genus *Hemigordius* Schubert, 1908

Type species: *Cornuspira schlumbergeri* Howchin, 1895, p. 195.

***Hemigordius decorus* Lin, 1978**

Pl. II, figs 37-39

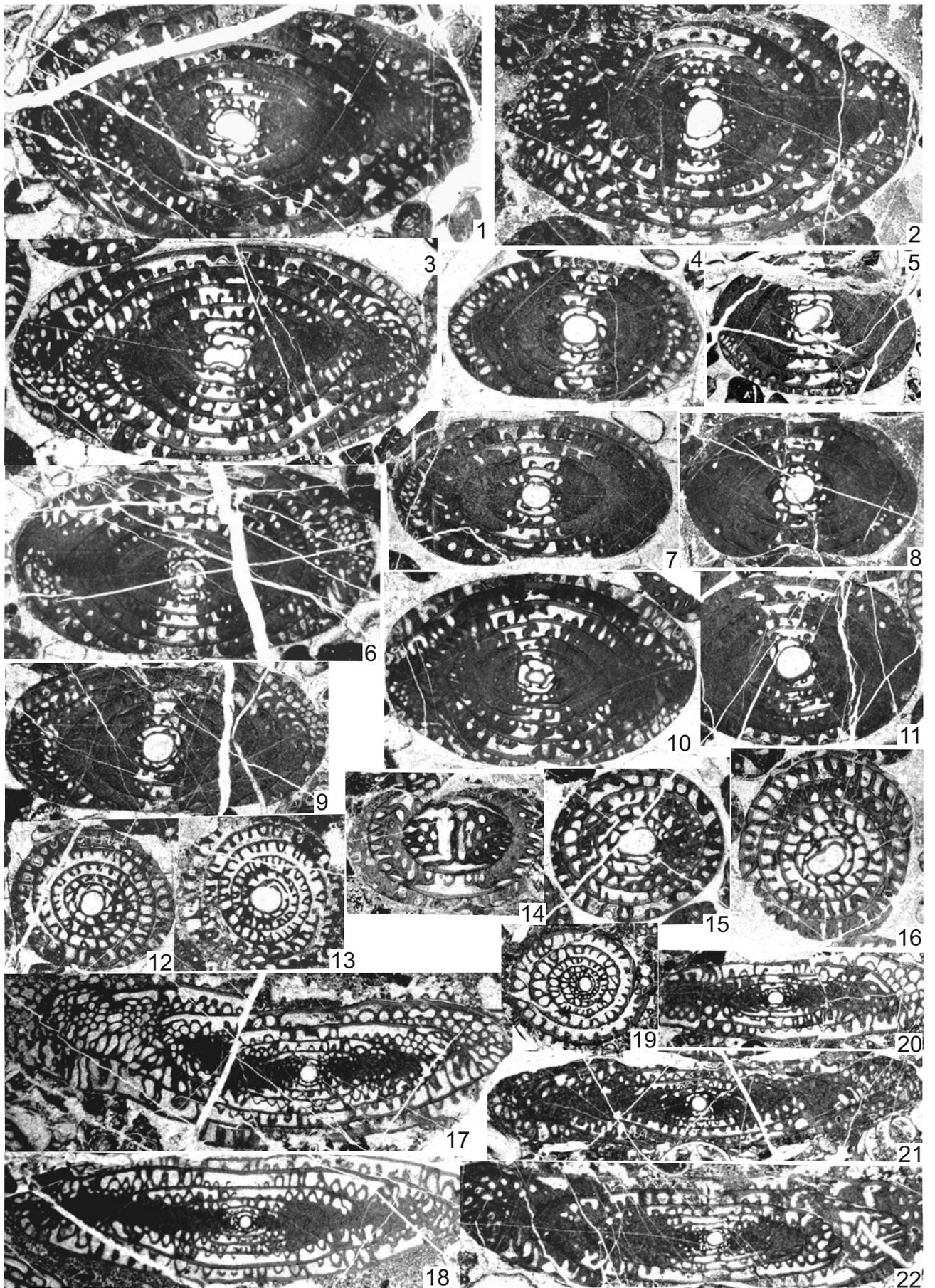
1978. *Hemigordius decorus* Lin, p. 38, pl. 5, fig. 15.

Remarks: The coiling pattern of tubler second chamber changes from streptospiral in tightly coiled, inner three to four whorls to nearly planispiral in outer four to five whorls. Wall is thin in inner whorls, gradually thickened, then rather abruptly thickened in the last few whorls in the present specimens. In addition to these ontogenetic changes of coiling pattern and thickness of wall, size and shape of the test and prolocular size of them are closely similar to those of *Hemigordius decorus* proposed by Lin (1978) based on the monotypic specimen from the upper Lower Permian (Chihhsian) of Guangxi, South China. More comparison with other species needs more numerous specimens from Guangxi.

Occurrence and stratigraphic distribution: Rare in the *Misellina dyhrenfurthi* Zone (Kz-37), *Cancellina pamirica* Zone (Kz-7), and *Parafusulina kaerimizensis* Zone (Ak-90).

Plate VIII

- Figs 1-16: *Paraleeina akiyoshiensis* n. sp. 1: D2-056196; 2: D2-056210 (holotype); 3: D2-056205; 4: D2-0562202; 5: D2-059746; 6: D2-056192; 7: D2-056208; 8, 14: D2-056190; 9: D2-056209; 10: D2-056212; 11: D2-056198; 12: D2-056207; 13: D2-056211; 15: D2-056203, 16: D2-056206. Locality 5: Kz-48 (Cp), others: Kz-11B (Pk). All $\times 10$.
Figs 17-22: *Parafusulina* sp. 17: D2-059763; 18: D2-059761; 19, 22: D2-059765; 20: D2-059753; 21: D2-059766. Locality all Kz-49 (Cp). All $\times 10$.



***Hemigordius dvinensis* K. V. Miklukho-Maklay, 1968**

Pl. II, figs 40-41

1968. *Hemigordius dvinensis* K. V. Miklukho-Maklay, pp. 140-141, pl. 35, fig. 5; pl. 36, figs 4-5.2005a. *Agathammina dvinensis* (K. V. Miklukho-Maklay).— Kobayashi, fig. 3.38-39.

Remarks: This species was proposed on the basis of specimens from the core sample of the lower Kazanian (Roadian) in the Bolgi Basin, Russian Platform by K. V. Miklukho-Maklay (1968). Two illustrated specimens, reassigned to *Agathammina* by Kobayashi (2005a), from the southern Kanto Mountains are closely similar to the original ones. They are better to be returned back to *Hemigordius* on account of nearly planispiral coiling in outer whorls and mode of the shift of axis of coiling between inner and outer whorls. The present Akiyoshi specimens resemble both the original Russian and southern Kanto ones in their coiling pattern of the tubular second chamber, the number of whorls, and size of the test.

Occurrence and stratigraphic distribution: Rare in the *Pamirina leveni* Zone (Ak-201) and common in the *Misellina dyhrenfurthi* Zone (Kz-37).

Genus *Neohemigordius* Wang & Sun, 1973

Type species: *Neohemigordius maopingensis* Wang & Sun, 1973, pp. 158, 178.

***Neohemigordius japonicus* (Y. Ozawa, 1925b)**

Pl. II, figs 46-48, 51-56

1925b. *Hemigordius japonica* Y. Ozawa, p. 7, pl. 2, figs 10-11.non 1936. *Hemigordius japonica* Y. Ozawa.— Huzimoto, p. 38, pl. 1, figs 24-27.1998. *Neohemigordius grandis* (Y. Ozawa, 1925b).— Leven & Campbell, p. 151, figs 3c-d.1998. *Neohemigordius japonicus* (Y. Ozawa).— Leven & Campbell, p. 151, fig. 4c-d, j.2012b. *Neohemigordius japonicus* (Y. Ozawa).— Kobayashi, p. 240, fig. 5.36-38, 5.44-45.2012c. *Neohemigordius japonicus* (Y. Ozawa).— Kobayashi, p. 323, pl. 5, figs 1-2, 7-8, 15.

Description: Test discoidal to thick discoidal with broadly rounded peripheral margin and almost straight lateral surface, and evident umbilical thickenings. Diameter of the test is about 1.35 to 1.95 mm. Proloculus

spherical to subspherical, and 0.09 to 0.21 mm in longer diameter. Streptospirally coiled inner few whorls are followed by enrolled, undivided, five to six whorls of the second chamber that are coiled nearly planispirally and gradually increasing their heights outwards. Wall dark, calcareous and seemingly microgranular in middle and outer whorls, and extends back over the umbilicus as lamellar thickenings. Chamber lumen increases outwards slowly in its height and decreases in its width.

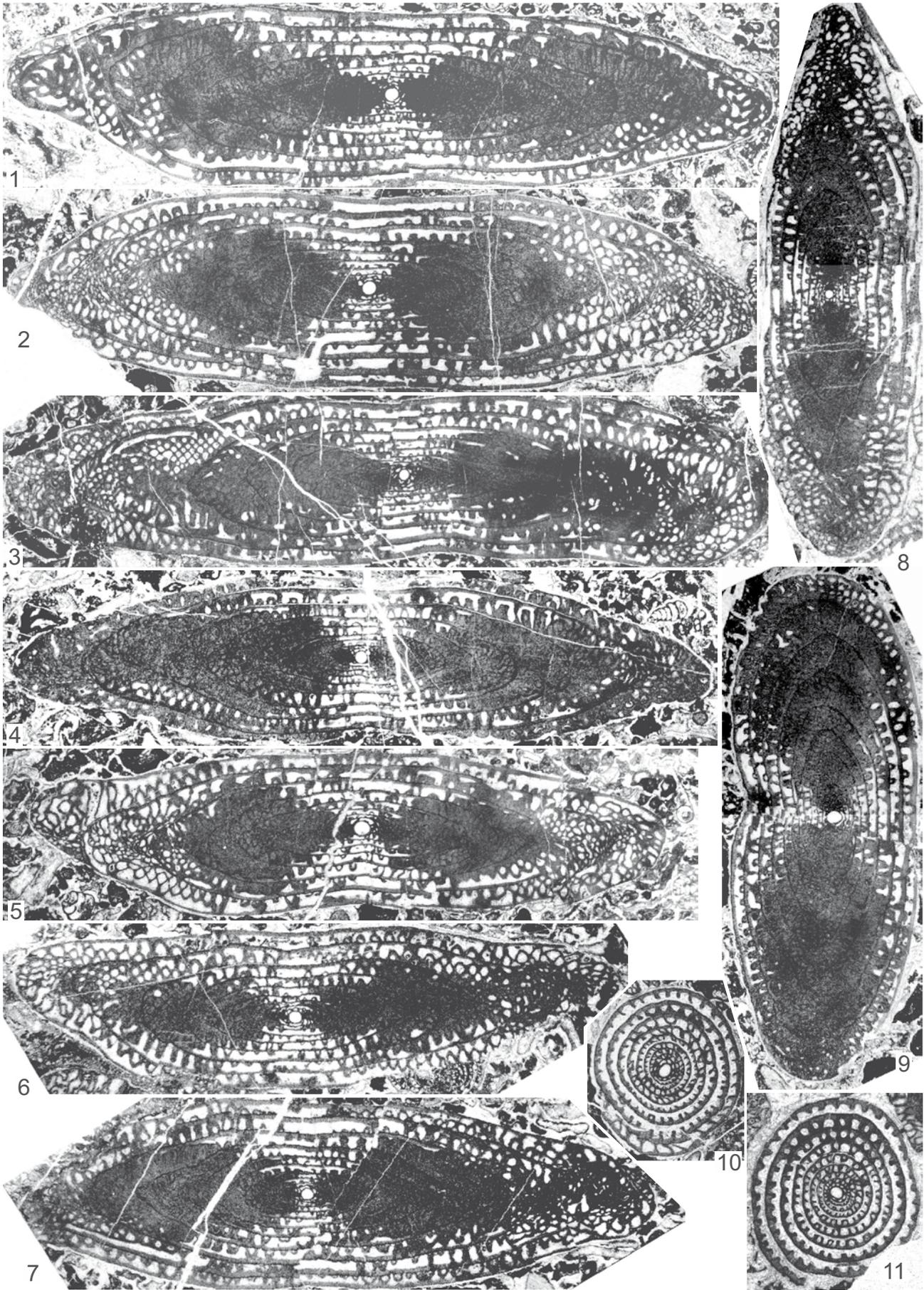
Remarks: Nearly planispirally coiled outer whorls of second tubler chamber, discoidal to thick discoidal test with evident umbilical thickenings are characteristic in the present specimens. These characters well agree with those of the types originally assigned to *Hemigordius* by Y. Ozawa (1925b) from the *Neoschwagerina craticulifera* Zone of the Akiyoshi Limestone. This species was reassigned to *Neohemigordius* by Leven & Campbell (1998) based on the New Zealand material. Specimens identical with this species are reported from the limestone fragments of the Tsunemori Formation (Kobayashi, 2012b) and from the *Neoschwagerina craticulifera* Zone of the Akasaka Limestone (Kobayashi, 2012c). Wall of this species might be not microgranular but originally imperforate, possibly porcelaneous. Its microgranular appearance in middle and outer whorls is presumably due to recrystallization.

Leven & Campbell (1998) described *Neohemigordius grandis* and *N. japonicus* from the same limestone sample (Murgabian) of the Torlesse Terrane, New Zealand. These two species were distinguished by the differences of test size and thickness of wall. The taxonomic independency of the former, originally assigned to *Spirillina* by Y. Ozawa (1925b) based on one insufficient specimen, seems to be uncertain. These two species, however, are supposed to be conspecific taking morphologic variations of *N. japonicus* into consideration. *Neohemigordius maopingensis* Wang & Sun, 1973 and *Multidiscus robustatus* Lin, 1978 are inferred to be allied to this species, as mentioned in Kobayashi (2012b). Four specimens from the Kanto Mountains identified with the original ones of this species by Huzimoto (1936) are better to be reassigned to the genus *Baisalina* because of having short septa-like protrusions in specimens.

Occurrence and stratigraphic distribution: Common in the *Parafusulina kaerimizensis* Zone (Ak-90) and *Afghanella schencki* Zone (Ak-86, 87, 184C, 187, 188), and rare in the *Neoschwagerina craticulifera* Zone (Ak-181).

Plate IX

Figs 1-11: *Parafusulina kaerimizensis* (Y. Ozawa). 1: D2-049363, 2: D2-049369, 3: D2-049388, 4: D2-049397, 5: D2-049418, 6: D2-049432, 7: D2-049449, 8: D2-049347, 9: D2-049362, 10: D2-049427, 11: D2-049344. Locality 1-4, 9: Ak-182B (Nc); 5: Ak-182C (Nc); 6-7, 10: Ak-182D (Nc); 8, 11: Ak-182A (Pk). All $\times 10$.



Genus *Hemigordiopsis* Reichel, 1946

Type species: *Hemigordiopsis renzi* Reichel, 1946, p. 528.

Junior synonym:

Gansudiscus Wang & Sun, 1973, p. 157 (type species, *Gansudiscus luquensis* Wang & Sun, 1973).

***Hemigordiopsis?* sp.**

Pl. II, figs 49-50

Remarks: Two specimens illustrated are distinguished from *Hemigordius dvinensis* by their larger test, more whorls of second chamber with much thicker wall, and from *Hemigordius decorus* by their more rounded test with thicker wall. They are easily distinguished from *Neohemigordius japonicus* by having larger and subspherical test with more whorls and thicker wall, and no umbilical thickenings. The present specimens are questionably assigned to *Hemigordiopsis* by their large, subspherical test with almost planispirally coiled second chamber. However, streptospirally coiled initial part of the second chamber is distinct, wall is thinner, and the number of whorls are fewer in them in comparison with typical forms of *Hemigordiopsis*.

Occurrence and stratigraphic distribution: Common in the *Misellina claudiae* Zone (Kz-68).

ACKNOWLEDGEMENTS

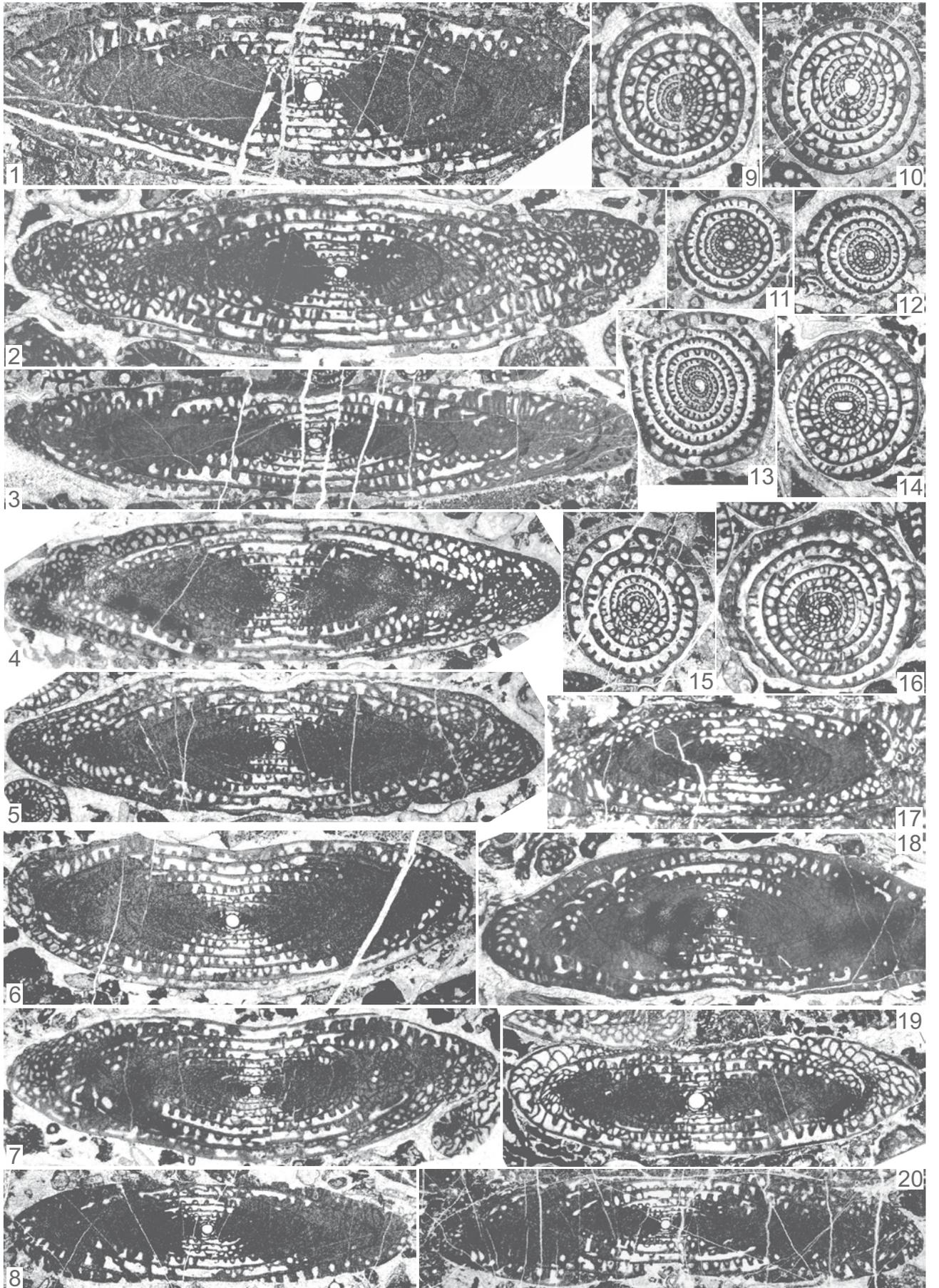
The author is much indebted to two anonymous reviewers for their critical reading of the manuscript and constructive comments. He obtained excellent facilities from Takehiko Haikawa and Masayuki Fujikawa for carrying out the field works of the Akiyoshi Limestone. Financial support from Grant-in Aid for Scientific Research (C) of Japan Society for promotion of Science in 2004-2005 (Project No. 16540428), 2007-2009 (Project No. 19540497), and 2013-2015 (Project No. 25400501) is thankfully acknowledged for the field and laboratory works.

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Plate X

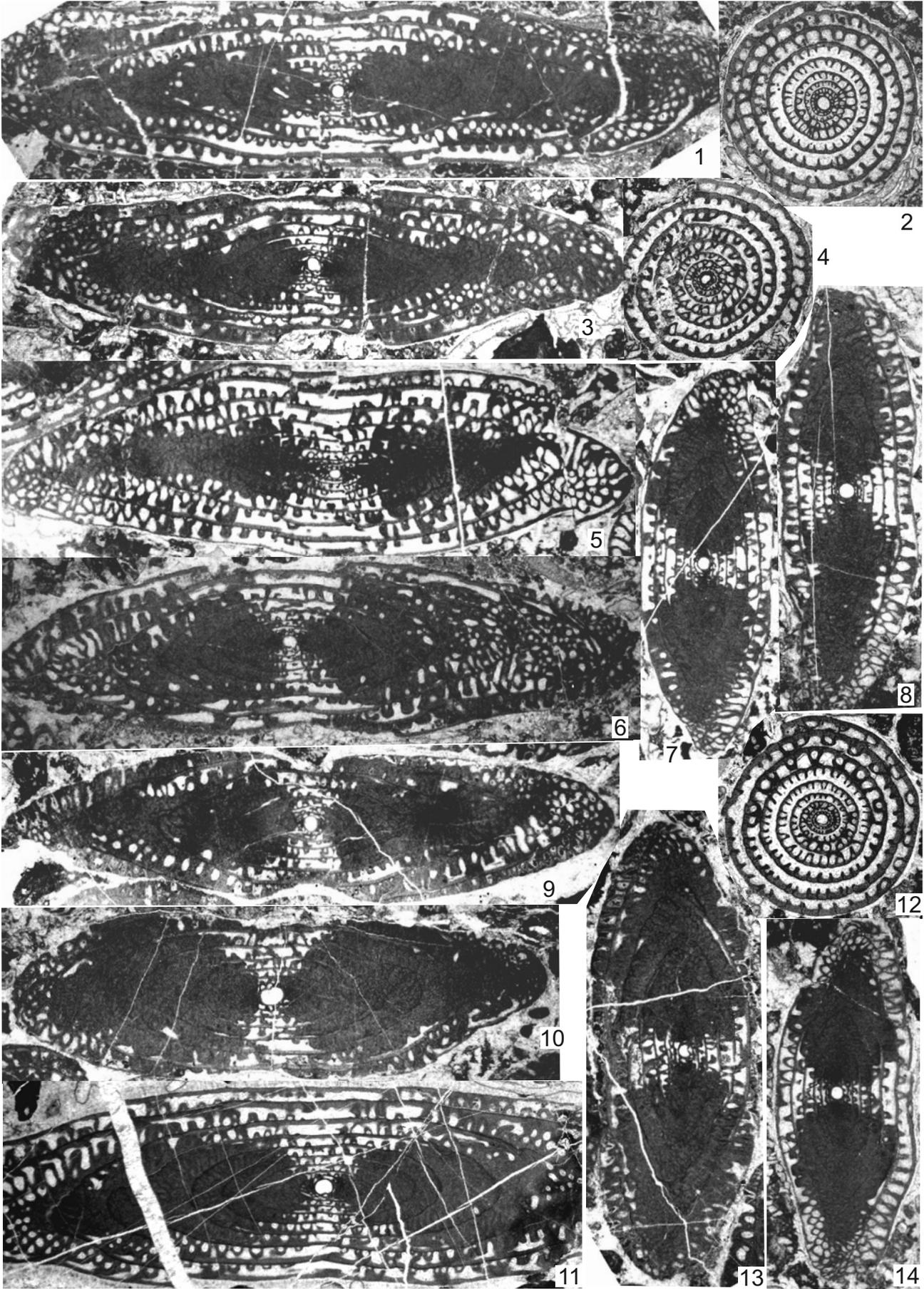
Figs 1-20: *Parafusulina kaerimizensis* (Y. Ozawa). 1: D2-030163, 2: D2-049308, 3: D2-049276, 4: D2-049319, 5: D2-049350, 6: D2-049451, 7: D2-049352, 8: D2-049201, 9: D2-049318, 10: D2-049253, 11: D2-049195, 12: D2-049236, 13: D2-049287, 14: D2-049322, 15: D2-049228, 16: D2-049339, 17: D2-030257, 18: D2-049323, 19: D2-049443, 20: D2-049255. Locality 1, 17: Kz-K (Pk); 2, 4-7, 9, 13-14, 16, 18: Ak-182A (Pk); 3, 10, 12, 20: Ak-181 (Pk); 8, 11, 15: Ak-180 (Pk); 19: Ak-182D (Nc). All $\times 10$.



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Plate XI

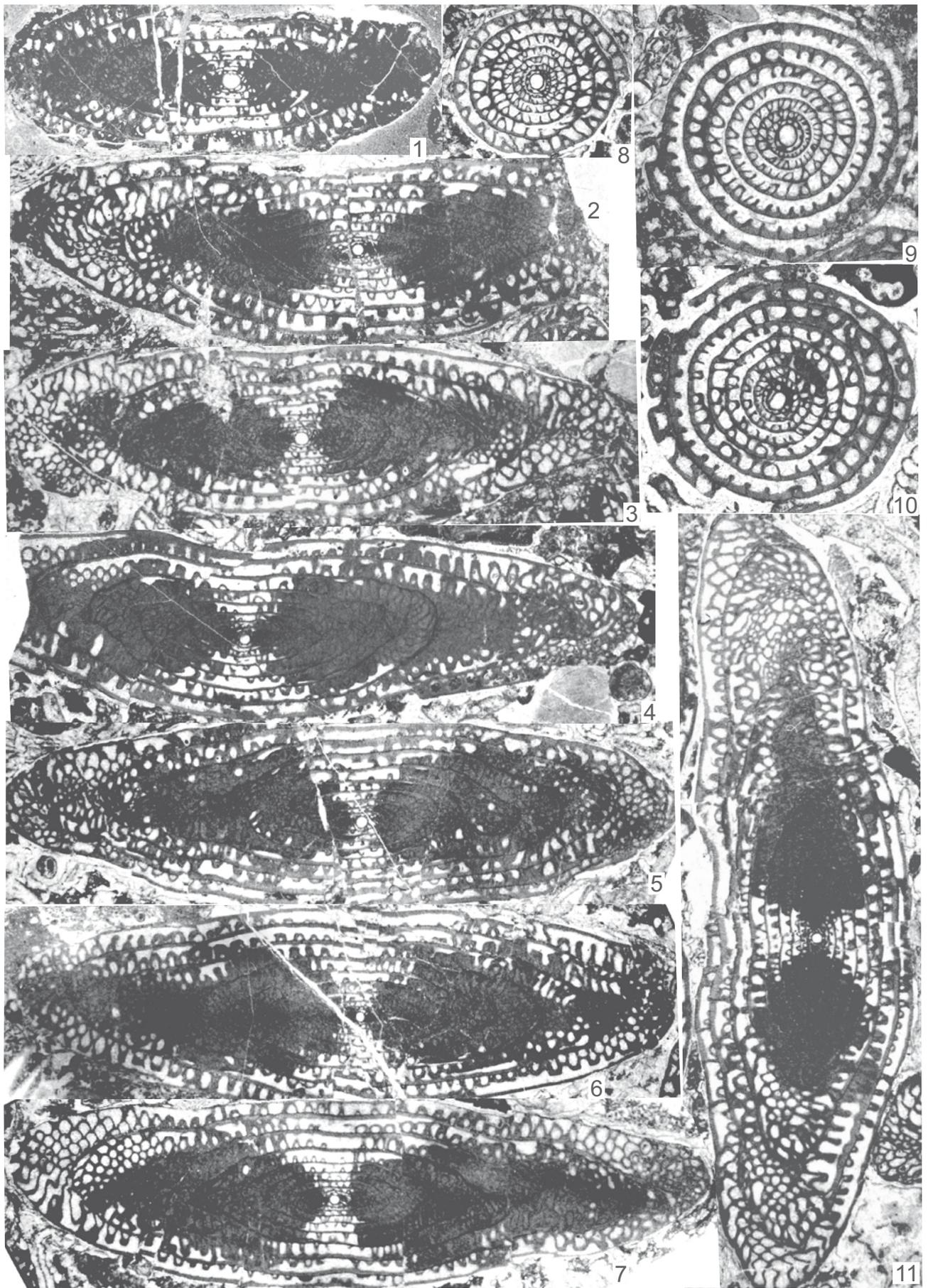
Figs 1-14: *Parafusulina kaerimizensis* (Y. Ozawa). 1: D2-056160, 2: D2-056215, 3: D2-056244, 4: D2-056219, 5: D2-056240, 6: D2-056438, 7: D2-056230, 8: D2-056229, 9: D2-056432, 10: D2-056436, 11: D2-059911, 12: D2-056217, 13: D2-056429, 14: D2-056227. Locality 1: Kz-10A (Pk); 2-5, 7-8, 12, 14: Kz-12 (Pk); 6, 9-10, 13: Kz-26 (Pk); 11: Kz-62 (Nc). All $\times 10$.



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Plate XII

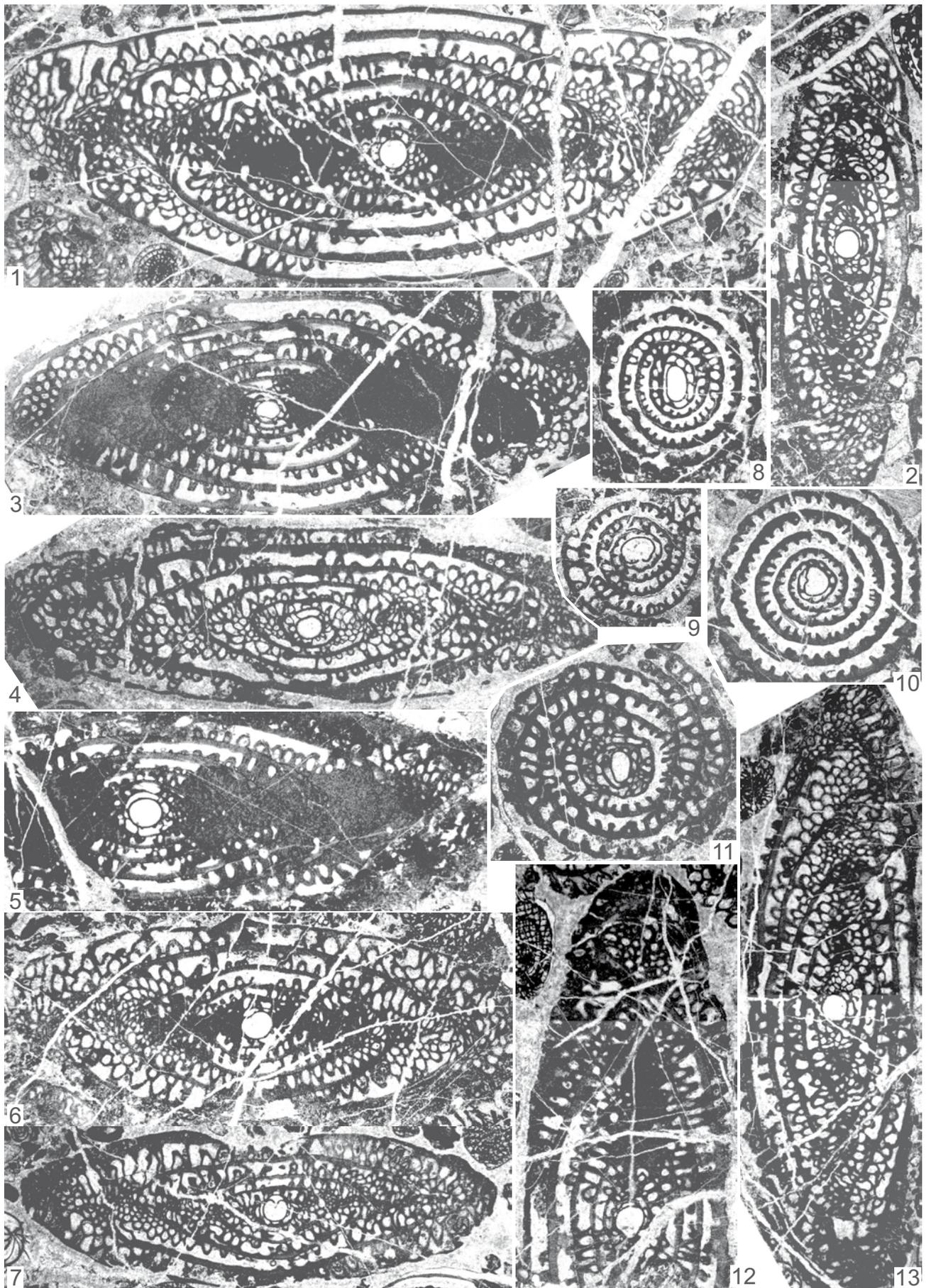
Figs 1(?), 2-11: *Parafusulina kaerimizensis* (Y. Ozawa). 1: D2-056366, 2: D2-056221, 3: D2-056242, 4: D2-056237, 5: D2-056234, 6: D2-056222, 7: D2-056226, 8: D2-056225, 9: D2-056238, 10: D2-056239, 11: D2-056243. Locality 1: Kz-21B (As), others: Kz-12 (Pk). All $\times 10$.



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Plate XIII

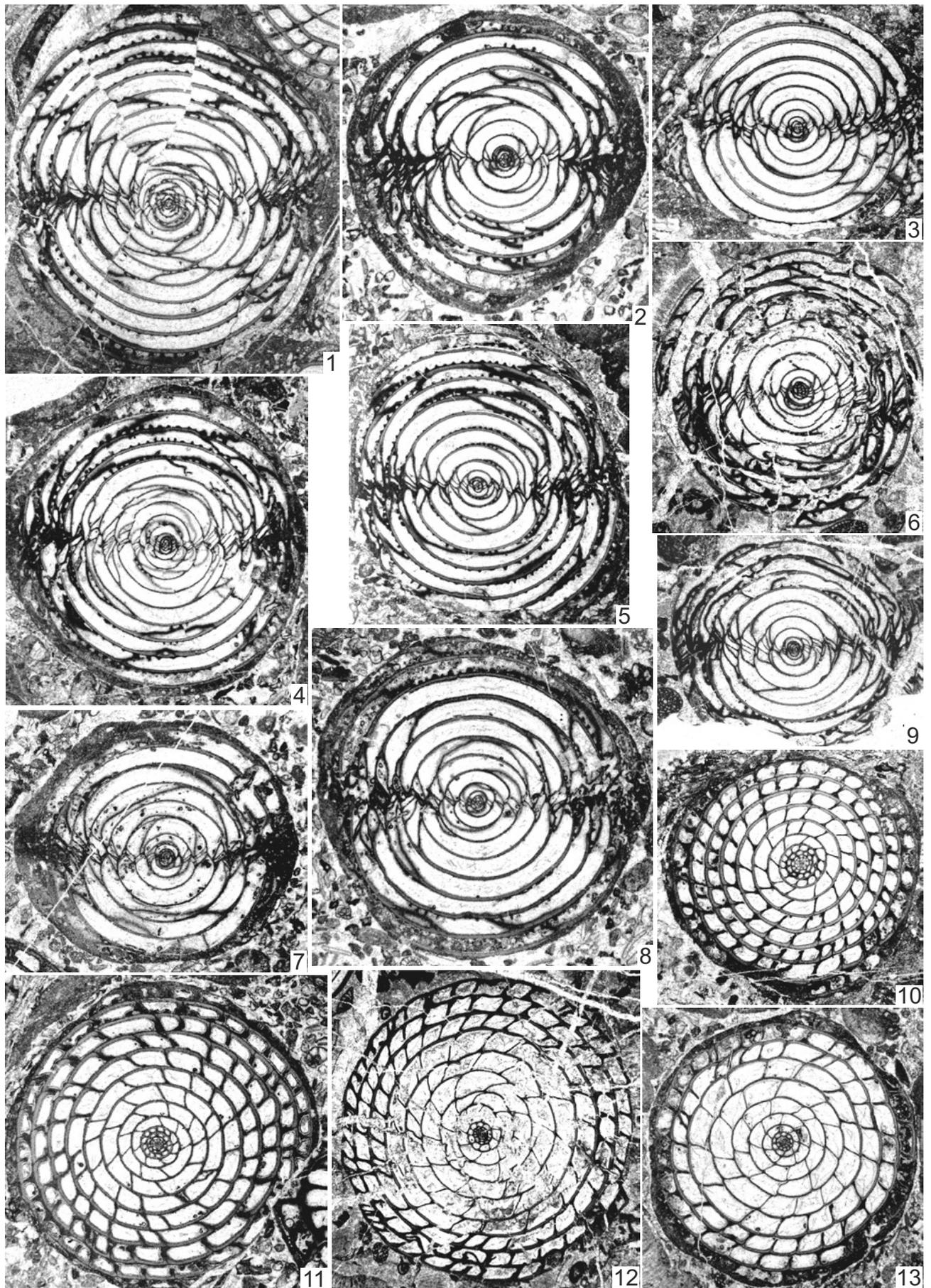
- Figs 1-2, 4, 6-10, 13: *Laosella gigantea* (Deprat). 1: D2-049605, 2: D2-049487, 4: D2-049519, 6: D2-049621, 7: D2-049507, 8: D2-049584, 9: D2-049534, 10: D2-049511, 13: D2-049599. Locality 1, 6, 13: Ak-188 (As); 2: Ak-184B (As); 4, 7, 10: Ak-184C (As); 8: Ak-187 (As); 9: Ak-185 (As). All $\times 10$.
- Figs 3, 5, 11-12: *Laosella edoensis* (Y. Ozawa). 3: D2-049616, 5: D2-049576, 11: D2-049509, 12: D2-049499. Locality 3: Ak-188 (As), 5: Ak-187 (As), 11-12: Ak-184C (As). All $\times 10$.



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Plate XIV

Figs 1-13: *Verbeekina verbeeki* (Geinitz). 1: D2-043064, 2: D2-043058, 3: D2-043062, 4: D2-043085, 5: D2-043033, 6: D2-049600, 7: D2-043046, 8: D2-043023, 9: D2-049495, 10: D2-043045, 11: D2-04061, 12: D2-049469, 13: D2-043020. Locality 1-5, 7-8, 10-11, 13: Ak-86 (As); 6: Ak-188 (As); 9: Ak-184B (As); 12: Ak-184A (As). All $\times 10$.

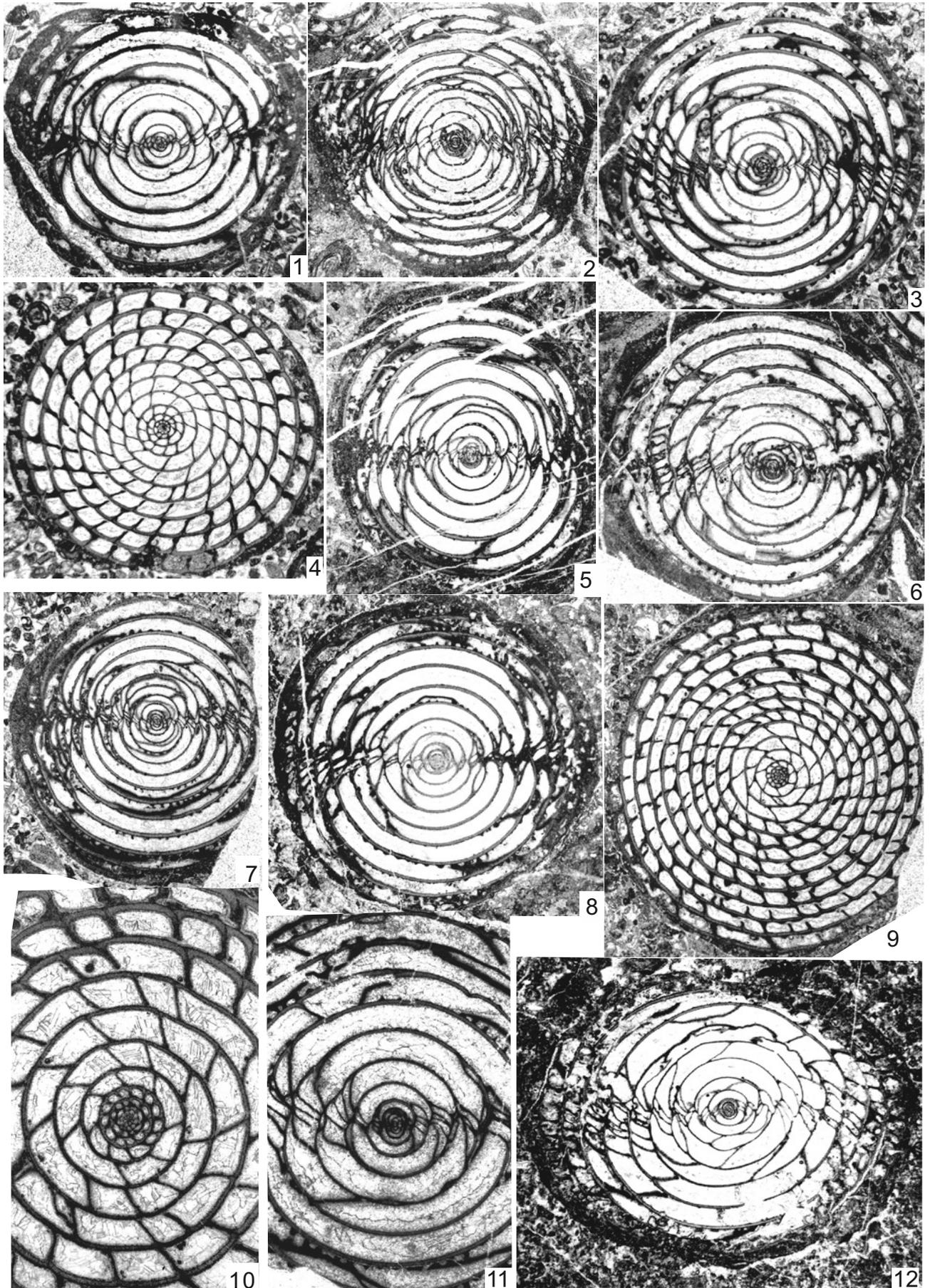


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Figs 1-11: *Verbeekina verbeeki* (Geinitz). 1: D2-042989, 2: D2-043013, 3: D2-043050, 4: D2-043081, 5: D2-043030, 6: D2-042997, 7: D2-043059, 8: D2-043063, 9: D2-043035, 10: D2-043061, 11: D2-043084. Locality all Ak-86 (As). 10-11: ×20, others: ×10.

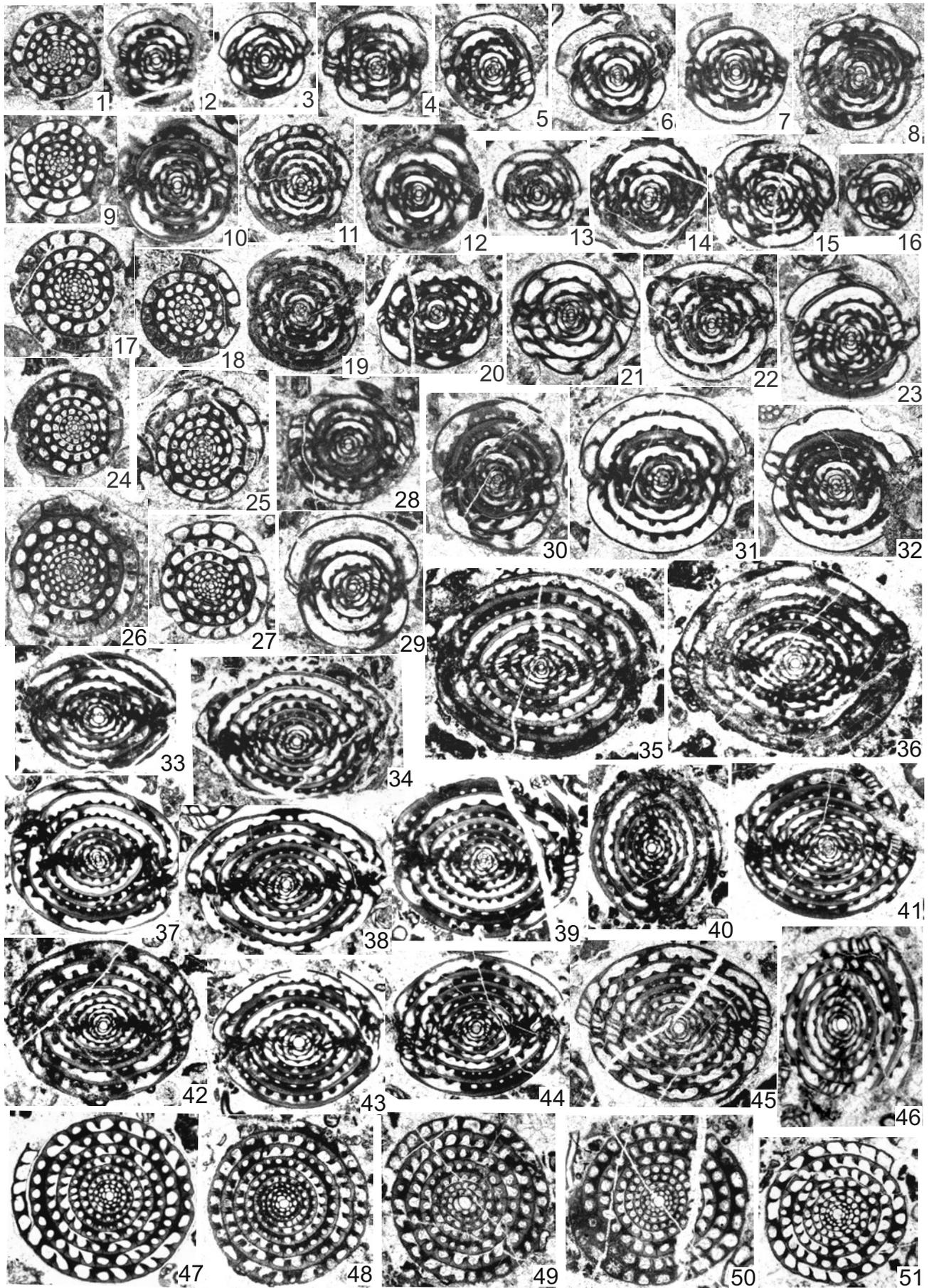
Fig. 12: *Verbeekina* cf. *douvillei* (Deprat). D2-059811. Locality Kz-53 (Cd). ×10.



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- Figs 1-22: *Misellina dyhrenfurthi* (Dutkevich). 1: D2-043195; 2, 12: D2-043203; 3: D2-043210; 4: D2-056563; 5: D2-043200; 6: D2-043202; 7: D2-043175; 8: D2-043197; 9: D2-056564; 10: D2-043171; 11: D2-043179; 13: D2-043193; 14: D2-056573; 15: D2-043191; 16: D2-056557; 17: D2-043180; 18, 21: D2-043209; 19: D2-043205; 20: D2-043195; 22: D2-043178. Locality 4, 9, 14, 16: Kz-37 (Md); others: Ak-91 (Md). All $\times 20$.
- Figs 23-32: *Misellina parvicostata* (Deprat). 23: D2-043194, 24: D2-043177, 25: D2-043206, 26: D2-043210, 27: D2-043199, 28: D2-056567, 29: D2-043210, 30: D2-043196, 31: D2-043183, 32: D2-043198. Locality 27: Kz-37 (Md), others: Ak-91 (Md). All $\times 20$.
- Figs 33-51: *Misellina claudiae* (Deprat). 33: D2-030144; 34: D2-043224; 35: D2-030137; 36: D2-030150; 37, 43: D2-030142; 38: D2-030152; 39: D2-030138; 40: D2-030144; 41: D2-030156 (microspheric form); 42: D2-030147; 44: D2-030139; 45, 46: D2-043226; 47: D2-030158; 48: D2-030165; 49: D2-043239; 50: D2-043225; 51: D2-030140. Locality 34, 45-46, 49-50: Ak-92 (Mc); others: Kz-M (Mc). All $\times 15$.



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Plate XVII

- Figs 1-19: *Misellina claudiae* (Deprat). 1: D2-030162; 2: D2-030157; 3: D2-030166; 4: D2-30161; 5: D2-043240 (microspheric form); 6: D2-043213; 7: D2-043222; 8: D2-043237; 9: D2-043236; 10: D2-043227; 11, 16 (microspheric form): D2-043217; 12: D2-043221; 13: D2-043218; 14: D2-043229; 15: D2-043241; 17: D2-043230; 18: D2-043232; 19: D2-043243. Locality 1-4: Kz-M (Mc), 5-19: Ak-92 (Mc). All $\times 15$.
- Figs 20-32: *Misellina postclaudiae* Ueno. 20: D2-049156, 21: D2-049164, 22: D2-049169, 23: D2-049161, 24: D2-049163, 25: D2-049148, 26: D2-049152, 27: D2-049172, 28: D2-049153, 29: D2-049173, 30: D2-049168, 31: D2-049157, 32: D2-049158. Locality all Ak-178 (Mc). 24b: $\times 30$, others: $\times 15$.

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Plate XVIII

- Fig. 1: *Misellininae?* gen. and sp. indet. D2-043196. Locality Ak-91 (Md). ×30.
- Fig. 2: *Misellina* sp. A. D2-056557. Locality Kz-37 (Md). ×20.
- Fig. 3: *Misellina* sp. B. D2-056568. Locality Kz-37 (Md). ×20.
- Figs 4-6: *Armenina* cf. *pamirensis* (Dutkevich). 4: D2-056480, 5: D2-056486, 6: D2-056481. Locality all Kz-32 (Cp). All ×15.
- Figs 7-23: *Cancellina pamirica* Leven. 7: D2-056502, 8: D2-056534, 9: D2-056512, 10: D2-056539, 11: D2-056503, 12: D2-056520, 13: D2-056555, 14: D2-056517, 15: D2-056505, 16: D2-056554, 17: D2-056504, 18: D2-056530, 19: D2-056493, 20: D2-056518, 21: D2-056507, 22: D2-056533, 23: D2-056488. Locality 7, 9, 11, 15, 17, 21: Kz-33 (Cp); 8, 10, 12, 14, 18, 20, 22: Kz-34 (Cp); 13, 16: Kz-36 (Cp); 19, 23: Kz-32 (Cp). All ×15.
- Figs 24-27: *Armenina salgirica* A. D. Miklukho-Maklay. 24: D2-056515, 25: D2-056519, 26: D2-056522, 27: D2-056499. Locality 24-26: Kz-34 (Cp), 27: Kz-33 (Cp). All ×15.

Plate XIX

Figs 1-29: *Presumatrina ozawai* (Hanzawa). 1: D2-043146 (microspheric form), 2: D2-043165 (microspheric form), 3: D2-043155, 4: D2-043164, 5: D2-043162, 6: D2-043139, 7: D2-049275, 8: D2-049250, 9: D2-059953, 10: D2-049240, 11: D2-049234, 12: D2-049209, 13: D2-049203, 14: D2-049257, 15: D2-049456, 16: D2-049215, 17: D2-043158, 18: D2-049192, 19: D2-049231, 20: D2-049222, 21: D2-043144, 22: D2-049247, 23: D2-049212, 24: D2-043159; 25, 27: D2-049243, 26: D2-049213, 28: D2-049264, 29: D2-043147. Locality 1-6, 17, 21, 24, 29: Ak-90 (Pk); 7-8, 10-11, 14, 19, 22, 25, 27: Ak-181 (Pk); 9: Kz-65 (Pk); 12-13, 16, 18, 20, 23, 26, 28: Ak-180 (Pk); 15: Ak-183 (Pk). 1b, 2b: $\times 30$; others: $\times 15$.

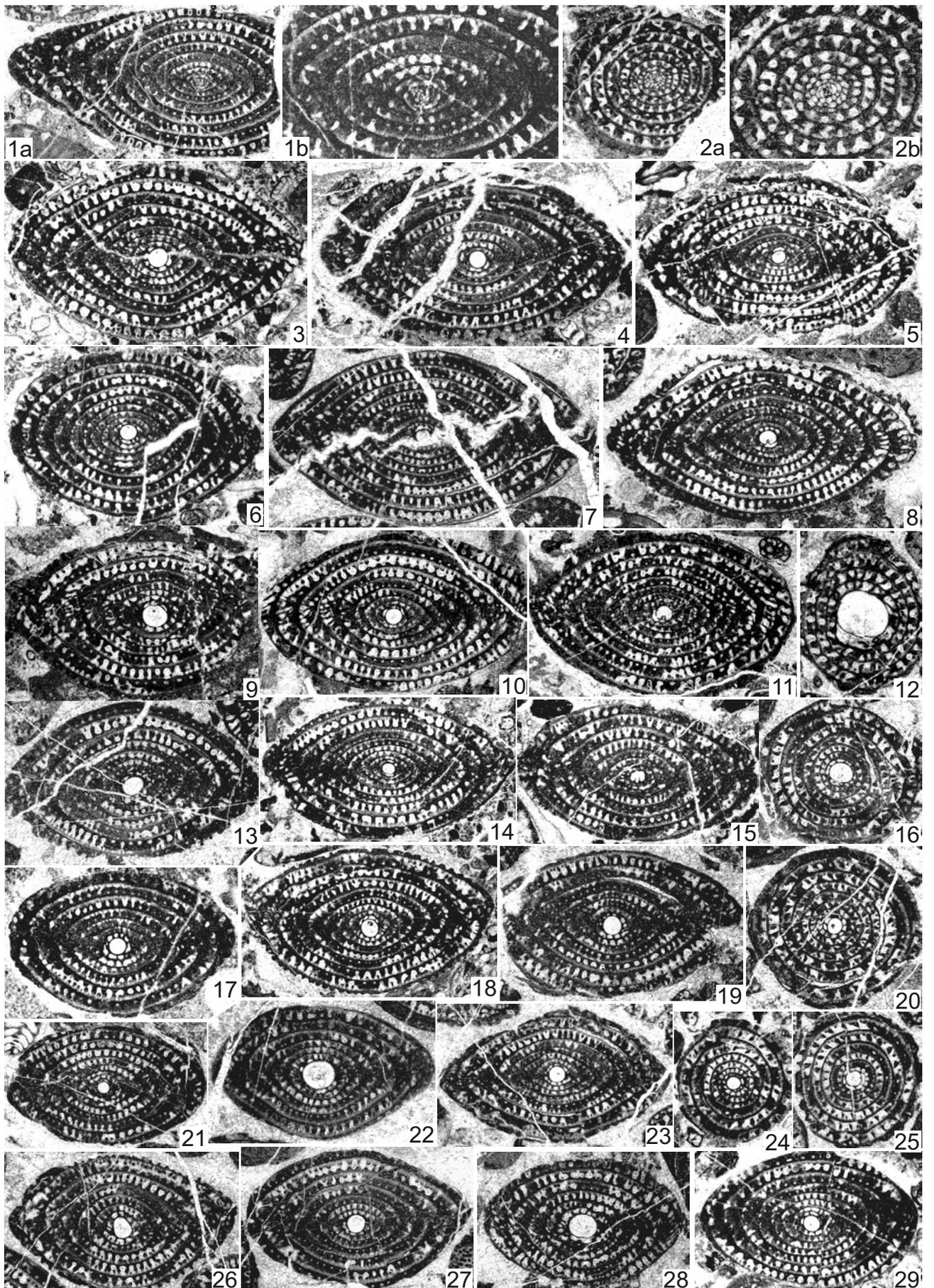


Plate XX

Figs 1-23: *Neoschwagerina craticulifera* (Schwager). 1: D2-049403, 2: D2-049417, 3: D2-043116, 4: D2-049385, 5: D2-049409, 6: D2-049408, 7: D2-04919, 8: D2-049406, 9: D2-056399, 10: D2-049376, 11: D2-049446, 12: D2-049425, 13: D2-049368, 14: D2-049414, 15: D2-049373, 16: D2-049448, 17: D2-049436, 18: D2-049420, 19: D2-049434, 20: D2-049365, 21: D2-049437, 22: D2-049384, 23: D2-049451. Locality 1-2, 5-8, 12, 14, 18: Ak-182C (Nc); 3: Ak-88 (Nc); 4, 10, 13, 15, 20, 22: Ak-182B (Nc); 9: Kz-23 (Nc); 11, 16-17, 19, 21, 23: Ak-182D (Nc). All $\times 10$.

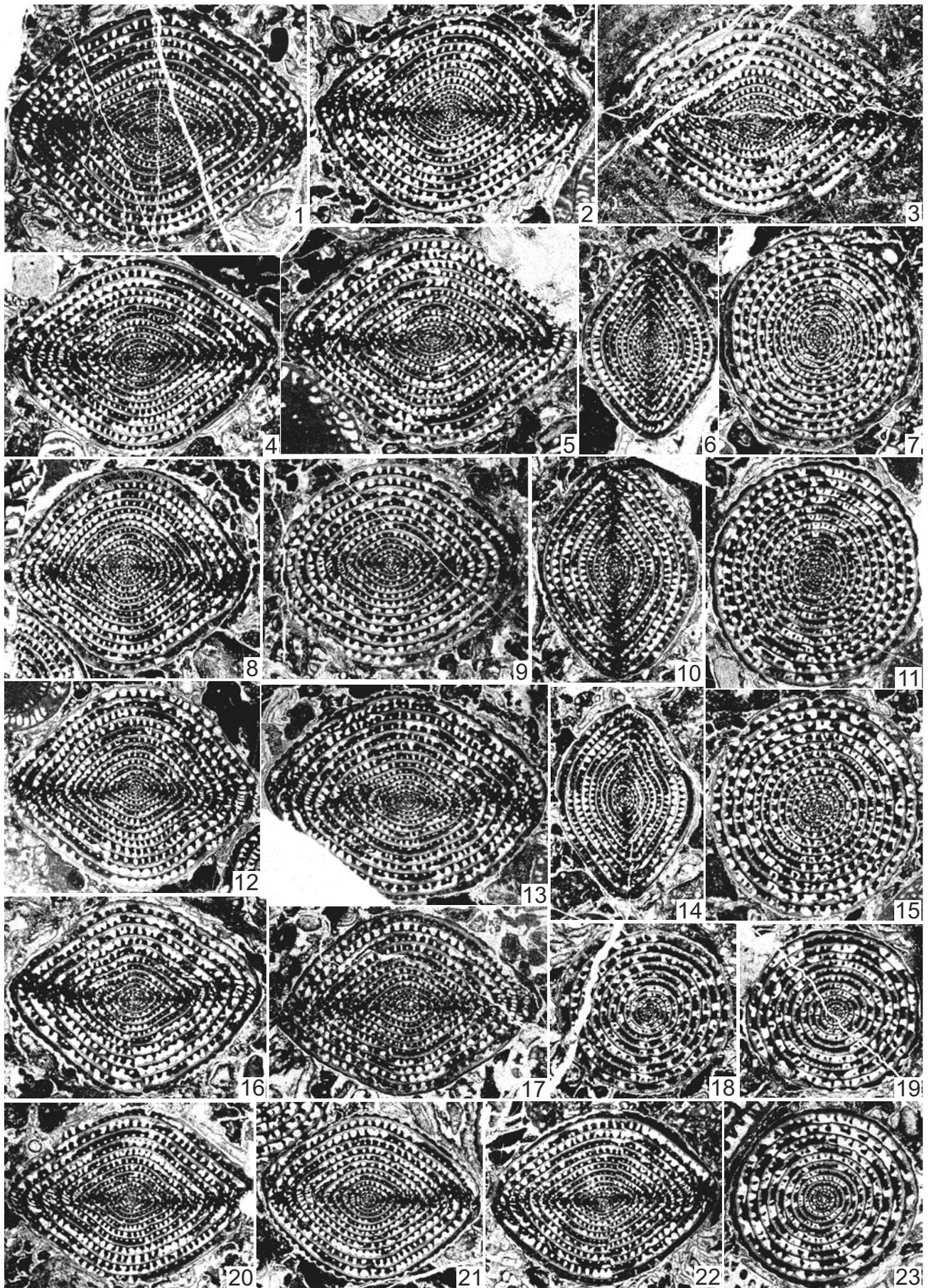


Plate XXI

Figs 1-27: *Neoschwagerina haydeni* Dutkevich. 1: D-056254, 2: D2-056256, 3: D2-056283, 4: D2-056260, 5: D2-056297, 6: D2-056284, 7: D2-056296, 8: D2-056264, 9: D2-056259, 10: D2-056250, 11: D2-056276, 12: D2-056280, 13: D2-056298, 14: D2-056289, 15: D2-049561, 16: D2-043111, 17: D2-056286, 18: D2-056292, 19: D2-043112, 20: D2-043090, 21: D2-043107, 22: D2-043102, 23: D2-043103, 24: D2-043113, 25: D2-043093, 26: D2-043096, 27: D2-049541. Locality 1-9, 11-14, 17-18: Kz-14 (As); 10: Kz-13 (As); 15, 27: Ak-186 (As), 16, 19-26: Ak-87 (As). All $\times 10$.

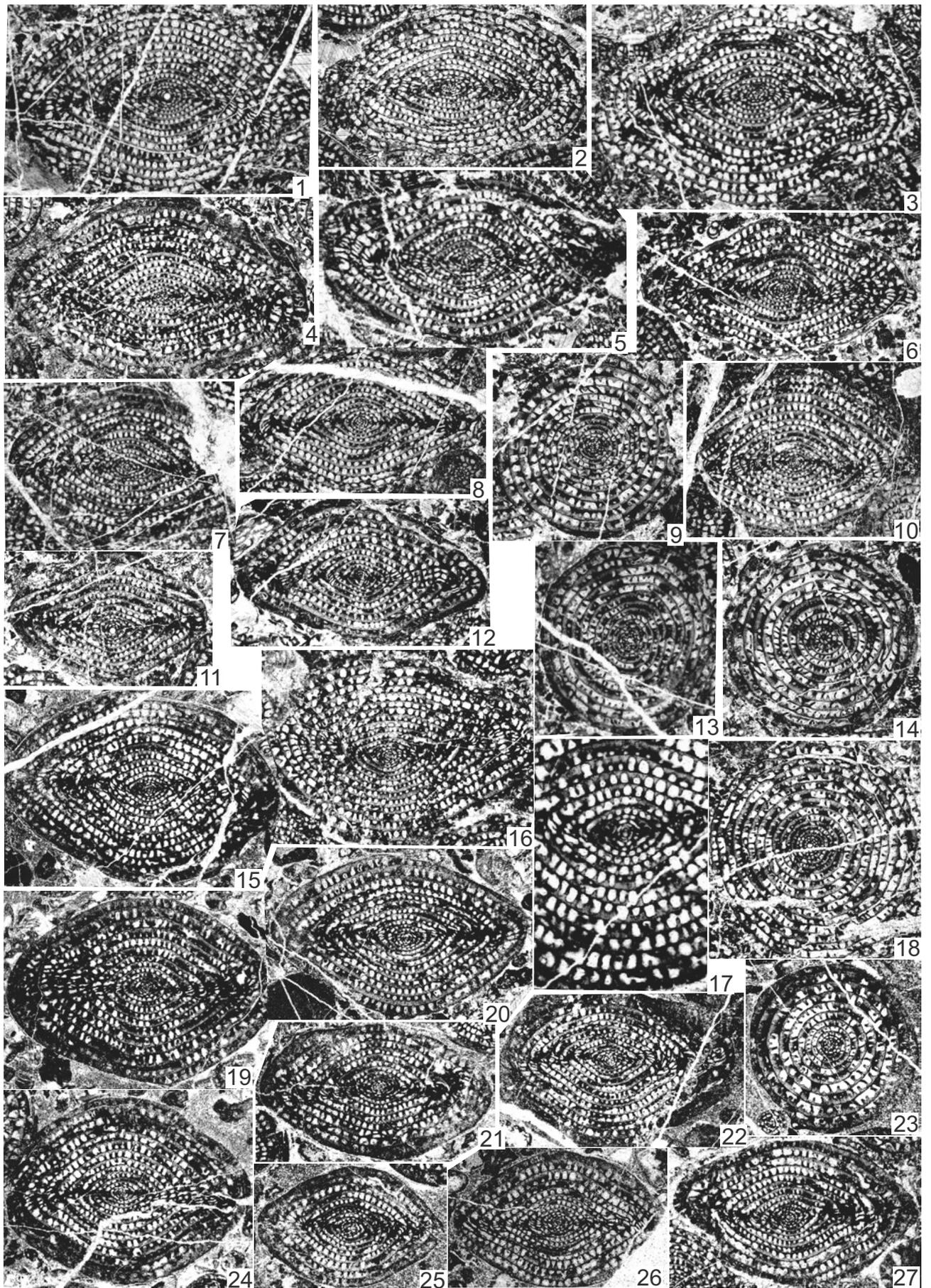


Plate XXII

- Figs 1-21: *Afghanella schencki* Thompson. 1: D2-049567, 2: D2-049581, 3: D2-049573, 4: D2-049502, 5: D2-049597, 6: D2-049583, 7: D2-049580, 8: D2-049572, 9: D2-049598, 10: D2-049520, 11: D2-049488, 12: D2-049513, 13: D2-049517, 14: D2-059852, 15: D2-059855, 16: D2-049476, 17: D2-049565, 18: D2-059860, 19: D2-049565, 20: D2-049615, 21: D2-059840. Locality 1-3, 6-8, 10, 17, 19: Ak-187 (As); 4, 12-13: Ak-184C (As); 5, 9, 20: Ak-188 (As); 11, 16: Ak-184B (As), 14-15, 18, 21: Kz-57 (As). All $\times 15$.
- Figs 22-26: *Colania douvillei* (Y. Ozawa). 22: D2-059788, 23: D2-059796, 24: D2-059809, 25: D2-056317, 26: D2-056309. Locality 22-23: Kz-52 (Cd), 24: Kz-53 (Cd), 25-26: Kz-16 (Cd). All $\times 10$.

