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Redescription of *Hidaella kameii* Fujimoto et Igo, 1955 (Fusulinacea, Carboniferous)

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Abstract *Hidaella* Fujimoto et Igo, 1955 is a Carboniferous fusulinacean genus occurred in the Ichinotani Formation exposed along the Ichinotani Valley, Fukuji, Hida Massif, Gifu Prefecture, central Japan. This genus closely resembles *Fusulinella* but has a characteristic rugose spirotheca. The occurrence of this genus outside of Japan has, until now, been reported from the Cantabrian Mountains of Spain, the Huanglung Formation of Anhui Province, East China, and probably from the Moscovian of former USSR. We collected specimens of *Hidaella kameii* from the type locality and prepared many thin sections to redescribe this peculiar species in detail and emphasize the validity of this genus. We also discuss problems of rugosity in the spiral wall of fusulinaceans.
Key words : Carboniferous, Fusulinacean, *Hidaella*, Ichinotani Formation, Moscovian.

Introduction

Fujimoto and Igo (1955) proposed the fusulinacean genus *Hidaella* with *H. kameii* as the type species, which was collected from the Ichinotani Formation exposed in the Ichinotani Valley, Fukuji, Hida Massif, Gifu Prefecture, central Japan. Subsequently, Igo (1957) studied the fusulinacean fauna of the Ichinotani Formation and settled the stratigraphic level of *Hidaella kameii* in his *Fusulina lanceolata–F. ichinotaniensis* subzone, which was correlated to the upper Moscovian. Niikawa (1978), Igo *et al*., (1984), Adachi (1985), Niko (1985, 1987), and others further continued studies of foraminifers in this fossiliferous Carboniferous section. Although outcrops of the Ichinotani Formation are restricted to a narrow area, these studies clarified that the formation represents one of the most complete uppermost Lower to Upper Carboniferous sections in the Japanese Islands. Moreover, these studies showed that the detailed stratigraphic levels of *Hidaella kameii* is assigned to the Podolsky Horizon of the Moscovian Stage.

The genus *Hidaella* is similar to the genus *Fusulinella* in many respects, but Fujimoto and Igo (1955) distinguished this genus from the latter by possessing a strong rugose spirotheca. Subsequently, Nikitina (1961) and Rozovskaya (1975) questioned the validity of *Hidaella* and synonymized to *Fusulinella*. Ginkel (1965) reported the second occurrence of *Hidaella* from the Escalada Limestone Formation exposed near Campo de Caso, Asturias, northern Spain and described a new subspecies, *H. kameii nalonensis*. He also suggested that *Profusulinella fluxoidalis* Manukalova and *Fusulinella variabilis* Kireeva described from the Donetz Basin of former USSR (Manukalova, 1950; Kireeva, 1949) should be assigned to the genus *Hidaella*. Thompson (1964), Skinner and Wilde (1965 b), Pasini (1965), Kahler and Kahler (1966), Loeblich and Tappan (1988), and others recognized *Hidaella* as a valid genus.

Concerning another record of the occurrence of *Hidaella* outside of Japan, Nanjing Institute of Geology and Mineral Resources (1982) reported *H. kameii* from the Huanglung Limestone exposed at Shijiachong, Guichi in Anhui Province, East China. Recently, Villa (1995) has documented the occurrence of *Hidaella* sp. from the section Playa La Huelga (uppermost Podolosky Horizon) exposed along the coast of the Cantabrian Sea, northern Spain. These reports suggest that the genus was rather widespread in the Paleotethys Province in Middle Carboniferous time.

In this paper we emphasize the validity of the genus *Hidaella* and redescribe topotype specimens to clarify the detailed specific character of *H. kameii*, because the original specimens described by Fujimoto and Igo (1955) were not so well document-

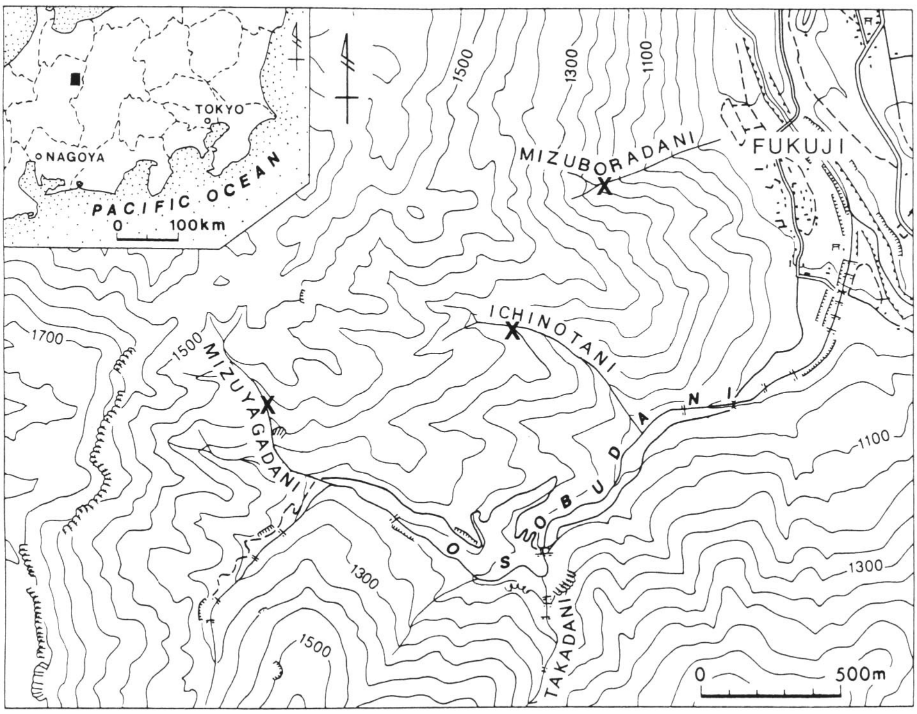


Fig. 1. Index map showing the type and other localities (×) of *Hidaella kameii*.

ed as already pointed out by Skinner and Wilde (1965 b). We also discuss problems of rugosity in the spirotheca of fusulinaceans.

Rugose Spirotheca in Fusulinaceans and the Validity of *Hidaella*

As already pointed out in original diagnosis (Fujimoto & Igo, 1955), the genus *Hidaella* is similar to a well-known Carboniferous genus *Fusulinella* von Möller, 1877 in many important respects, but it is characterized by conspicuous rugosity running around the shell in both equatorial and meridional directions. These authors mentioned that the rugosity is the same character with that observable in the spirotheca of *Rugosofusulina* Rauser-Chernousova, 1937. They further noted that *Hidaella* represents an aberrant descendant of *Fusulinella*.

Subsequently, Nikitina (1961) questioned the validity of *Hidaella* and showed two well-oriented fusulinellids with a distinct rugose spiral wall, which occurred in the Moscovian of the North-Archedinskaya area, former USSR. She assigned these specimens to *Fusulinella pseudobocki* Lee et Chen and interpreted that their rugose spirothecae indicate particular adaptation for the sedimentary environments. Moreover, she mentioned that the rugosity does not have any generic value. *F. pseudobocki* Lee et Chen was originally described from the Middle Carboniferous Huanglung Limestone exposed at Kwanshan and Chuanshan, Southeast China (Lee, Chen & Chu, 1930) and has been repeatedly described by many authors elsewhere in the Paleotethys-Panthalassa Provinces. This species is the most common Moscovian fusulinacean species in these provinces. Compared with many described and illustrated specimens previously assigned to *Fusulinella pseudobocki*, Nikitina's specimens have large shells besides strong rugosity in spirotheca. We examined a number of figures illustrated by many previous authors and our own specimens assigned to *F. pseudobocki*, but we could not recognize any specimens having a large shell and rugose spirotheca like Nikitina's Russian specimens. We consider that Nikitina's specimens might be assigned to another species, probably a new species of the genus *Hidaella* rather than *Fusulinella pseudobocki*.

Before the proposal of *Hidaella* a similar rugose spirotheca was known in the genus *Rugosofusulina*, which was enacted by Rauser-Chernousova (1937) with "*Fusulina prisca* Ehrenberg em. Möller" as the type species. This genus has, until now, been widely accepted by many authors particularly among former Soviet and Chinese fusulinacean specialists (e.g., Rauser-Chernousova & Fursenko, 1959; Sheng, 1962; Rozovskaya, 1975; Davydov, 1980; Rauser-Chernousova *et al.*, 1996).

J. W. Skinner and his collaborator G. L. Wilde were very eager to discuss the problem of this rugosity in the fusulinacean spirotheca because they encountered with many *Pseudofusulina* species having rugose spiral walls in various degrees and types in the Permian McCloud Limestone in northern California (Skinner & Wilde, 1965 a). They considered that the "rugosity" in spirotheca does not have any value as a generic criterion of *Pseudofusulina* in their monographic study. In the same year, however, Skinner and Wilde (1965 b) proposed a new genus *Rugosochusenella* that is characterized by a strong rugose spirotheca. They (Skinner & Wilde, 1966 a) also proposed a new subgenus *Sosioella*, which was split from the genus *Chusenella* in having a rugose spirotheca in the juvenarium. Furthermore, Skinner and Wilde (1966b) restudied the type species of *Pseudofusulina*, *P. huecoensis* Dunbar et Skinner, 1931 and pointed out that the species has a rugose spirotheca and other diagnostic characters of *Rugosofusulina* mentioned by Rauser-Chernousova (1937) including strong but irregular septal fluting, the common presence of phrenothecae, and abundant conspicuous septal pores. They concluded that the genus *Rugosofusulina* must be regarded as a junior synonym of *Pseudofusulina*.

Except for many species of *Pseudofusulina* (=*Rugosofusulina*) with a rugose spirotheca, some other fusulinacean species having a similar indented spirotheca have been known in the genera *Fusulinella*, *Quasifusulina*, *Jigulites*, *Daixina*, *Chusenella*, *Thompsonella*, *Rugososchwagerina*, and others. Rauser-Chernousova (1937) originally classified the nature of rugosity in spriotheca of her *Rugosofusulina* into three types. Skinner and Wilde (1965 a, b; 1966 a, b) repeatedly cited her three types of "rugosity" and discussed the problem. The followings are quoted from Skinner and Wilde (1965 b); ***Rauser recognized two general types of "rugosity." The first which she regarded as more primitive, consists of "sharply expressed undulations of the whole wall," while the second consists of "rugosity of its surface due to the rugose structure of the tectum—the outside layer of the theca." Dunbar (1948) pointed out that the wall is not actually rugose, saying, "Since the wall appears to undulate, regardless of the orientation of the section, it is evident that the inequalities are of the nature of dimples and mounds rather than rugae." An examination of the exterior of specimens free of matrix shows that the "rugosity" is the result of narrow grooves or furrows which indent the spirotheca in both the axial and sagittal directions, producing a pebble appearance much like that of a cobblestone pavement [sic]***

The above mentioned Dunbar's opinion seems to be literally correct and "rugosity" or "rugose" is not suitable expressions, but we use these words herein because such a wall structure has long been referred as "rugae," and the "rugosity" or "rogose spiroptheca" has also been commonly used among many fusulinacean workers.

Paratypes of *Pseudofusulina huecoensis* illustrated by Skinner and Wilde (1966 b) show weak but clear rugosity resembling "a miniature cobblestone pavement." Rugosity developed in the outer surface of these spirothecae is not commonly parallel with that of the inner surface and can be assigned to Rauser-Chernousova's type 2.

Rozovskaya (1975) ignored the opinion of Skinner and Wilde (1966 b) and she treated both *Pseudofusulina* and *Rugosofusulina* as valid. In the same paper, however, she synonymized *Rugosochusenella* proposed by Skinner and Wilde (1965 b) to *Rugosofusulina* as a junior synonym. Followed with Rauser-Chernousova and Rozovskaya, most of the subsequent Russian specialists assigned that the rugosity in spirotheca of *Rugosofusulina* and other schwagerinid (not in Russian sense) even in restricted to the juvenarium is one of the criteria to characterize these genus, but in the same publication these authorities incomprehensibly overlooked this rugosity and treated an aberrant character within the same species (e.g., Rozovskaya, 1975, pl. 35, Fig. 10, *Daixina* sp.).

Niikawa (1978) studied fusulinaceans of the Ichinotani Formation and described *Fusulinella schwagerinoides* (Deprat). One of his specimens illustrated on pl. 7, fig. 5 has a rugose spirotheca in the final volution, but he did not mention anything about this rugosity. The rugosity observed in his specimens is not consistent.

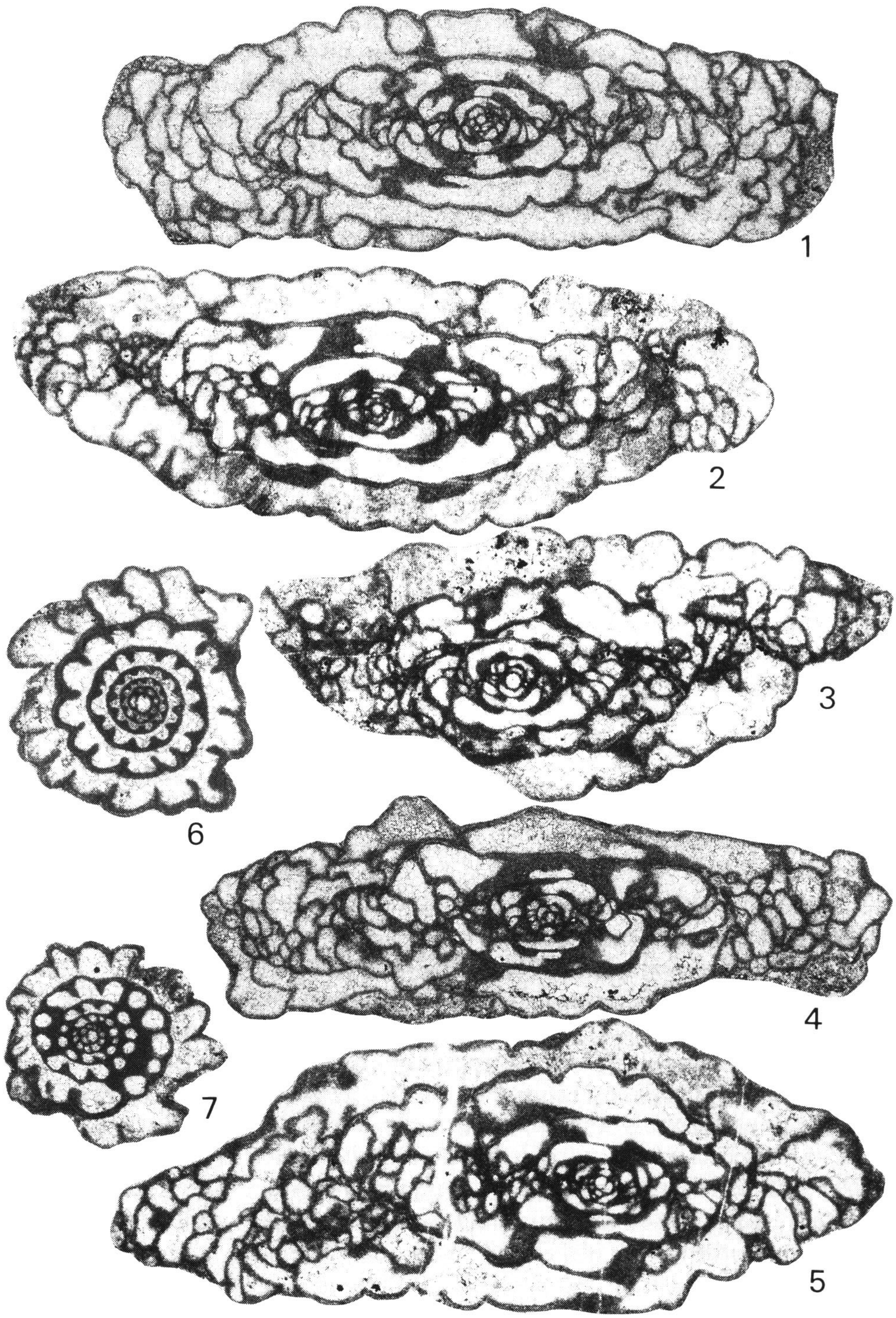
Zolotukhina (1982) discussed the undulation and rugosity of the spiral wall in *Triticites rossicus* (Schellwien) collected from the Volgograd district of former USSR and concluded that the character does not have any taxonomic significance. She emphasized that fusulinaceans with a rugose spirotheca were adapted to a specific ecological niche such as clayey-carbonate sedimentation and a certain water salinity.

Davydov (1980), however, considered that the rugosity in spirotheca is an important criterion and proposed the subfamily Rugosofusulininae that is schwagerinids (not in Russian sense) possessing a rugose spirotheca and grouped the genera *Rugosofusulina*, *Schagonella*, *Ruzhenzevites*, and *Dutkevitchia* in this subfamily. He further documented his idea of the phylogenetic relationship and evolutional trend among these genera (Davydov, 1988).

Recently, Rauser-Chernousova *et al.* (1996) have comprehensively discussed the systematics of Paleozoic foraminifers (Superorder Endothyroida and Fusulinoida) and concerning rugosofusulinids, they mostly accepted Davydov's opinion but upgraded the subfamily Rugosofusulininae to the family Rugosofusulinidae. They assigned the following six genera with a rugose spirotheca to this family such as *Rugosofusulina*, *Dutkevitchia*, *Kahlerella*, *Rugosochusenella*, *Rugosofusulinoides*, and *Schagonella*.

As mentioned above, there are opposite debates concerning the rugosity of spirotheca as a generic criterion. In the case of *Hidaella*, we restudied many additional specimens including original material registered in the paleontological collections of Tokyo University of Education (=Tokyo Kyoiku Daigaku) now kept in the Institute of Geoscience, The University of Tsukuba, and resulted in the following conclusion.

Rugosity is very distinct and consistent in all of the specimens collected from the levels 549, 550, of Bed 43 (Adachi, 1985) of dark gray to black bedded limestone of about 5 m in thickness. This limestone is particularly abundant in fusulinaceans including the genera *Nankinella*, *Fusiella*, *Ozawainella*, *Pseudostaffella*, *Beedeina*, and others. The abundant co-occurrence of these fusulinaceans and smaller foraminifers and common association of gastropods, pelecypods, and brachiopods indicate that the sedimentary environments of this limestone provided optimum condition for niche of fusulinaceans and other smaller foraminifers. Therefore, the environments should not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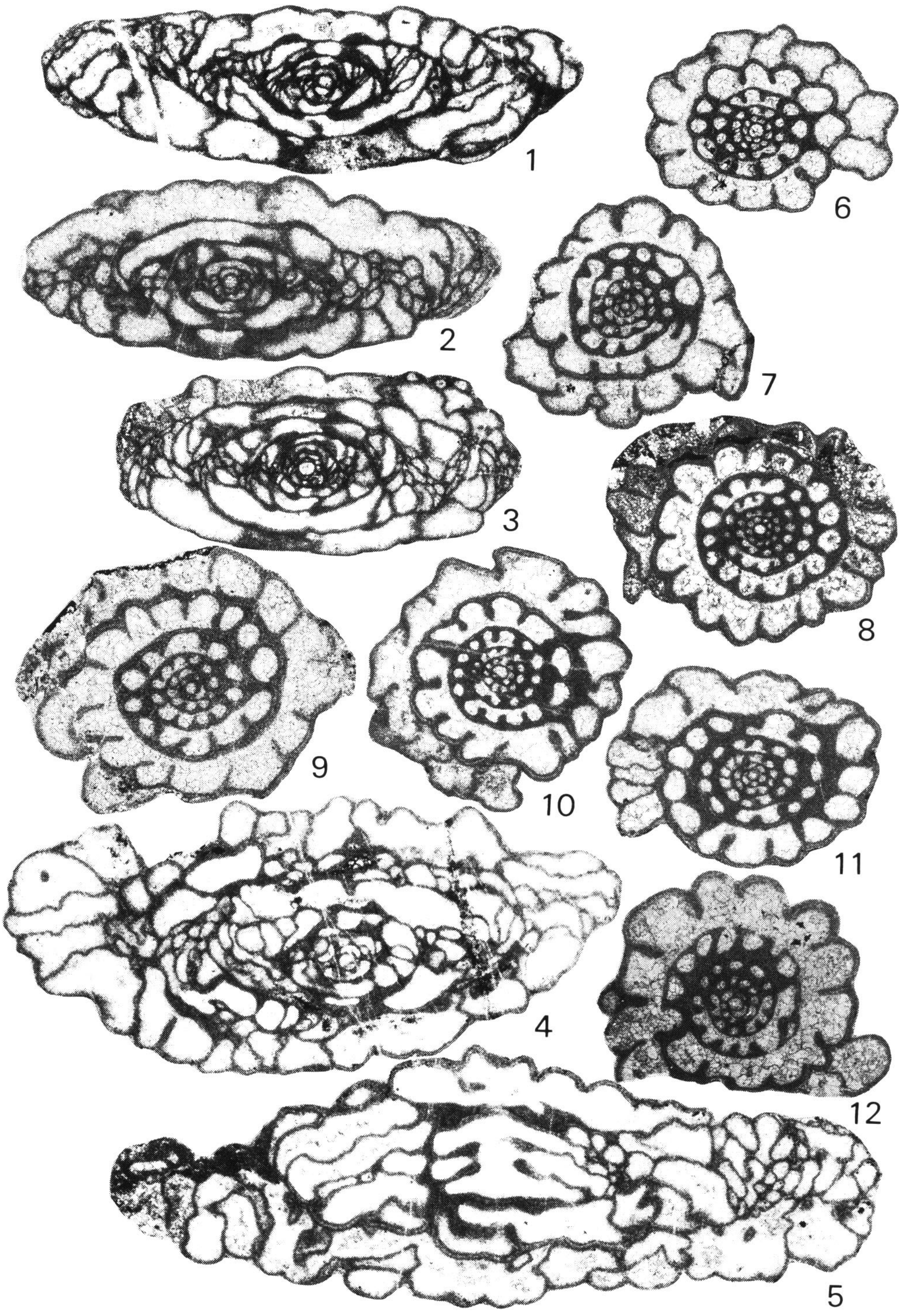
be particular ones to inhabit an aberrant species. The limestone beds consist mostly of black to dark gray and clayey limestone (calcareous wackestone-packstone). This lithic character reminds Zolotukhina's (1982) paper in which she emphasized the relationship between the depositional environments including salinity and the occurrence of *Triticites rossicus* with a rugose spirotheca. We, however, do not have any direct indication to estimate salinity during the deposition of *Hidaella*-bearing limestones.

The occurrence of *Hidaella* has, until now, been known in a few areas outside of Japan, such as the Cantabrian Mountains in Spain (Ginkel, 1965; Villa, 1995), Anhui Province, East China (Nanjing Institute of Geology and Mineral Resources, 1982), and possibly in the North-Archedinskaya area (Nikitina, 1961) and Donbass of former USSR (Kireeva, 1949; Manukalova, 1950). We have been unable to confirm the conclusion of Zolotulkina (1982) since we could not compare the detailed lithology of limestones which yielded *Hidaella* in these foreign countries.

We further quote herein the opinion of Skinner and Wilde (1965 b) that commented on the occasion of their proposal of *Rugosochusenella* as follows; ***Many workers have questioned the generic importance of "rugosity" in the various forms which display this character (e.g., *Pseudofusulina* Dunbar and Skinner [*Rugosofusulina* of authors] and *Hidaella* Fujimoto and Igo). The important point, however, is whether such characters are present wherever a given species is encountered. Certainly enough is known about the geographic and stratigraphic distribution of the numerous species of *Pseudofusulina* that little question remains as to the validity of this genus. *Hidaella* has only recently become known (Fujimoto & Igo, 1955), and is not so well documented; but topotype specimens of the type species, *H. kameii*, show consistent furrowing of the walls. In the same manner, all specimens of *Rugosochusenella* seen in the Big Hatchet Mountains, regardless of location in the range, display the furrowing, or "rugosity." As this new genus is recognized and documented elsewhere, it is expected that such features will hold true [sic]***

We quite agree with the above quoted comments given by Skinner and Wilde (1965 b) and the rugosity or furrowing present in the spirotheca of *Hidaella* is consistent and has generic importance. The senior author, Igo in collaboration with Fujimoto once considered that *Hidaella* is an aberrant descendant of *Fusulinella* (Fujimoto & Igo, 1955), but at present we conclude that the former is a specialized form of the latter. *Hidaella kameii*, the type-species of the genus was adapted to the sedimentary

←Fig. 2. *Hidaella kameii* Fujimoto et Igo, ×35. 1, Axial section of subcylindrical shell, IGUT 5810; 2, Axial section of elongate fusiform shell, IGUT5811; 3, Axial section of slightly broken elongate fusiform shell, IGUT5813c; 4, Axial section of subcylindrical and slightly irregularly coiled shell, IGUT5812; 5, Slightly oblique axial section of elongate fusiform shell with slightly irregularly coiled final volution, IGUT5813b; 6, 7, Sagittal sections of shells with deep septal furrow, undulated septa, and irregular rugose spirotheca in outer volutions, IGUT5815, 5817c, respectively.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environments that deposited clayey limestone but it was not aberrant individuals of the genus *Fusulinella*.

Description of Species

Family Fusulinidae Möller, 1878
Subfamily Fusulinellinae Staff et Wedekind, 1910
Genus *Hidaella* Fujimoto et Igo, 1955

Hidaella Fujimoto et Igo, 1955, p. 46; Thompson, 1964, p. 406; Ginkel, 1965, p. 148; Pasini, 1965, p. 75; Kahler and Kahler,1966, p. 390; Nanjing Institute of Geology and Mineral Resources, 1982, p. 46; Loeblich and Tappan, 1988, p. 268; Villa, 1995, p. 195.
Fusulinella Nikitina, 1961, pl. 1, figs. 1, 2, non fig. 3; Rozovskaya, 1975, p. 68; Rauser-Chernousova *et al*., 1996, p. 107.

Type species: *Hidaella kameii* Fujimto et Igo, 1955

Diagnosis: Shell small, fusiform to subcylindrical with rounded or truncated poles. Inner one or two volutions tightly coiled at large angle to outer ones and subspherical to short fusiform in shape. Outer volutions with long axis and rather loosely coiled. Spirotheca thin and consists of tectum and outer and inner tectoria in inner volutions besides diaphanotheca in outer volutions, but three layers and inner tectorium commonly lacking in final volution. Spirotheca intensely dimpled and furrowed throughout outer volutions both in equatorial and meridional directions. Septa irregularly fluted in axial regions. Septal furrow deep in outer volutions. Tunnel singular, low, and rather wide in outer volutions. Chomata distinct and commonly massive.

Discussion: This genus is distinguishable from *Fusulinella* in deeply furrowed rugose spirotheca in the outer volutions. It differs from *Pseudofusulina* (=*Rugosofusulina*) and other schwagerinids with a rugose spirotheca in spirothecal composition. This genus seems to be a specialized form of *Fusulinella* and occurs in the upper Moscovian.

Hidaella kameii Fujimoto et Igo, 1955

(Figs. 2-4)

Hidaella kameii Fujimoto et Igo, 1955, p. 46–48, pl. 7, figs. 1–10; Nanjing Institute of Geology and Mineral Resources, 1982, p. 46–47, pl. 9, fig.17.

←Fig. 3. *Hidaella kameii* Fujimoto et Igo, ×35. 1, 2, Axial sections of immature fusiform shell, IGUT5813a, 5814, resectively; 3, Axial section of short subcylindrical shell, IGUT5821; 4, Slightly oblique axial section of shell with irregularly coiled outer volutions and trapped proloculus in second volution, IGUT5822; 5, Tangential section of shell with irregular septal folding and undulated spirotheca, IGUT5823; 6–12, Sagittal sections showing irregularly coiled final volution, deep septal furrow and irregular septal fluting in outer volutions, IGUT5819, 5824, 5816, 5817a, 5818, 5820, and 5825, respectively.

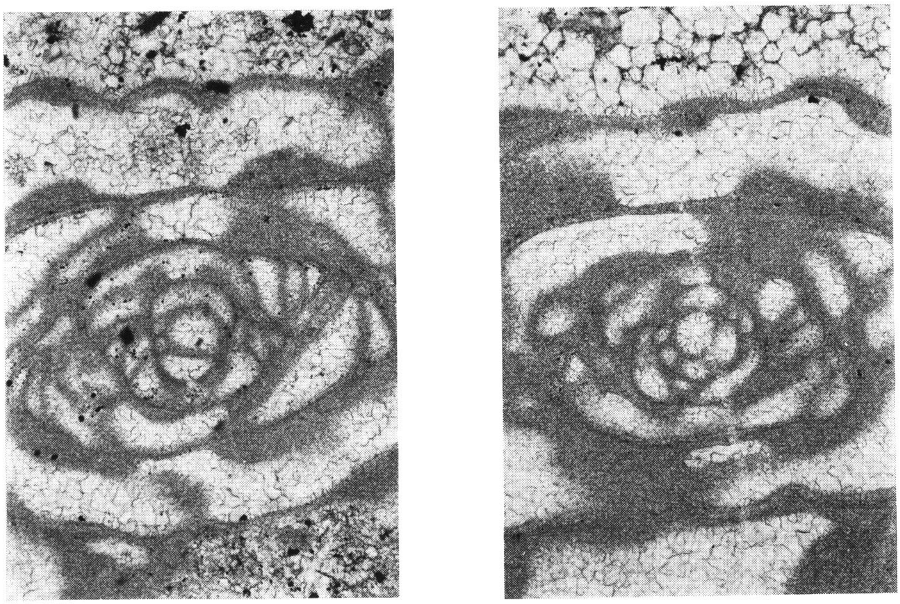
Material studied: About 50 thin-sectioned specimens came from the levels 549 and 550, Bed 43, lower part of the Upper Member of the Ichinotani Formation, Ichinotani Valley (type locality), and the same limestones exposed in the Mizuboradani and Mizuyagadani Valleys, Fukuji, Gifu Prefecture.

Description: Shell small, fusiform, elongate fusiform to subcylindrical in shape. Poles are rounded to truncated in general outline but show irregular surface because of tightly undulated rugged spirotheca. Median part is almost straight to slightly expanded in outline but rarely depressed. Mature shell consists of five to five and one half volutions. Axial length varies from 2.075 to 3.075 mm and averages 2.860 mm for seven well-oriented axial sections. Median width ranges from 0.700 to 1.250 mm and averages 1.053 mm for 15 well-oriented axial and sagittal sections. Form ratio ranges from 1 : 2.77 to 1 : 3.32 and averages 1 : 2.97 for seven specimens.

Volutions are tightly coiled in the young stage, loosely and more or less irregularly coiled in the mature stage. The first volution is coiled at almost right angles with the axis of outer volutions. The second one is subshperical or nautiliformis in shape and coiled in staffelloid with a short axis. The third volution is short fusiform to fusiform and followed by elongate fusiform, cylindrical or subcylindrical outer volutions. Height of volutions and radius vectors increase slowly in inner three but rather rapidly in outer volutions. Moreover, axial length increases rapidly in outer two volutions. Average heights of the first to fifth volutions in 15 specimens are 0.036, 0.049, 0.077, 0.126, and 0.177 mm, respectively. For the sixth volution an average height is 0.184 mm in five specimens. Average radius vectors of the first to fifth volutions in the same materials are 0.068, 0.114, 0.193, 0.315, and 0.499 mm, respectively. For the sixth volution a radius vector averages 0.680 mm in five oriented specimens.

The spirotheca in inner two or three volutions has a smooth surface, but in outer volutions it is tightly dimpled and furrowed in both equatorial and meridional directions. This rugged surface of spirotheca appears as irregular wavy undulations in axial section. In the final volution the undulations commonly have amplitude ranging from 0.080 to 0.100 mm and wavelength ranging from 0.150 to 0.200 mm. In sagittal section the spirotheca of outer volutions also shows undulations in between septal furrows. The spirotheca consists of a tectum and the inner and outer tectoria in immature two or three volutions, besides a thin diaphanotheca is discernible in the third or fourth volution. The spirotheca in the last volution is commonly three layered and the inner tectorium is lacking. Fine alveolar structure is discernible as perpendicular pillars in the last volution. Thickness of spirotheca is thin for the size of shell and variable because of different thickness of the outer and inner tectoria in places. Average thicknesses of spirotheca measured along the equatorial axis in the first to fifth volutions of 15 specimens are 0.009, 0.014, 0.017, 0.023, and 0.023, respectively. An average thickness of spirotheca in the sixth volution is 0.017 mm in five specimens.

The septa are weakly but irregularly folded in most part of the shell, but their folding becomes complicate throughout the polar regions of outer volutions. In axial sections, this folding forms closed chamberlets of fine irregular meshwork pattern in places along the coiling axis. In inner two to three volutions septal furrows are not developed, and the septa are closely and regularly spaced and almost vertically arranged with spiral walls. In the outer volutions septal furrows become distinct and deeply indented, and the septa are rather widely and unevenly spaced, tending arched both forward and inward or irregularly dimpled in places. This irregular undulated



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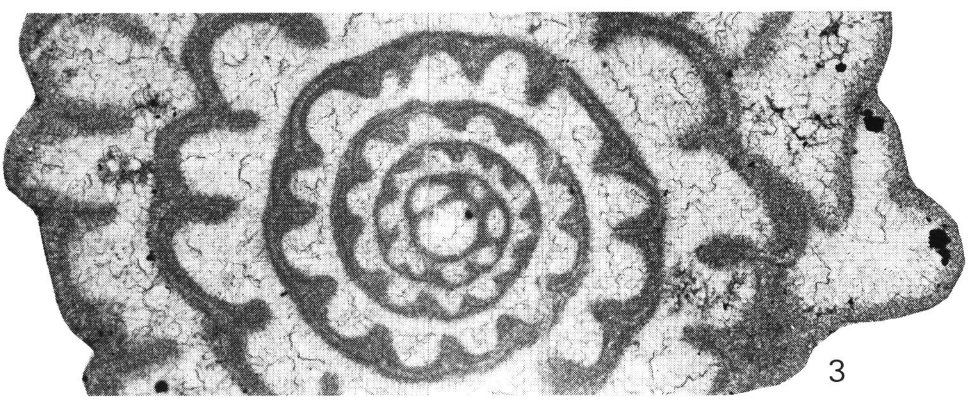

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Fig. 4. *Hidaella kameii* Fujimoto et Igo, ×110, 1, 2, Part of same specimens as Fig. 3-1 and Fig. 2-5 enlarged showing coiling and spirothecal structure of inner volutions; 3. Part of same specimen as Fig. 2-6 enlarged showing structural composition of spirotheca and septa.

Table 1. Measurements of *Hidaella*

No.	Specimen	Length	Width	Ratio	Dia. of proloculus	Height of volutions						Radius		
						1	2	3	4	5	6	1	2	3
1	IGUT5810	3.075	0.988	3.11	0.050	0.022	0.040	0.058	0.108	0.130	0.120	0.055	0.090	0.150
2	IGUT5811	3.150	1.100	2.86	0.065	0.039	0.050	0.120	0.170	0.180	—	0.080	0.130	0.238
3	IGUT5812	2.875	0.900	3.19	0.050	0.031	0.049	0.065	0.105	0.195	—	0.050	0.095	0.162
4	IGUT5813a	2.325	0.700	3.32	.065/.080	0.035	0.038	0.048	0.110	0.150	—	0.060	0.102	0.140
5	IGUT5813b	3.275	1.150	2.85	0.065	0.030	0.040	0.065	0.110	0.220	0.200	0.055	0.095	0.160
6	IGUT5813c	3.250	1.180	2.77	0.080	0.025	0.040	0.080	0.090	0.130	0.240	0.060	0.100	0.180
7	IGUT5814	2.075	0.763	2.72	0.070	0.028	0.040	0.070	0.092	0.180	—	0.062	0.090	0.165
8	IGUT5815	—	1.163	—	.075/.095	0.045	0.055	0.065	0.100	0.182	0.210	0.095	0.150	0.235
9	IGUT5816	—	1.225	—	0.069	0.039	0.058	0.065	0.110	0.220	0.150	0.070	0.115	0.180
10	IGUT5817a	—	1.250	—	0.060	0.040	0.061	0.110	0.160	0.190	—	0.090	0.150	0.250
11	IGUT5818	—	1.125	—	.060/.080	0.040	0.052	0.080	0.120	0.220	—	0.070	0.120	0.190
12	IGUT5819	—	1.100	—	0.080	0.045	0.060	0.090	0.150	0.200	—	0.070	0.140	0.240
13	IGUT5820	—	1.200	—	0.058	0.030	0.045	0.068	0.090	0.180	—	0.050	0.090	0.165
14	IGUT5817b	—	1.075	—	0.075	0.049	0.060	0.095	0.220	0.150	—	0.080	0.140	0.240
15	IGUT5817c	—	0.875	—	0.062	0.039	0.052	0.080	0.150	0.140	—	0.080	0.110	0.198

ragged surface of the septa is well discernible in the fifth and sixth volutions of sagittal sections. Average septal counts in the first to fifth volutions of eight specimens number 7, 11, 12, 13, and 15, respectively. The septa number in the sixth volutions 16 to 18 in two complete specimens.

The proloculus is small relative to the shell size, spherical to subspherical, and ranges from 0.065 to 0.095 mm in outside diameter. An average diameter of the proloculi for 15 specimens is 0.067 mm. The tunnel is narrow and one-half to two-thirds as high as the chambers. Tunnel angle increases gradually from inner to outer volutions, and average tunnel angles of the first to fourth volutions in seven specimens are 20, 31, 41, and 49 degrees, respectively. Chomata are generally prominent and massive, but their shape and height vary a great deal.

Discussion: Our present topotype specimens are similar to the original specimens of *Hidaella kameii* reported by Fujimoto and Igo (1955). Compared with the holotype the present specimens are slightly larger in average size, and the outer volutions are more irregularly coiled. Other important characters, however, are exactly the same with each other. *H. kameii* described from the Huanglung Formation of Anhuri Province, East China (Nanjing Institute of Geology and Mineral Resources, 1982) stands very close but the Chinese specimen has a slightly larger shell. Compared with Ginkel's subspecies, *Hidaella kameii nalonensis* described from the Cantabrian Mountains, Spain, our species has a larger shell, thicker spirotheca, more irregularly coiled volutions, and stronger rugosity in the spirotheca than those of the Spanish subspecies. This Spanish subspecies may be assigned to an independent new species rather than the subspecies of *kameii*. *Hidaella* sp. reported by Villa (1995) is similar to our specimens, but the detailed comparison is difficult because her illustration is based on only one slightly oblique section.

kameii Fujimoto et Igo. (in mm)

vector			Thickness of spirotheca						Tunnel angle (degree)						Septal counts					
4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
0.255	0.380	0.510	0.010	0.012	0.013	0.025	0.023	0.015	20	32	34	60	—	—	—	—	—	—	—	—
0.410	0.580	—	0.015	0.020	0.023	0.025	0.020	—	20	34	46	60	—	—	—	—	—	—	—	—
0.280	0.460	—	0.005	0.010	0.013	0.020	0.020	—	20	30	50	—	—	—	—	—	—	—	—	—
0.250	0.395	—	0.005	0.010	0.013	0.015	0.014	—	16	28	32	36	—	—	—	—	—	—	—	—
0.265	0.490	0.700	0.006	0.021	0.014	0.022	0.024	0.015	23	32	42	45	73	—	—	—	—	—	—	—
0.260	0.430	0.640	0.010	0.013	0.018	0.017	0.017	0.018	20	32	42	49	—	—	—	—	—	—	—	—
0.260	0.430	—	0.011	0.014	0.016	0.018	0.019	—	26	30	39	43	—	—	—	—	—	—	—	—
0.380	0.580	0.640	0.008	0.009	0.010	0.015	0.030	0.020	—	—	—	—	—	—	12	13	13	14	14	16
0.280	0.490	0.650	0.007	0.009	0.015	0.025	0.032	0.018	—	—	—	—	—	—	6	11	13	15	17	18
0.420	0.620	—	0.009	0.012	0.013	0.016	0.025	—	—	—	—	—	—	—	9	12	13	14	15	—
0.310	0.550	—	0.008	0.010	0.020	0.028	0.033	—	—	—	—	—	—	—	7	11	12	13	15	5
0.400	0.620	—	0.010	0.018	0.021	0.023	0.024	—	—	—	—	—	—	—	7	10	13	14	14	—
0.260	0.440	—	0.008	0.015	0.022	0.030	0.023	—	—	—	—	—	—	—	5	9	13	13	15	7
0.440	0.530	—	0.015	0.020	0.028	0.033	0.025	—	—	—	—	—	—	—	6	10	12	12	16	—
0.360	0.495	—	0.008	0.013	0.016	0.023	0.021	—	—	—	—	—	—	—	8	12	12	13	17?	—

Depository: The specimens treated in this paper are kept at the paleontological collections of the Institute of Geoscience, The University of Tsukuba, Nos. IGUT5810–IGUT5830 (all topotypes)

References

Adachi, S., 1985. Smaller foraminifers of the Ichinotani Formation (Carboniferous-Permian), Hida Massif, central Japan. *Sci. Rep., Inst. Geosci., Univ. Tsukuba*, Sec. B, **6**: 59–139, pls. 8–23.

Davydov, V. I., 1980. Rugosofusulininae-novoy podsemeystvo fuzulinid s morshinistoy stenkoy. *Tam Zh.*, 44–45. (In Russian.)

Davydov, V. I., 1988. About a phylogenetic criterion of weighing speck features in foraminifer systematics (exemplified fusulinids). *Revue Paléobiologie*, Vol. Spéc. (2): Benthos'86, 47–55.

Dunbar, C. O., 1948. Fusuline Foraminifer. *In* Cushman, J. A.: Foraminifer, Their Classification and Economic Use, 4th ed.,142–170, pls. 10–12, 44, 45. Harvard Univ. Press, Cambridge, Mass.

Fujimoto, H. & H. Igo, 1955. *Hidaella*, a new Pennsylvanian fusulinids from the Fukuji district, eastern part of the Hida mountainland, central Japan. *Trans. Proc. Pal. Soc. Japan, New Series,* (18): 45–48, pl. 7.

Ginkel, A. C., 1965. Carboniferous fusulinids from the Cantabrian Mountains (Spain). *Leidse Geol. Mededelingen*, **34**: 1–225, pls. 1–53.

Igo, H., 1957. Fusulinids of Fukuji, southeastern part of the Hida Massif, central Japan. *Sci. Rep. Tokyo Kyoiku Daigaku*, Sec. C, **5** (47): 153–246. pls. 1–15.

Igo, Hisayoshi, S. Adachi, & Hisaharu Igo, 1984. Foraminiferal biostratigraphy of the Ichinotani Formation, Hida Massif, central Japan. *Neuvième Congrès International de Stratigraphie et de Géologie du Carbonifère, Compte Rendu*, **2**: 453–465.

Kahler, F. & G. Kahler, 1966. Fossilium Catalogus, I: Animalia, Fusulinida (Foraminiferida), Parts. 1–4, 974 pp. Uitgeverij Dr. W. Junk, Gravenhage.

Kireeva, G. D., 1949. Nekotorye novye vidy fuzulinid izkamennougol'nykh yizvestnyakov tsentraal'nogo rayona Donbassa. *Trudy, Geol. Inst., Byuro Glavuglerazvedki*, **6**: 25–54, pls. 1–2. (In Russian.)

Lee, J. S., S. Chen, & S. Chu, 1930. The Huanglung limestone and its fauna. *Mem. Nat. Res. Inst. Geol. Acad. China*, (9): 85–143, pls. 2–15.

Loeblich, A. R., Jr. & H. Tappan, 1988. Foraminiferal Genera and Their Cassification. **1–2**, 970 pp., 874 pls., Van Nostrand Reinhold Co., New York.

Manukalova, M. F., 1950. Novye vidy fuzulinid iz izevestnyakov srednego karbona Donbassa. *Geol. Issledovatelyskne raboty (Ugletekhizdat), Materialy po stratigrafii i paleontologii Donetsskogo basseyna*, 219–233, pls. 1–2. (In Russian.)

Nanjing Institute of Geology and Mineral Resources, 1982. Paleontological Atlas of East China, **2**, Volume of Late Paleozoic, Protozoa, 108 pp., 30 pls., Geological Publishing House, Beijing. (In Chinese.)

Niikawa, I., 1978. Carboniferous and Permian fusulinids from Fukuji, central Japan. *Jour. Fac. Sci., Hokkaido Univ.*, Ser. 4, **18** (4): 533–610, pls.1–14.

Nikitina, T. N., 1961. O volnistoy stenke u nekotorykh fuzulinell. *Voprosy Mikropaleontologii*, **5**: 143–146, pl. 1. (In Russian.)

Niko, S., 1985. *Mediocris* (primitive Fusulinacea) from the Ichinotani Formation, Fukuji district, central Japan. *Sci. Papers, Coll. Arts, Sci., Univ., Tokyo*, **35** (2): 165–180, pls. 1–3.

Niko, S., 1987. Early Carboniferous *Eostaffella* (primitive Fusulinacea) from the Ichinotani Formation, Fukuji district, central Japan. *Trans. Proc. Palaeont. Soc. Japan, New Series*, (147): 117–130.

Pasini, M., 1965. Fusulinidi, una Chiave Analitica per la Determin Azione dei Generi. *Paleontographia Italica*. 107 pp., 18 pls. (In Italian.)

Rauser-Chernousova, D. M., 1937. *Rugosofusulina*-novyy rod fuzulinid. *Etyudy po Mikropaleontologii*, **1** (1): 9–26, pls. 1–3. (In Russian.)

Rauser-Chernousova, D. M. & A. V. Fursenko, 1959. Osnovy Paleontologii, Obshchaya Chast' Prosreyshyie. 482 pp., 13 pls. Akad. Nauk SSR, Moskva. (In Russian.)

Rauser-Chernousova, D. M., F. P. Bensh, & M. V. Vdovenko, 1996. Spravochnik po Sistematike Foraminifer Paleozoya (Endotironidy, Fuzulinoidy). 207 pp., 48 pls. Akad. Nauk Rossiiskaya, Geol. Inst., Moskva. (In Russian.)

Rozovskya, S. E., 1975. Sostav, sistema i filogenija otryada fuzulinida. *Akad. Nauk SSSR, Trudy Paleontologicheskogo Instituta*, **149**: 1–268. (In Russian.)

Sheng, J. S., 1962. Fusulinids of China. 177 pp., 27 pls. Sci. Publishing Co., Beijing. (In Chinese.)

Skinner, J. W. & G. L. Wilde, 1965 a. Permian biostratigraphy and fusulinid faunas of the Shasta Lake area, northern California. *Univ. Kansas Pal., Contr.*, Art. 6: 1–98, pls. 1–65.

Skinner, J. W. & G. L. Wilde, 1965 b. Lower Permian (Wolfcampian) fusulinids from the Big Hatchet Mountains, southwestern New Mexico. *Contr. Cushman Found. Foram. Res.*, **16** (3): 95–104, pls. 13–15.

Skinner, J. W. & G. L. Wilde, 1966 a. Permian fusulinids from Sicily. *Univ. Kansas Pal. Contr.*, Paper 8: 1–16, pls. 1–20.

Skinner, J. W. & G. L. Wilde, 1966 b. Type species of *Pseudofusulina* Dunbar & Skinner. *Univ. Kansas Pal. Contr.*, Paper 13: 1–7, pls.1–4.

Thompson, M. L.,1964. Fusulinacea, C358–C436. *In* Moore, R. C. (ed.):Treatise on Invertebrate Paleontology, Part C, Protista 2, **1**, Univ. Kansas Press, Lawrence, Kansas.

Villa, Elisa, 1995. Fusulinaceos Carboniferos del este de Asturias (N de Espãna). *Biostrastigraphie du Paleozoique, Univ. Claude Bernard-Lyon*, **13**: 1–261, pls.–36. (In Spanish.)

Zolotukhina, G. P., 1982. O taksonomicheskom znachenii volnistosti i morshinistosti stenki rakovin fuzulinidei. *Voprosy Mikropaleontologii*, **25**: 22–25, pls. 1–3. (In Russian.)