Fusulinids from the Yayamadake Limestone of the Hikawa Valley, Kumamoto Prefecture, Kyushu, Japan Part III : Fusulinids of the Lower Permian

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Fusulinids from the Yayamadake Limestone of the Hikawa Valley, Kumamoto Prefecture, Kyushu, Japan*

Part III-Fusulinids of the Lower Permian

By

Kametoshi KANMERA

Introductory Remarks

In 1952 I reported that the Yayamadake limestone of the Hikawa Valley, Kumamoto Prefecture, Kyushu, consisting of the *Fusulina*, *Triticites* and *Pseudoschwagerina* zones, is the most nearly complete display of the Upper Carboniferous and the Lower Permian section known in the Orient. This paper deals with the fusulinids of the *Pseudoschwagerina* zone and their stratigraphic distribution in the upper part of the Yayamadake limestone. It is the companion to Part I (1954) and II (1955) in which I treated respectively of the fusulinids of the *Fusulina* and the *Triticites* zone of the lower and the middle part of the limestone.

In part II I gave some remarks on the stratigraphic distribution of the fusulinids of the *Pseudoschwagerina* zone with regard to the stratigraphic relationship between the *Triticites* and the *Pseudoschwagerina* zone of the limestone. However, since the remarks were brief, I again give necessary accounts on that respect in more detail, with some additional emendations on the previous descriptions (1952).

Lithology of the *Pseudoschwagerina* zone and stratigraphic distribution of fusulinids

The *Pseudoschwagerina* zone occupying the upper part of the Yayamadake limestone is typically distributed in NEE trend along the north slope of the Mt. Yayamadake ridge and overlies the limestone of the *Triticites* zone. The limestone is merged laterally and upwardly into pyroclastic rocks composed of basic tuffs and breccia tuffs with intercalation of lava flows.

As mentioned in my previous paper (1952, 1954), the Yayamadake limestone is massive throughout the whole thickness and has no stratification. The rocks of the *Pseudoschwagerina* zone are, with the exception of the conglomerate occupying the basal part of the zone, a monotonous succession made up of white to grey limestones, division of which is, therefore, hardly done by such usual way as using lithological characteristics. The thickness of the *Pseudoschwagerina* zone

* Received October 15, 1958

of the limestone is estimated to be about 130 meters.

The basal part of the *Pseudoschwagerina* zone is composed of a limestone conglomerate, which is of a simple lithologic composition and poor sorting, has generally abundant matrix, and is made up of angular to slightly rounded pebbles, cobbles and boulders exclusively of several kinds of limestone invariably in a matrix of finer lime material. The conglomerate is so variable in the amount of pebbles and cobbles that it has sometimes relatively little matrix and sometimes, on the contrary, contains isolated pebbles randomly scattered in abundant matrix.

The conglomeratic part ranges from 1 to 25 meters in thickness, generally 5, and laterally and upwardly grades into normal types of limestone which are rather heterogenous in lithic characters, partly highly oolitic in texture and generally grey in colour.

Fusulinids identified from the basal part under consideration are *Pseudoschwagerina morikawai* Igo and *Quasifusulina longissima ultima* n. subsp., which were collected not only from the non-conglomeratic normal limestone but also from the matrix of the conglomerate. In the former they occur commonly, and abundantly in places, but in the latter they are rather rarely contained, though fairly common in places. In addition to the species mentioned above, *Triticites montiparus* [(Ehrenberg) Möller] was obtained from the non-conglomeratic part at a horizon about 5 to 10 meters above the base. The collections from about 15 meters above the base contain *Triticites yayamadakensis evectus* n. subsp., *Triticites ozawai* Toriyama [=*Schellwienia montipara*, Ozawa, 1925] and those from 20 to 25 meters above the base contain *T. ozawai*. They are also associated with *Pseudoschwagerina morikawai* Igo and *Quasifusulina longissima ultima* n. subsp.

While a certain kind of pebbles and cobbles of the conglomerate are highly fossiliferous and contain a rich fauna consisting exclusively of *Triticites* and *Ozawainella* which are different from those of the Permian section under consideration and from the known species of the underlying *Triticites* zone. The species of *Triticites* are smaller in size than those from the Permian section and of morphologically primitive types of the genus. Those pebbles and cobbles are found abundantly in the basal part of the *Pseudoschwagerina* zone.

The limestone of the succeeding middle part of about 30 to 55 meters above the base is generally grey in colour, roughly speaking, homogenous in texture, compact and, for the most part, siliceous in composition, and not oolitic. Fossils are rather rare in this part, especially in its upper part, being not good in preservation, if exist. However its lower part is richly fossiliferous in some limited horizons. Collected fusulinids from this lower part are *Triticites* aff. *T. haydeni* (Ozawa), *Rugosofusulina prisca* [(Ehrenberg) Möller], *Pseudoschwagerina* sp. and *Quasifusulina longissima ultima* n. subsp., and those of the upper part are *Triticites parvulus* (Schellwien), *Triticites* sp., *Rugosofusulina prisca* [(Ehrenberg) Möller] and *Quasifusulina* sp. The limestone, about 10 meters thick, immediately above the siliceous limestone is so highly traversed by a network of calcite veinlets that the contained fusulinids are hardly determinable exactly. However the unidentified forms are *Pseudofusulina* of *complicata* (SCHELLWIEN) group and *vulgaris* (SCHELLWIEN) group, and *Schwagerina* of *alpina* (SCHELLWIEN) group.

The upper half, about 55 meters thick, of the *Pseudoschwagerina* zone of the Yayamadake limestone is white to white grey in colour, not oolitic in texture and highly fossiliferous at many horizons. The lowest part, about 10 meters thick, of this unit is filled with a number of individuals of *Nankinella kawadai* (IGO), *Triticites pusillus* (SCHELLWIEN), *Pseudoschwagerina minatoi* n. sp., *Paraschwagerina shimodakensis* n. sp., *Schwagerina grandensis* THOMPSON, *Pseudofusulina* aff. *P. dongvanensis* (COLANI) and *Schwagerina* sp. This fossiliferous part is well traceable along the strike at least within the surveyed area. It is followed upwardly by the limestone which is characterized by *Pseudofusulina sokensis* RAUSER-CERNOUSSOVA, *P. horrida* n. sp. and *P.* n. sp. The fusulinids identified from the succeeding beds of about 5 meters thick are *Pseudofusulina regularis* (SCHELLWIEN), *P. kumasoana* n. sp., *Schwagerina stabilis* (RAUSER-CERNOUSSOVA), *S.* cf. *S. grandensis* THOMPSON and *S. krotowi* (SCHELLWIEN). In upward succession next comes the grey limestone of about 5 meters which is characterized by species described as *Rugosofusulina serrata* RAUSER-CERNOUSSOVA and *Pseudoschwagerina minatoi* n. sp. From the limestone of 5 meters thick immediately above the bed were obtained *Pseudofusulina stabilis* RAUSER-CERNOUSSOVA, *P. santyuensis* HUZIMOTO, *Rugosofusulina pristina* n. sp., *Pseudoschwagerina minatoi* n. sp. and *Triticites* sp. Above the said fossil bed there are followed the limestones of 15 meters thick teeming with numerous specimens of *Triticites samaricus* (RAUSER-CERNOUSSOVA) and *Pseudofusulina regularis* (SCHELLWIEN) and scattered specimens of *T. fornicatus* n. sp., *Rugosofusulina pristina* n. sp. and *Pseudoschwagerina minatoi* n. sp. The species at the uppermost 10 meters are *Nankinella kotakiensis* (FUJIMOTO and KAWADA), *Triticites pusillus* (SCHELLWIEN) and *Pseudofusulina regularis* (SCHELLWIEN).

Thus fusulinid fossils occur throughout the whole thickness of the Permian section of the Yayamadake limestone, although they had been found sparingly in the middle part. The occurrence of rich fusulinids in this limestone permits a general zonation and a correlation with other areas.

In short *Schwagerina*, *Paraschwagerina* and *Pseudofusulina* make their first appearance in the middle part of the section, and *Triticites* and *Quasifusulina* in the lower part, so far as has been determined, do not range up into the upper part. According to the distribution, assemblage and evolutionary development of the fusulinids we can discriminate conveniently at present the following two fossil zones in the *Pseudoschwagerina* zone. They are:

F)* The lower fossil zone, characterized by *Pseudoschwagerina morikawai* and by numerous individuals of *Triticites montiparus*, *T. ozawai*, *T. yayamadakensis evectus* n. sp., *Rugosofusulina prisca* and *Quasifusulina longissima ultima* n. subsp.

G)* The upper subzone dominated by *Paraschwagerina*, *Pseudofusulina* and *Schwagerina* in addition to *Pseudoschwagerina*, which consist of the above

* These heading letters are succeeded in order after Part I and II of this series of papers (1954, 1955).

mentioned species.

The fusulinid faunas of the type section are indicated in the accompanying diagram (fig. 3), and detailed descriptions of species are given in the following chapter. The fusulinid faunas of the *Pseudoschwagerina* zone under consideration are probably more extensive than is indicated in the list, but the fusulinids from several horizons are not favourable in the preservation for the identification of species or, in some cases, even of genera. Moreover, as species of minute form are difficult to obtain their well-oriented sections, there are some species unable

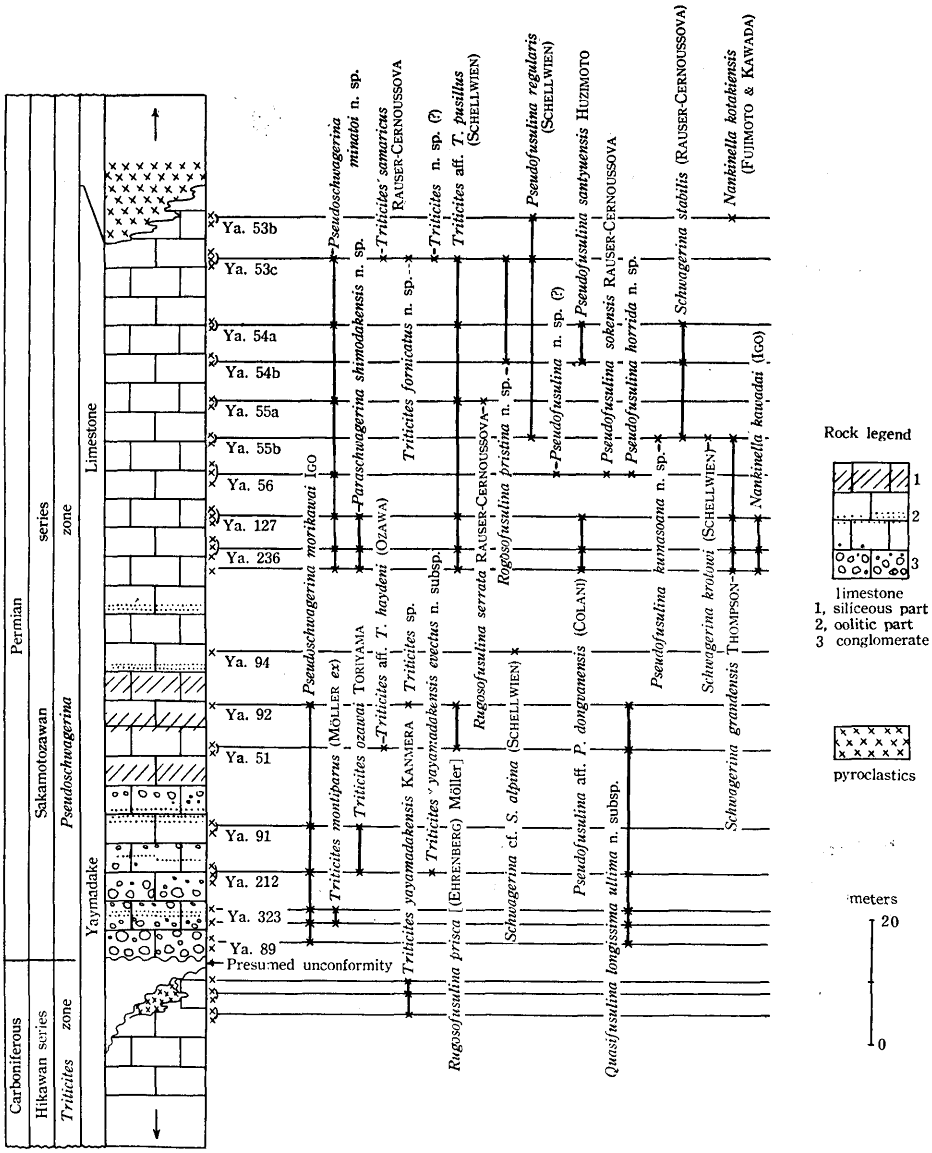

Fig. 3. The type section of the upper part of the Yayamadake Limestone, showing the stratigraphic distribution of the fusulinid faunas.

to describe here.

In spite of the great abundance of *Pseudofusulina* and *Schwagerina*, numerous thin sections have not yielded any of the more advanced forms of fusulinid which have a well developed cuniculi structure. Only two specimens which are provided with low cuniculi in their outermost volution were found among them. They are uncertain to which species they should be referred, but one of them is associated with *Pseudofusulina kumasoana* n. sp., *Schwagerina stabilis* (RAUSER-CERNOUSSOVA), *S. grandensis* THOMPSON and *S. krotowi* (SCHELLWIEN), and the other seems to be referable to either of *Pseudofusulina* cfr. *P. dongvanensis* (COLANI) or *Schwagerina grandensis* THOMPSON.

The Yayamadake limestone are not succeeded by the fossil-bearing rocks, but covered by pyroclastics, about 10 to 20 meters thick, with no fossil. While the pyroclastics—" schalstein "—are conformably overlain by the Shimodake group which is a thick series of massive and coarse to medium grained sandstones with intercalated slates and cherts of 10 to 50 meters thick at many horizons. As fossil data are completely lacking in the group, the recognition of the *Parafusulina* zone and the definite correlation of the group with other known Permian sections are impossible. However, so far as the available knowledge is concerned*, it is highly probable that the Shimodake group may be referable to the *Parafusulina* zone at least in its middle part which occupies about 300 to 400 meters above the upper limit of the Yayamadake limestone.

Stratigraphic relationship between the *Triticites* and the *Pseudoschwagerina* zone

So far as has been determined, the contact between the limestones of the *Triticites* and the *Pseudoschwagerina* zone is considered to be unconformable. The distribution of the fossil subzones of the *Triticites* zone is not essentially parallel to those of the overlying *Pseudoschwagerina* zone, at least in areas of the type section. Eastwards from the immediate north of the summit of Mt. Yayamadake the *Triticites yayamadakensis* subzone decreases in thickness and is overlain directly by the basal conglomerate of the *Pseudoschwagerina* zone in the northeastern slope of Mt. Yayamadake. The very boundary of the unconformity in question was detected in only a small area of the type section, but in another areas it has not been determined, for the exposure of limestone is not throughly continuous. However the occasional exposures of the limestone conglomerate along the boundary zone suggest the presence of the unconformity.

The fusulinids of the *Triticites* zone suggest the significance of this break. As already described (Part II), the *Triticites* zone in the Yayamadake limestone is composed of only two subzones characterized by primitive forms of *Triticites*, and

* In the Usuki district, the eastern extremity of Kyushu, which belongs to the same terrain as the Kuma massif, there is a formation containing lenses of *Parafusulina*-bearing limestone. The formation, the Meiji formation, is very similar to the Shimodake group under consideration in the stratigraphic succession and lithology, and in its middle part has limestone lenses, in which *Parafusulina kaerimizensis* (OZAWA) and *P. yabei* HANZAWA are contained.

any species of more advanced forms like those of the upper part (Virgilian series) of the *Triticites* zone in North America has not been found. In addition to this fact, as mentioned in the foregoing chapter, some pebbles and cobbles of the basal conglomerate contain abundant specimens of species exclusively of *Triticites* and *Ozawainella*, of which the species of *Triticites* are of small primitive forms. Although those fossiliferous limestone cobbles and pebbles are not ascertained from where they had been derived, judging from their size and amount, they are believed to have come from the outcrops of the *Triticites* zone in a nearby source area of some relief at the end of the period of denudation which preceded the deposition of the Permian rocks.

In short the disharmony in the distribution of the subzones of the two zones in question and the presence of the basal conglomerate of the *Pseudoschwagerina* zone, which contains limestone pebbles and cobbles yielding *Triticites* faunas of small primitive type, suggest that an unconformity separates the *Pseudoschwagerina* zone from the *Triticites* zone. No species of fusulinids of the *Triticites* zone is known to cross this boundary and to range up into the *Pseudoschwagerina* zone.

Description of species

Subfamily Fusulininae RHUMBLER, 1895

Genus *Quasifusulina* CHEN, 1934

Quasifusulina longissima ultima n. subsp.

Plate 24, figures 1-8

Quasifusulina longissima, IGO, 1957, Sci. Rep. Tokyo Kyoiku Daigaku, sect. C, Vol. 5, no. 47, p. 224-225, pl. viii, figs. 13-18, pl. xi, figs. 12, 13.

Shell highly elongate subcylindrical to cylindrical, with broadly arched to irregular axis of coiling, bluntly pointed poles and flat but irregular lateral slopes. Mature shells attain 6 to 6½ volutions, having a length of 9.5-12.2 mm. and a width of 1.9-2.5 mm. Form ratio 4.5-5.0. Average form ratios of 1st to 5th volution in 5 specimens 1.81, 2.74, 3.18, 3.99 and 4.17, respectively.

Proloculus of most specimens rather large and irregular in shape, but in some spherical. Its outside diameter measures 231-522 microns, averaging 338 microns for 11 specimens. Shells expand slowly and uniformly. Average heights of 1st to 5th volution in 11 specimens 76, 102, 152, 183 and 222 microns, respectively. Chambers lowest above tunnel, increasing in height slowly poleward.

Spirotheca thin, composed of a tectum, a less dense central layer and a dense lower layer which is exceedingly thin and discontinuous. Central layer never fibrous, and in some well-preserved specimens it is fairly transparent. Average thicknesses of spirotheca in 1st to 5th volution in 11 specimens 20, 26, 33, 37 and 40 microns, respectively. Spirotheca remains nearly uniform in thickness throughout length of shell. It is sometimes undulating laterally, although not uniformly rugose.

Table 1. Measurements of *Quasifusulina longissima ultima* n. subsp. in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions 1	2	3	4	5	6	Form ratio of volutions 1	2	3	4	5
1	6	9.27	1.99	4.65	.276	.072	.101	.116	.174	.217	.203(?)	1.63	2.50	3.29	3.75	4.04
2	6	12.15*	2.49	4.87	.276	.075	.105	.174	.188	.290	.319	1.60	2.75	2.92	3.88	4.36
3	6	9.80	ca.2.05	4.78	.290	.065	.080	.123	.170	.203	—	2.00	3.01	3.40	4.15	4.10
4	6	7.16**	1.87	3.82	.247	.065	.072	.130	.145	.203	.232	1.81	2.66	3.00	4.00	—
5	5	8.03	—	—	.348	.072	.101	.130	.160	—	—	2.00	2.77	3.33	4.06	—
6	6	12.07***	2.18(?)	ca.5.53	.420	.072	.101	.160	.145	.190	—	—	—	—	—	—
7	6	—	2.41	—	.370	.087	.108	.145	.166	.217	.246	—	—	—	—	—
8	5	—	2.18	—	.341	.072	.101	.160	.181	.203	—	—	—	—	—	—
9	-	—	—	—	.406	.087	.116	.174	.217	.217	—	—	—	—	—	—
10	4	—	1.91	—	.377	.062	.116	.174	.246	—	—	—	—	—	—	—
11	5	—	2.18	—	.369	.087	.128	.190	.218	.261	—	—	—	—	—	—

Specimen	Thickness of spirotheca 1	2	3	4	5	6	Tunnel angle (degrees) 1	2	3	4	septal count 1	2	3	4	5
1	.021	.029	.031	.036	.045	—	18	21	38	27	—	—	—	—	—
2	.023	.033(?)	.033	.038	.040	.050	—	23	47	—	—	—	—	—	—
3	.021	.018	.033	.040	.043	—	—	—	37	—	—	—	—	—	—
4	.016	.018	.027	.036	.036	—	—	20	32	42	—	—	—	—	—
5	.021	.029	.036	.042	—	—	—	—	45	34	—	—	—	—	—
6	.021	.025	.029	.031	.043		—	—	—	—	—	—	—	—	—
7	.021	.029	.033	.042	.045	.045	—	—	—	—	13	22	26	21	35(?)
8	.016	.018	.029	.025	.029	—	—	—	—	—	13	26	30	40(?)	43
9	.016	.023	.036	.040	.040	—	—	—	—	—	12	25	27	33	—
10	.023	.029	.036	.036	—	—	—	—	—	—	10	21	32	34	—
11	.021	.030	.036	.043	.036	—	—	—	—	—	14	25	29	35	41(?)

* twice a half; ** not well cut along the polar extremities; *** deformed.

Specimens 1, 2, 5–7 and 8 are illustrated on Plate 24 as figures 1, 2, 9, 10, 7 and 11, respectively.

Septa closely spaced, and so intensely fluted throughout shell that closed chamberlets extend almost completely to tops of chambers, and low cuniculi developed in outer volutions. Septal counts of 1st to 5th volution in 5 specimens average 12, 24, 29, 30 and 40, respectively.

Tunnel low and narrow, but absence of distinct chomata makes it difficult to determine borders of tunnel and to measure its angle. Tunnel angles of 2nd to 4th volution vary 20–23, 32–47 and 27–53 degrees, respectively. In most specimens dense deposits fill chambers in axial regions of 1st to 4th volution. Lighter deposits occur immediately along axis in 5th and 6th volutions.

Measurements of the present subspecies are given in Table 1.

Remarks.—*Quasifusulina longissima* (MÖLLER) is a well-known species of the Upper Carboniferous and the Lower Permian in the Tethys Sea region. It was first recorded from Tzarew Kurgan, Russia and later identified or listed from various areas of Eastern Asia, including Indochina, North and South China and the Japanese Islands. Several varieties of this form were set up from the Lower Permian of North China.

The specimens obtained from the *Pseudoschwagerina* zone of the Yayamadake limestone have larger and more highly elongate shells, and narrower and less dense axial fillings than the types of *longissima*. Moreover their septa are more intensely fluted, forming cuniculi in outer volutions. In my previous paper (1952) they were listed under the name of *Q. longissima*, but they differ from the types in the above mentioned respects, and may represent a distinct species. Since there is, however, a striking similarity in essential shell structures between the two groups, I prefer to regard them as subspecific significance and am considering the Yayamadake specimens a direct descendant of the typical subspecies.

They are also distinguishable from *Q. tenuissima* (SCHELLWIEN) described from the Troghofel limestone and the several forms described by LEE as varieties of *longissima* from the Lower Permian of China in having more slender shells and less heavier axial fillings.

Occurrence.—Common in the basal part of the *Pseudoschwagerina* zone and rather sparse in the succeeding middle part, but has not been found in the upper half of the Permian section. Associated with *Pseudoschwagerina morikawai* IGO, *Triticites yayamadakensis evectus* n. subsp., *T. montiparus* [(EHRENBERG) MÖLLER] and *Rugosofusulina prisca* [(EHRENBERG) MÖLLER].

Subfamily Schwagerininae DUNBAR & HENBEST, 1930

Genus *Triticites* GIRTY, 1904

Triticites montiparus [(EHRENBERG) MÖLLER]

Plate 25, figures 21–27

Fusulina montipara, MÖLLER, 1878, Mem. Acad. St.-Pétersb., Ser. VII, Bd. 25, no. 9, p. 61–63, pl.

Table 2. Measurements of *Triticites montiparus* [(EHRENBERG) MÖLLER] in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions						Form ratio of volutions					
						1	2	3	4	5	6	1	2	3	4	5	6
1	5½	4.45	1.88	2.36	.100	.035	.050	.100	.200	.322	.372	1.40	1.83	2.20	2.00	2.00	2.09
2	6	4.99	2.23(+)	2.24	.150	.043	.068	.100	.179	.286	.415	1.33	1.55	2.00	2.08	2.00	2.16
3	5	3.92	1.54**	2.55	.086*	.043	.057	.097	.172	.257	—	1.70	2.00	2.33	2.40	2.41	
4	6	—	2.00	—	.125	.043	.072	.107	.157	.272	.315	—	—	—		—	—
5	6		1.92	—	.122	.040	.072	.114	.186	.243	.300	—	—	—	—	—	—
6	6	—	1.92	—	.100*	.043	.064	.114	.143	.257	.358	—	—	—	—	—	—
7	6		1.80	—	.100	.050	.064	.100	.186	.272			—	—	—	—	—

Specimen	Thickness of spirotheca						Tunnel angle (degrees)					Septal count					
	1	2	3	4	5	6	2	3	4	5	6	1	2	3	4	5	6
1	.012	.018	.021	.038	.072	.072	—	27	30	32	26(?)	—	—	—	—	—	—
2	.014	.021	—	.057	.075	.086	28	25	26	33	40	—	—	—	—	—	—
3	.014	.021	.025	.036	.050	—	—	27	34	35	—	—	—	—	—	—	—
4	.014	.021	.029	.036	.057	.072	—	—	—	—	—	8	12	17	18	22	23
5	.014	.029	.043	.064	.086	.100	—	—	—	—	—	8	14	17	20	26	—
6	—	.021	.029	.043	.057	.092	—	—	—	—	—	8(?)	13	16	20	24	25
7	.014	.021	—	.038	.057	—	—	—	—	—	—	7(?)	12(?)	12	18	24	—

* Not well-centered; ** slightly deformed.
Specimens 1, 2, and 6 are illustrated on Plate 25 as figures 21, 22 and 23, respectively.

iii, fig. 2, pl. viii, fig. 2;———, SCHELLWIEN, 1908, Palaeontographica Vol. 55, p. 185-186, pl. xix, figs. 8-10.

Triticites (*Montiparus*) *montiparus*, ROZOVAKAYA, 1948, Dokladi Academia Nauk U. S. S. R. Vol. 59, no. 9, p. 1637;———, THOMPSOM, Univ. Kansas Paleont. Contr., Protozoa, art. 5, p. 11, pl. 4, figs, 5, 6.

(Not *Alveolina montipara* EHRENBERG, 1854; *Schellwienia montipara*, OZAWA, 1925; *Fusulina montipara*, SILVESTRI, 1933; *Triticites montiparus*, HUZIMOTO, 1936)

A number of sectioned specimens referable to *Triticites montiparus* were obtained from the lowest part of the *Pseudoschwagerina* zone.

Shell small, inflated fusiform in shape, with straight to slightly arched axis of coiling. Lateral slopes generally straight to slightly concave, but sometimes slightly convex. Mature shells of 5 to 6 volutions 4.5-5.5 mm. long and 1.8-2.4 mm. wide, giving form ratios of 2.2-2.6. Average form ratios of 1st to 6th volution of 4 specimens 1.4, 1.72, 2.06, 2.16, 2.15 and 2.21, respectively.

Proloculus small; its outside diameter 100-150 microns, averaging 120 microns for 7 specimens. Shell tightly coiled in inner volutions. Average heights of 1st to 6th volution of 8 specimens 42, 64, 104, 174, 263 and 353 microns, respectively. Heights of chambers increase slightly poleward from central part of shell.

Spirotheca composed of a tectum and a finely alveolar keriotheca, and covered with a thin upper tectorium under tunnel. It becomes thinner poleward from center of shell. Average thicknesses of all layers of spirotheca for 1st to 6th volution of 8 specimens 14, 21, 29, 44, 63 and 83 microns, respectively.

Septa numerous. Average septal counts for 1st to 6th volution of 5 specimens 8, 13, 15, 19, 24 and 24, respectively. Septa closely and somewhat irregularly fluted in axial region, but almost unfluted across central part of shell.

Tunnel moderately wide and its path slightly irregular. Tunnel angles for 2nd to 6th volution 22-28, 25-35, 26-39, 32-41 and 26(?)-40 degrees, respectively. Chomata well developed in all volutions and characteristically very heavy. In inner volutions they extend down lateral slopes into polar regions, and in outer volutions rectangular in cross-section and generally more than half as high as chambers.

Measurements of this species are shown in Table 2.

Remarks.—There has been a excessive confusion in the identification of this species. Having restudied EHRENBERG's original material of *Alveolina montipara*, DUNBAR and SKINNER (1936) found out that it is not a *Triticites* but a *Schwagerina*, and that the form illustrated by MÖLLER as to be identical with it is neither conspecific nor congeneric. Since MÖLLER's misidentification, all of later workers that have described the species followed MÖLLER's conception in identification of their forms. However, in consequence of the information of DUNBAR and SKINNER, FUJIMOTO (HUZIMOTO, 1937) set up a new species, *T. kawanoboriensis*, based on specimens from the limestone of Kawanobori-mura, Ōita Prefecture, southern Kyushu, which he considered to be conspecific with MÖLLER's form. He also identified with it his *T. montiparus* from the Kanto massif and OZAWA's *Schellwienia montipara* from the Akiyoshi limestone. However, having considered OZAWA's *montipara* from Akiyoshi is neither conspecific with *T. montiparus* nor with *T. kawanoboriensis*, TORIYAMA (1952) established a new species, *T. ozawai*, based on OZAWA's specimen.

Thus all *montiparus* previously described from Japan were distinguished from MÖLLER's one. The important characteristics of *T. montiparus* are the highly inflated fusiform shape, tightly coiled inner volutions, very heavy and massive chomata throughout the shell and almost unfluted septa in the central part of the shell. In these regards and other characteristics the Yayamadake specimens well agree with MÖLLER's original ones.

The specimens referred here to *T. montiparus* is similar to *T. ozawai* TORIYAMA but are distinguishable in their heavier chomata and more numerous septa for corresponding volutions. MÖLLER's original specimens and those at my disposal differ from *Y. kawanoboriensis* in having more weakly fluted septa and more massive chomata.

Occurrence.—Abundant at about 5 to 10 meters above the base of the *Pseudoschwagerina* zone; associated with *Pseudoschwagerina morikawai* IGO, *Triticites* sp., *Staffella* (?) sp. and *Quasifusulina longissima ultima* n. subsp.

Triticites yayamadakensis evectus n. subsp.

Plate 25, figures 1–10

Shell small and elongate fusiform, with inflated central region. Poles pointed in inner volutions, but narrowly rounded in outer ones. Lateral slopes slightly concave near polar ends in outermost volution of most specimens, but generally slightly concave in inner volutions. Mature specimens of 5½ to 6 volutions 4.65–5.3 mm. long and 1.90–2.25 mm. wide, giving form ratios of 2.3–2.45. Average form ratios of 1st to 6th volution of 5 specimens 1.8, 2.0, 2.1, 2.1, 2.2 and 2.25, respectively.

Proloculus thin-walled and minute, with outside diameter of 107–115 microns. Shell tightly coiled in inner 3 volutions and expands rapidly in 4th volution. Chambers about the same height throughout length of shell. Average heights of 1st to 6th volution in 8 specimens 42, 63, 109, 202, 318 and 376 microns, respectively.

Spirotheca very thin in inner 3 or 4 volutions and becomes moderately thick in outer volutions where it has relatively coarse alveoli. Average thicknesses of spirotheca in 1st to 6th volution of 8 specimens 15, 22, 29, 53, 87 and 96 microns, respectively. Spirotheca gradually thins polewards.

Septa thin and rather widely spaced. Average septal counts in 1st to 6th volution of 5 specimens 7, 11, 14, 15, 17 and 20, respectively. Across central part of shell septa almost plane in their upper parts, and fluting confined to their lower parts, but in polar regions they are narrowly fluted.

Tunnel moderate in width for the size of shell, increasing from 26 degrees in 2nd volutions to 38–68 degrees in 5th. Tunnel clearly defined by chomata in all volutions except last volution. Chomata small and semi-elliptical or semi-circular in cross-section.

Table 3. Measurements of *Triticites yayamadakensis evectus* n. subsp. in millimeters.

Speci-men	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions						Form ratio of volutions				
						1	2	3	4	5	6	1	2	3	4	5
1	6	4.84	2.07	2.33	.100*	.041	.064	.100	.164	.260	.336	1.82	1.95	2.00	2.10	2.03
2	5½	4.65	1.90	2.44	.107	.043	.079	.114	.229	.329	——	1.80	2.11	2.12	2.22	2.27
3	5½	4.72	2.03	2.43	.114	.043	.072(?)	.129	.229	.400		1.83	2.00	2.11	2.00	2.20
4	6	5.18	2.19	2.36	——	——	.057	.100	.200	.315	.400	1.81	2.00	2.11	2.25	2.35
5	6	4.68	1.92	2.44	——	.036(?)	.057	.100	.186	.286	.415	1.85	2.00	2.16	2.00	2.05
6	6	——	2.19	——	.100*	.043	.057	.100	.200	.329	.372	——	——	——		
7	5¾	——	2.19	——	.114	.046	.068	.129	.229	.329	.358	——	——	——	——	——
8	6¼	——	2.16	——	.116	.043	.057	.107	.186	.286	.372	——	——	——	——	——

Speci-men	Thickness of spirotheca						Tunnel angles (degrees)					Septal count					
	1	2	3	4	5	6	2	3	4	5	6	1	2	3	4	5	6
1	.014	.023	.029(?)	.043	.078	.088	26	26	33	38	63	—	—	—	—	—	—
2	.016	.019	.029	.064	.086	——	—	33	41	55	—	—	—	—	—	—	—
3	.014	.021	.029	.057	.100	——	—	35	38	47	—	—	—	—	—	—	—
4	——	.021	.029	.043	.086	.100	—	37	43	57	—	—	—	—	—	—	—
5	——	.021	.029	.057	.086	.100	—	43	51	68	—	—	—	—	—	—	—
6	.016	.021	.031	.057	.086	.093	—	—	—	—	—	8	10	13	14	17	18
7	.014	.025	.029	.057	.093	?	—	—	—	—	—	8	12	13	14	15	—
8	.016	.025	.029	.050	.082	.100	—	—	—	—	—	7	10	12	13	16	20

* Not well centered.

Specimens 2-4, 6, 7, 9 and 10 are illustrated on Plate 25 as figures 2, 4, 5, 3, 6, 7 and 8, respectively.

Measurements of the present subspecies are given in Table 3.

Remarks.—The distinguished features of the present form are the close coiling in inner three volutions, rapid expansion of the shell in the fourth to outer volutions, minute proloculus, thin spirotheca in inner three volutions and rapid increase in thickness of spirotheca in the fourth volution and weak septal fluting.

The specimens here referred to the subspecies *evectus* of *Triticites yayamadakensis* KANMERA (1955) differ from the specimens of the typical subspecies in their larger shell* and thicker spirotheca. However there are so many essentially similar features between these two groups that I am inclined to regard them as subspecific significance. The present subspecies occurs stratigraphically in the upper horizon than *T. yayamadakensis* does and is considered to be a direct descendant of the latter species.

The present subspecies was compared to *Triticites kagaharensis* HUZIMOTO (1936) in my preliminary work (1952), but it is constantly larger than that species, has decidedly more numerous septa in corresponding volutions and more tightly coiled inner volutions. Thus the distinction is now clear.

The present form resembles *T. schwageriniformis* RAUSER-CERNOUSSOVA from the horizon I_2 of the so-called Upper Carboniferous of Samara Bend region but differs in having more tightly coiled inner volutions and less numerous septa in corresponding outer volutions.

Occurrence.—Abundant at about 10 to 15 meters above the base of the *Pseudoschwagerina* zone, associated with *Pseudoschwagerina morikawai* IGO, *Triticites ozawai* TORIYAMA, and *Quasifusulina longissima ultima* n. subsp.

Triticites ozawai TORIYAMA

Plate 25, figures 11-19, 20(?)

Shellwienia montipara OZAWA, 1925, Jour. Coll. Sci., Imp. Univ. Tokyo, Vol. XLV, art. 6, p. 40, pl. ix, fig. 1.
Triticites ozawai TORIYAMA, 1954, Mem. Fac. Sci., Kyushu Univ., Ser. D, Vol. IV, no. 1, p. 62.

TORIYAMA (1954) distinguished OZAWA's *Triticites montiparus* from Akiyoshi as a distinct species from MÖLLER's *Triticites montiparus* in that the former has less massive chomata throughout the shell and less numerous and regularly fluted septa. He gave a new name *T. ozawai* for the species and designated the specimen illustrated by OZAWA as fig. 1 on pl. IX as the holotype. I agree with him in regarding OZAWA's form as distinct from MÖLLER's one. I have obtained a number of sectioned specimens which closely resemble the specimen described by OZAWA. The following description is based on them.

Shell of medium size, inflated fusiform, with straight axis of coiling and

* The maximum length and width of the typical subspecies are much smaller than the minimum length and width of this subspecies.

Table 4. Measurements of *Triticites ozawai* TORIYAMA in millimeters.

Speci- men	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions						Form ratio of volutions				
						1	2	3	4	5	6	1	2	3	4	5
1	5	4.05	1.75	2.31	.188(?)	.045	.080	.138	.217	.247	—	1.42	1.92	2.00	2.06	—
2	5	3.47	1.56	2.22	.130	.056	.094	.145	.203	.247		1.42	1.66	1.70	1.80	—
3	6	4.60(+)	2.14	2.15	.138	.058	.072	.160	.189	.261	.377	1.50	1.75	1.80	2.00	2.00
4	6	4.98	2.41	2.06	.145	.043	.072	.145	.189	.406	.420	1.33	1.60	1.87	1.77	1.82
5	6	5.45	2.36	2.31	.128	.043	.072	.145	.210	.290	.391	1.35	1.82	2.00	2.13	2.27
6	5	—	1.68	—	.188	.058	.087	.157	.217	.261	—	—	—	—	—	—
7	5½	—	1.67	—	.150	.058	.087	.116	.189	.261	—	—	—	—	—	—
8	5¾	—	1.83	—	.145	—	.087	.116	.203	.261	—	—	—	—	—	—
9	5½	—	1.60	—	.140	.050	.072	.101	.174	.247	—	—	—	—	—	—
10	5½	—	1.75	—	—	.058	.072	.160	.203	.247	—	—	—	—	—	—

Speci- men	Thickness of spirotheca						Tunnel angle (degrees)					Septal count				
	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4	5
1	—	—	.046	.080	.070	—	—	20	26	42	44	—	—	—	—	—
2	.023	.030	.043	.050	—	—	—	—	31	—	—	—	—	—	—	—
3	.017	—	.038	.046	.087	.094	—	—	—	44	47	—	—	—	—	—
4	.021	.025	.030	.058(?)	.116	.116	—	27	29	45	—	—	—	—	—	—
5	.017	.021	.058	.087	.101	.109	28	24(?)	43	43	—	—	—	—	—	—
6	.021	.030	.043	.072	—	—	—	—	—	—	—	7	16	21	20	—
7	.017	.030	.040	.060	.072	—	—	—	—	—	—	7	15	17	19	22
8	—	—	.045	.072	.058	—	—	—	—	—	—	—	—	17	18(?)	20
9	.017	.019	.033	.058	.060	—	—	—	—	—	—	7	13	15	15	19
10	.017	.028	.043	.065	.062	—	—	—	—	—	—	—	14	16	19	17(?)

Specimens 1-3, 7, 8 and 9 are illustrated on Plate 25 as figures 12, 13, 11, 16, 17 and 18, respectively.

bluntly pointed to rounded poles. Lateral slopes slightly concave in general, but in some specimens slightly convex. Specimens of 5 volutions 3.4–4.1 mm. long and 1.5–1.85 mm. wide, giving form ratios of 2.2–2.3. Form ratios of 1st to 4th volution in a typical specimen 1.42, 1.92, 2.00 and 2.06, respectively.

Proloculus small; its outside diameter 130–190 microns, averaging 157 microns for 6 specimens. In many specimens shell expands uniformly, but in some ones inner 2 or 3 volutions rather tightly coiled and in 3rd or 4th volution shell rapidly increases in height. Average heights of 1st to 5th volution in 7 specimens 54, 82, 133, 201 and 218 microns, respectively. Chambers nearly uniform in height in central third of shell and increase only in polar regions.

Spirotheca relatively thin and distinctly alveolar. It decreases in thickness gradually and uniformly towards poles. Average thicknesses of spirotheca above tunnel in 1st to 5th volution of 7 specimens 19, 27, 42, 65 and 64 microns, respectively.

Septa closely spaced and composed of a distinct pycrotheca. Septa fluted throughout lenght of shell, but fluting confined only to basal margins. Average septal counts in 1st to 5th volution of 6 specimens 7, 15, 17, 18 and 19, respectively.

Tunnel moderately wide with straight path. Tunnel angle 26–31 degrees in 3rd volution, 42 degrees in 4th, 44 degrees in 5th. Chomata narrow, low and symmetrical.

Measurements of the present species are given in Table 4.

Remarks.—Most of the Yayamadake specimens have less numerous volutions than the type specimen from Akiyoshi, accordingly being smaller in size. However, in the general shell shape, proloculus size, heights of the corresponding volutions and in the mode of the septal fluting they are quite similar to the type.

They are also similar to *Triticites yayamadakensis evectus* n. subsp. but have a larger proloculus and more loosely coiled inner volutions, and expand uniformly throughout the shell.

Occurrence.—Fairly common in the lowest part of the *Pseudoschwagerina* zone; associated with *Pseudoschwagerina morikawai* Igo and *Quasifusulina longissima ultima* n. subsp. Some referable specimens were found in another locality of a little upper horizon in association with *Triticites yayamadakensis evectus* n. subsp. in addition to the above mentioned species.

Triticites aff. *T. haydeni* (Ozawa)

Plate 26, figures 14–19

Compare: *Shellwienia haydeni* Ozawa, 1925, Jour. Coll. Sci., Imp. Univ. Tokyo, Vol. XLV, art. 6, p. 39–40, pl. ix, figs. 8, 9.

Shell small and highly elongate fusiform, possessing a straight axis of coiling, low straight to slightly irregular lateral slopes and bluntly pointed poles. Mature shells of 5 to 6 volutions attain 5.5–8.5 mm. in length and 1.65–2.3 mm. in width, giving form ratios of 3.0–3.7. Shell assumes its mature shape in 3rd volution.

Proloculus small, and its outside diameter measures 130–203 microns, averaging 155 microns for 6 specimens. Shell tightly coiled in inner 2 volutions and beyond 2nd volution it expands uniformly. Average heights of 1st to 5th volution in 6 specimens 53, 86, 142, 244 and 314 microns, respectively. Chambers slightly increase in height poleward from center of shell.

Spirotheca relatively thin, composed of a tectum and a keriotheca with very fine alveoli. Average thicknesses of spirotheca in 1st to 5th volution of 6 specimens measure 18, 28, 43, 65 and 72 microns, respectively. Spirotheca about the same in thickness throughout length of shell.

Septa composed of a pycnotheca, and loosely spaced. Average septal counts of 1st to 5th volution in 3 specimens 8, 12, 16, 17 and 19, respectively. Septa rather broadly and highly fluted in polar regions, but fluting rapidly decreases from poles toward central part of shell, where they are almost plane.

Tunnel narrow in inner volutions but becomes wider rapidly in 4th volution. Tunnel path about straight in inner volutions but irregular in outer. Tunnel angles range from 35 to 46 degrees in 3rd volution, 37 to 52 degrees in 4th, 56 degrees in 5th. Chomata low and small, and seme-circular in cross-section.

Remarks.—Fortunately I could directly compare the specimens at hand with OZAWA's original types from the Akiyoshi limestone. The original types generally have a much larger proloculus and more numerous septa in corresponding volutions. However, so far as the general shell shape, heights of the volutions, thickness of the spirotheca for corresponding volutions, septal fluting and chomata development are concerned, the Yayamadake specimens well agree with the original types. However more material is needed before the definite specific comparison can be made.

They also closely resemble *T. noinskyi* described by RAUSER-CERNOUSSOVA from the so-called Upper Carboniferous rocks of Samara Bend. However they are slightly larger, attaining about 8.5 mm. in length in the largest specimen. RAUSER-CERNOUSSOVA gave a septal count in only the last volution of her specimen without any illustration of sagittal section. It is, therefore, difficult to exactly compare the specimens with her ones. However they have a striking similarity in general shell structures.

Occurrence.—Rather rare in a horizon about 35 meters above the base of the *Pseudoschwagerina* zone; associated with *Rugosofusulina prisca* [(EHRENBERG) MÖLLER].

Triticites samaricus RAUSER-CERNOUSSOVA

Plate 26, figures 1-13

Triticites secalicus var. *samarica* RAUSER-CERNOUSSOVA, 1938, Acad. Sci., U. S. S. R., Work Geol. Inst., Vol. 7, p. 156, pl. iv, figs. 1, 2.

I have obtained a number of sectioned specimens which have close affinities with *Triticites secalicus samaricus* RAUSER-CERNOUSSOVA. The following description is entirely based on them.

Table 5. Measurements of *Triticites samaricus* RAUSER-CERNOUSSOVA in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions 1	2	3	4	5	6	Form ratio of volutions 1	2	3	4	5
1	6	5.53	2.00	2.76	.190	.056	.072	.125	.174	.232	.275	1.25	1.66	2.00	2.50	2.63
2	6	5.84	1.94	3.01	.174	.058	.072	.094	.131	.218	.275	1.25	1.33	1.81	2.08	2.74
3	5¾	5.30	1.71	3.10	.177	.058	.072	.087	.167	.246	.218	1.37	1.50	2.12	2.42	2.66
4	6½	5.53	1.95	2.83	.145	—	.080	.123	.145	.232	.250	1.42	1.92	2.00	2.33	2.50
5*	6	4.48	1.64	2.74	.132**	.058	.065	.094	.135	.203	.218	1.38	1.50	1.93	2.50	2.64
6	6½	—	2.00	—	.178	.058	.080	.094	.145	.210	.275	—	—	—	—	—
7	5½	—	1.85	—	.203	.060	.074	.114	.174	.218	—	—	—	—	—	—
8	6	—	2.06	—	.175	.058	.076	.116	.203	.232	.247	—	—	—	—	—
9	6	—	1.75	—	.174	.065	.080	.116	.145	.189	.203	—	—	—	—	—
10	6½	—	1.83	—	.116**	.065	.085	.096	.159	.186	.218	—	—	—	—	—

Specimen	Thickness of spirotheca 1	2	3	4	5	6	Tunnel angle (degrees) 1	2	3	4	5	6	Septal count 1	2	3	4	5	6
1	.021	.031	.040	.058	.087	.101	30(?)	—	33	37	61	—	—	—	—	—	—	—
2	.017	.023	.036	.050	.080	.087	—	29(?)	35	58	59	—	—	—	—	—	—	—
3	.019	.029	—	.058	.087	.087	—	—	30	45	69	—	—	—	—	—	—	—
4	.019(?)	.029	.038	.058	.070	.094	—	30	42	42	51	67	—	—	—	—	—	—
5	.017	.031	.033	.040	.075	.080	25	28	28	38	57	—	—	—	—	—	—	—
6	.017	.027	.038	.050	.070	.085	—	—	—	—	—	—	9	11	12	13	15	18
7	.019	.027	.038	.058	.072	—	—	—	—	—	—	—	9	13	18	16	17	—
8	.021	.031	.043	.058	.087	.072	—	—	—	—	—	—	9	12	14	16	19	20
9	.017	.021	.036	.052	.072	.072	—	—	—	—	—	—	8	12	14	15	17	20(?)
10	.021	.029	.031	.058	.060	.075	—	—	—	—	—	—	8	12	14	15	16	16

* slightly oblique section; ** not well centered.

Specimens 1, 2, 3 and 8 are illustrated on Plate 26 as figures 2, 1, 5 and 8, respectively.

Shell elongate subcylindrical in shape, with straight axis of coiling, slightly convex lateral slopes and bluntly rounded poles. Mature specimens which have 6 volutions range in length from 5.0 to 5.9 mm. and in width from 1.8 to 2.1 mm. Form ratios 2.7–3.1, averaging 2.89 for 5 specimens. Inner 2 volutions generally subspherical in shape, but beyond 3rd volution shell rapidly elongated. Average form ratios of 1st to 6th volution in 8 specimens 1.35, 1.58, 2.02, 2.34, 2.62 and 2.75, respectively. Thus shell assumes its mature shape in 4th volution.

Proloculus of moderate size and its outside diameter ranges from 145 to 203 microns, with average of 197 microns for 9 specimens. Inner 2 or sometimes 3 volutions tightly coiled, short and thickly fusiform, but adult shells approach a subcylindrical form with a progressive change during their growth. Average heights of 1st to 6th volution in 11 specimens 59, 76, 106, 157, 217 and 240 microns, respectively. Heights of chambers increase slightly toward polar areas and abruptly near polar ends.

Spirotheca composed of a tectum and a keriotheca with very fine alveoli. It is thin in inner 4 volutions but beyond the end of 3rd volution becomes rapidly thick. Average thicknesses of spirotheca in 1st to 6th volution of 11 specimens 19, 28, 37, 55, 75 and 80 microns, respectively.

Septa narrowly and regularly fluted along their lower parts up to near tunnel, but their upper parts almost plane across central region of shell. Septa rather loosely spaced. Average septal counts of 1st to 6th volution for 5 specimens 9, 12, 14, 15, 17 and 18, respectively.

Tunnel rather broad, with straight path. Tunnel angles 28–30 degrees in 2nd volution, 28–42 degrees in 3rd, 37–58 degrees in 4th and 51–69(?) degrees in 5th. Chomata occur in inner 5 volutions, being small, generally symmetrical and semi-circular to semi-ellipsoidal in cross-section.

Measurements of the present species are given in Table 5.

Remarks.—The present species was originally described by Rauser-Cernoussova as a variety of *Triticites secalicus* (Say) from the First Complex in Samara Bend region of Russia. I am now strongly inclined to regard Rauser-Cernoussova's *samaricus* as a distinct species from *T. secalicus* described from Nebraska in having much smaller shells with less numerous volutions and in a different mode of septal fluting. Rauser-Cernoussova stated that the first volution of her specimens is elongated. However, as seen in her illustration (pl. IV, fig. 2), the first and second volutions are spherical to subspherical in shape, and the third is ellipsoidal. The spirotheca is thin in inner four volutions but beyond the fourth volution it becomes rather rapidly thick.

The Yayamadake specimens well agree with the types of *samaricus* in the shell shape and size, regular and low septal fluting, proloculus size and in the above mentioned shell structures. Unfortunately, as we have neither illustration of sagittal section nor record of septal count of the Russian form, it is impossible to critically compare the Yayamadake specimens with the original types. Therefore this identification is tentative.

Another close related species to this species is *T. langsonensis* SAURIN which is the characteristic species of the *Pseudoschwagerina* zone of Langson in North Viet-Nam, but it slightly differs in having more tightly coiled inner volutions. Indeed these two species doubtlessly belong biologically to the same group. The present species also resembles *Triticites uddeni* DUNBAR & SKINNER from the Wolfcamp formation of the Glass mountain, Texas, in many respects, but it has a thinner spirotheca for corresponding volutions, especially in inner volutions, and less distinct chomata.

The present species is one of the highly elongate subcylindrical forms of the genus in the Oriental province. The shell expands slowly and uniformly and have rounded polar ends. The septa are characteristically narrowly and regularly fluted along their lower margins. In these respects the present species, as well as *T. langsonensis* SAURIN and *T. uddeni* DUNBAR & SKINNER, is common in nature to those of *T. pusillus* (SCHELLWIEN) and "*Schwagerina*" *chernyschewi* (SCHELLWIEN). While *Parafusulina gracilis* (MEEK), *Parafusulina* sp. described by THOMPSON and HAZZARD (1946), *P. kattaensis* (WAAGEN), *P. alaskensis* DUNBAR, *P. wanneri* (SCHUBERT), *P. matsubaishi* FUJIMOTO, *P. peruana* ROBERTS and *P. linealis* DUNBAR & SKINNER have larger and more elongate cylindrical shells, more strongly fluted septa and more numerous volutions. I believe that there is a direct phylogenetic connexion between those species of *Parafusulina* and such elongate species of *Triticites* as mentioned above.

Occurrence.—Abundant in the upper part of the *Pseudoschwagerina* zone, associated with *Triticites fornicatus* n. sp., *T.* (?) sp., *Pseudofusulina regularis* (SCHELLWIEN) and *Pseudoschwagerina* sp.

Triticites fornicatus n. sp.

Plate 24, figures 9-17

Shell small, ovoid to very highly inflated fusiform, with tumid central region, straight axis of coiling, distinctly convex lateral slopes and pointed poles. Mature shells of 6½ to 7 volutions 2.6-3.3 mm. long and 1.9-2.8 mm. wide, giving form ratios of 1.2-1.5. First 2 volutions about spherical in shape and give form ratios of 1.0-1.3. At the end of 3rd volution or the beginning of 4th volution shell assumes its mature shape with form ratio of 1.25-1.45.

Proloculus minute; its outside diameter measures 64-87 microns. Shell tightly coiled in inner 3 volutions and increases rather rapidly in height in 4th volution to maturity. Average heights of 1st to 7th volution in 7 specimens 42, 58, 95, 149, 218, 294 and 348 microns, respectively. Chambers about the same in height throughout length of shell.

Spirotheca rather coarsely alveolar; thin in inner 3 volutions, rapidly increases in thickness in 4th volution and very thick in outer volutions for size of shell. It is thickest immediately above tunnel and gradually decreases towards poles. Average thicknesses of spirotheca of 1st to 7th volution for 7 specimens 16, 20, 39, 67, 89, 113 and 129 microns, respectively.

Table 6. Measurements of *Triticites fornicatus* n. sp. in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions 1	2	3	4	5	6	7	Form ratio of volutions 1	2	3	4	5	6
1*	7	3.24(+)	2.26	ca 1.50	.070	.040	.045	.087	.145	.232	.253	.333	1.00	1.22	1.45	1.45	1.45	1.52
2	7	2.69(+)	2.48	ca 1.08(+)	—	—	.072(?)	.101	.145	.217	.333	.348	—	—	1.25	1.25	1.23	1.22
3	6½	2.65	1.91	1.38	.087	.043	.058	.087	.145	.232	.261	.333(6½v.)	1.10	1.25	1.33	1.40	1.43	1.45
4	5½	2.18	1.48	1.47	—	.043	.058	.101	.167	.217	—	—	—	1.33	1.40	1.55	1.57	—
5*	7½	ca 2.92(+)	2.73	—	—	—	.055(?)	.116	.145	.217	.290	.362(+)	—	—	—	—	—	—
6	7	—	2.80	—	.064	.043	.058	.099	.170	.225	.333	.348	—	—	—	—	—	—
7	5½	—	—	—	—	—	.058	.072	.130	.189	—	—	—	—	—	—	—	—

Specimen	Thickness of spirotheca 1	2	3	4	5	6	7	Tunnel angle (degrees) 1	2	3	4	5	6	7	Septal count 1	2	3	4	5	6
1	.015	.021	.045	.068	.100	.109	.123	—	—	32	37	42	40	—	—	—	—	—	—	—
2	—	—	.043	.068	.080	.101	.116	—	—	23	23	23	25	24(?)	—	—	—	—	—	—
3	.015	.018	.029	.065	.094	.105	—	—	—	23	29	28	34	—	—	—	—	—	—	—
4	.015	.023	.040	.080	.085	—	—	—	—	—	32	38	34	—	—	—	—	—	—	—
5	—	.021	.036	.058	.087	.123	.145	—	—	—	—	—	—	—	—	—	—	—	—	—
6	.018	.021	.045	.070	.103	.125	.130	—	—	—	—	—	—	—	9	10	13	16	22	29
7	—	.021	.036	.060	.075	—	—	—	—	—	—	—	—	—	?	10(?)	13	17	21	—

* slightly oblique section.

Specimens 1-6 are illustrated on Plate 24 as figures 9, 11, 12, 13, 10 and 15, respectively.

Septa thin and composed of a pycnotheca. Septa of inner volutions weakly fluted only in extreme polar regions, but those of outer volutions strongly fluted in polar regions, and across central part of shell they weakly fluted in their lower parts. A specimen has 9, 10, 13, 16, 22 and 29 septa respectively for 1st to 5th volution.

Tunnel relatively broad for size of shell in outer volutions; its path straight throughout shell. Average tunnel angles in 3rd to 6th volution of 4 specimens 26, 30, 33 and 34 degrees, respectively. Chomata massive but narrow, semi-elliptical to rectangular in cross-section, and about half as high as chambers in most volutions.

Measurements of the present new species are given in Table 6.

Remarks.—The pronounced features of the shell of *Triticites fornicatus* n. sp. are the tiny globular shell, minute proloculus, close coiling in inner volutions and thick spirotheca. In these respects the species belongs to *Triticites* of *plummeri* DUNBAR & CONDRA group. It is easily distinguishable from *plummeri* by its smaller shell, thicker spirotheca and less numerous septa for corresponding volutions. The present species is also similar to *Triticites ovoideus* CHEN described from the Chuanshan limestone [*Pseudoschwagerina* zone] of Hangchow, Chekiang, South China, but it differs by its larger shell, more minute proloculus and thicker spirotheca in corresponding outer volutions. It is somewhat similar to *Triticites satoi* HUZIMOTO recorded from Kawanobori-mura, Ōita Prefecture, Kyushu, but its proloculus is much smaller, its inner volutions are more tightly coiled, and its spirotheca is thicker.

Occurrence.—Rare; associased with *Triticites samaricus* RAUSER-CERNOUSSOVA, *Triticites* (?) sp., *Rugosofusulina pristina* n. sp., *Pseudofusulina regularis* (SCHELLWIEN), *Schwagerina* sp. and *Pseudoschwagerina* sp.

Triticites aff. *T. pusillus* (SCHELLWIEN)

Plate 26, figures 20–28

Compare: *Fusulina pusilla* SCHELLWIEN, Palaeontographica, Vol. XLIV, p. 253–255, pl. xx, figs. 8–14; ————, STAFF, 1912, Palaeontographica, Vol. XLIV, p. 180–181, pl. xviii, fig. 12.
Schellwienia pusilla, LEE, 1927, Palaeontologia Sinica, Ser. B, Vol. IV, fasc. 1, p. 104–107, pl. xvi, figs. 4–11.
Triticites pusillus, CHEN, 1934, Palaeontologia Sinica, Ser. B, Vol. IV, fasc. 2, p. 46–47, pl. iii, fig. 23.

Triticites pusillus (SCHELLWIEN) was originally described from the Carnic Alps and identified from the Lower Permian rocks of North and South China. The following description is entirely based on the specimens from Yayamadake.

Shell elongate subcylindrical, with bluntly pointed to rounded poles and a straight arcuate axis of coiling. Mature specimens have 5 to 6½ closely coiled volutions, attaining 2.5–5.3 mm. in length and 0.89–1.4 mm. in width. Form ratios 2.8–3.96. Average form ratios of 1st to 5th volution in 6 specimens 2.00, 2.54, 3.00,

Table 7. Measurements of *Triticites pusillus* (SCHELLWIEN) in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions 1	2	3	4	5	6	Form ratio of volutions 1	2	3	4	5
1	$5\frac{1}{4}$	4.32	1.09	3.96	.153	.058	.072	.101	.103	.116(+)	—	2.00	2.54	3.00	3.18	3.70
2	5	2.51	0.89	2.82	—	—	.058	.087	.109	.152	—	—	2.50	2.66	2.94	—
3	$4\frac{1}{4}$	3.08	0.97	3.17	.199	.043	.072	.109	.120	—	—	1.75	2.75	2.80	—	—
4	$4\frac{1}{2}$	3.86	1.01	3.82	.152	.040	.062	.087	.138	.174	—	—	2.50	3.40	3.60	—
5	6	5.26	1.40	3.75	—	.043(?)	.065	.090	.116	.145	.188	2.50(?)	2.50	3.06	3.36	3.46
6	5	3.27	ca 0.93	3.51	.102*	.040	.043	.058	.116	.174(?)	—	2.00	2.44	3.07	3.33	—
7	—	—	—	—	.145	.050	.068	.087	.123	—	—	—	—	—	—	—

Specimen	Thickness of spirotheca 1	2	3	4	5	6	Tunnel angle (degrees) 2	3	4	5	Septal count 1	2	3	4	5
1	.018	.027(?)	.027	.032	—	—	35	45	45	43	—	—	—	—	—
2	—	.021	.027	.036	.042	—	—	45	40	—	—	—	—	—	—
3	.016	.027	.036	.040	—	—	—	38	—	—	—	—	—	—	—
4	.016	.023(?)	—	.038	.040	—	—	43	—	—	—	—	—	—	—
5	—	.025	.027	.030	.044	.043	35	50	54	—	—	—	—	—	—
6	.014	.019	.020	.032	.038(?)	—	—	37	41	—	—	—	—	—	—
7	.016	.017	.030	.040	—	—	—	—	—	—	7(?)	11	11	15	17

* not well-centered.

Specimens 1, 2, 5, 6 and 7 are illustrated on Plate 26 as figures 20, 23, 21, 24 and 26, respectively.

3.28 and 3.58, respectively.

Proloculus generally subspherical; its outside diameter ranges from 116 to 210 microns, averaging 158 microns for 6 specimens. Shell expands gradually and uniformly. Average heights of 1st to 5th volution in 8 specimens 46, 62, 85, 116 and 152 microns, respectively.

Spirotheca very thin, and composed of a tectum and a keriotheca with very fine alveoli, but in inner volutions the alveolar structure not distinct. Average thicknesses of spirotheca for 1st to 5th volution of 7 specimens 16, 23, 28, 35 and 41 microns, respectively.

Septa thin and rather loosely spaced. Septal counts of 1st to 5th volution of a specimen 7(?), 11, 11, 15 and 17, respectively. In another specimen septa counted 14 for 2nd volution, 15 for 3rd, 18(?) for 4th. Septa regularly fluted throughout length of shell in outer volutions. Fluting reach nearly tops of chambers in polar regions but low in central region, where septa fluted along their lower parts and nearly plane in their upper parts. In inner volutions septa weakly fluted in axial regions.

Tunnel wide and straight. Tunnel angles in 2nd to 4th volution 35, 37–50 and 40–54 degrees, respectively. Chomata present in all volutions, but those of the last volution small and low, semi-elliptical in cross-section. Light fillings occur in axial region of 3rd to 5th volution.

Measurements of the present species are given in Table 7.

Remarks.—The important shell structures of *Triticites pusillus* (SCHELLWIEN) are the elongate subcylindrical shell with bluntly rounded poles, slow and uniform expansion of the shell, low and regular fluting of the septa and thin spirotheca. In these shell structures the axial sections at hand well agree with the types of the species from the Carnic Alps. However they are smaller in size and seem to have slightly weakly fluted septa. Unfortunately no well-oriented sagittal section has been obtained, so that I have tentatively refer them to the species.

Occurrence.—Rather common; associated with *Pseudoschwagerina minatoi* n. sp., *Paraschwagerina shimodakensis* n. sp., *Pseudofusulina* aff. *P. dongvanensis* (COLANI), *Schwagerina grandensis* THOMPSON and *Nankinella kawadai* (IGO).

Triticites (?) sp.

Plate 24, figures 18, 19

Only two centered specimens of the present species were obtained, of which the specimen sectioned axially is incomplete. The present species apparently belongs to a group of fusulined species that occur in the Lower Permian of many areas of the world. This group of fusulinids includes "*Rugosofusulina*" *alpina* (SCHELLWIEN) and its several subspecies from the Carnic Alps, Russia and China, "*Rugosofusulina*" *artiensis* (SCHELLWIEN) and *Pseudofusulina arctica* (SCHELLWIEN) from Russia, *Schwagerina laxima* DUNBAR & SKINNER from Texas, *Triticites wellsi*

NEEDAM from New Mexico, *Pseudofusulina robleda* THOMPSON from New Mexico, and *Schwagerina* (?) *patens* DUNBAR & NEWELL from Bolivia. Of these, *Triticites wellsi* is the most primitive form of this group in shell structures. The species of this group have some outstanding shell structures which serve to distinguish them from other groups of schwagerinid. Those distinctions are as follows: The shell is elongate subcylidrical, with rather irregularly undulating lateral sides, and expands rapidly in outer volutions, the spirotheca is thin and irregularly and rather broadly dimpled, the septa are irregularly fluted and the chomata are generally well developed in inner volutions but discontinuous or indistinct in outer volutions. Some workers have referred them to *Schwagerina*, some to *Rugosofusulina* and others to *Pseudofusulina*. Moreover the species which have a small shell and weakly fluted septa have been referred to *Triticites*. In 1937 RAUSER-CERNOUSSOVA referred "*Fusulina*" *alpina* and its subspecies to her *Rugosofusulina*, but I am inclined to consider that the species in question should be separated from the group of *Rugosofusulina* as a different stock.

In the irregularly elongate subcylindrical shell, the thin spirotheca for the size of the shell and the irregular septal fluting the species of this group are similar to species of *Kansanella* (s. s.). But they differ in the looser coiling of the shell in inner volutions and less massive chomata.

Shells of the Yayamadake specimens subcylindrical, with bluntly rounded poles and flat to broadly undulating lateral sides. Specimens of 6 volutions about 6.3 mm. long (twice a half) and 2.3–2.6 mm. wide. Form ratio 2.67.

Proloculus small and its outside diameter measures 185–200 microns. Heights of 1st to 6th volution in an axial section 70, 101, 140, 210, 290 and 261 microns, respectively, and those in a sagittal section 74, 101, 145, 203, 290 and 280 microns, respectively.

Spirotheca very thin for size of shell and composed of a tectum and an obscurely alveolar keriotheca. Average thicknesses of spirotheca for 1st to 6th volution of 2 specimens 20, 30, 38, 48, 65 and 72 microns, respectively.

Septa broadly and apparently irregularly fluted throughout most length of shell but in central region slightly wavy. Septal counts in 1st to 6th volution of a specimen 7, 11, 13, 12, 15 and 18, respectively.

Tunnel wide. Tunnel angles in 3rd to 5th volution in a specimen 38, 47 and 54 degrees, respectively. Chomata well developed in inner volutions but indistinct in outer volutions. Chomata narrow, symmetrical, and rectangular in cross-section.

This species resembles "*Schwagerina*" *alpina* (SCHELLWIEN) from the Carnic Alps more closely than any other known species. However it differs from the latter by its less intense septal fluting and less numerous septa for corresponding volutions.

Occurrence.—Rare; associated with *Triticites samaricus* RAUSER-CERNOUSSOVA, *T. fornicatus* n. sp., *Pseudofusulina regularis* (SCHELLWIEN) and *Rugosofusulina pristina* n. sp.

Genus *Pseudoschwagerina* Dunbar & Skinner, 1936

Pseudoschwagerina morikawai Igo

Plate 27, figures 1-11

Pseudoschwagerina morikawai Igo, 1957, Sci. Rep., Tokyo Kyoiku Daigaku, sect. C, Vol. 5, no. 47, p. 238-239, pl. xv, figs. 11-17

Shell highly inflated fusiform to subspherical, with bluntly pointed poles and convex lateral slopes. Mature specimens of 7-8 volutions attain a length of 5.5-8.37 mm. and a width of 3.7-5.5 mm. Form ratios 1.2-1.5.

Proloculus very minute, and its outside diameter ranges from 86 to 100 microns, averaging 95 microns for 7 specimens. Inner 4 volutions very tightly coiled, with sharply pointed poles in general, but beyond 4th volution shell expands rapidly and poles become bluntly pointed. 6th and 7th volutions have the most highly expanded chambers. However, as a rule, shell expands rather uniformly for the genus. The last volution declines in height again. Average heights of 1st to 8th volution in 12 specimens 33, 49, 92, 185, 386, 596, 645 and 477 microns, respectively.

Spirotheca thin in inner 3 volutions but very thick for the genus in outer volutions, where alveoli coarse. Average thicknesses of spirotheca of 1st to 8th volution in 12 specimens 13, 20, 32, 51, 80, 106, 114 and 102 microns, respectively. Spirotheca thickest in central part of shell and thins gradually in lateral slopes and sharply near extreme polar ends.

Septa closely spaced for the genus throughout all volutions. Septal counts of 1st to 7th volution in 6 specimens average 8, 12, 14, 17, 21, 26 and 31, respectively. Septa composed of a pycnotheca, and almost plane throughout length of shell in inner 2 volutions. Beyond 3rd volution fluting reaches near tops of septa, but it is weak and rather irregular. In extreme polar regions septa narrowly fluted.

Tunnel moderately broad for size of shell. Tunnel angles of 2nd to 7th volution in 6 specimens average 22, 27, 31, 34, 36 and 36 degrees, respectively. Chomata distinct in all volutions except last several chambers, being relatively massive in inner volutions, and sometimes spreading laterally onto septa for short distances towards poles.

Measurements of the present species are given in Table 8.

Remarks.—This species was recently described from the Mizuyagadani formation in the Hida massif, Central Japan, and the Yayamadake specimens well agree with the types of the species in essential shell structures. The Yayamadake specimens closely resemble "*Paraschwagerina*" *yabei* (Staff) from Sicily but have a thicker spirotheca for corresponding volutions, shorter and highly inflated inner volutions, more closely spaced septa in the middle-aged shell and more massive chomata. Moreover the septal fluting in inner volutions of the latter is more pronounced than that of the former. They are also similar to a specimen illustrated by Thompson (1954) as *Pseudoschwagerina uddeni* (Beede & Kniker) from the Hueco

Table 8. Measurements of *Pseudoschwagerina morikawai* IGO in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions								Form ratio of volutions							
						1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1	8	8.37	5.50	1.52	.086	.025	.043	.072	.157	.329	.629	.715	.658	1.25	1.66	2.00	1.88	1.66	1.41	1.35	1.45
2	7	5.50(+)	4.57	1.20	.107	.029	.054	.086	.172	.358	.658	.715	—	1.00	1.30	1.63	1.70	1.42	1.22	1.21	—
3	7½	6.07	4.61	1.31	.086	.029	.043	.072	.157	.315	.543	.715	.458	1.20	1.33	1.60	1.77	1.53	1.36	1.22	1.31
4	7	5.76	4.34	1.32	.105	.035	.043	.100	.186	.372	.643	.686	—	1.50	1.81	2.00	1.99	1.61	1.38	1.40	—
5	8	—	4.99	—	.072*	.035	.043	.114	.172	.358	.468	.500	.315	—	—	—	—	—	—	—	—
6	7½	—	4.69	—	.086*	.035	.043	.100	.214	.500	.658	.643	—	—	—	—	—	—	—	—	—
7	7	—	4.26	—	.092*	.040	.057	.114	.229	.443	.643	.529	—	—	—	—	—	—	—	—	—
8	6½	—	3.30	—	.110	.035	.054	.072	.186	.429	.586	.715	—	—	—	—	—	—	—	—	—

Specimen	Thickness of spirotheca								Tunnel angle (degrees)					Septal count							
	1	2	3	4	5	6	7	8	3	4	5	6	7	1	2	3	4	5	6	7	8
1	.012	.018	.023	.040	.057	.079	.100	.114	26	30	37	36	33	—	—	—	—	—	—	—	—
2	.014	.021	.029	—	.086	.100	.105(?)	—	24	34	27	30(?)	34	—	—	—	—	—	—	—	—
3	—	—	.031	.043	.057	.100	.129	.121	28	30	30	36	37	—	—	—	—	—	—	—	—
4	—	.021	—	.050	.086	.114	.086	—	27	35	37	44	40	—	—	—	—	—	—	—	—
5	.014	.016	.029	.043	.072	.086	.100	.072	—	—	—	—	—	9(?)	11(?)	12(?)	15	21	27	29	36
6	.012	.018	.029	.057	.079	.100	.129	—	—	—	—	—	—	8(?)	11	13	17	23	26	28	—
7	—	.029	.036	.057	.079	.100	.114	—	—	—	—	—	—	8	12	15	18	21	29	36(?)	—
8	.012	.021	.036	.050	.079	.086	.107	—	—	—	—	—	—	8	12	14(?)	16	20	29	—	—

* not well centered.

Specimens 1, 2, 4, 6-8 and 10 are illustrated on Plate 27 as figures 4, 1, 2, 7, 6, 10 and 8, respectively.

limestone of Texas, but they can be distinguished by their thicker spirotheca for corresponding volutions and more massive chomata. The typical form of the latter species has a larger proloculus and more loosely coiled inner volutions. They somewhat resemble *Pseudoschwagerina muongthensis* (DEPRAT) from Tonkin, Indochina, but they differ in the general shell shape, thicker spirotheca, smaller proloculus, more closely coiled juvenarium and irregularly fluted septa. Furthermore they have less numerous septa for corresponding inner volutions.

Occurrence.—The present species occurs fairly commonly in the basal part of the *Pseudoschwagerina* zone, where the limestone is, for the most part, conglomeratic and specimens of this species are contained not only in the normal limestone but also in the matrix of the conglomerate. It occurs throughout the basal part, about 30 meters thick, but it has not been found in the upper half of the zone under consideration. They were collected in association with *Quasifusulina longissima ultima* n. subsp. and *Triticites yayamadakensis evectus* n. subsp. in one locality, and with *Triticites montiparus* [(EHRENBERG) MÖLLER], *T. ozawai* TORIYAMA and *T.* cf. *T. haydeni* (OZAWA) in other localities.

Pseudoschwagerina minatoi n. sp.

Plate 28, figures 1-8

Shell highly inflated fusiform to subspherical, with bluntly pointed poles and convex lateral slopes. Mature specimens of 7 volutions 6.5–8.5 mm. long and 4.8–5.3 mm. wide, giving form ratios of 1.30–1.55. Average form ratios of 1st to 6th volution of 4 specimens 1.73, 2.00, 2.05, 1.95, 1.39 and 1.32, respectively.

Proloculus minute; its outside diameter 86–100 microns, averaging 93 microns for 5 specimens. Inner 4–4½ volutions very tightly coiled, with rather sharply pointed poles and nearly straight lateral slopes in general; beyond 4th or 4½th volution shell expands rapidly, and outer volutions highly inflated, having convex lateral slopes and pointed poles. 5th and 6th volutions have the most highly expanded chambers and the ultimate volution of mature specimens gradually decreases in height again. Average heights of 1st to 7th volution in 6 specimens 36, 59, 105, 234, 717, 784 and 591 microns, respectively.

Spirotheca thin in inner volutions, but beyond 5½th volution it rather rapidly increases in thickness. Average thicknesses of spirotheca in 1st to 7th volution in 5 specimens 15, 22, 29, 43, 70, 105 and 111 microns, respectively. Alveoli of spirotheca fine.

Septa composed of a pycnotheca and rather closely spaced for the genus. Septal counts of 1st to 7th volution of 4 specimens 11, 13–14, 17–18, 15–16, 21–24 and 31–38, respectively. Septa almost plane in inner volutions, but irregularly and feebly fluted throughout length of shell in outer volutions.

Tunnel narrow in inner 3-4 volutions but becomes rapidly wider in 5th volution where shell increases in height rapidly. In the holotype (pl. 28, fig. 1) tunnel angles in 3rd to 5th volution 20, 35 and 45 degrees, respectively. Chomata broad

Table 9. Measurements of *Pseudoschwagerina minatoi* n. sp. in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions							Form ratio of volutions					
						1	2	3	4	5	6	7	1	2	3	4	5	6
1	7¼	7.22	5.26	1.37	.093	.043	.064	.114	.329	.772	.858	.572	1.70	1.70	1.95	2.00	1.35	1.20
2	7	6.80	—	—	.097	.036	.072	.114	.200	.858	.586	—	1.85	2.00	2.00	2.15	1.34	1.27
3	7	6.40	4.90	1.30	—	.043	.062	.080	.188	.584	.701	.722	1.71	2.08	2.00	1.80	1.35	1.30
4	7	8.56	ca 5.50	ca 1.55	.100	.043	.057	.128	.243	.686	.858	.672	1.66	2.20	2.25	1.85	1.53	1.49
5	7	—	4.84	—	.086	.029	.043	.093	.286	.829	.815	.429	—	—	—	—	—	—
6	7	—	4.91	—	.090	.029	.057	.100	.157	.572	.887	.558	—	—	—	—	—	—

Specimen	Thickness of spirotheca							Tunnel angle (degrees)					Septal count					
	1	2	3	4	5	6	7	3	4	5	6	7	2	3	4	5	6	7
1	.014	.021	.027	—	.072	.116	.130	20	35	44	—	—	—	—	—	—	—	—
2	.016	.021	.029	.050	.075	.103	—	28	26	54	30	33	—	—	—	—	—	—
3	—	.029	.031	.040	.080	.088	—	—	24	—	40	46	—	—	—	—	—	—
4	—	—	.035	—	.064	.100	.086	35	43	39	—	—	—	—	—	—	—	—
5	.014	.018	.025	.043	.072	.120	.116	—	—	—	—	—	11	14	18	16	24	38
6	—	.021	.029	.040	.057	.086	.114	—	—	—	—	—	11	13	17	15	21	31

* Heights of volutions are measured at 1¼th, 2¼th...6¼th volution, respectively.
Specimens 1-6 are illustrated on Plate 28 as figures 1, 3, 2, 4, 6 and 7, respectively.

and high, with approximately vertical tunnel sides and lower poleward slopes in inner 4 volutions.

This species is named in honour of Dr. M. MINATO of Hokkaido University who has rendered great contributions to the study of the Japanese Carboniferous and Permian.

Measurements of the present species are given in Table 9.

Remarks.—The present new species is closely allied to *Pseudoschwagerina morikawai* IGO mentioned immediately before. Indeed differences are hardly discernible in their early immature stage, so that they seem to be regarded as forms derived from the same lineage. However those in the middle and later stages are so distinct as to justify specific difference: The present species has much more widely spaced septa and more rapidly expanded volutions in the middle-aged shells.

The present species is similar to *Pseudoschwagerina orientale* HUZIMOTO described from the Kawanobori limestone of Ōita Prefecture, Kyushu, but some differences are found: The former species has tightly coiled more numerous inner volutions and highly expanded less numerous middle-aged volutions. That is, it attains adult ultimate shells earlier than in the latter. Besides this difference the former has more massive chomata throughout the shell and a thicker spirotheca in corresponding volutions.

Occurrence.—Common in the upper part of the *Pseudoschwagerina* zone, in association with *Triticites pusillus* (SCHELLWIEN), *Paraschwagerina shimodakensis* n. sp., *Pseudofusulina* aff. *P. dongvanensis* (COLANI), *Schwagerina grandensis* THOMPSON and *Nankinella kawadai* (IGO).

Genus *Paraschwagerina* DUNBAR & SKINNER, 1936

Paraschwagerina shimodakensis n. sp.

Plate 29, figures 1–13

Shell large, highly inflated fusiform, with straight to broadly curved axis of coiling, convex lateral slopes and bluntly pointed poles. Largest length and width of individuals cannot be precisely measured, because their outer one or two volutions are destroyed or missing. However shells of 6 to 7 volutions measure 6.5–7.5 mm. long and 4.0–4.5 mm. wide, having form ratios of 1.5–1.75.

Proloculus small to minute, rather variable in size, having outside diameter of 80–190 microns. In general inner 3 volutions tightly coiled, 4th and 5th volutions expand rapidly, and during 6th volution chambers are largest in individual shells, but in maturity chambers decrease in height slowly. However heights of chambers, shape of shells and rate of expansion in inner volutions are fairly variable individually according to proluculus size. In one specimen (pl. 29, fig. 2) which have the largest proloculus among the specimens obtained inner volutions are inflated fusiform in shape, being comparatively loosely coiled: Heights of 1st to 6th volution 72, 130, 174, 406, 551 and 652 microns, respectively, and form ratios of 1st to 5th 1.50, 1.70, 2.00, 1.95 and 1.80, respectively. While typical specimens of this species have minute proloculus and elongate and tightly coiled inner volutions. In those specimens form ratios of 1st to 6th volution in 3 specimens 1.65–2.00, 1.70–2.00, 2.00–2.35, 2.00–2.14, 1.60–1.92 and 1.41–1.75, respectively, and average heights of the given volutions in 4 specimens 50, 76, 141, 286, 479 and 642 microns, respectively. Furthermore, in an axially sectioned specimen which have subcylindrical and tightly coiled inner volutions form ratios of 2nd to 6th volution 2.80, 2.90, 2.20, 1.80 and 1.70, respectively, and heights of 3rd to 6th volution 87, 246, 580 and 650 microns, respectively. In all specimens the heights of the given chambers in inner volutions are about the same from tunnel to poles, but in outer volutions the chambers are highest in central part of shell and slowly decrease in height poleward.

Spirotheca finely alveolar; thin in inner volutions and gradually increases in thickness in outer volutions. Average thicknesses of spirotheca in 1st to 6th volution in 5 specimens 24, 30, 42, 62, 74 and 95 microns, respectively. It is thickest in central part of shell and thins slowly as poles are approached.

Septa thin and numerous. Septal counts of 2nd to 6th volution of a typical specimen (pl. 29, fig. 11) 16(?), 21, 25, 31 and 36, respectively. Those of another illustrated specimen (fig. 10), which expands rapidly during 3rd volution, 11 in 2nd volution, 15 in 3rd, 18 in 4th, 22 in 5th and 43(?) in 6th. Thus septal counts also seem to be variable in individuals. Septal fluting intense and extreme completely to their tops across shell. Salients of at least two adjacent septa intersect an axial section even in central part of shell in outer volutions.

Tunnel narrow in inner volutions. However, due largely to high degree of septal fluting, it is difficult to locate tunnel with certainy in outer volutions. Chomata weakly developed in 1st volutions, but indistinct in 2nd to maturity.

Remarks.—Paraschwagerina shimodakensis n. sp. has a fairly wide variation in the proloculus size, shell shape in inner volutions, expansion of the shell and number of the septa. However the specimens described above and illustrated are considered to be conspecific. Among them the specimens which have cylindrical and tightly coiled inner volutions closely resemble a specimen (pl. IV, fig. 4) of the species described and illustrated by RAUSER-CERNOUSSOVA (1936) as *Pseudofusulina schwageriniformis* from the Lower Permian of Petschoraland, North-Urals. The specimen belongs obviously to the genus *Paraschwagerina*, but her other illustrated specimens (pl. IV, figs. 5, 6; pl. V, fig. 1) seem to be not conspecific with it. Thus the true nature of *Paraschwagerina schwageriniformis* is not exactly known, and it is, therefore, difficult to compare the species at my disposal with the Russian species. However the present new species can be distinguished from the Russian species by having much thinner spirotheca for corresponding volutions.

The present species resembles *Paraschwagerina reveloi* THOMPSON & MILLER from the La Vainilla limestone in southern Mexico in the axial profile and the nature of septal fluting, but the distinction is in the thickness of spirotheca: The present species has thinner spirotheca in corresponding outer volutions.

No Tethyan species of *Paraschwagerina* closely resembles *P. shimodakensis* n. sp.

Occurrence.—The present species characterizes a zone in the middle part of the *Pseudoschwagerina* zone of the Yayamadake Limestone. It is associated with *Triticites pusillus* (Schellwien), *Pseudoschwagerina minatoi* n. sp., *Pseudofusulina* aff. *P. dongvanensis* (Colani), *Schwagerina grandensis* Thompson and *Nankinella kawadai* (Igo).

Genus *Rugosofusulina* Rauser-Cernoussova

Rugosofusulina prisca [(Ehrenberg) em. Möller]

Plate 30, figures 1-5

Fusulina prisca (Ehrenberg) Möller, 1876, Mém. Acad. Imp. Sci. St.-Petersbourg, Ser. VII^{e}, XXV, no. 9, p. 59, pl. iii, figs. 1a-c, pl. vi, figs. 2a-c; ———, Schellwien, 1908, Palaeontographica, Vol. LV, p. 182-184, pl. xviii, figs. 7-11 (not fig. 10).

Schellwienia prisca, Ozawa, 1925, Jour. Coll. Sci., Imp. Univ. Tokyo, Vol. XLV, art. 6, p. 38-39, pl. v, figs. 4, 5; ———, Lee, 1927, Palaeontologia Sinica, Ser. B, Vol. 4, fasc. 1, p. 47-50, pl. vi, figs. 5, 7-23.

Pseudofusulina prisca, Chen, 1934, [part] Palaeontologia Sinica, Ser. B, Vol. IV, fasc. 2, p. 57-59. pl. v, figs. 1, 14 [not pl. iv, figs. 2-9, 11-17]; ———, Huzimoto, 1936, Sci. Rep. Tokyo Bunrika Daigaku, Sect. C, Vol. 1, p. 87-89, pl. iv, figs. 7-10, pl. xix, fig. 6(?); ———, Rauser-Cernoussova, 1938, Acad. Sci., U. S. S. R., Work Geol. Inst., Vol. 7, pl. vii, fig. 7.

Rugosofusulina prisca, Rauser-Cernoussova, 1937, Lab. Paleontology, Vol. 1, fasc. 1, pl. 1, fig. 1; ———, Rauser-Cernoussova, 1938, Acad. Sci., U. S. S. R., Work Geol. Inst., Vol. 7, p. 151, pl. vii, fig. 7; ———, Thompson, 1948, Univ. Kansas Paleont. Contr. Protozoa, art 1, p. 49, pl. 9, fig. 13; ———, Saurin, 1954, Archiv. Geol. Viet-Nam, no. 1, p. 13, pl, i, figs. 24-26.

? *Schwagerina prisca*, Toriyama, 1941, Jour. Geol. Soc. Japan, Vol. 48, p. 561-562, figs. 1-2.

Rugosofusulina prisca [(Ehrenberg) Möller] was originally described from Tzarew, Kurgen, Russia. This is a well-known species so widely distributed in the Lower Permian (Sakmarian) of Russia and the Orient. The following description is based on the Yayamadake specimens.

Shell small for the genus, fusiform, with straight axis of coiling, straight to slightly convex loteral slopes and bluntly pointed poles. Mature shells of 5 to 6½ volutions 4.8-5.5 mm. long and 1.5-2.0 mm. wide, giving form ratios of 2.4-2.6. Average form ratios of 1st to 4th volution of 5 specimens 1.53, 1.77, 2.08 and 2.46, respectively.

Proloculus small; its outside diameter 150-214 microns, averaging 178 microns for 6 specimens. Shell expands about uniformly throughout growth of shell. Average heights of 1st to 5th volution of 6 specimens 58, 94, 144, 230 and 270 microns, respectively. Chambers increase in height slightly poleward from center of shell.

Spirotheca composed of a tectum and a finely alveolar keriotheca; distinctly undulated or dimpled in most specimen. Tectum and keriotheca equally dimpled, so that inner margin of spirotheca reflects the same undulations as outer. Average thicknesses of spirotheca in 1st to 5th volution of 6 specimens 21, 32, 42, 55 and 63 microns, respectively.

Septa thin and numerous. Septal counts of 1st to 5th volution in a specimen 8, 14, 17, 21 and 26, respectively. Septa irregularly fluted throughout length of shell, but fluting weak in central part of shell.

Tunnel less than half as high as chambers and moderately wide. Its path generally straight. Tunnel angle measures 24–25 degrees in 2nd volution, 26(?)–42 degrees in 3rd, 20–45 degrees in 4th and 40–44 degrees in 5th. Chomata well developed in inner volutions, where they are narrow and semi-circular in cross-section, but indistinct in outermost volution.

Remarks.—In the nature of the irregular septal fluting, the lateral irregularity of the spirotheca and the general shape and structure of the shell the present specimens seem to be safely referable to *Rugosofusulina prisca*. A slight difference is recognized only in the weaker fluting of septa than in the original Russian type.

Occurrence.—Fairly common in the lower part of the *Pseudoschwagerina* zone; associated with *Triticites* cf. *T. haydeni* (OZAWA), *T. ozawai* TORIYAMA, *T.* sp., *Pseudoschwagerina morikawai* IGO and *Quasifusulina longissima ultima* n. subsp.

Rugosofusulina pristina n. sp.

Plate 30, figures 6–10

Shell of medium size, inflated fusiform, with slightly curved axis of coiling and convex lateral slopes. Polar ends pointed in outer volutions but narrowly rounded in inner volutions. Mature shells of 5 to 6 volutions measure 5.5–7.4 mm. in length and 2.4–2.9 mm. in width, giving form ratios of 2.1–2.5. Average form ratios of 1st to 5th volution of 5 typical specimens 1.41, 1.45, 1.78, 2. 17 and 2.18, respectively. Mature shape of shells first attains in 3rd volution.

Proloculus rather small, and its outside diameter measures 174–218 microns, with average of 198 microns for 5 specimens. Inner 2–3 volutions of typical specimens tightly coiled, but beyond 3rd volution shells rather rapidly expand. Average heights of 1st to 5th volution of 5 specimens 72, 122, 200, 294 and 356 microns, respectively.

Spirotheca very thin in inner 2½ volutions and rapidly thickens usually at the end of 3rd volution. It thins sharply near polar regions in 3rd to 5th volution. Average thicknesses of spirotheca in 1st to 5th volution of 5 specimens 32, 45, 80, 99 and 109 microns, respectively. Spirotheca structure is typical of the genus and alveoli rather coarse. Surfaces of spirotheca slightly undulated across chambers, but the irregularities not spaced evenly.

Septa thin and composed of a pycnotheca. Septal counts of 1st to 6th volution of a specimen 9, 15, 20, 22, 26 and 27, respectively. Septa strongly fluted, and flut-

Table 10. Measurements of *Rugosofusulina pristina* n. sp. in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions						Form ratio of volutions				
						1	2	3	4	5	6	1	2	3	4	5
1	5¾	5.50	2.53	2.17	.174	.065	.101	.167	.290	.362	.435	1.42	1.66	1.60	1.76	2.00
2*	5½	6.27	2.76	2.27	.218	.073	.125	.196	.319	.362	—	1.41	1.45	1.78	2.17	2.18
3	6	7.36	2.92	2.52	—	—	.145	.188	.275	.333	.377	—	1.41	1.50	1.63	1.88
4	5¼	—	2.80	—	.189	.075	.159	.261	.319	.377	—	—	—	—	—	—
5	6¼	—	3.00(+)	—	—	.087(−)	.116	.217	.290	.362	.391	—	—	—	—	—
6	5¼	—	2.42	—	.189	.073	.105	.145	.254	.304	—	—	—	—	—	—

Specimen	Thickness of spirotheca						Tunnel angle (degrees)				Septal count					
	1	2	3	4	5	6	2	3	4	5	1	2	3	4	5	6
1	.031	.038	.072	.110	.120	.137(5¾th)	29	30	34	43(?)	—	—	—	—	—	—
2	.036	.040	.080	.101	.109	—	30	32	30	—	—	—	—	—	—	—
3	—	.043	.072(?)	.101	.115	.115(?)	—	23	22	—	—	—	—	—	—	—
4	.023	.040	.087	.105	.116	—	—	—	—	—	9	14(?)	18	20	24	—
5	.023	.036	.068	.101	.116	.090	—	—	—	—	9	15	20	22	26	27
6	.029	.036	.058	.062	.087	—	—	35	35	46(?)	—	—	—	—	—	—

* Slightly diagonal section. Specimens 1-5 are illustrated on Plate 30 as figures 6, 7, 8, 9 and 10, respectively.

ing characteristically irregular both laterally and vertically, as seen in other species of *Rugosofusulina* RAUSER-CERNOUSSOVA.

Tunnel narrow and its path rather irregular. Tunnel angles of 2nd to 4th volution in 3 specimens measure 23–30, 22–32 and 22–34 degrees, respectively. Chomata occur in inner 4 volutions, being small and having vertical to overhanging tunnel sides and steep poleward slopes.

Measurements of the present species are given in Table 10.

Remarks.—The present new species seems to be referable to the genus *Rugosofusulina* RAUSER-CERNOUSSOVA in having the distinctly rugose spirotheca and the irregularly fluted septa.

The most distinctive features of the present species are, in addition to the natures mentioned just above, the rapid increase in thickness of spirotheca at the end of the third volution and the sharp thinning of the spirotheca in the polar regions. In these regards the present species closely resembles *Rugosofusulina laosensis* (DEPRAT) from the lower Permian of Cammon, but it differs in having shorter and more inflated thickly fusiform shells, that is, smaller form ratios, and thicker spirotheca in corresponding volutions, especially in inner volutions, and slightly weaker fluting.

The present species is somewhat similar to *Pseudofusulina pseudoexilis* CHEN recorded from Swine limestone of South China but differs in having no axial fillings and larger shells.

The present species is also similar to *Triticites stuckenbergi* RAUSER-CERNOUSSOVA described from the I_1 horizon in the Samara Bend region of Russia. It is distinguished by its larger shell, thicker spirotheca in corresponding outer volutions and less distinct chamata.

Occurrence.—Rare in the upper part of the *Pseudoschwagerina* zone, associated with *Triticites samaricus* RAUSER-CERNOUSSOVA, *T. fornicatus* n. sp., *T* (?) sp., *Pseudofusulina regularis* (SCHELLWIEN) and *Pseudoschwagerina* sp.

Rugosofusulina serrata RAUSER-CERNOUSSOVA

Plate 30, figures 11–19

Rugosofusulina serrata RAUSER-CERNOUSSOVA, 1937, Moscou Univ., Studies in Micropaleontology, Vol. 1, fasc. 1, pl. 1, figs. 4–6.

Shell of medium size, elongate fusiform, with straight axis of coiling, nearly parallel and convex to slightly irregular lateral slopes and bluntly pointed poles. Mature specimens of 5 to 6 volutions 6.5–8.2 mm. long. Being outer 1 or 2 volutions of most specimens often deformed, the widths of individuals are not precisely measured. Less deformed specimens about 1.9–2.4 mm. wide. Form ratios 3.2–3.8, averaging 3.4 for 7 specimens. Average form ratios of 1st to 4th volution in 7 specimens 1.57, 2.19, 2.37 and 2.77, respectively.

Proloculus of moderate size; its outside diameter 175–320 microns, averaging

Table 11. Measurements of *Rugosofusulina serrata* RAUSER-CERNOUSSOVA in millimeter.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions					Form ratio of volutions				
						1	2	3	4	5	1	2	3	4	5
1*	6	7.87	2.03(+)	3.86(−)	.261	.072	.087	.160	.203	.261	1.30	2.25	2.35	2.61	3.00
2*	5½	7.40	2.06(+)	3.59	.261	.072	.101	.169	.218	—	1.40	2.00	2.41	3.05	—
3*	5½	6.20(+)	1.95(+)	3.18	.236	.058	.109	.189	.210	—	1.75	2.45	2.66	2.94	—
4*	6	7.09	2.10(+)	3.37	.210	.055	.101	.145	.218	.261	1.75	2.22	2.40	2.68	2.82
5*	5	8.18	2.34(+)	3.49	.319	.087	.138	.176	.218	—	1.50	2.33	2.71	3.05	—
6	5	6.62	2.26	2.92	.232	.080	.130	.218	.333	.348	1.50	1.87	1.50	2.22	—
7*	5½	6.97	1.95(+)	3.57	.261	.075	.109	.167	.261	—	1.77	2.23	2.54	2.82	—
8*	5½	—	1.95(+)	—	.196	.055	.090	.160	.232	.290	—	—	—	—	—
9	4½	—	1.70	—	.210	.072	.130	.160	.218	—	—	—	—	—	—
10*	4¼	—	1.83	—	.276	.075	.145	.246	.275	—	—	—	—	—	—
11*	5	—	2.22(+)	—	.239	.087	.140	.203	.246	.290(?)	—	—	—	—	—
12*	5	—	1.63(+)	—	.175	.072	.116	.174	.232	.290(?)	—	—	—	—	—

Specimen	Thickness of spirotheca						Tunnel angle (degrees)			Septal count				
	1	2	3	4	5	6	2	3	4	1	2	3	4	5
1	.023	.033	.054	.069	.074	.105(+)	—	27(?)	33	—	—	—	—	—
2	.021	.040	.060	.087	.090	—	42	47	50	—	—	—	—	—
3	.025	.036	.070	.087	.101	.105	40	67	—	—	—	—	—	—
4	—	.030	.065	.072	.105	.103	38	49	56	—	—	—	—	—
5	.043	.065	.080	.087	.116	.116	35	43	46	—	—	—	—	—
6	.029	.040	.080	.087	.090	—	41	49	51	—	—	—	—	—
7	.023	.036	.060	.070	.087	—	—	42	43	—	—	—	—	—
8	.023	.028	.050	.087	.090	—	—	—	—	—	14	17	19	21
9	.025	.043	.068	.072	—	—	—	—	—	9	16	15	18	—
10	.031	.050	.070	.075	—	—	—	—	—	10	17	20	26	—
11	.023	.043	.058	.072	.072	—	—	—	—	7	14	17	22	20(?)
12	.025	.031	.058	.081	.087	—	—	—	—	9	17	21	23	—

* deformed. Specimens 1, 3, 4 and 10 are illustrated on Plate 30 as figures 16, 15, 11 and 18, respectively.

240 microns for 13 specimens. Shell expands uniformly. Chambers of about the same height across central part of shell and gradually increase in height poleward. Average heights of 1st to 4th volution in 12 specimens 71, 116, 181 and 239 microns, respectively. Heights of 5th and 6th volutions not accurately measured due to deformation. However that of 5th volution in less deformed 6 specimens averages 290 microns.

Spirotheca thin in inner 2 volutions, and rather thick in outer volutions. In most specimens it increases rapidly in thickness at the end of 2nd volution or at the beginning of 3rd volution. Average thicknesses of spirotheca in 1st to 6th volution of 14 specimens 25, 39, 64, 79, 91 and 107 microns, respectively. It is thickest in central part of shell but remains of quite similar thickness across most length of shell. Alveoli rather fine in outer volutions, and too fine to abserve clearly in inner volutions.

Septa closely spaced and composed of a thin pycnotheca. Septal counts in 1st to 5th volution in 8 specimens average 9, 15, 18, 21 and 21, respectively. Septa highly fluted throughout length of shell. Closed chamberlets extend slightly above top of tunnel in central part of shell and almost to tops of chambers in end regions.

Tunnel wide; its path nearly straight, being about half as high as chambers. Tunnel angle measures 35–42 degrees in 2nd volution, 42–67 degrees in 3rd, 33–56 degrees in 4th. Chomata occur throughout all except outer several chambers, being small and generally symmetrical. In most specimens dense or light deposits fill chambers in immediate axial area in 4th volution to maturity.

Measurements of the present species are shown in Table 11.

Remarks.—A number of specimens of the present species were obtained, in many of which outer one or two volutions are deformed or destroyed. They well agree with *Rugosofusulina serrata* RAUSER-CERNOUSSOVA (1937) from southern Urals in the shell shape and size, general axial appearance, thickness of the spirotheca, expansion of the shell and mode of the septal fluting. However they have less numerous septa for corresponding volutions.

They are also similar to the specimens illustrated by RAUSER-CERNOUSSOVA (1938) as *Triticites arcticus* (SCHELLWIEN) from Samara Bend. However, from the types of *Schwagerina arctica* (SCHELLWIEN) from Spitzbergen the specimens at hand clearly differ by their larger shells and thicker spirotheca in corresponding volutions.

A specimen of axial section illustrated as fig. 11 on plate 30 is like some specimens of *Pseudofusulina tchernyschewi* (SCHELLWIEN) from Timan. It has a subcylindrical shell and rather low and regularly fluted septa, so that it may not be conspecific with others. Since most of the specimens at hand are, however, more or less deformed, I prefer to refer it to the species in questson as conspecific.

Occurrence.—Abundant in a limited horizon of the upper part of the *Pseudoschwa-*

gerina zone of the Yayamadake limestone. It is associated with *Pseudoschwagerina* sp. and *Schubertella* sp.

Genus *Schwagerina* Möller, 1877

Schwagerina grandensis Thompson

Plate 31, figures 1-12

Schwagerina grandensis Thompson, 1954, Univ. Kansas, Paleont. Contr., Protozoa, art 5, p. 59-60, pl. 32, figs. 10-18.

Schwagerina grandensis Thompson was originally described from the Wolfcampian rocks of Robledo Mountains, New Mexico. The following description is entirely based on the Yayamadake specimens.

Shell of medium size, elongate fusiform, with bluntly pointed poles and straight to concave lateral slopes. Mature shells of 6 to 6½ volutions 6.5-7.5 mm. long and 2.0-2.5 mm. wide, giving form ratios of 2.9-3.35. Average form ratios of 1st to 6th volution in 5 specimens 1.13, 1.45, 1.95, 2.18, 2.45 and 2.90, respectively. Thus inner 1½ volutions subspherical in shape, but beyond 3rd volution axis ends become rather rapidly extended. Shell expands uniformly throughout its growth.

Proloculus of moderate size, and its outside diameter 116-200 microns, averaging 156 microns for 11 specimens. Average heights of 1st to 6th volution above tunnel in 10 specimens 60, 93, 135, 194, 264 and 304 microns, respectively. Chambers increase in height slowly poleward.

Spirotheca moderately thick and finely alveolar. Average thicknesses of spirotheca for 1st to 6th volution in 10 specimens 19, 28, 39, 53, 65 and 70 microns, respectively.

Septa closely spaced, highly and narrowly fluted throughout length of shell. Fluting extends up to near tops of septa in outer volutions. Average septal counts of 1st to 6th volution in 5 specimens 9, 15, 19, 25, 28 and 29, respectively.

Tunnel narrow in inner 4-5 volutions but becomes rapidly wider in 5th or 6th volution. Average tunnel angles of 2nd to 6th volution in 5 specimens 19, 21, 23, 26, 42 and 53 degrees, respectively. Chomata massive in inner 4 volutions, where they are asymmetrical with steep to overhanging tunnel sides and rather steep lateral slopes, and narrow and symmetrical in outer volutions. In most specimens thin secondary deposits which join with chomata spread over septa and spirotheca in central region of shell and sometimes to polar ends of inner volutions of shell.

Measurements of the present species are given in Table 12.

Remarks.—The present specimens can hardly be distinguished from the types of *Schwagerina grandensis* Thompson described from New Mexico. Although they have a slightly smaller proloculus and smaller form ratios for corresponding inner volutions, they well agree with the types in many important characters as follows: The shell is of medium size and elongate fusiform; inner volutions tightly coiled and fairly vaulted; the chomata massive; the tunnel nar-

Table 12. Measurements of *Schwagerina grandensis* THOMPSON in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions 1	2	3	4	5	6	Form ratio of volutions 1	2	3	4	5	6
1	6½	6.58	2.10	3.13	.116	.043	.072	.116	.172	.229	.290	1.00	1.50	2.21	2.50	2.50	2.80
2	6½	7.29	2.18	3.34	.138	.043	.069	.116	.152	.218	.304	1.00	1.55	1.86	2.00	2.06	3.00
3	6	6.39	2.18	2.93	.183	.072	.101	.141	.188	.261	.304	1.25	1.44	2.00	2.33	2.70	2.90
4	6	6.00(+)	—	—	.188	.072	.116	.145	.181	.275	—	1.22	1.33	1.74	2.06	2.34	—
5	5	6.62	—	—	—	.072(?)	.101	.145	.174	.232	.290	1.19	1.47	1.93	2.00	2.66	2.91
6	5	—	1.83	—	.145	.072	.108	.152	.218	.290	—	—	—	—	—	—	—
7	5¼	—	1.75(+)	—	.160	.065	.087	.130	.203	.275	—	—	—		—	—	—
8	5¾	—	1.99	—	—	.058	.101	.130	.188	.275	.348	—	—	—	—	—	—
9	5	—	1.83	—	.143	.055	.099	.159	.275	.319	—	—	—	—	—	—	—
10	6	—	1.95	—	.138	.043	.072	.116	.189	.261	.290	—	—	—	—	—	—

Specimen	Thickness of spirotheca 1	2	3	4	5	6	Tunnel angle (degrees) 1	2	3	4	5	6	Septal count 1	2	3	4	5	6
1	.014	.025	.038	.053	.058	.068	20	20	24	31	37	54	—	—	—	—	—	—
2	.014	.027	—	.043	.058	.073	20	22	19	22	30	45	—	—	—	—	—	—
3	.020	.031	.043	.058	.069	.079	18	23	26	30	58	61(5¼ th)	—	—	—	—	—	—
4	.022	.029	.040	.058	.080	—	16	18	19	16	—	—	—	—	—	—	—	—
5	.018	—	.035	.045	.070	.073	—	22	26	32	—	—	—	—	—	—	—	—
6	.022	.029	.040	.054	.072	—	—	—	—	—	—	—	8	15	19	27	27	—
7	.024	.029	.043	.057	.057(+)	—	—	—	—	—	—	—	9	17	21	27	30	—
8	.020	.029	.033	.043	.058	.058	—	—	—	—	—	—	9	16	20	24	28	—
9	.018	.029	.043	.065	.072	—	—	—	—	—	—	—	9(?)	15	17	22	—	—
10	.016	.025	.040	.055	.058	.072	—	—	—	—	—	—	10	14	18	25(?)	26	29

Specimens 1-10 are illustrated on Plate 31 as figures 1, 2, 3, 4, 6, 7, 9, 12, 8 and 11, respectively.

row in inner volutions but becomes rapidly wider in the last one or two volutions; and the light secondary deposits fill the chambers in the axial region of inner volutions and line the surfaces of the septa and spirotheca in the central region.

They are also somewhat similar to a specimen of *Schwagerina andersoni* (SCHELLWIEN) described and illustrated by STAFF and WEDEKIND (1909) from Spitzbergen but differ in their more elongate fusiform shells.

No species similar to the present species has been known from the Orient including Japanese Islands.

Occurrence.—Abundant in the upper part of the *Pseudoschwagerina* zone; associated with *Pseudoschwagerina minatoi* n. sp., *Paraschwagerina shimodakensis* n. sp., *Triticites* aff. *T. pusillus* (SCHELLWIEN), *Pseudofusulina* aff. *P. dongvanensis* (COLANI) and *Nankinella kawadai* (IGO).

Schwagerina stabilis (RAUSER-CERNOUSSOVA)

Plate 32, figures 1-8

Rugosofusulina stabilis RAUSER-CERNOUSSOVA, 1937, Lab. Paleont., Moscou Univ., U. S. S. R., Studies Micropaleont. Vol. 1, fasc. 1, pl. i, fig. 7.

Pseudofusulina stabilis, RAUSER-CERNOUSSOVA, 1938, Acad. Sci., U. S. S. R., Work Geol. Inst., Vol. 7, p. 158, pl. vii, figs. 8, 9, pl. viii, fig. 3.

Schwagerina stabilis (RAUSER-CERNOUSSOVA) was originally described from the second and the third Complex in Samara Bend, Russia. The following description is based entirely on the Yayamadake specimens.

Shell of medium size, highly vaulted fusiform, with convex lateral slopes and pointed poles. Mature specimens of 7 to 7½ volutions 6.0–8.1 mm. long and 2.8–3.5 mm. wide, giving form ratios of 2.0–2.4. Shell assumes its mature shape in 2nd volution. Average form ratios of 1st to 5th volution in 6 specimens 1.98, 2.29, 2.34, 2.27 and 2.2, respectively.

Proloculus rather small and its outside diameter measures 195–305 microns, averaging 224 microns for 9 specimens. Shell expands slowly and uniformly throughout its growth. Average heights of 1st to 7th volution in 9 specimens 81, 135, 193, 227, 321, 367 and 347 microns, respectively. Chambers about the same in height throughout length of shell.

Spirothecal structure typical of the genus. Average thicknesses of spirotheca in 1st to 7th volution of 9 specimens 26, 46, 63, 85, 95, 99 and 103 microns, respectively. Surfaces of spirotheca partly dimpled, especially along lateral slopes.

Septa closely spaced. Average septal counts of 1st to 6th volution in 3 specimens 11, 20, 24, 33, 40 and 42, respectively. Septa narrowly and highly fluted throughout length of shell. Fluting regular, and closed chamberlets extend to almost tops of chambers in lateral areas.

Tunnel of moderate width. Average tunnel angles in 1st to 5th volution for 6 specimens 28, 27, 24, 26 and 24 degrees, respectively. Tunnel path rather irregular. Chomata distinct in inner volutions but discontinuous in outer volutions;

Table 13. Measurements of *Schwagerina stabilis* (RAUSER-CERNOUSSOVA) in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions							Form ratio of volutions					
						1	2	3	4	5	6	7	1	2	3	4	5	6
1	$7\frac{1}{2}$	ca 8.10	3.39	2.09	.234	.087**	.116**	.160**	.232**	.319**	.348*	.333*	2.09	2.50	2.50	2.35	2.35	—
2	6	ca 6.70	3.35	2.00	.305	.087	.174	.218	.304	.420	.406	—	1.83	2.00	2.06	2.08	2.05	—
3	$6\frac{3}{4}$	5.92	2.84	2.08	.195	.072**	.102**	.152**	.218**	.290**	.362**	—	1.83	2.12	2.00	2.10	2.11	—
4	$5\frac{1}{2}$	6.00	2.42	2.44	.234	.094	.131	.232	.290	.290+	—	—	2.20	2.66	2.75	2.77	2.69	—
5	$5\frac{1}{2}$	5.80	2.42	2.36	.234	.073	.174	.218	.319	.362	—	—	2.00	2.22	2.50	2.13(?)	2.03(?)	—
6	7	6.30	3.15	2.00	.220	.087	.131	.203	.276	.276	.348	.290	2.00	2.25	2.25	2.20	2.04	2.00
7	6	—	2.55	—	.195	.073	.129	.174	.247	.290	.348	—	—	—	—	—	—	—
8	5	—	2.26	—	.204	.073	.145	.203	.333	.319+	—	—	—	—	—	—	—	—
9	$7\frac{1}{4}$	—	3.50	—	.196*	.080	.110	.174	.276	.319	.391	.420	—	—	—	—	—	

Specimen	Thickness of spirotheca							Tunnel angle (degrees)						Septal count					
	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	3	4	5	6
1	.031	.040	.073	.090	.104	.101	.116	—	18	23	25	20	28	—	—	—	—	—	—
2	.029	.058	.078	.101	.101	.080	—	32	30	—	—	26	—	—	—	—	—	—	—
3	.029	.034	.048	.065	.116	.116	—	26(?)	28	19	23	26	—	—	—	—	—	—	—
4	.029	.052	.071	.075	.058(+)	—	—	28	—	30	—	—	—	—	—	—	—	—	—
5	.022	.056(?)	.060	.099	.116	—	—	27	31	23	27	—	—	—	—	—	—	—	—
6	—	.056	.058	.087	.087	.101	.080	—	—	23	27	25	—	—	—	—	—	—	—
7	.022	.040	.050	.072	.075	.065	—	—	—	—	—	—	—	11	19	24	35	39	42
8	.020	.043	.067	.087	—	—	—	—	—	—	—	—	—	12	20	24	31(?)	—	—
9	.029	.038	.058	.087	.101	.130	.116	—	—	—	—	—	—	—	20	24	33	40	42

* not well centered; ** Measured at $\frac{3}{4}$th volution, $1\frac{3}{4}$th..............$6\frac{3}{4}$th, respectively.

Specimens 1, 3-6 and 7 are illustrated on Plate 32 as figures 5, 3, 1, 2, 4 and 8, respectively.

semi-circular or rectangular in cross-section. Secondary deposits dense, completely fill chambers in wide belt along axis of coiling in 2nd to outer volutions. Surfaces of septa in central region of shell lined with dense material as same as axial fillings.

Measurements of the present species are given in Table 13.

Remarks.—The present species was originally referred to *Rugosofusulina* and later to *Pseudofusulina*, but it differs from the former genus in the different mode of septal fluting and in having heavy axial fillings, although it is similar to that genus in having slighfly dimpled surfaces of spirotheca, and from the latter by its slowly expanded shell and thin spirotheca. It seems better to be referred to the genus *Schwagerina*.

The salient features of *S. stabilis* (RAUSER-CERNOUSSOVA) are the ovoid shell with pointed poles and convex lateral slopes, tight coiling in inner volutions, dense and broad axial fillings and very numerous septa. In those important features the Yayamadake specimens well agree with the Russian types.

It closely resembles *Schwagerina ahlfeldi* DUNBAR & NEWELL from the Lower Permian rocks in Tiquina of Central Andes in many important features mentioned above. It is hardly distinguishable from the latter, but the slight distinction is observed in the septal fluting: The latter species has more intensely and highly fluted septa.

It is somewhat like *Dunbarinella concisa* THOMPSON and HAZZARD (1946) described from the Bird Spring formation of southern California, but it differs in its larger proloculus, more loosely coiled shell and less developed chomata.

It is easily distinguishable from any of the known species in the Orient.

Occurrence.—Abundant in the upper part of the *Pseudoschwagerina* zone; associated with *Pseudofusulina santyuensis* HUZIMOTO, *Pseudofusulina* sp., *Rugosofusulina pristina* n. sp., *Triticites* sp. and *Nankinella kotakiensis* (FUJIMOTO and KAWADA).

Schwagerina krotowi (SCHELLWIEN)

Plate 24, figure 20; Plate 35, figures 13, 14

Fusulina krotowi SCHELLWIEN, 1908, Palaeontographica Vol. 55, p. 190-192, pl. xx, figs. 1-10.
Schellwienia krotowi, OZAWA, 1925, Jour. Coll. Sci., Imp. Univ. Tokyo, Vol. XLV, art 6, p. 27, 28, pl. vii, figs. 5, 6.
Pseudofusulina krotowi, HUZIMOTO, 1936, Sci. Rep., Tokyo Bunrika Daigaku, sect. C, Vol. 1, no. 2, pl. xv, figs. 1-5, 9-15; ———, RAUSER-CERNOUSSOVA, 1938, Acad. Sci., U. S. S. R., Work Geol. Inst., Vol. 7, pl. ix, figs. 1, 2.
? *Pseudofusulina krotowi*, MORIKAWA, 1955, Sci. Rep. Saitama Univ., ser. B, Vol. II, no. 1, p. 86, pl. xiv, figs. 5, 6.

Shell small, short and highly inflated fusiform, with convex lateral slopes and short polar ends. Owing to no well-oriented section, exact length and width of shell of Yayamadake specimens can not be determined. Shell of 6 volutions has a length of little larger than 3.5 mm. and a width of 2.6 to 3.2 mm. Form ratio slightly larger than 1.32. Shell tightly coiled and expands uniformly.

Proloculus moderate in size, with outside diameter of 260–290 microns. Chambers nearly the same height throughout length of shell in inner volutions but increase in height slowly poleward in outer volutions. Heights of 1st to 6th volution above the tunnel in 2 specimens 87–90, 130, 160, 217–246, 290–304 and 304 microns, respectively.

Spirotheca of moderate thickness and finely alveolar. Average thicknesses of spirotheca in 1st to 6th volution in 2 specimens 27, 34–36, 45–50, 72, 87–95 and 72–87 microns, respectively.

Septa intensely fluted throughout length of shell, and fluting forms closed chamberlets up to margins of tunnel. Number of septa not counted owing to no well-oriented sagittal section.

Tunnel narrow and its path about straight. Because of no well-oriented axial section, tunnel angles cannot be measured accurately.

Chomata slighly developed in inner volutions. Light secondary deposits fill chambers in axial regions of 2nd to 4th volution and line surfaces of septa in central region of shell.

Remarks.—Only several sectioned specimens have been available for our study, a few of which agree closely with description and illustrations of *Schwagerina krotowi* (SCHELLWIEN). However the availabel material is few, so that the identification is tentative.

Occurrence.—Rare in the upper part of the *Pseudoschwagerina* zone; associated with *Triticites* sp., *Schwagerina stabilis* (RAUSER-CERNOUSSOVA), and *Pseudofusulina kumasoana* n. sp.

Genus *Pseudofusulina* DUNBAR & SKINNER, 1931

Pseudofusulina regularis (SCHELLWIEN)

Plate 33, figures 1–10

Fusulina regularis SCHELLWIEN, 1898, Palaeontographica, Vol. 44, p. 250–251, pl. xix, figs. 1–6.
Pseudofusulina regularis, HUZIMOTO, 1930, Sci. Rep., Tokyo Bunrika Daigaku, sect, C. Vol. 1, no. 2, p. 94–95, pl. x, figs. 9–11, pl. xviii, fig. 1.
? *Fusulina regularis*, DEPRAT, 1912, Mém. Service Géol. Indochine, Vol. 1, fasc. 3, p. 28–29, pl. vii, figs. 14, 15.
? *Schellwienia regularis*, LEE, 1927, Palaeontologia Sinica, Ser. B. Vol. 4, fasc. 1, p. 50–52, pl. vii, figs. 8–10.

Shell elongate fusiform, with almost straight axis of coiling, bluntly pointed poles and straight to slightly convex lateral slopes. Shells of 5 to 5½ volutions 6.6–8.2 mm. long and 2.2–2.5 mm. wide, giving form ratios of 2.7–3.6. Ist volution about subspherical in shape, but beyond 2nd volution shells become rapidly extended and polar ends become pointed. Form ratios of 1st to 5th volution in 5 specimens 1.3–1.6, 1.8–2.1, 2.1–2.2, 2.3–2.6 and 2.7–2.8, respectively.

Table 14. Measurements of *Pseudofusulina regularis* (SCHELLWIEN) in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions						Form ratio of volutions				
						1	2	3	4	5	6	1	2	3	4	5
1	5	7.50**	2.41	3.11	.292	.072	.120(?)	.188	.362	.304	—	1.60	2.00	2.14	2.66	2.75
2	5	6.66	2.30	2.89	.340	.101	.145	.217	.304	.362	—	1.43	1.81	2.17	2.50	2.75
3	4¼	4.07	1.50	2.71	.250	.056*	.101*	.188*	.217*	—	—	1.33	1.94	2.16	2.64	—
4	5¾	8.18**	2.26	ca 3.60	.246	.050*	.087*	.174*	.217*	.261*	.268*	1.50	2.16	2.20	2.50	
5	6	—	2.26	—	.290	.072	.116	.160	.232	.290	.305(+)	1.46(+)	1.88(+)	2.15(+)	2.36(+)	—
6	5½	7.40	2.14(+)	3.45(−)	.253	.065	.116	.174	.203	.261	—	1.77	2.26	2.35	2.58	2.85
7	4½	—	ca 2.30	—	.273	.072	.130	.270	.319	—	—	—	—	—	—	—
8	4¾	—	ca 2.22	—	.290	.087	.145	.203	.290	—	—	—	—	—	—	—
9	4	—	2.14	—	.290	.087	.159	.290(?)	—	—	—	—	—	—	—	—

Specimen	Thickness of spirotheca					Tunnel angle (degrees)					Septal count			
	1	2	3	4	5	1	2	3	4	5	1	2	3	4
1	.018	.036	.072	.116	—	23	—	26	38	54	—	—	—	—
2	.029(?)	.058(?)	.087	.123	—	20	21	30	45	—	—	—	—	—
3	.016	.040	.058		—	—	31	33	50(?)	—	—	—	—	—
4	.016	.046	.060	.072	.058	—	—	34	47	59	—	—	—	—
5	—	.030	.046	.072	.105(+)	—	—	27	46	41	—	—	—	—
6	.027	.043	.055	.075	.087	—	28	36	31	52	—	—	—	—
7	—	.043(?)	.060(?)	.090	.130(?)	—	—	—	—	—	10(?)	17(?)	24	27
8	.023	.050(?)	—	.087	—	—	—	—	—	—	9	16	24	24
9	.016	.030	.058	.060	—	—	—	—	—	—	9	19	25	—

* Heights of volutions are measured at ¾th volution, 1¾th...3¾th, respectively; ** twice a half.
Specimens 1-8 are illustrated on Plate 33 as figures 1, 5, 7, 3, 2, 4, 10 and 8, respectively.

Proloculus moderate in size and its outside diameter measures 240–340 microns, averaging 284 microns for 8 specimens. Shell expands somewhat uniformly. Heights of 1st to 5th volution of 8 specimens average 75, 125, 215, 277 and 304 microns, respectively.

Spirotheca generally thin in inner 3 volutions, and rather thick and coarsely alveolar in outer ones. Average thicknesses of spirotheca in 1st to 4th volution of 7 specimens 20, 43, 64 and 93 microns, respectively. It is about the same in thickness across central three-fourths of length of shell. Proloculus wall about 22–29 microns.

Septa composed of a distinct pycnotheca, and fluted throughout length of shell. Fluting extends to tops of chambers in polar regions and gradually decreases in height toward tunnel margins, where septa are almost plane in inner volutions but rather strongly fluted in their bases in outer volutions. Septal counts in 1st to 4th volution of 3 specimens 9–10, 16–19, 24–25 and 24–27, respectively.

Tunnel of moderate width, with straight path. Tunnel angle generally becomes large in 4th volution where it attains 40–50 degrees. Chomata occur in inner 4 volutions, being small and generally about symmetrical.

Measurements of the present species are given in Table 14.

Remarks.—*Pseudofusulina regularis* was originally described by SCHELLWIEN from the Carnic Alps and later identified by DEPRAT from Yunnan and Indochina, by LEE from Shansi and Kansu of North China and by FUJIMOTO from the Kanto massif of Japan. As discussed by FUJIMOTO (HUZIMOTO, 1936), however, DEPRAT's and LEE's specimens are dissimilar to the types of this species; DEPRAT's one differs in having a different mode of septal fluting and LEE's in having the smaller shell and thinner spirotheca and also in a different mode of septal fluting.

The Yayamadake specimens well agree with the types in many important characters; in the regularly fusiform shape, regular and rather rapid expansion of the shell, thick spirotheca in outer volutions, and in the mode of the septal fluting which is regular and low. They have about the same number of septa for corresponding volutions. Thus they seem to be safely referable to *P. regularis*.

Occurrence.—Rather rare in the upper part of the *Pseudoschwagerina* zone; associated with *Triticites fornicatus* n. sp., *T. samaricus* RAUSER-CERNOUSSOVA, *T.* (?) sp., *Pseudoschwagerina minatoi* n. sp. and *Schubertella* sp.

Pseudofusulina horrida n. sp.

Plate 31, figures 13–20

Fusulina richthofeni, DEPRAT, 1912, Mém. Service, Geol. Indochine, vol. 1, fasc. 3, pl. viii, fig. 15–16.

Shell large and fusiform, with vaulted central portion and straight to slightly curved axis of coiling. Poles usually sharply pointed in inner volutions but become extended and bluntly rounded in mature volutions. Lateral slopes usually convex in all volutions except outermost volution in which they are sometimes concave near polar ends.

Mature specimens of 5 to 6 volutions attain a length of 6.6–8.2 mm. and a width of 2.6–3.1 mm. Form ratios range 2.5–3.0. Average form ratios of 1st to 5th volution in 6 specimens 1.8, 2.1, 2.25, 2.35 and 2.52, respectively. Generally beyond 4½th volution poles rapidly extended.

Proloculus large, ranging commonly from 330 to 410 microns in outside diameter and averaging 360 microns for 13 specimens. Shell uniformly expands throughout its growth. Average heights of 1st to 5th volution in 13 specimens 107, 166, 251, 333 and 345 microns, respectively. Chambers slightly increase in height poleward from central portion of shell.

Spirotheca moderate in thickness. Average thicknesses of 1st to 5th volution of 13 specimens 31, 48, 72, 81 and 87 microns, respectively. Surfaces of spirotheca weakly but irregularly undulated in all volutions.

Septa closely spaced. Average septal counts of 1st to 4th volution in 9 specimens 9, 22, 29 and 34, respectively. Septa narrowly and irregularly fluted throughout length of shell. Fluting reaches almost tops of septa even in central portion of shell.

Tunnel shows considerable variation in width with differences as great as 15 degrees in the same volution on opposite side of single section. A tunnel angle of 30–35 degrees is common in inner 3 volutions with an increase of 35–55 degrees in succeeding volutions. Its path irregular in most specimens. Chomata weakly developed only in inner 3 volutions. Light deposits fill chambers in axial region of 2nd to 4th volution in many specimens.

Measurements of the present species are shown in Table 15.

Remarks.—The most outstanding features of the shell of the present new species are its large proloculus, rapid axial prolongation in the fifth volution, irregularity of septal fluting and numerous septa. In these respects the present species belongs to *Pseudofusulina* of *richthofeni* (SCHWAGER) group.

In the shell shape, proloculus size, rate of expansion, thickness of the spirotheca, and mode and intensity of the septal fluting the present species closely resembles the form described by DEPRAT as "*Fusulina*" *richthofeni* (1921, pl. vii, figs. 15, 16) from "*Schwagerina*" *princeps* bed of Tsen-Kouang. However DEPRAT's *richthofeni*, as discussed by LEE (1927) and SAURIN (1954) in detail, can be clearly distinguished from SCHWAGER's original types and from the forms described by LEE and SAURIN. DEPRAT's form in question seems to be referable to the present new species.

The present species differs from the original types of *P. richthofeni* and LEE's specimens by the weaker septal fluting and more loosely coiled outer volutions and from SAURIN's specimens by the weaker septal fluting and more uniformly coiled shell. The present species is of biologically more primitive form than *richthofeni*, and from their faunal assemblage is judged to occur stratigraphically in

Table 15. Measurements of *Pseudofusulina horrida* n. sp. in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions						Form ratio of volutions				
						1	2	3	4	5	6	1	2	3	4	5
1	5½	8.22	2.75***	2.98	.295	.080	.152	.268	.406	.290(4½th)	——	1.80	2.33	2.34	2.41	2.50
2	5	7.80	——	2.65*	.311	.101	.152	.275	.355	——	——	1.83	2.30	2.35	2.42	2.65
3	5½	6.60	2.57	2.56	.232**	.094	.145	.217	.348	.319	——	1.81	2.11	2.00	2.20	2.50
4	4½	7.21	2.50	2.88	.351	.145	.217	.275	.333	.377	——	1.87	2.13	2.40	2.40	2.44
5	5	——	2.61	——	——	.101	.174	.253	.348	.319	——	——	——	——	——	——
6	4¼	——	2.41	——	.398	.130	.188	.290	.333	——	——	——	——	——	——	——
7	6	——	3.04	——	.275**	.101(?)	.130	.240	.290	.365	.362	——	——	——	——	——
8	4½	——	2.67	——	.369	.125	.174	.261	.290	——	——	——	——	——	——	——
9	4¼	——	2.34	——	.390	.101	.174	.275	.304	——	——	——	——	——	——	——
10	4½	——	2.42	——	.331	.101	.188	.290	.348	——	——	——	——	——	——	——

Specimen	Thickness of spirotheca						Tunnel angle (degrees)					Septal count				
	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4	5
1	.029	.047	.072	.087	.087	——	34	36	32	34	38	—	—	—	—	—
2	.021	.045	.084	.096	——	——	—	34	28	39	54	—	—	—	—	—
3	.025	.043(?)	.065	.072	.082	——	—	31	31	38	40	—	—	—	—	—
4	——	.050	.065	.116	——	——	32	34	32	47	—	—	—	—	—	—
5	——	.058	.072	.103	.087	——	—	—	—	—	—	10	21	26	33	—
6	.038(?)	——	.072	.101(?)	——	——	—	—	—	—	—	10	26	32	36	—
7	.029	.050	.072	.080	.094	.094	—	—	—	—	—	9	18	28	30(?)	38
8	.036	.046	.078	——	——	——	—	—	—	—	—	10	26	32	32	—
9	.031	.058	.080	.094	——	——	—	—	—	—	—	10	24	30	36	—
10	.029	.050	.072	.087	——	——	—	—	—	—	—	9	17	24	33	—

* Form ratio in the fourth volution; ** not well centred; *** outer volution missed.

Specimens 1-4, 6-8 and 9 are illustrated on Plate 31 as figures 14, 13, 16, 15, 20, 18, 19 and 17, respectively.

lower horizon than the latter does.

Occurrence.—Abundant in the upper part of the *Pseudoschwagerina* zone; associated with *Pseudofusulina sokensis* RAUSER-CERNOUSSOVA, *Pseudofusulina* n. sp. (?) and *Pseudofusulina* sp.

Pseudofusulina kumasoana n. sp.

Plate 32, figures 9–15; Plate 35, figures 10–12

Shell large and elongate fusiform, with gently arched axis of coiling and blunt polar ends. Lateral slopes slightly convex in general but occasionally concave near poles. Mature shells of 5 to 6 volutions 9.5–11 mm. long and 2.7–3.4 mm. wide, giving form ratios of 2.8–3.6. 1st volution ellipsoidal, and in the following 1 or 1½ volutions shells rapidly increase in axial length and assume their mature shape. Owing to heavy axial fillings, it is difficult to measure the exact length of each volution. Accordingly form ratios of each volution not accurately estimated. Average form ratios of 1st to 4th volution of 5 specimens approximately 1.93, 2.46, 2.64 and 2.95, respectively.

Proloculus large and generally subspherical but fairly variable in shape. Its outside diameter measures 290–420 microns, averaging 332 microns for 11 specimens. Average heights of 1st to 5th volution in 11 specimens 110, 200, 279, 362 and 373 microns, respectively. Heights of chambers increase slightly as poles are approached.

Spirotheca rather coarsely alveolar. It is thin in first 2 volutions, increases in thickness rapidly at the end of 2nd volution, and remains thick to maturity. Average thicknesses of spirotheca in 1st to 5th volution for 11 specimens 32, 60, 85, 106 and 106 microns, respectively. It is about the same in thickness across most length of shell except in extreme polar regions. Surfaces of spirotheca dimpled in minor scale in lateral regions.

Septa closely spaced. Average septal counts of 1st to 5th volution in 6 specimens 12, 25, 31, 38 and 40, respectively. Septa narrowly and highly fluted throughout length of shell, and fluting extends to almost tops of chambers, being complicatad in extreme polar regions of outer volutions.

Tunnel rather wide with irregular path. Average tunnel angles of 1st to 4th volution in well-oriented 3 specimens 30, 39, 38 and 41 degrees, respectively. Chomata occur only in inner 2 volutions, being very small. Axial fillings very heavy in all but the last volution. They fill chambers completely in polar regions.

Measurements of this species are given in Table 16.

Remarks.—*Pseudofusulina kumasoana* n. sp. is characterized by the loosely coiled and elongate fusiform shells with heavy axial fillings in most volutions.

It is closely allied to *Pseudofusulina kraffti* (SCHELLWIEN & DYRENFURTH) from Darwas in having the loosely coiled shell and heavy axial fillings, but it differs in its more elongate fusiform shells with extended and rather sharply pointed

Table 16. Measurements of *Pseudofusulina kumasoana* n. sp. in millimeters.

Speci-men	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions 1	2	3	4	5	6	Form ratio of volutions 1	2	3	4	5
1	5½	ca. 11.0	ca. 3.05	ca. 3.60	.369	.101	.203	.304	.333	.290+	—	1.85(?)	2.50	2.75	3.33	3.60
2	5	ca. 9.5	3.39	ca. 2.80	.390	.120	.232	.362	.435	.440	—	1.87	2.14	2.20	2.42	—
3	6	ca. 11.0	3.10	ca. 3.54	.299	.116	.160	.268	.362	.337	.319	1.83	2.70	3.12	3.20	—
4	6	ca. 10.5	3.27	ca. 3.21	.418	.130	.189	.261	.348	.362	.362	2.22	2.59	2.63	2.85	2.85
5	6¼	—	3.62	—	.292	.101	.181	.203	.319	.406	.450	—	—	—	—	—
6	5	—	3.12	—	.323	.130	.203	.304	.406	.420	—	—	—	—	—	—
7	5½	—	3.15	—	.232	.116	.188	.261	.333	.348	—	—	—	—	—	—
8	5	—	2.73	—	.332	.096	.188	.218	.319	.319	—	—	—	—	—	—
9	5½	—	2.84	—	.218*	.101	.160	.230	.319	.362	—	—	—	—	—	—

Speci-men	Thickness of spirotheca 1	2	3	4	5	6	Tunnel angle (degrees) 1	2	3	4	5	Septal count 1	2	3	4	5
1	.040	.058	.101	.101	.101	—	33	38	41	42	66(?)	—	—	—	—	—
2	.045	.065	.101	.116	.101	—	27	38	36	—	—	—	—	—	—	—
3	.032	.045	.072	.087	.094	.087	—	40	36	40	41	—	—	—	—	—
4	.043	.070	.072	.116	.101	.101	25	—	22	22	42	—	—	—	—	—
5	.029	.043	.072	.101	.116	.116	—	—	—	—	—	10(?)	24	34	33	44
6	.036	.058	.087	.116	.116	—	—	—	—	—	—	14	29(?)	31(?)	41	41
7	.036	.058	.087	.110	.116	—	—	—	—	—	—	13	23	29	34	38
8	.043	.058	.072	.101	.101	—	—	—	—	—	—	13	25(?)	31	38	43
9	.031	.055	.080	.101	.116	—	—	—	—	—	—	10(?)	22	29	35	39

* not well-centered. Specimens 1, 3-6 and 8 are illustrated on Plate 32 as figures 9, 10, 11, 13, 12 and 14, respectively.

poles in contrast to the cylindrical shells with broadly rounded polar ends of the latter. In its loosely coiled and elongate fusiform shape it somewhat resembles *P. fusiformis* (SCHELLWIEN & DYRENFURTH) from the same locality, but it can be distinguished by its much heavier axial fillings. It is also similar to one (pl. xii, fig. 1) of the specimens described by MORIKAWA (1955) as *Schwagerina motohashii* from the Kanto massif. However MORIKAWA's species, judging from his illustrations, seems to be constituted by at least two different species. Furthermore, on account of ill-orientation of the sections of his specimens, the true nature of *motahashii* is not understood, and it is, therefore, difficult to exactly compare the present species with Morikawa's form.

The present species is somewhat like *Pseudofusulina aganoensis* HUZIMOTO from the Shomaru-pass, of the Kanto massif, but it differs from the latter in its much more loosely coiled shell, much heavier axial fillings and more numerous septa in corresponding volutions.

Occurrence.—Common at a horizon about 90 meters above the base of the *Pseudoschwagerina* zone of the Yayamadake limestone, associated with *Pseudofusulina regularis* (SCHELLWIEN), *Schwagerina stabilis* (RAUSER-CERNOUSSOVA), *S. grandensis* THOMPSON, *S. krotowi* (SCHELLWIEN) and *Staffella* sp.

Pseudofusulina n. sp. (?)

Plate 24, figure 21

Only one axial section of an unique form was obtained, which is not referable to any of the species previously known.

Shell thickly fusiform, with bluntly pointed poles and straight axis of coiling. Lateral slopes nearly straight to slightly concave in outer volutions but distinctly convex in inner volutions. Shell of 5½ volutions 7.52 mm. long and about 3.5 mm. wide, giving a form ratio of about 2.1.

Proloculus large and its outside diameter measures 462 microns. Form ratios of 1st to 4th volution 1.40, 1.35, 1.68 and 1.85, respectively. Shell expands rather rapidly in 2nd volution but it uniformly increases in height in 3rd volution to maturity. Heights of 1st to 4th volution 174, 261, 304 and 362 microns, respectively. Chambers slightly increase in height from tunnel to poles.

Spirotheca very thick; composed of a tectum and a coarsely alveolar keriotheca. Thicknesses of 1st to 4th volution 44, 80, 130 and 174 microns, respectively. Proloculus wall 34 microns thick. Spirotheca about the same in thickness throughout length of shell.

Septa thin, closely fluted in extreme polar regions, but owing to the insufficiency of available material the fluting in central region is not clearly understood. So far as be observed, the septa are rather highly fluted in inner volutions, but they seem to be weakly fluted only in their lower parts in outer volutions. On account of no sagittal section number of septa not counted.

Tunnel well defined, having a straight path. Tunnel angle of 1st to 4th volution measures 26, 26, 33 and 51 degrees, respectively. Chomata rather small, asymmetrical in cross-section. Light secondary deposits line surfaces of septa and upper surfaces of the spirotheca in axial region.

Remarks.—The pronounced features of this species are the thick fusiform shell, large proloculus, very thick spirotheca and weak septal fluting. In these respects the most close similar species is *Pseudofusulina nakaoensis* HUZIMOTO which was originally described as a variety of *Schwagerina krotowi* (SCHELLWIEN), but it can be distinguished by the smaller and more highly vaulted shell with rather straight lateral slopes and narrower tunnel angles.

However, owing to insufficiency of available material, some of the natures of the shell are not understood, and it is, therefore, difficult to exactly compare this species with the known species.

Occurrence.—The specimen was found in association with *Pseudofusulina sokensis* RAUSER-CERNOUSSOVA, *P. horrida* n. sp. and *Pseudofusulina* sp.

Pseudofusulina santyuensis HUZIMOTO

Plate 34, figures 1-7

Pseudofusulina santyuensis HUZIMOTO, 1936, Sci. Rep., Tokyo Bunrika Daigaku, sect. C, Vol. 1, no. 2, p. 79-80, pl. xiii, figs. 1-5.

? *Schellwienia vulgaris* var. *fusiformis*, LEE, Palaeontologia Sinica, Ser. B, Vol. 4, fasc. 1, p. 67-68, pl. ix, figs. 3, 5.

Pseudofusulina santyuensis HUZIMOTO was originally described from the Lower Permian of the Kanto massif in Japan. From the upper part of the Yayamadake limestone I have obtained a number of sectioned specimens which closely resemble the species. The following description is based on those specimens.

Shell fairly large and highly vaulted fusiform, with straight to slightly curved axis of coiling and bluntly pointed poles. Lateral slopes slightly concave to straight in general but occasionally slightly convex. Mature shells of 4½ to 5 volutions 6.1–7.5 mm. long and 3.1–3.8 mm. wide, giving form ratios of 1.8–2.4. Average form ratios of 1st to 4th volution in 5 specimens 1.56, 1.80, 1.87 and 2.20, respectively. Shell attains its mature shape in 2nd volution.

Proloculus fairly large and its outside diameter 312–430 microns, averaging 375 microns for 9 specimens. Shell expands rapidly but uniformly. Average heights of 1st to 4th volution of 10 specimens 162, 259, 386 and 457 microns, respectively. Heights of chambers increase slowly poleward as poles are approached.

Spirotheca lstructure is typical of the genus. Average thicknesses of spirotheca in 1st to 4th volution in 10 specimens 45, 79, 109 and 113 microns, respectively. Spirotheca thins only slightly poleward from center of shell. Surfaces of spirotheca slightly dimpled in lateral sides.

Septa closely spaced and composed of a pycnotheca. Average septal counts in 1st to 4th volution of 5 specimens 12, 23, 29 and 37, respectively. Septa narrowly

Table 17. Measurements of *Pseudofusulina santyuensis* HUZIMOTO in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions 1	2	3	4	5	Form ratio of volutions 1	2	3	4
1	4	7.13	3.27	2.15	.370	.195	.312	.429	.450	—	1.50	1.66	1.72	2.00
2	4½	6.16	3.35	1.83	.312	.155	.273	.429	.545	—	1.60	1.77	1.61	2.11
3	4	7.32	3.23	2.25	.429	.188	.283	.406	.450	—	1.86	1.92	2.05	—
4	4½	5.84(+)	3.31	1.76(+)	.390*	.145	.218	.341	.450	.420	1.33	1.66	1.82	—
5	4	7.29	3.08	2.36	.371	.136	.234	.386	.470	—	1.50	2.00	2.17	2.50
6	4¾	—	3.50	—	.390	.145	.261	.406	.508	.450	—	—	—	—
7	4	—	2.61	—	.409	.145	.247	.362	.333	—	—	—	—	—
8	4¼	—	2.81	—	.315	.131	.232	.362	.435	—	—	—	—	—
9	4½	—	3.74	—	.390	.234	.312	.390	.526	.560(4½th)	—	—	—	—
10	5	—	3.35	—	.273*	.145	.218	.348	.400	.435	—	—	—	—

Specimen	Thickness of spirotheca 1	2	3	4	5	Tunnel angle (degrees) 1	2	3	4	Septal count 1	2	3	4	5
1	.043	.108	.123	.116	—	24	27	22	—	—	—	—	—	—
2	.043	.101	.130	.087	—	—	21	25	28	—	—	—	—	—
3	.065	.101	.116	.116	—	25	42	35	25	—	—	—	—	—
4	.043	.060	.101	.123	.109	—	—	—	—	—	—	—	—	—
5	.043	.057	.093	—	—	25	31	—	—	—	—	—	—	—
6	.043	.063	.101	.109	.131	—	—	—	—	12	25	28	42	—
7	.043	.072	.116	.101	—	—	—	—	—	12	22(?)	28	34	—
8	.040	.072	.087	.101	—	—	—	—	—	11	22	31	40	—
9	.043	.087	.125	.145	—	—	—	—	—	11	25(?)	31	36	—
10	.043	.072	.101	.116	.116	—	—	—	—	12	23	29	34	34

* not well centered. Specimens 1-3, 6 and 8 are illustrated on Plate 34 as figures 2, 1, 3, 7 and 5, respectively.

but rather irregularly fluted throughout length of shell. Phrenotheca developed partly in all volutions except 1st one. Tunnel of moderate width and its path rather irregular. Tunnel angles measure 24–25 degrees in 1st volution, 20–31 degrees in 2nd, 22–25 degrees in 3rd. Chomata weakly developed in all volutions except outermost volution.

Measurements of the present species are given in Table 17.

Remarks.—The most pronounced features of the shell of *Pseudofusulina santyuensis* HUZIMOTO are the highly vaulted fusiform shell, rapid expansion of the shell and irregularly fluted septa. This species can be distinguished from other known forms of the genus by the characteristics mentioned above. The Yayamadake specimens doubtlessly belong to a group of this species and are shaped like the types of the species. But they have more highly vaulted shells and less intensely fluted septa, more distinctly dimpled spirotheca and less developed phrenothecae. Thus some differences are observed, therefore, they may be a distinct species.

Occurrence.—Abundant at a horizon of about 100 meters above the base of the Permian section of the Yayamadake limestone; associated with *Pseudoschwagerina minatoi* n. sp., *Triticites* sp., *Schwagerina stabilis* (RAUSER-CERNOUSSOVA) and *Rugosofusulina pristina* n. sp.

Pseudofusulina aff. *P. dongvanensis* (COLANI)

Plate 34, figures 8–15

Compare:

Fusulina dongvanensis COLANI, 1924, Mém., Service Geol. Indochine, Vol. XI, fasc. 1, p. 87–89, pl. v, figs. 2, 3, 5, 6, 8–10.

Pseudofusulina cf. *dongvanensis*, HUZIMOTO, 1936, Sci. Rep., Tokyo Bunrika Daigaku, sect. C, Vol. I, no. 2, p. 73, pl. xix, figs. 13, 14.

This species was originally described from Dong-Van, Indochina. The following description is based entirely on the Yayamadake specimens.

Shell elongate fusiform, having bluntly pointed to narrowly rounded poles. Axis of coiling slightly arcuate or irregular. Lateral slopes slightly convex to irregularly concave and, in some specimens, irregular. Inner volutions highly vaulted, with pointed poles and straight to slightly convex lateral slopes. Specimens of 4 to 5 volutions 7.4–9.4 mm. long and 2.7–3.4 mm. wide, giving form ratios of 2.6–2.85. Average form ratios of 1st to 4th volution in 6 specimens 1.59, 1.78, 2.22 and 2.57, respectively.

Proloculus large, and its outside diameter measures 390–740 microns, averaging 460 microns for 20 specimens. Shell rapidly expands. Average heights of 1st to 4th volution in 14 specimens 157, 238, 348 and 408 microns, respectively.

Spirotheca composed of a tectum and a keriotheca with fine alveoli. Average thicknesses of spirotheca in 1st to 4th volution of 14 specimens 42, 63, 87 and 98 microns, respectively. Proloculus wall of 5 specimens 40–45 microns in thickness. Heights of chambers lowest above tunnel and largely increase toward

Table 18. Measurements of *Pseudofusulina* aff. *P. dongvanensis* (COLANI) in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions					Form ratio of volutions			
						1	2	3	4	5	1	2	3	4
1	4	8.10	2.84	2.85	.507	.188	.218	.362	.479	—	1.76	1.87	2.16	2.85
2	4¼	7.64(+)	2.77(+)	2.61(4thvol.)	.406	.145	.275	.319	.392	.435	1.47(?)	1.66	2.15	2.61
3	3½	—	2.14	—	.393	.155	.218	.348	.333(?)	—	1.84	2.09	2.34	—
4	4	7.43	ca. 2.69	2.76	.406	.152	.218	.362	.319(+)	—	1.33	1.55	2.23	2.62
5	5	—	3.12	—	.377	.159	.232	.333	.479	.392(+)	—	—	—	—
6	4¾	—	3.04	—	.384	.174	.261	.319	.435	—	—	—	—	—
7	4	—	3.12	—	—	.159	.290	.479	.406	—	—	—	—	—
8	5	—	3.40	—	.435	.159	.232	.348	.435	.406	—	—	—	—

Specimen	Thickness of spirotheca					Tunnel angle (degrees)				Septal count			
	1	2	3	4	5	1	2	3	4	1	2	3	4
1	.043	.058	.104	.118	—	19	26	23	32	—	—	—	—
2	—	.045	.082	.101	.130	18	19	26	37	—	—	—	—
3	.050	.072	.096	—	—	22	—	—	—	—	—	—	—
4	.040(?)	.072	.101	—	—	24	24	25	32	—	—	—	—
5	.043	.072	.094	.116	—	—	—	—	—	8	19	25	32
6	.043	.065	.087	.087	—	—	—	—	—	11	24	28	33
7	—	.058	.087	.072	—	—	—	—	—	11	25	30	31
8	.043	—	.083	.101	.087	—	—	—	—	10	25	30(?)	32

Specimens 1, 2, 4-6 and 8 are illustrated on Plate 34 as figures 10, 8, 9, 12, 15 and 14, respectively.

poles.

Septa numerous. Average septal counts of 1st to 4th volution of 11 specimens 10, 24, 30 and 32, respectively. Septa closely and somewhat irregularly fluted throughout length of shell.

Tunnel well defined, having slightly irregular path in some specimens. Tunnel angles of 1st to 4th volution measure 18-24, 19-26, 23-26 and 32-37 degrees, respectively. Chomata small and generally symmetrical in cross-section.

Measurements of the present species are given in Table 18.

Remarks.—*Pseudofusulina dongvanensis* (COLANI) was originally established based on a few ill-oriented incomplete specimens, so that the true nature of the species is not understood, and it is, therefore, difficult to compare forms with the species with certainty. However we can recognize that the salient features of the shell of *P. dongvanensis* are the large proloculus, rather irregular fluting of the septa and loose coiling of the shell. In these respects the Yayamadake specimens are similar to COLANI's specimens but have less numerous septa in corresponding volutions, and also differ in that the septa are probably less highly fluted.

They closely resemble the specimens compared by HUZIMOTO (1936, p. 73, pl. xix, fig. 14) from the Kanto massif with COLANI's types but differ slightly in having well developed phrenothecae and well developed chomata.

The present species is also similar to *Pseudofusulina horrida* n. sp. in general features but differs in its more highly vaulted inner volutions and more loosely coiled shell.

According to COLANI, *P. dongvanensis* occurs in association with *Schwagerina japonica* (GÜMBEL) which is commonly found in the *Parafusulina* zone. While the specimens from the Kanto massif and Yayamadake occur associated with more primitive fusulinids which are known from the *Pseudoschwagerina* zone.

Occurrence.—Abundant in the upper part of the *Pseudoschwagerina* zone in association with *Pseudoschwagerina minatoi* n. sp., *Paraschwagerina shimodakensis* n. sp., *Triticites pusillus* (SCHELLWIEN) and *Nankinella kotakiensis* (FUJIMOTO & KAWADA).

Pseudofusulina sokensis RAUSER-CERNOUSSOVA

Plate 35, figures 1-9

Pseudofusulina sokensis RAUSER-CERNOUSSOVA, [part], 1938, Acad. Sci., U. S. S. R., Work Geol. Inst., Vol. 1, p. 69-167, fig. 2 (not fig. 1).

Shell large, inflated fusiform, with bluntly pointed poles and convex lateral slopes. Mature specimens of 6-6½ volutions measure 7.4-8.3 mm. in length and 3.7-4.3 mm. in width. Form ratios 1.85-2.32, averaging 2.09 for 5 specimens.

Proloculus large, its outside diameter ranging from 290 to 409 microns and averaging 358 microns for 9 specimens. Shell expands rapidly but about uniformly. Average heights of 1st to 6th volution in 9 specimens 125, 213, 312, 408, 427 and 375 microns, respectively. Heights of chambers about uniform in central two-

Table 19. Measurements of *Pseudofusulina sokensis* RAUSER-CERNOUSSOVA in millimeters.

Specimen	Number volut.	Length	Width	Form ratio	Diam. prol.	Height of volutions						Form ratio of volutions				
						1	2	3	4	5	6	1	2	3	4	5
1	6	7.40	4.00	1.85	.292	.101	.188	.312	.406	.464	.428	1.33	1.60	1.76	1.78	1.75
2	6	8.26	4.03	2.04	.292	.130	.203	.319	.420	.464	.377	1.42	1.75	1.75	1.71	1.74
3	6	8.00(+)	3.78	2.11	.445	.126	.220	.290	.348	.363	.377(+)	1.44	1.73	1.90	1.89	1.87
4	5	7.79	3.35	2.32	.389	.087	.188	.275	.427	.377	—	1.57	1.91	2.00	2.16	2.12
5	5	7.09	3.27	2.16	.350	.159	.246	.319	.449	.348	—	1.55	1.78	1.87	1.94	2.00
6	6¼	—	3.90	—	.350	.130	.174	.261	.348	.391	.377	—	—	—	—	—
7	5	—	3.38	—	.389	.145	.246	.304	.450	.435	—	—	—	—	—	—
8	5	—	4.10	—	.409	.145	.290	.449	.536	.580	—	—	—	—	—	—
9*	6	—	ca. 3.35	—	.307	.101	.159	.275	.290	.420	.319	—	—	—	—	—

Specimen	Thickness of spirotheca						Tunnel angle (degrees)					Septal count					
	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4	5	6
1	.029	.043	.093	.150	.172	.136	27	29	34	26	40(?)	—	—	—	—	—	—
2	.036	.057	.100	.157	.143	.140	22	28	27	28	—	—	—	—	—	—	—
3	.036	.086	.107	.129	.157	.114(?)	—	30	36(?)	—	—	—	—	—	—	—	—
4	.032	.064	.093	.114	.121	—	29	32	27	37	—	—	—	—	—	—	—
5	—	—	.114	.129	.100(?)	—	29	30	28	31	38	—	—	—	—	—	—
6	.029	.057	.086	.114	.129	.129	—	—	—	—	—	10	20	26	37	36	47
7	.038	.057	.100	.143	.129	—	—	—	—	—	—	11	21	27	32	36	—
8	.040	—	.114	.157	.129	—	—	—	—	—	—	10	19(?)	32	43	—	—
9	.036	—	.080	.123	.145	—	—	—	—	—	—	10	18	22	29	—	—

* Deformed specimen. Specimens 1-3, 5-7 and 8 are illustrated on Plate 35 as figures 2, 1, 3, 4, 7, 9 and 6, respectively.

thirds of shell but increase slightly as extreme polar areas are approached.

Spirotheca very thick and finely alveolar. Average thicknesses of spirotheca in 1st to 6th volution of 9 specimens 34, 61, 99, 135, 136 and 130 microns, respectively.

Septa closely spaced and composed of a thin pycnotheca. Average septal counts in 1st to 5th volution of 4 specimens 10, 20, 27, 35 and 36, respectively. Septa narrowly fluted throughout length of shell, and fluting extends to upper parts of septa in central portion of shell.

Tunnel of moderate width, with nearly straight path. Tunnel angles vary from 22 to 29 degrees in 1st volution, 28 to 32 degrees in 2nd, 27 to 34 degrees in 3rd, 26 to 31 degrees in 4th. Chomata narrow, and occur in inner 3, rarely 4, volutions. Lighter axial fillings occur in extreme polar regions of most specimens.

Measurements of the present species are given in Table 19.

Remarks.—The above description is entirely based on the Yayamadake specimens. *Pseudofusulina sokensis* was originally described by RAUSER-CERNOUSSOVA based on only a few specimens from the complex II of Samara Bend. I am strongly inclined to believe that *P. sokensis* includes two forms, of which the elongate form (pl. viii, fig. 1) should better be distinguished from the obese form (fig. 2) as a different species. The latter form should be chosen as the lectotype of *sokensis*, since the original description of *P. sokensis* was based chiefly on it. I have obtained a number of well-oriented specimens which show striking similaritles to the Russian obese form and seem to be identical with it. Unfortunately so little can be known concerning *P. sokensis* that it is difficult to correctly compare my specimens with the Russian form, but I tentatively refer them to that species.

The specimens are also similar to *Pseudofusulina intermedia* RAUSER-CERNOUSSOVA (1936) and *Pseudofusulina "vulgaris* var. *exigua"* (SCHELLWIEN & DYRENFURTH) (1909) in the general shell structure, but they differ from the latter two species in having much larger shells and thicker spirotheca for corresponding volutions.

Occurrence.—Abundant at a horizon about 80 meters above the base of the *Pseudoschwagerina* zone; associated with *Pseudofusulina horrida* n. sp., *Pseudofusulina* n. sp (?), *Pseudofusulina* sp., *Schwagerina* sp. and *Pseudoschwagerina minatoi*, n. sp.

Subfamily Ozawainellinae THOMPSON & FOSTER, 1937

Genus *Nankinella* LEE, 1933

Nankinella kotakiensis (FUJIMOTO & KAWADA)

Plate 28, figures 9-13

Hayasakaina kotakiensis FUJIMOTO & KAWADA, 1953, Sci. Rep., Tokyo Bunrika Daigaku, sect. C, Vol. 2, no. 13, p. 208-209, pl. 1, figs. 1-10

[Not *Hayasakaina kotakiensis*, IGO, 1956]

Shells are so highly replaced by secondarily crystallized calcites that their detailed internal features cannot be determined with certainty. However, in the general appearance they closely resemble *Hayasakaina kotakiensis* FUJIMOTO and KAWADA which was originally described from the Lower Permian of the Omi limestone, Niigata Prefecture, Japan. The following brief description is based on the Yayamadake specimens.

Shell small and thickly discoidal to subspherical in shape, with broadly to narrowly angular periphery and broadly convex axial regions. Mature shells of 6 to 7 volutions measure 0.85–0.98 mm. in axial length and 1.2–1.5 mm. in width. Form ratios 0.55–0.77. Inner 4 volutions have a sharply angular periphery and steep and straight lateral slopes.

Proloculus small; its outside diameter about 100 microns. Heights of 1st to 5th volution in 3 specimens of sagittal section 40–50, 72–87, 101–116, 123–145 and 145–189 microns, respectively. Shell expands gradually.

The nature of the spirotheca and the structure of the septa are unable to be determined because of poor preservation of available material. Thickness of spirotheca in one specimen (pl. 28, fig. 9) measures 23 microns in 2nd volution, 40 microns in 4th and 36 microns in 5th. The last volution of the same specimen of 5 volution contains 19 septa. Nature of tunnel and chomata is not ascertained.

Remarks.—Owing to the extremely poor preservation of the specimens I have been able to determine so little about this form that its generic affinities are uncertain. However it resembles the species described by FUJIMOTO and KAWADA as *Hayasakaina kotakiensis* from the Lower Permian of the Omi limestone. *Hayasakaina* was designated as ozawainellid which has the senile one or two volutions coiled at right angles to the coiling of the inner volutions. Although they stated that most of their original material have this aberrant nature in outer one or two volutions, so far as their illustrations are concerned, this feature is not recognized in well-oriented specimens (Figs. 3, 4, 7, 8)*. If the discoidal shell is obliquely or diagonally cut even a little, such a figure of septa as shown in their illustration (figs. 1, 2, 5 and 6) should be expected to appear even in the planispiral shells which have the straight axis of coiling throughout the growth. I am inclined to regard *Hayasakaina* FUJIMOTO & KAWADA as sgnonymous with *Nankinella* LEE.

Very recently IGO (1956) referred to this species his specimens from the Lower Permian of the Hida massif, Japan, and described that his specimens also have one or two senile volutions coiled at right angles to the axis of inner ones. However, such an aberrant nature is not shown in any of this illustration. They are all cut diagonally or obliquely (figs. 1, 6, 13 and 14). IGO's specimens have much larger shells than *H. kotakiensis*, and it is, therefore, highly possible that the specimens are not referable to *H. kotakiensis* but conspecific with his *Hayasakaina ? kawadai* described from the same locality.

* FUJIMOTO and KAWADA stated that figs. 2 and 6 on the plate show perfect axial sections. However it is clear that they are slightly diagonally cut.

Occurrence.—Rather rare in the lower part of the *Pseudoschwagerina* zone; associated with *Triticites* sp., *Rugosofusulina prisca* [(EHRENBERG) MÖLLER] and *Schubertella* sp.

Nankinella kawadai (IGO)

Plate 33, figures 11-18

Hayasakaina ? kawadai IGO, 1956, Trans. Proc. Palaeont. Soc. Japan, N. S., no. 22, p. 173, pl. 29, figs. 2-5, 7-11, 17-20.
Hayasakaina kotakiensis, IGO, 1956, Ibid., p. 172-173, pl. 27, figs. 1, 6, 12-16.

The present species is represented by a number of sectioned specimens, but as in the case of the species described immediately above, the shells of those specimens are so highly replaced by secondary mineralization that most of the internal features of the shell cannot be determined. Only the following brief accounts are given for this species.

Shell planispiral throughout its growth, and thickly discoidal in shape, with broadly angular periphery and broadly rounded polar regions. Periphery narrowly angular in inner volutions and becomes gradually broader in outer volutions. Lateral slopes nearly straight to slightly concave. Mature shells seemingly have 7 to 8 volutions, attaining 1.3-1.6 mm in axial length and 1.8-2.6 mm. in width. Form ratios range from 0.63 to 0.77.

In the shape and size and the general appearance of the shell the present specimens can hardly be distinguished from *Nankinella kawadai* (IGO) which was originally referred to *Hayasakaina* FUJIMOTO & KAWADA with a query. Due to the unfavourable preservation of the specimens the true nature of this species are not understood, and it is, therefore, difficult to determine the generic affinities with certainty. However, on account of the reason remarked on *Nankinella kotakiensis* (FUJIMOTO & KAWADA) described immediately before, I prefer to refer this species to *Nankinella*.

The present specimens are similar to *Nankinella kotakiensis* (FUJIMOTO & KAWADA) but have much larger shells.

Occurrence.—Abundant in the upper part of the *Pseudoschwagerina* zone in association with *Triticites pusillus* (SCHELLWIEN), *Triticites* sp., *Pseudoschwagerina minatoi* n. sp., *Paraschwagerina shimodakensis* n. sp., *Pseudofusulina* aff. *P. dongvanensis* (COLANI), *Schwagerina grandensis* THOMPSON and *Schwagerina* sp.

Correlation

Fusulindis of the *Pseudoschwagerina* zone are widespread in the Japanese Islands, and systematic paleontological researches and bistratigraphic studies on them have been carried out to some extent and become to be facilitate a definite correlation.

OZAWA (1925) discriminated two fossil zones in the Lower Permian section of the Akiyoshi limestone, the lower *Schwagerina muongthensis* subzone and the upper *Schwagerina princeps* or *Fusulina vulgaris* subzone. According to TORIYAMA (1952), who has studied biostratigraphically the Paleozoic rocks of the Akiyoshi area including the Akiyoshi limestone at length, the *Pseudoschwagerina* zone of the said limestone is divided into two subzones, the lower *Triticites simplex* and upper *Pseudofusulina vulgaris* subzones, which, in turn, correspond safely to OZAWA's two subzones, respectively. He correlated the two subzones respectively with the lower and the upper part of the Sakmarian of Russia and of the Wolfcampian of America.

The lower subzone in the Akiyoshi limestone is marked with many species of *Triticites* in addition to *Pseudoschwagerina muongthensis* (DEPRAT), *Schwagerina satoi* (OZAWA) and *Quasifusulina longissima tenuis* (LEE). While the upper subzone, which overlies conformably the lower one, is characterized by *Pseudofusulina vulgaris* and its allies and prolifc faunas containing *Triticites, Acervoschwagerina, Schwagerina, Pseudofusulina* and *Dunbarinella.*

The similar stratigraphic occurrence of the close related fusulinids are also found in the Permian section of the Yayamakake limestone. As mentioned in the foregoing chapter, the *Pseudoschwagerina* zone of the Yayamadake limestone is divided into two subzones, the upper and the lower. The lower subzone is characterized by species of *Triticites, Rugosofusulina* and *Quasifusulina* in addition to *Pseudoschwagerina.* This fusulinid assemblage is definitely of early Permian age. Of these the specimens described under the name of *Rugosofusulina prisca* [(EHRENBERG) MÖLLER] are the most primitive representatives of the genus and are of *Triticites*-stage in shell development. It should be noted here that there are parts characterized by exclusively specimens of *Triticites* at a few horizons about 5 to 20 meters above the base. Similar stratigraphic occurrence of fusulinids has been recognized in the basal part of the *Pseudoschwagerina* zone of the Akiyoshi limestone (TORIYAMA, 1952) and of the Ichinotani group in the Fukuji district of the Hida massif (IGO, 1957) and in the basal Wolfcampian rocks of the Kansas region (THOMPSON, *et. al.* 1948; THOMPSON, 1956). In Akiyoshi there is a horizon composed entirely of *Triticites* at the base of the *Triticites simplex* subzone of the *Pseudoschwagerina* zone. Although Akiyoshi and Yayamadake are a little common in the contained species, this similar occurrence of fusulinids indicates that the lower subzone in question is equivalent in age to the *Triticites simplex* subzone in the Akiyoshi limestone.

In the Yayamadake limestone, as well as in the Akiyoshi limestone, *Schwagerina, Pseudofusulina* and *Paraschwagerina* begin to occur explosively at a horizon some distance above the base of the Permian section. Many of them are very abundant in the number of individuals. Species of *Triticites* found in the upper subzone have much advanced shell structures than those of the lower subzone, and *Quasifusulina* which is characteristic throughout the lower subzone has not been found in the upper subzone, as in the Akiyoshi limestone. It is no doubt that the upper subzone is correlated with the *Pseudofusulina vulgaris* subzone of Akiyoshi. This subzone is probably the most widespread of the Lower Permian zones and has been recognized in various areas, as in the Kanto massif (FUJIMOTO, 1936; MORIKAWA, 1955), the Hida massif (KANUMA, 1952; IGO, 1957), the Omi limestone (KAWADA, 1954 a,b,c), the Taishaku limestone (FUJIMOTO, 1938) and the Kitakami massif (HANZAWA, 1938; TORIYAMA, 1950).

The *Pseudoschwagerina* zone has also been widely recognized in the world, viz., in North and South America, European Russia, the Carnic Alps, Asia Minor, the Himalayas, Sumatra, China, Korea and Japan. This zone shows the striking similarities in general aspect of the faunal assemblage throughout the whole extensive distribution. It is characterized by the presence of species of *Pseudoschwagerina*, generally associated with species of *Triticites*, *Dunbarinella*, *Schwagerina*, *Pseudofusulina*, *Paraschwagerina*, *Schubertella* and *Quasifusulina*, the last of which is characteristic in the Tethys Sea area. *Pseudoschwagerina* in the Yayamadake limestone occurs throughout most parts of the stratigraphic section under consideration. It is, therefore, evident that the *Pseudoschwagerina* zone is correlated with the Taiyuan series in North China, the Chuanshan limestone of South China, the Wolfcampian series of North America and the equivalent rocks of South America.

As already pointed out (1952), we can recognize the close similarities of the Yayamadake fusulinids especially to the so-called Upper Carboniferous and the Sakmarian fauna of European Russia and to the faunas of the *Pseudoschwagerina* zone in the Tethys Sea area including the Carnic Alps, Darwas, Indochina and China. Many of the Yayamadake fusulinids very closely resemble Russian forms and several species cannot be distinguished from the Russian ones. As evidence of the close faunal similarities between the two areas the following species are compared:

Russia	Yayamadake
Triticites montiparus [(HHRENBERG) MÖLLER]	”
T. schwageriniformis RAUSER-CERNOUSSOVA	*T. yayamadakensis evectus* n. subsp.
T. noinskyi R.-C.	*T.* cf. *T. haydeni* (OZAWA)
T. samaricus (R.-C.)	”
Rugosofusuliua prisca [(EHRENBERG) MÖLLER]	”
R. serrata R.-C.	”
Schwagerina stabilis (R.-C.)	”
Pseudofusulina sokensis R.-C.	”
Paraschwagerina schwageriniformis (R.-C.)	*P. shimodakensis* n. sp.
Quasifusulina longissima (MÖLLER)	*Q. longissima ultima* n. subsp.

Among the Russian species listed above, severals are characteristic of the so-called Upper Carboniferous, viz., of the I and the II Complex of RAUSER-CERNOUSSOVA in the Samara Bend region or of C_3^{1-b} to C_3^{1-d} (*Triticites jigulensis*, *T. stuckenbergi* and *T. irregularis* zones of ROZOVSKAYA) and C_3^2 (*Pseudofusulina sokensis* zone) and some occur in both the so-called Upper Carboniferous and the Sakmarian. So far as the species of *Triticites*, *Pseudofusulina*, *Rugosofusulina* and *Schwagerina* are concerned, the lower half of the Permian section in the Yayamadake limestone seems to be correlated with the C_3^{1-b} to C_3^{1-d} zones of Russia, and the upper half with the Complex II or *Pseudofusulina sokensis* zone to the Sakmarian. In fact, ROZOVSKAYA (1950) correlated the lower part of the Taiyuan series in North China with the Upper Carboniferous C_3^{1-b} and C_3^{1-c}, and the upper with C_3^{1-d} and the *Pseudofusulina sokensis* zone. However it is well known that the Taiyuan series is evidently of the *Pseudoschwagerina* zone and rests with a distinct unconformity upon the Penchi series of the *Fusulinella* zone.

Whereas the Yayamadake fusulinids are not specifically compared so closely with the Wolfcampian ones of the Midcontinent and Texas regions of North America as with Russian ones. The collections under consideration contain only one species which is considered to be identical with the American species. The species referred to *Schwagerina grandensis* THOMPSON, together with *Pseudoschwagerina minatoi* n. sp., *Paraschwagerina shimodakensis* n. sp. and *Triticites pusillus* (SCHELLWIEN), characterize a prominent zone in the lower part of the upper half of the *Pseudoschwagerina* zone. The species originally came from the lower part of the Hueco limestone of New Mexico. Excepting the species mentioned above, no species is common to the two areas, but most of the genera characteristic of the *Pseudoschwagerina* zone are found, and the identified species represent the same or about the same degree in their evolutionary development in the respective genus or the group of similar species of fusulinids in both areas.

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K. KANMERA

Fusulinids from the Yayamadake Limestone of the Hikawa Valley, Kumamoto Prefecture, Kyushu, Japan

Part III–Fusulinds of the Lower Permian

Plates

Plate 24

All figures ×10.2

Figure

1-8—*Quasifusulina longissima ultima* n. subsp. ....p. 158

1, Axial section of the holotype; 2, 4, axial sections of paratypes; 3, tangential section of a paratype; 5-8, sagittal sections of paratypes. Specimens of figures 1-4 and 7 are from Loc. Ya. 212, and others from Loc. Ya. 218.

9-17—*Triticites fornicatus* n. sp. ....p. 171

9, Axial section of the holotype; 10, 11, 13, nearly centered, slightly oblique tangential sections of paratypes; 12, axial section of a paratype; 14, parallel section of a paratype; 15, sagittal section of a paratype; 16, oblique sagittal section of a paratype; 17, tangential section of a paratype. All specimens are from Loc. Ya. 53c.

18, 19—*Triticites* (?) sp. indet. ....p. 175

18, Slightly diagonal axial section; 19, sagittal section. From Loc. Ya. 53c.

20—*Schwagerina krotowi* (SCHELLWIEN) ....p. 193

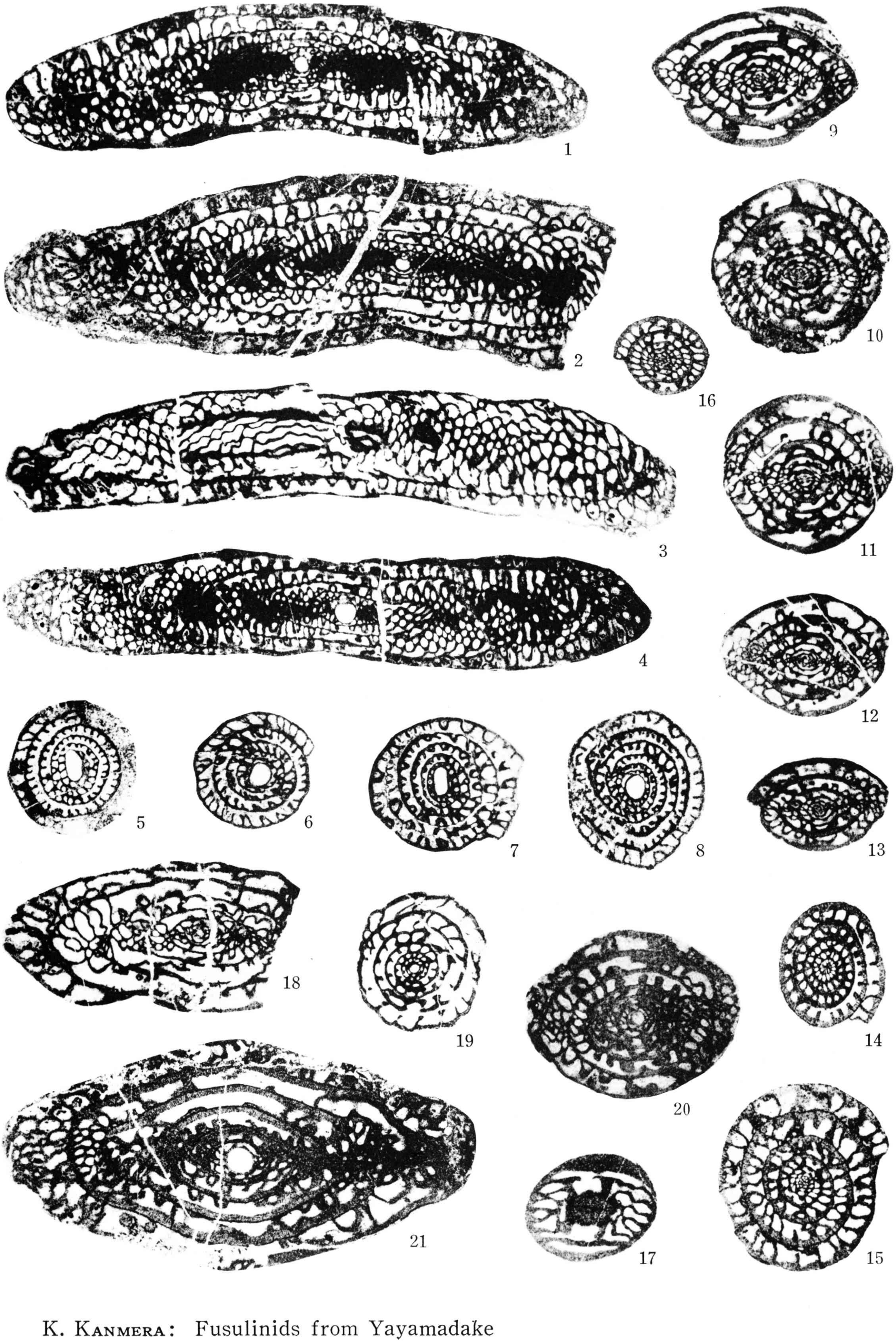
Slightly diagonal axial section. From Loc. Ya. 55b.

21—*Pseudofusulina* n. sp. (?) ....p. 201

Axial section. Loc. Ya. 56.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. KANMERA.



K. Kanmera: Fusulinids from Yayamadake

Plate 25

All figures ×10.2

Figure

1-10—*Triticites yayamadakensis evectus* n. subsp. ....p. 163

1, Axial section of the holotype; 2, 5, 6, axial sections of paratypes; 3, 4, nearly centered axial sections of paratypes; 7-10, sagittal sections of paratypes; All specimens are from Loc. Ya. 212.

11-19, 20(?)—*Triticites ozawai* TORIYAMA ....p. 165

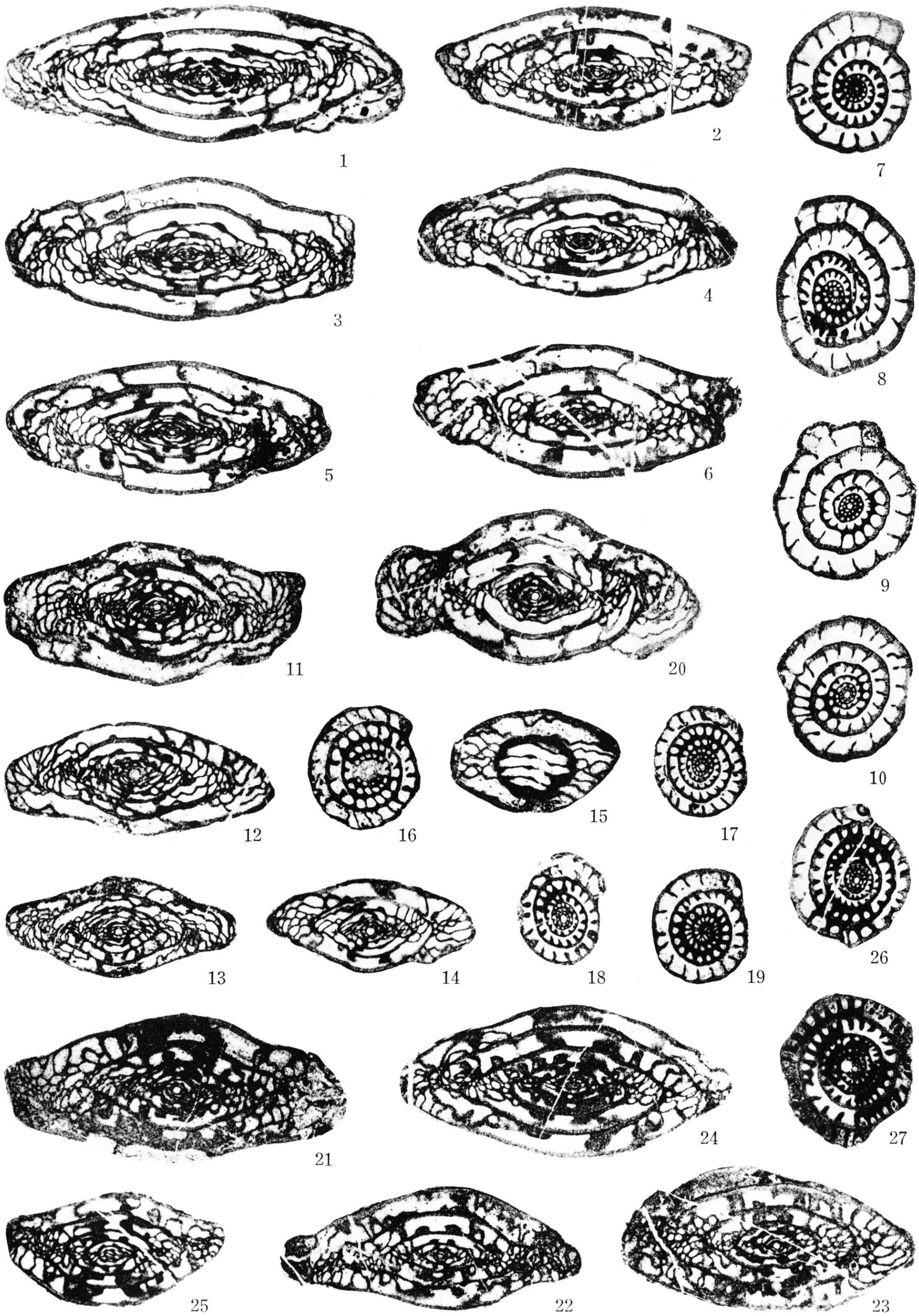
11-14, Axial sections (12-14, of immature); 15, tangential section; 16-17, sagittal sections; 19, parallel section, 20, axial section referred to this species with question. Specimens of figures 11 and 20 are from Loc. Ya. 212, and others from Loc. Ya. 91.

21-27—*Triticites montiparus* [(EHRENBERG) MÖLLER] ....p. 160

21, 22, Axial sections; 23, slightly diagonal axial section; 24, 25, tangential sections; 26, 27, sagittal sections. Specimens of figures 21-23 and 26 are from Loc. Ya. 323, those of figures 24 and 25 from Loc. Ya. 324, and that of 27 from Loc. Ya. 231.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. KANMERA.



K. Kanmera: Fusulinids from Yayamadake

Plate 26

All figures ×10.2

Figure

1-13—*Triticites samaricus* RAUSER-CERNOUSSOVA ....p. 168

1-7, Axial sections; 8-13, sagittal sections. All are from Loc. Ya. 53c.

14-19—*Triticites* aff. *T. haydeni* (OZAWA) ....p. 167

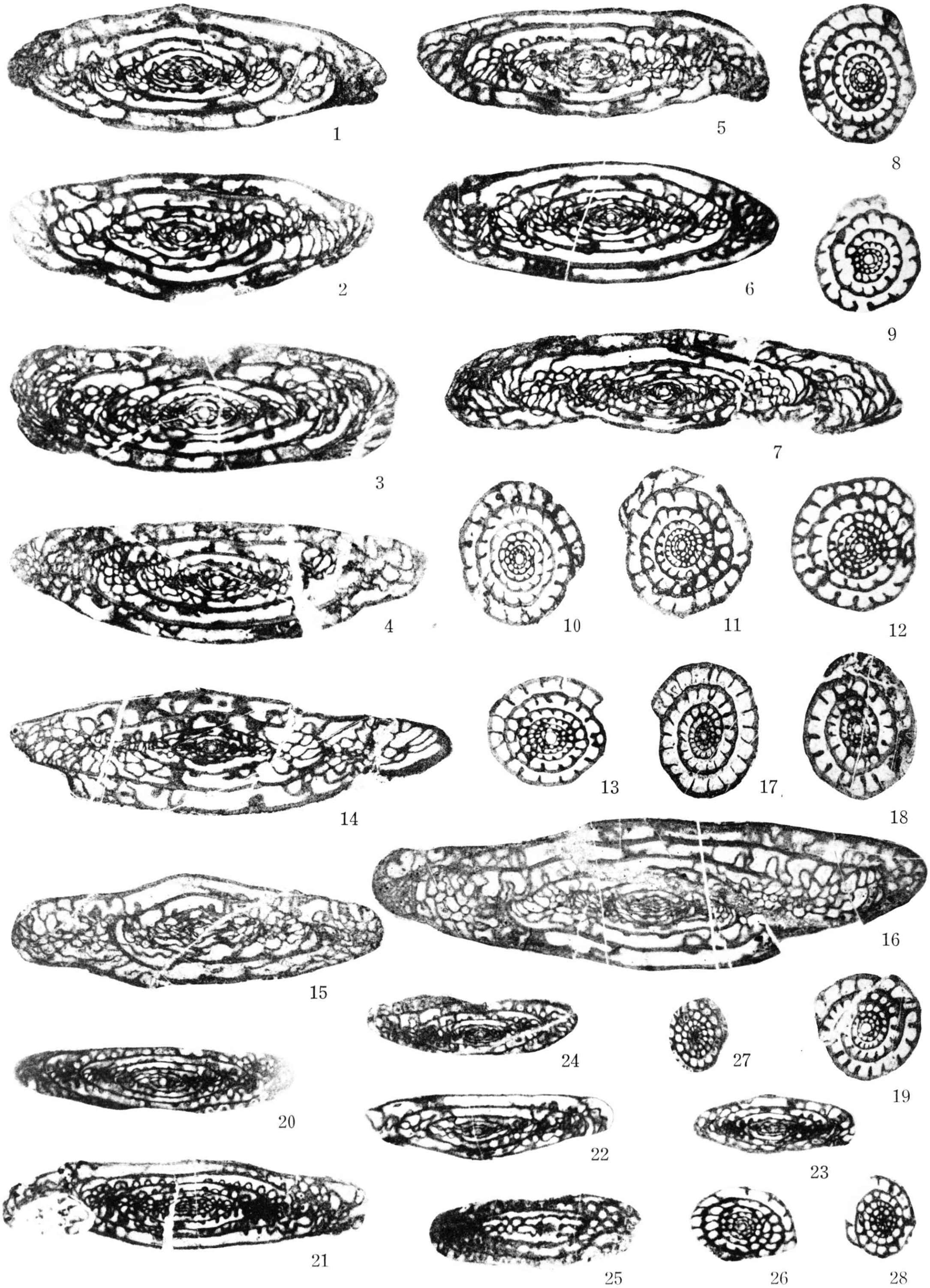
14, 15, Axial sections; 16, tangential section; 17-19, sagittal sections. From Ya. 51.

20-28—*Triticites* aff. *T. pusillus* (SCHELLWIEN) ....p. 173

20, 22, 24, Axial sections; 21, 23, nearly centered axial sections; 25, tangential sections; 26, diagonal section; 27, 28, parallel sections. Specimens of figures 20, 23 and 26-28 are from Loc. Ya. 236, those of figures 21 and 22 from Ya. 58, and those of figures 24 and 25 from Loc. Ya. 330.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. KANMERA.



K. Kanmera; Fusulinids from Yayamadake

Plate 27

All figures ×10.2

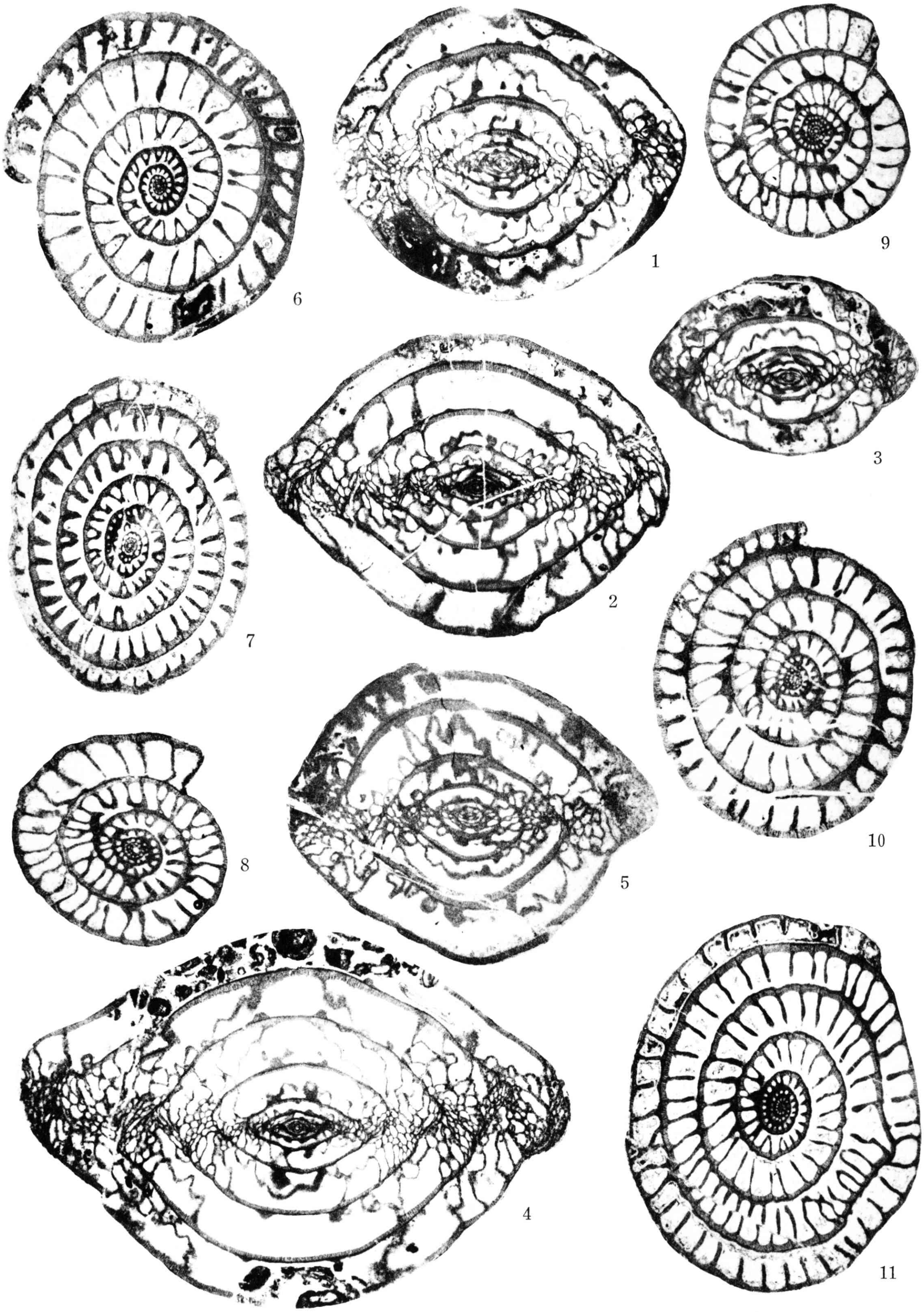
Figure

1-11—*Pseudoschwagerina morikawai* Igo ....p. 177

1-4, Axial sections; 5, tangential section; 6-9, sagittal sections; 10, 11, nearly centered parallel sections. All specimens are from Loc. Ya. 212, except that of figure 7 which is from Loc. Ya. 213.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. Kanmera.



K. Kanmera: Fusulinids from Yayamadake

Plate 28

Figures 1-8 are ×10.2; others ×20.4

Figure

1-8—*Pseudoschwagerina minatoi* n. sp. ....p. 179

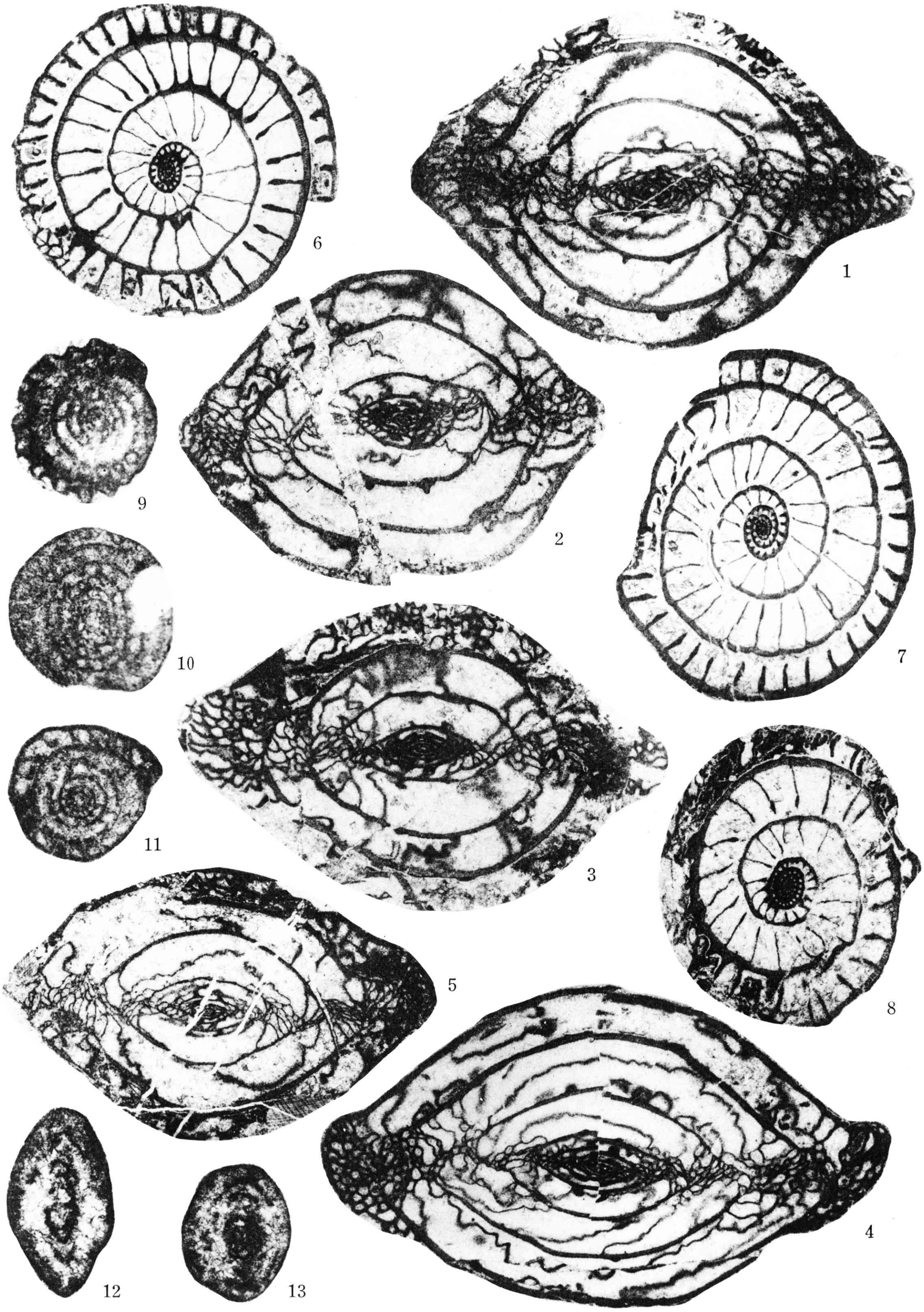
1, Axial section of the holotype; 2, 5, nearly centered axial sections of paratypes; 3, 4, axial sections of paratypes; 6, 7, sagittal sections of paratypes; 8, parallel section of a paratype. All specimens are from Loc. Ya. 127, except that of figure 4 which is from Loc. Ya. 56.

9-13—*Nankinella kotakiensis* (Fujimoto & Kawada) ....p. 208

9-11, Sagittal sections; 12, tangential section, 13, slightly oblique axial section. From Loc. Ya. 53c.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. Kanmera.



K. Kanmera: Fusulinids from Yayamadake

Plate 29

All figures ×10

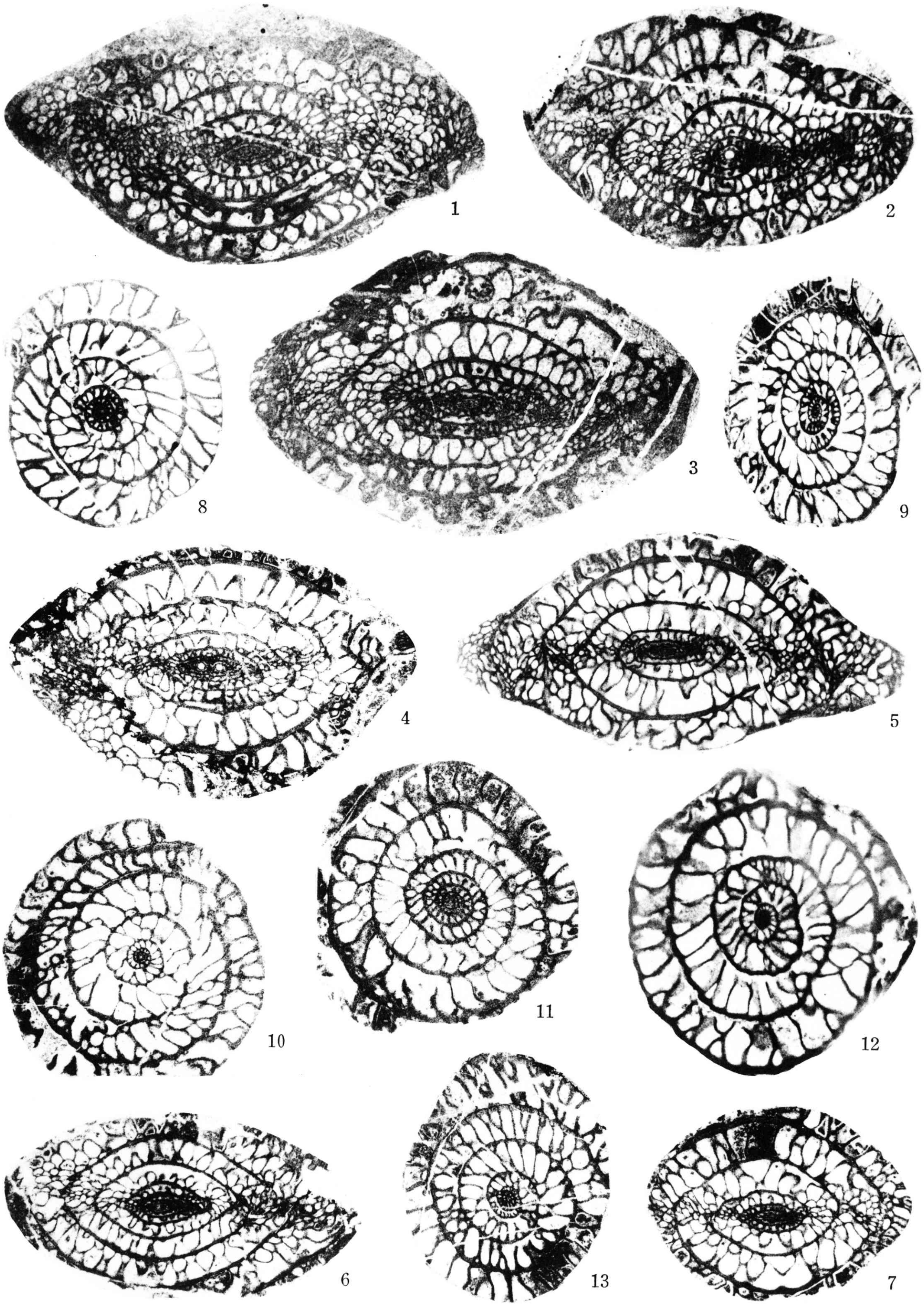
Figure

1-13—*Paraschwagerina shimodakensis* n. sp. ....p. 181

1, Axial section of the holotype; 2, 4, axial sections of paratypes; 3, 5, 6, 7, nearly centered axial sections of paratypes; 8-11, sagittal sections of paratypes; 12, 13, nearly centered parallel sections of paratypes. Specimens of figures 1-7 and 10 are from Loc. Ya. 127, those of figures 8 and 9 from Loc. Ya. 236, and those of figures 10-13 from Loc. Ya. 330.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. KANMERA.



K. Kanmera: Fusulinids from Yayamadake

Plate 30

All figures ×10.2

Figure

1-5—*Rugosofusulina prisca* [(EHRENBERG) MÖLLER] ....p. 183

1-4, Axial sections; 5, nearly centered axial section. Specimens of figures 1 and 5 are from Loc. Ya. 51, those of 2 and 3 from Loc. Ya. 92 and that of 4 from Loc. Ya. 91.

6-10—*Rugosofusulina pristina* n. sp. ....p. 184

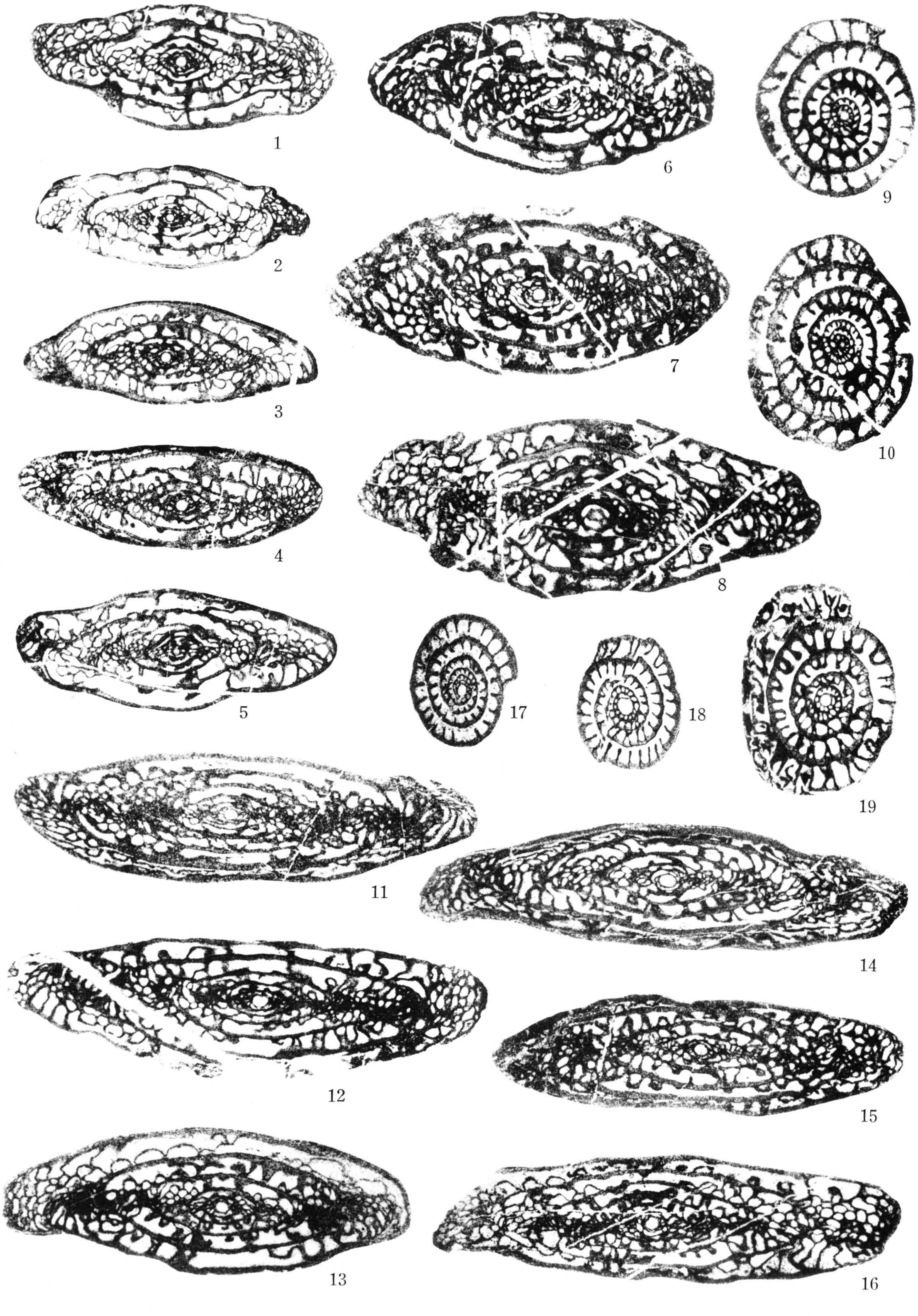
6, Axial section of the holotype; 7, 8, axial sections of paratypes; 9, 10, sagittal sections of paratypes. Specimens of figures 6, 7, 9 and 10 are from Loc. Ya. 53c and that of figures 8 is from Loc. Ya. 54b.

11-19—*Rugosofusulina serrata* RAUSER-CERNOUSSOVA ....p. 186

11-16, Axial sections (outer volutions in the specimens of figures 11, 14-16 are crushed); 17-19, sagittal sections. From Loc. Ya. 55a.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. KANMERA.



K. Kanmera: Fusulinids from Yayamadake

Plate 31

All figures ×10

Figure

1-12—*Schwagerina grandensis* THOMPSON ....p. 189

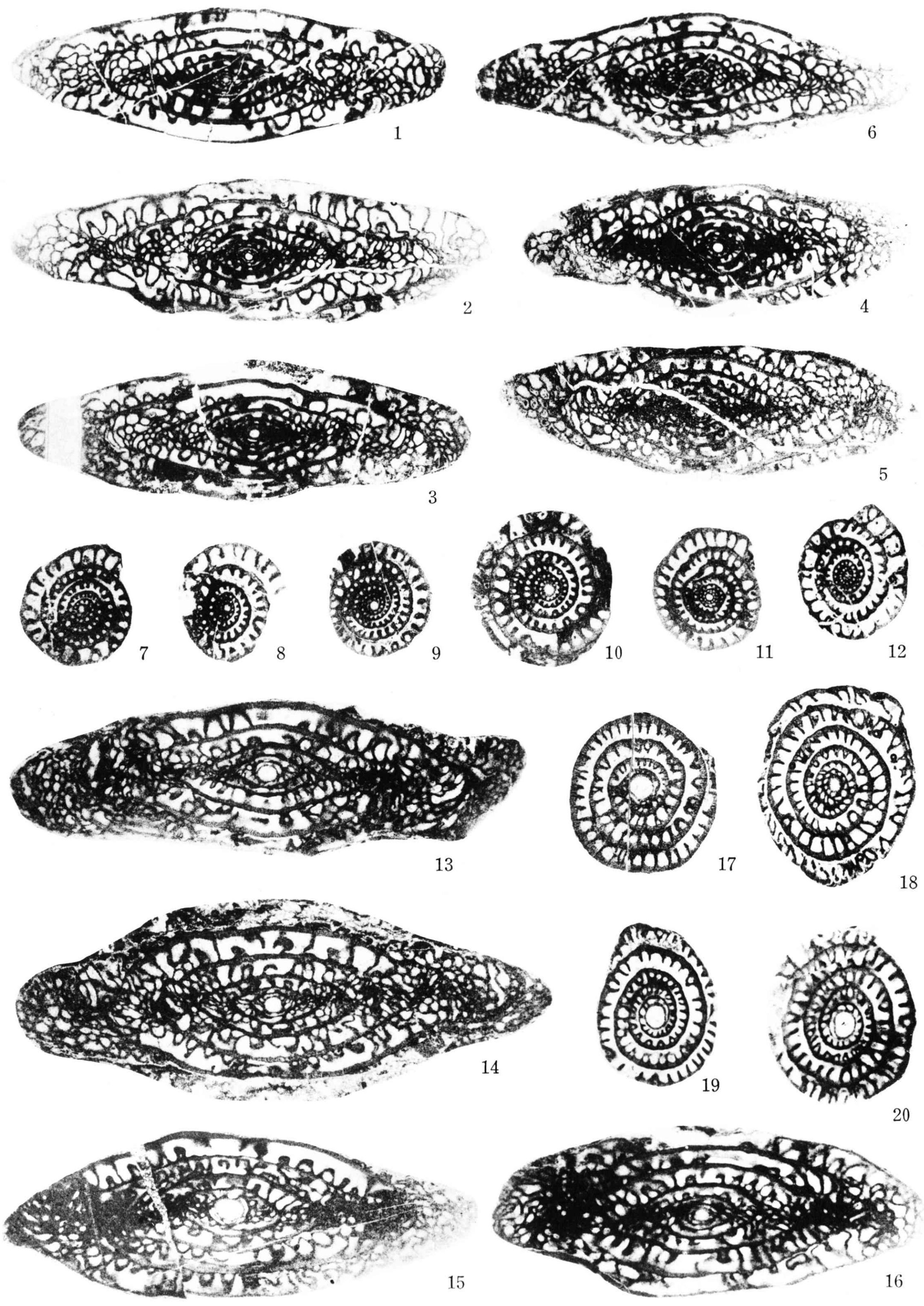
1-5, Axial sections; 6, nearly centered axial section; 7-12, sagittal sections. All specimens from Loc. 236 except that of figure 5 which is from Loc. Ya. 234.

13-20—*Pseudofusulina horrida* n. sp. ....p. 196

13, 15, 16, Axial sections of paratype; 14, axial section of the holotype; 17-20, sagittal sections of paratypes. From Loc. Ya. 56.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. KANMERA.



K. Kanmera: Fusulinids from Yayamadake

Plate 32

All figures ×10.2

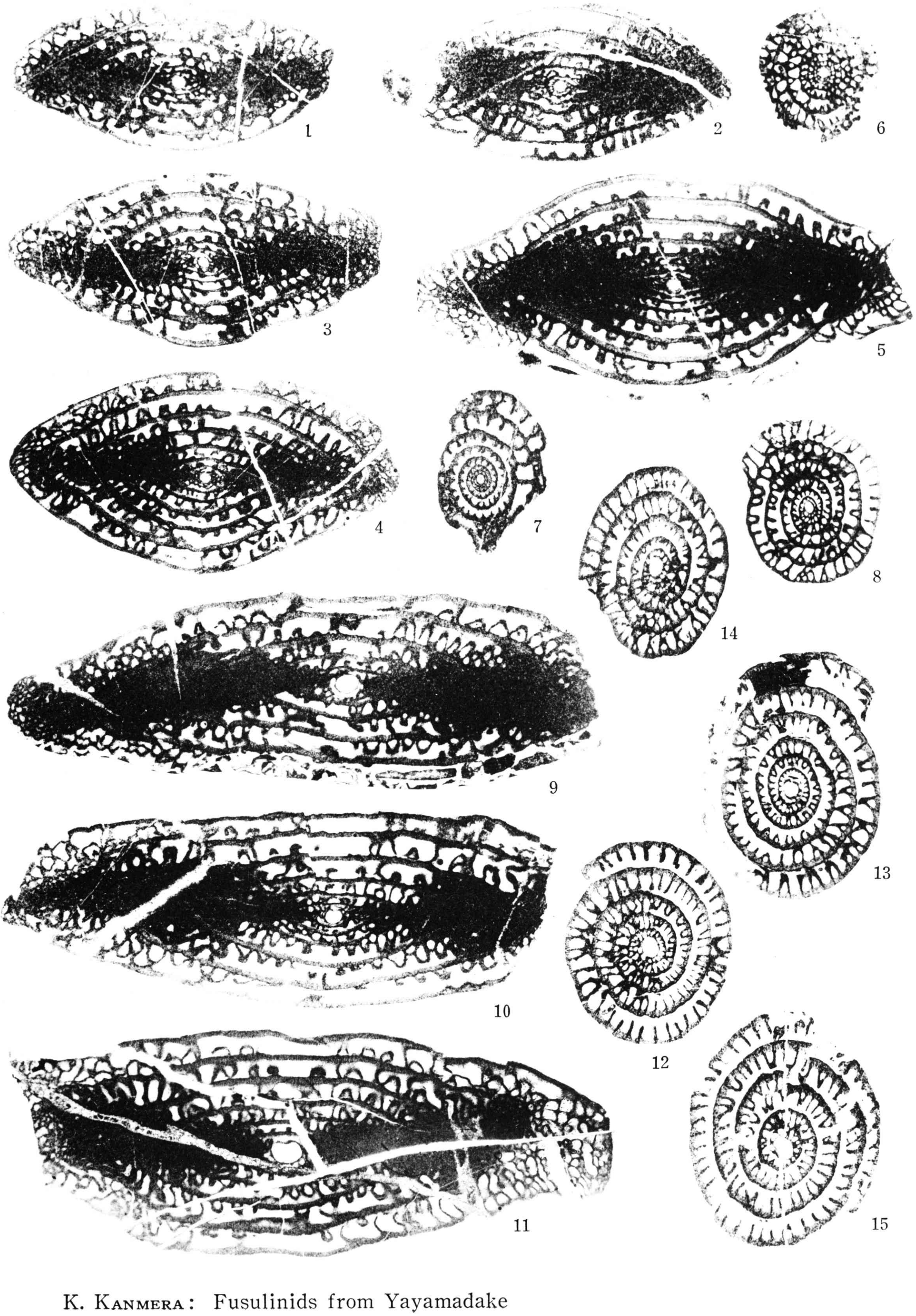
Figure

1-8—*Schwagerina stabilis* (RAUSER-CERNOUSSOVA) ....p. 191
1-5, Axial sections; 6-8, sagittal sections. Specimens of figures 1, 2, 4 and 8 are from Loc. Ya. 54b and others from Loc. Ya. 55b.

9-15—*Pseudofusulina kumasoana* n. sp. (See also Plate 35) ....p. 199
9, Axial section of the holotype; 10, 11, axial sections of paratypes; 12-15, sagittal sections of paratypes. All from Loc. Ya. 55b.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. KANMERA.



K. Kanmera: Fusulinids from Yayamadake

Plate 33

Figures 1-10 are ×10.2; others ×20.4

Figure

1-10—*Pseudofusulina regularis* (SCHELLWIEN) .... p. 194

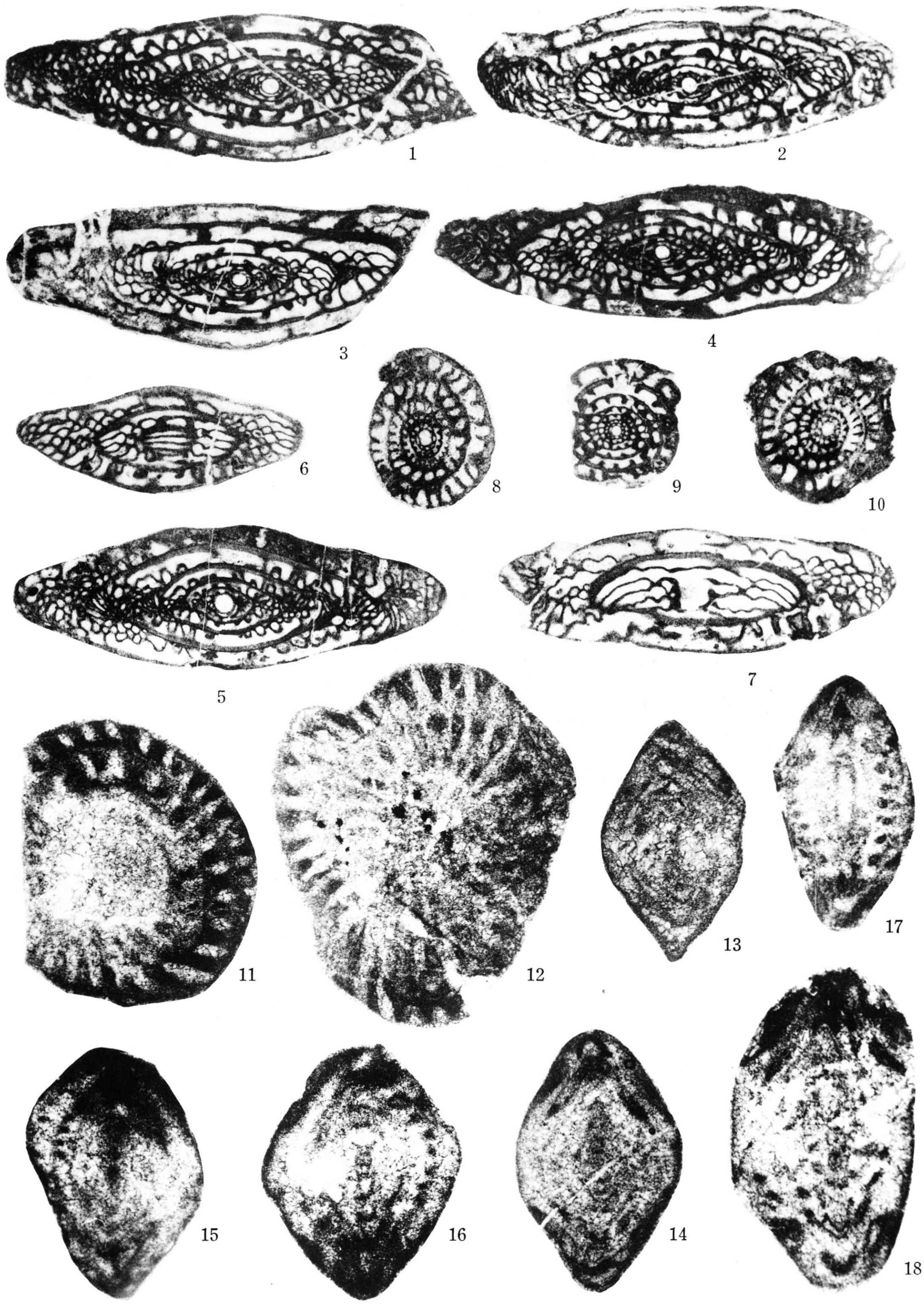
1-5, Axial sections; 6, 7, tangential sections; 8-10, sagittal sections. All specimens are from Loc. Ya. 53c, except that of figure 4 which is from Loc. Ya. 55b.

11-18—*Nankinella kawadai* (IGO) .... p. 210

11, 12, Parallel sections; 13, 14, axial sections; 15, 16, slightly diagonal axial sections; 17, 18, tangential sections. Specimen of figure 13 is from Loc. Ya. 54a, that of figure 14 from Loc. Ya. 234 and that of figure 15 from Loc. Ya. 236.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. KANMERA.



K. KANMERA: Fusulinids from Yayamadake

Plate 34

All figures ×10

Figure

1-7—*Pseudofusulina santyuensis* Huzimoto ....p. 202

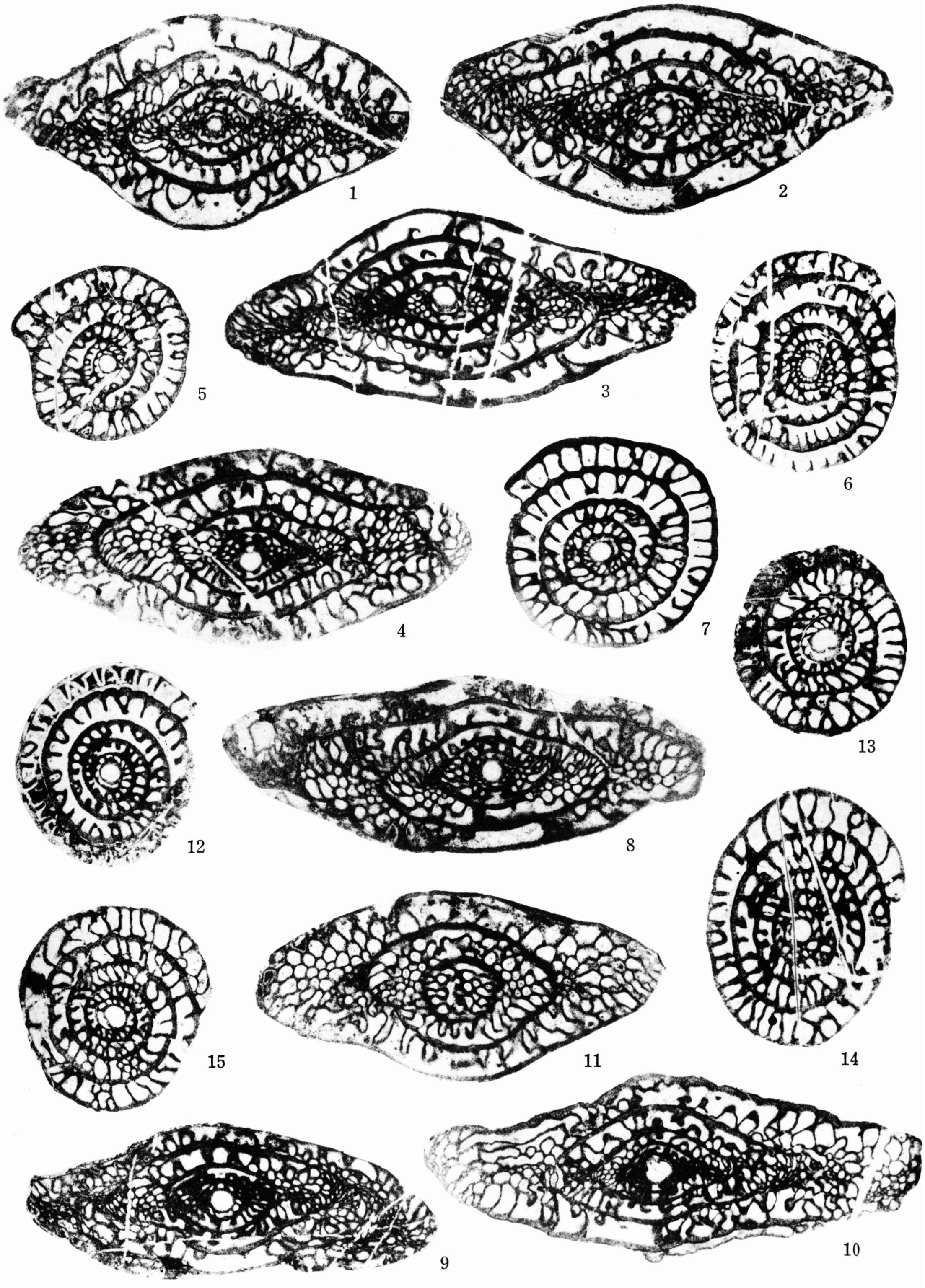
1-4, Axial sections; 5-7, sagittal sections. All specimens from Loc. Ya. 54a.

8-14—*Pseudofusulina* aff. *P. dongvanensis* (Colani)..p. 204

8-10, Axial sections; 11, tangential section; 12, 13, sagittal sections; 14, 15, slightly diagonal sagittal sections. Specimens of figures 8 and 11 are from Loc. Ya. 330 and others from Loc. Ya. 236.

Above all localities are in the northeastern slope of Mt. Yayamadake.

Photos by K. Kanmera.



K. Kanmera: Fusulinids from Yayamadake

Plate 35

All figures ×10

Figure

1-9—*Pseudofusulina sokensis* RAUSER-CERNOUSSOVA ....p. 206

1-4, Axial sections; 5, axial section of an immature specimen; 6-9, sagittal sections. All from Loc. Ya. 56.

10-12—*Pseudofusulina kumsaoana* n. sp. (See also Plate 32) ....p. 199

10, Axial section of a paratype; 11, tangential section of a paratype, 12, sagittal section of a paratype. From Loc. Ya. 55b.

13, 14—*Schwagerina krotowi* (SCHELLWIEN) (See also Plate 24) ....p. 193

13, Tangential section; 14, sagittal section of an immature specimen. From Loc. Ya. 55b.

Above all localities are in the northeastern slope of Mt. Yayamadake.

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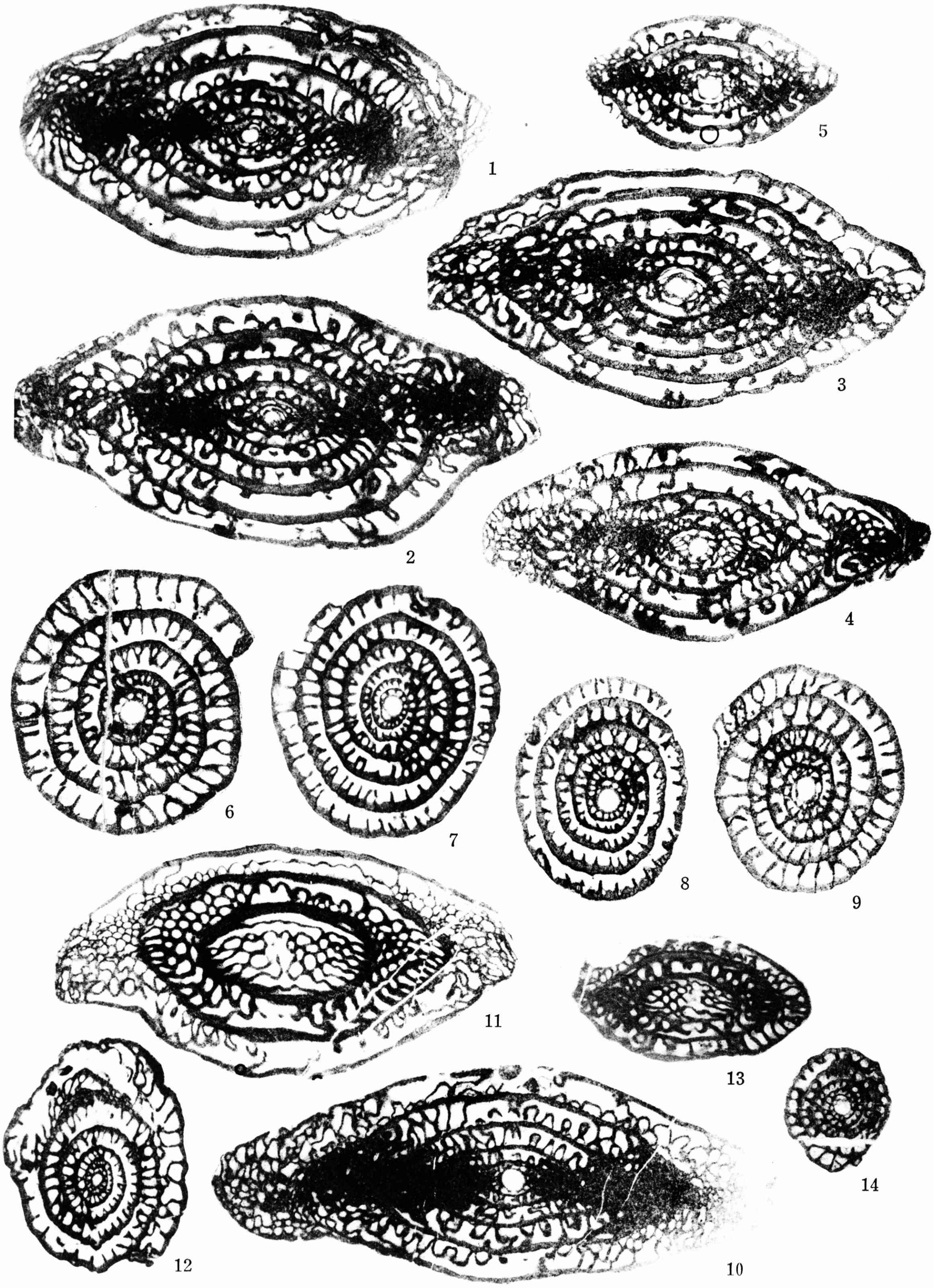

K. KANMERA: Fusulinids from Yayamadake