Geology of Akiyoshi Part III. : Fusulinids of Akiyoshi

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Geology of Akiyoshi

Part III. Fusulinids of Akiyoshi*

By

Ryuzo TORIYAMA

ABSTRACT — This paper is Part III of "Geology of Akiyoshi" and is concerned the Pennsylvanian and Permian fusulinids of the Akiyoshi limestone group of Southwest Japan. It includes the concise stratigraphical consideration of the fusulinid zones of the Akiyoshi limestone group summarized from Part I of this series of paper in addition to further information obtained by recent investigation.

The Systematic Paleontology of this paper consists of two parts; Parts A and B respectively concern the Pennsylvanian and Permian fusulinids of the Akiyoshi limestone group, comprising 101 species of 25 genera.

The Pennsylvanian fusulinids described in Part A include an unnamed form of *Nankinella*, each one of new and previously described species of *Staffella*, one previously described and two unnamed forms of *Eoschubertella*, one previously described species of *Fusiella*, each one of new, previously described, and unnamed forms of *Profusulinella*, two new, four previously described and four unnamed forms of *Fusulinella*, and one new species of *Fusulina*.

The Permian fusulinids described in Part B contain one new species of *Ozawainella*, one new and three unnamed forms of *Nankinella*, two previously described species of *Staffella*, one previously described and an unnamed forms of *Schubertella*, an unnamed form of *Quasifusulina*, nine new, six previously described and an unnamed forms of *Triticites*, each one of new, previously described and unnamed forms of *Dunbarinella*, two new, eight previously described and three unnamed forms of *Schwagerina*, one new species of *Paraschwagerina*, each one of previously described and unnamed forms of *Pseudoschwagerina*, each one of previously described and unnamed forms of *Nagatoella*, each five of new and previously described species of *Pseudofusulina*, four previously described and an unnamed forms of *Parafusulina*, one previously described species of *Verbeekina*, one previously described species of *Misellina*, two previously described species of *Pseudodoliolina*, four previously described and an unnamed forms of *Neoschwagerina*, three previously described, one new and an unnamed forms of *Yabeina*, two previously described species of *Afghanella*, and two previously described species of *Sumatrina*.

Introduction

Our knowledge of the Upper Paleozoic stratigraphy and paleontology of the Japanese Islands has been much increased during the last decade, and many

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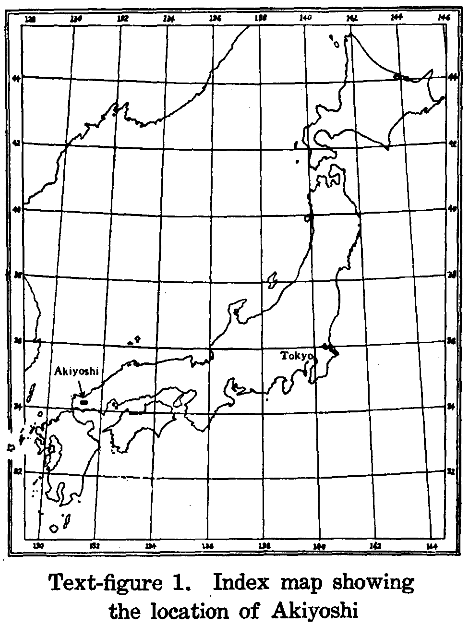
important and valuable facts have been brought to us. From the standpoint of the study of fusulinid foraminifers, almost all the fusulinid zones recognized in the Tethys region have been found in the Upper Paleozoic formations with foraminiferous limestones in this country. However, many important species for the purpose of the correlation have still been left undescribed, although some new genera and species were discovered and described from Honshu, Shikoku and Kyushu Islands.

This paper is the third part of "the geology of Akiyoshi" and is concerned principally with the Pennsylvanian and Permian fusulinids of the Akiyoshi limestone group. As already mentioned in Part I of this paper, OZAWA published an excellent monograph on the fusulinids of Akiyoshi in 1925 in which he described fifty-one species of nine genera. Since then, however, more than thirty years have passed, and there is a need for restudying of the Akiyoshi fusulinids under the modern knowledge of micropaleontology.

After I began the biostratigraphical and paleontological studies of the Upper Paleozoic formations in the Akiyoshi district, Yamaguchi Prefecture, Southwest Japan in 1944, I collected numerous specimens of fusulinids both from the Akiyoshi limestone group and from the limestone lenses interbedded in the Ota, Gampi, Beppu and Tsunemori groups which are largely noncalcareous in facies and are developed around the Akiyoshi limestone group. The stratigraphy of these groups and the geologic history of the Akiyoshi district were already described and discussed in Parts I and II of this paper published in 1954.



Text-figure 1. Index map showing the location of Akiyoshi

This paper is the result of the micropaleontological studies mainly on my collection which will be kept in the Department of Geology, Kyushu University, and partly on the OZAWA's collection which is kept in the Department of Geology, the University of Tokyo.

The fusulinid fauna of the Akiyoshi district comprises 103 species* of 26 genera, of which 21 species are of the Pennsylvanian age and described in Part A, and 80 species are of the Permian age and described in Part B. The Pennsylvanian fusulinids of Part A have been expected to be described and illustrated together

* Of 103 species of 26 genera *Akiyoshiella ozawai* TORIYAMA and *A.* sp. A were already described (TORIYAMA, 1953).

with those of British Columbia which are now studied by Dr. M. L. THOMPSON of the Geological Survey of Illinois, because these two Pennsylvanian faunas collected from the opposite sides of the Pacific Ocean are so similar with each other that it seemed pertinent to publish in one and the same monograph for comparison's sake. However, very similar or the same Pennsylvanian fusulinid species to some of Akiyoshi species have recently been found from several localities in Central and Southwest Japan, and, in fact, some new species described in this paper have been quoted for the paleontological comparison from my manuscript, which was completed before I left Madison, Wisconsin in 1951. Such being the case, the publication of a monograph on all the fusulinids of Akiyoshi, including the Pennsylvanian species, is now requested without further delay before the completion of Dr. M.L. THOMPSON's work on the Pennsylvanian fusulinids of British Columbia.

As an introductory part of this paper, an article titled "the fusulinid zones of Japan" was also prepared in which almost all the fusulinid zones and faunas known up to the present are summarized and discussed. However, this article was omitted to save the high cost of printing and will be published in future as a separate paper.

Acknowledgments

Appreciation is gratefully acknowledged to many persons and institutions in completing this work. First of all, I am indebted to Professor T. KOBAYASHI of the University of Tokyo who encouraged me during my study and granted permission of the use of the Dr. Y. OZAWA's collection. Doctor M.L. THOMPSON* of the Geological Survey of Illinois gave me valuable criticism, and technical advices in preparation of numerous microphotographs while I** was in Madison, Wisconsin in 1950–1951. Associate Professor K. KANMERA of Kyushu University also gave me helpful criticism and suggestion and aided me in preparation of the thin sections and the microphotographs. Professors T. TOMITA, H. MATSUSHITA and T. MATSUMOTO, all of the same University, Professor Emeritus H. YABE of Tohoku University, and Doctor M. MATSUYAMA, the president of Yamaguchi University, gave me continuous encouragement.

I am also indebted to many persons who gave me kind assistances in carrying out the field works and in collecting numerous fusulinid specimens: Messers I. ETO, M. FUJIMURA and S. OBA, all of Akiyoshi, Shuho-cho and Messers G. NAITO and G. OKAFUJI of Omine High School.

I wish, further, to express my sincere thanks to Mr. H. HARA who made a

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* Formerly Professor of the University of Wisconsin.

** Research Associate in Graduate School, the Uiversity of Wisconsin in 1950–1951.

large part of the thin sections used in this study, and to Mr. H. TAKATA and Misses M. IIO, M. ISHIKAWA, C. OKAMURA, and J. TAKAMIYA for careful preparation of the typescript and fossil lists.

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Stratigraphical Summary of the Fusulinid Zones of the Akiyoshi Limestone Group

In Parts I and II of this paper, the stratigraphical consideration of the fusulinid zones of the Akiyoshi limestone group and the correlation and the paleontological comparison of fusulinid faunule of each zone or subzone were already given at length. Since then, however, some informations have been added to the stratigraphical study of the Akiyoshi limestone group, and many valuable and important facts on the Upper Paleozoic rocks of Southwest Japan have become available to us during these few years. Therefore, it seems advisable to describe concisely the fusulinid zones of the Akiyoshi limestone group for convinience's sake of readers of this paper.

In my previous paper of 1954 (Part I) I divided the Akiyoshi limestone group into six fusulinid zones, the Lower and Middle Permian three zones of which were subdivided into two or three subzones. My later study has clarified the existence of the *Millerella* zone in the basal part of the group. Accordingly, the Akiyoshi limestone group is divisible into the following seven fusulinid zones in descending order.

7. *Yabeina* zone: *Yabeina shiraiwensis* zone ....Puα
6. *Neoschwagerina* zone:
   - *Neoschwagerina douvillei* subzone ....Pmδ
   - *Verbeekina verbeeki* subzone ....Pmγ
   - *Neoschwagerina craticulifera* subzone ...Pmβ
5. *Parafusulina* zone:
   - *Parafusulina kaerimizensis* subzone.........Pmα
   - *Pseudofusulina ambigua* subzone...............Plγ

4. *Pseudoschwagerina* zone: { *Pseudofusulina vulgaris* subzone ......Plβ
   Triticites simplex subzone ....Plα }
3. *Fusulinella* zone: *Fusulinella biconica* zone ....Cmβ
2. *Profusulinella* zone: *Profusulinella beppensis* zone....................Cmα
1. *Millerella* zone: *Millerella* sp. α zone..Cl

1. *Millerella* sp. α zone, Cl

Although I suggested the possibility of finding of *Millerella* zone in the Akiyoshi limestone group, I had not been able to recognize that zone before the completion of the manuscript of my previous paper in 1953. Accordingly, the *Profusulinella beppensis* zone was regarded as the lowest fusulinid zone in the Akiyoshi limestone group in Part I of this series of paper. I have recently found species of *Millerella* in several localities in the rocks hitherto referred to the lower part of the *Profusulinella beppensis* zone. However, since micropaleontological study of these species has not been completed, I am tentatively designating the rocks containing exclusively species of *Millerella* as *Millerella* sp. α zone.

So far has been observed, *Millerella* sp. α zone develops along the recently constructed sight-seeing road from the east of the Shuhodo cave to the bus stop on the Akiyoshi plateau. It also occurs at the "Uzura" quarry located about 1 km east of Yowara (Yobara) on the Ofuku plateau, where species of *Millerella* are associated with extremely abundant specimens of undescribed forms of brachiopod and rare ones of coral and ammonoid.

Because paleontological study of these fossils has not yet been completed, the correlation of the *Millerella* sp. α zone with other Onimaruan and/or Nagaiwan rocks of Japan is not discussed here. The stratigraphical relation between the *Millerella* sp. α zone and the OZAWA's *Nagatophyllum satoi* zone (C_1^1) is also not clear. More extensive future study of the lower part of the rocks referred to the *Profusulinella beppensis* zone will be necessary before the definite correlation can be made.

2. *Profusulinella beppensis* zone, Cmα

The *Profusulinella beppensis* zone is characterized by the association of the typical forms of *Profusulinella, P. beppensis* TORIYAMA, n. sp. and *P.* sp., a little more advanced form of the same genus, *P. rhomboides* (LEE et CHEN), the primitive member of *Fusulinella, F.* sp. C, two species of *Akiyoshiella* and minute species of *Nankinella, Staffella,* and *Eoschubertella.* Of these *P. beppensis* closely resembles *P. fukujiensis* reported by IGO (1956, 1957) from the lower part of the *Profusulinella* zone of the Ichinotani formation in the Hida massif. The close similarity between two species under consideration in the developmental stage of the shell suggests that the *Profusulinella beppensis* zone of Akiyoshi and *P. fukujiensis* zone of Hida are nearly the same in the stratigraphical position. The lower part of the Huanglung limestone of South China is also correlated with them.

It should be noted that the genera *Profusulinella* and *Fusulinella* do overlap each other in their stratigraphical range in the Akiyoshi limestone group, while they are not in the Mid-Continent of North America. The genus *Profusulinella* seemingly has considerably long range in the Tethys area including Southwest Japan.

3. *Fusulinella biconica* zone, Cmβ

Among the Pennsylvanian fusulinid zones, the *Fusulinella biconica* zone is most widely developed in the Akiyoshi limestone group as well as in the Middle Pennsylvanian (Moscovian) rocks of Japan and China. The fusulinid fauna of *Fusulinella biconica* zone comprises several species of *Fusulinella*—*F. simplicata* n. sp., *biconica* (HAYASAKA), *itoi* OZAWA, cf. *bocki* MÖLLER, cf. *pseudobocki* (LEE et CHEN), *subspherica* n. sp. and spp. A, B, and C.—and *Fusulina akiyoshiensis* n. sp.

Fusulinella simplicata TORIYAMA, n. sp., which predominates in the lower part of *F. biconica* zone, is closely allied to *F. jamesensis* THOMPSON, PITRAT and SANDERSON*. The latter species was described from the Cache Creek limestone of central British Columbia along with *Akiyoshiella toriyamai* THOMPSON, PITRAT and SANDERSON. It is of interest that *F. jamesensis* has been found by IGO (1956, 1957) from the *Fusulinella bocki* var. *asiatica* subzone, the upper half of the *Fusulinella* zone of the Ichinotani formation in the Hida massif.

It is also noted that ISHII (1956) reported the occurrence of *F. simplicata* with its subspecies *F. simplicata onoi* ISHII (MS) from the Itadorigawa group in the western part of Shikoku Island. According to him, the said species occurs in both the lower and upper fossil zones, but not in the intervening middle one which is characterized by the predominance of small primitive species of *Fusulina*. ISHII is of opinion that the Itadorigawa group is correlated either with the lower part of the *Fusulinella biconica* zone or with the part lower than that zone.

Fusulinella subspherica TORIYAMA, n. sp. and *Fusulina akiyoshiensis* TORIYAMA, n. sp. are characteristic to the upper part of *Fusulina biconica* zone, while other species of *Fusulinella*—*F. biconica, itoi,* cf. *bocki* and cf. *pseudobocki*—are known to occur throughout the zone under consideration.

As a whole, the *Fusulinella biconica* zone is, as already discussed in Part I, correlated either with the whole of the *Fusulinella* zone and probably a basal part of *Fusulina* zone in North America or with the Middle Moscovian of Tethys region. So far has been observed in the field, the Pennsylvanian three fusulinid zones are successively conformable with one another.

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* See the remark of *Fusulinella simplicata* TORIYAMA, n. sp. (p. 38).

4. *Pseudoschwagerina* zone

A. *Triticites simplex* subzone, Plα

The *Triticites simplex* subzone, the lowest part of the Permian section of the Akiyoshi limestone group, directly overlies either the *Fusulinella biconica* or *Profusulinella beppensis* zone without any physical break in the field. Therefore, an unconformity is presumed under the base of the *Triticites simplex* subzone.

The *Triticites simplex* subzone is flourished by a rich faunule of *Triticites* with few specimens of *Pseudoschwagerina*, and the very basal part of this subzone, though several meters in thickness, is characterized by exclusively species of *Triticites*. With several new species described later, the *Triticites* faunule of this subzone contains *T. simplex* (SCHELLWIEN), *T.* cf. *petschoricus* RAUSER-CERNOUSSOVA, BELJAEV and REITLINGER, and other species which are known from both Uralian and Sakmarian rocks of Moscow Basin and Samara Bend of Russia. So far as known in Japan, *T. simplex, T. montipara* and *T. kagaharensis* have been reported from the Sakamotozawan (Wolfcampian or Sakmarian) rocks with species of *Pseudoschwagerina*. These forms, with their allied forms, are biologically clearly different from recently described typical Uralian species, such as *Triticites matsumotoi* KANMERA and *T. yayamadakensis* KANMERA from the Yayamadake subgroup of southern Kyushu (KANMERA, 1954) and *T. nakatsugawensis* MORIKAWA and its variety, *hemmii*, from Okuchichibu of the Kwanto massif (MORIKAWA, 1953).

In short, the characteristic of the *Triticites simplex* subzone is the abundance of species of the index genus, and, at the same time, the occurrence of *Pseudoschwagerina* must not be neglected.

B. *Pseudofusulina vulgaris* subzone, Plβ

Likewise the lower one, the upper subzone of the *Pseudoschwagerina* zone is widely developed and is most prolific of fusulinids, containing about fifty species. The fauna of this subzone comprises thirteen species of *Triticites,* twelve species of *Schwagerina,* nine species of *Pseudofusulina,* three species of *Dunbarinella,* each two species of *Nagatoella* and *Parafusulina,* one species of *Paraschwagerina,* and several species of minute fusulinids such as *Ozawainella, Staffella* and *Schubertella*. Of these *Paraschwagerina* (*Paraschwagerina*) *akiyoshiensis* TORIYAMA, n. sp., *Triticites ellipsoidalis* TORIYAMA, n. sp. and several new species of *Triticites, Schwagerina* and *Dunbarinella* are characteristic to this subzone.

Although the index species, *Pseudofusulina vulgaris* (SCHELLWIEN), is not restricted to this subzone in the stratigraphical occurrence, ranging up to overlying subzones, the faunal assemblage indicates that the *Pseudofusulina vulgaris* subzone is undoubtedly the Lower Permian in age, and is probably equivalent to the middle part of it.

It is noted that the representative of the genus *Parafusulina* has already appeared in the upper part of this subzone.

Extreme abundance in numbers of species and individuals of fusulinids and the wide distribution of this subzone suggest that the Lower Permian sea was most widely spread out at least in the Akiyoshi area in the age of *Pseudofusulina vulgaris* subzone.

5. *Parafusulina* zone

A. *Pseudofusulina ambigua* subzone, Plγ

Although the *Pseudofusulina ambigua* subzone is rather limited in its geographical distribution, it still contains a considerably rich fauna of the Lower Permian aspect, comprising of seven species of *Pseudofusulina,* five species of *Schwagerina,* each two species of *Triticites, Nagatoella* and *Parafusulina* and few species of minute fusulinids.

Although neither species of *Pseudoschwagerina* nor *Paraschwagerina* has been found in this subzone, the occurrences of *Pseudofusulina vulgaris* and its allied forms and of the representatives of *Triticites* indicate that the *Pseudofusulina ambigua* subzone is certainly of the Lower Permian age, while the existence of species of *Parafusulina* throughout the subzone suggests that it is referable to a part of *Parafusulina* Zone.

B. *Parafusulina kaerimizensis* subzone, Pmα

Showing a rather marked contrast to the lower subzone in the faunal assemblage, the *Parafusulina kaerimizensis* subzone is comprising many representatives of the primitive verbeekinids and neoschwagerinids as the forerunner but no species of *Triticites* and primitive *Schwagerina.* The index genus of this subzone is represented by the typical forms such as *Parafusulina kaerimizensis* (OZAWA), *P. edoensis* (OZAWA), *P. gigantea* (DEPRAT) and *P.* spp. A and B, and the stratigraphical range of most of them extends into the lower part of the overlying *Neoschwagerina craticulifera* subzone but not to the upper part. On the other hand some of neoschwagerinids and verbeekinids do not occur in the lower part of this subzone and some are very incidental in occurrence if exist.

Not likewise in the Mid-Continent region of North America where the *Parafusulina* zone is paleontologically well defined, the *Parafusulina* zone in the Permian rocks of Japan is, as already discussed in Part I of this paper, sometimes difficult to recognize paleontologically, because no formation has been known in which species of *Parafusulina* are exclusively contained, and the Permian rocks hitherto referred to the *Parafusulina* zone are usually comprising a mixed fauna of parafusulinids, verbeekinids and neoschwagerinids. Such being the case, a question arises whether a formation containing such the mixed fauna is referred to a part of *Parafusulina* zone or of *Neoschwagerina* zone.

As *Parafusulina kaerimizensis* subzone is characterized by an assemblage of the typical species of *Parafusulina* and the primitive members of *Pseudodoliolina, Afghanella* and *Neoschwagerina,* it is regarded as a part, probably the upper part, of the *Parafusulina* zone. The lower and upper subzones of the *Parafusulina* zone of the Akiyoshi limestone group are conformable with each other in the field, though they are considerably different in the faunal assemblage.

6. *Neoschwagerina* zone

A. *Neoschwagerina craticulifera* subzone, Pmβ

The lower subzone of the *Neoschwagerina* zone is flourished by prolific neoschwagerinids and verbeekinids comprising the index species and its variety, *N. haydeni* DOUTKEVITCH and KHABAKOV, *N.* spp. A and B, *Afghanella schencki* THOMPSON, *A.* sp. A, *Pseudodoliolina pseudolepida* (DEPRAT) and *P. ozawai* YABE and HANZAWA, with accompanying several species of *Schwagerina, Nagatoella, Parafusulina* and minute fusulinids.

Although the stratigraphical occurrence of the index species, *N. craticulifera* (SCHWAGER), is considerably limited in the Akasaka limestone, the type locality of the species, ranging from the upper part of the Nn zone through the Nc zone to the lower part of the Nm zone, it is somewhat more wide in other localities; for example, it ranges from the P_1 (Zone of *N. craticulifera* or *Pseudofusulina ambigua*) to P_3 (Zone of *Yabeina globosa*) in the Kwanto massif, and, according to OZAWA, from CPg (*Parafusulina lutugini* subzone) to P_3 (*Sumatrina annae* subzone) in the Akiyoshi limestone.

So far as the present study is concerned, the stratigraphical range of *N. craticulifera* covers both the Pmα and Pmβ subzones, though its occurrence is more abundant in the latter. Therefore, if the faunal association is taken into account the present subzone is rather faunistically well defined at least in the Akiyoshi limestone group, and is certainly correlated with the Nc zone of the Akasaka limestone.

B. *Verbeekina verbeeki* subzone, Pmγ

The distribution of the *Verbeekina verbeeki* subzone is very much limited in the Akiyoshi area, and the index species occurs only with undeterminable species of *Schwagerina,* but without any species of other verbeekinid and neoschwagerinid. Such being the case, the correlation of the present subzone with other Middle Permian fusulinid zone is not determined with certainty. However, *Verbeekina verbeeki* (GEINITZ) has often been described or reported in Japan from a zone in which *Neoschwagerina margaritae* (DEPRAT) occurs. The Nm zone of the Akasaka limestone and P_2, the zone of *Neoschwagerina margaritae* of the Kwanto massif are the examples.

In the field the present subzone is conformably overlying the *Neoschwagerina craticulifera* subzone, and the Nm zone also directly covers the Nc zone in the Akasaka limestone. These facts led me a conclusion that the present subzone is probably an equivalent of *N. margaritae* zone of other parts of Japan.

C. *Neoschwagerina douvillei* subzone, Pmδ

Likewise the subzone stated above, the *Neoschwagerina douvillei* subzone is very much restricted in distribution, but the number of individuals of fusulinid species found in this subzone is fairly large. It contains numerous specimens of *N. douvillei* OZAWA, *N. megaspherica* OZAWA, and *Yabeina tobleri* (LANGE) (?) and few specimens of *N. craticulifera haydeni* DOUTKEVITCH and KHABAKOV.

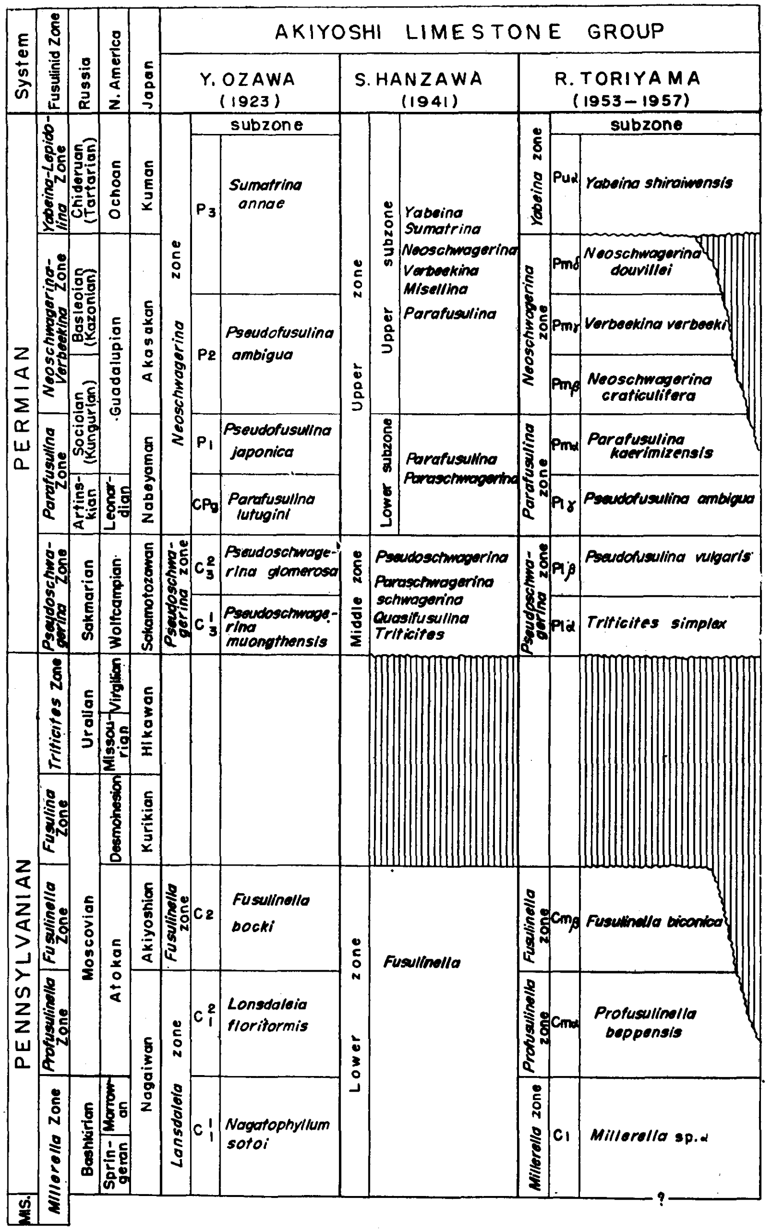
Phylogenetically speaking, the first two species are the advanced member of the genus *Neoschwagerina*, while the third one is rather primitive for the genus *Yabeina* if it is really referable to that genus. In the original description of *N. toblei*, LANGE pointed out the similarity between that species and *Yabeina globosa* (YABE) which is also a primitive member of *Yabeina*.

From the stratigraphical and paleontological points of view KANMERA (1952, 1954, 1957) repeatedly emphasized the separation of the so-called *Yabeina* zone, hitherto regarded as the uppermost fusulinid zone, into two zones, the lower *Yabeina globosa* zone and the upper *Lepidolina* zone. The former is characterized by the association of the primitive species of *Yabeina* and the advanced species of *Neoschwagerina*, while the latter by species of *Lepidolina* and highly advanced species of *Yabeina* without any species of *Neoschwagerina*. A typical example of the former is the Ng zone of the Akasaka limestone. The *Neoschwagerina douvillei* subzone, comprising the advanced species of *Neoschwagerina* and *Yabeina tobleri* (LANGE) (?), may probably be referable to the *Yabeina globosa* zone.

7. *Yabeina shiraiwensis* zone, Puα

The *Yabeina shiraiwensis* zone, the uppermost fusulinid zone of the Akiyoshi limestone group, is rather widely developed in the Ofuku plateau, and is characterized by the advanced forms of *Yabeina*, *Sumatrina* and *Schwagerina*: namely, *Yabeina shiraiwensis* OZAWA, *Y. yasubaensis* TORIYAMA, *Y. pinguis* TORIYAMA, n. sp., *Y.* spp. A and B, *Sumatrina longissima* (DEPRAT), and *Schwagerina* sp. A. Of these, the index species and *Y. yasubaensis* are, according to KANMERA, the characteristic species of the *Lepidolina* zone of the Kuma massif discussed above, to either of them *Y. pinguis* is closely allied, being nearly the same in relative degree of the evolutionary development.

Stratigraphically speaking, the limestones of *Yabeina shiraiwensis* zone are composed almost of limestone conglomerates, in pebbles of which fusulinids of



Text-figure 2. The fusulinid zones of the Akiyoshi limestone group.

various lower subzones are contained. Moreover, the *Yabeina shiraiwensis* zone is directly overlying either of the *Neoschwagerina douvillei* and lower subzones. An unconformable relation is, therefore, presumed between the *Yabeina shiraiwensis* and underlying fusulinid zones.

In short, from the paleontological and stratigraphical standpoints, the *Yabeina shiraiwensis* zone is correlated with the *Lepidolina* zone of the Kuma massif and its equivalent formations in Southwest Japan, and with the Mable Canyon limestone of British Columbia and the Upper Permian formation of Cambodge, all of which are presumed to belong to the same faunal province in the late Permian time.

Collection Locality

More than 300 collecting localities, from which the fusulinids described and illustrated in this paper have been collected during the period from 1941 to 1957, cover the almost whole area of Miné-gun and a part of Miné-shi* of Yamaguchi Prefecture, Southwest Japan.

In the following description of the collecting points, the Arabic figures in parentheses immediately following the collection number indicate the height above the sea-level. In the collecting points which belong to any of the Section described in Part I of Geology of Akiyoshi, the Roman numerals indicate the Section number, and the Arabic figures following the Section number mean the "number" in the Section. For example, **286** (205m), I–4 indicates that the collecting point 286 is of 205m height above the sea-leavel and is No. 4 limestone of Section I.

As all the localities are in Yamaguchi Prefecture, the prefectural name is omitted from the following description for briefness' sake.

1 (120m), XXVII-1; Just S of the irrigation reservoir on the northern slope of Amagoi-yama, W of Okugawara, Isa, Miné-shi.

2 (100m); About 300m S of Okugawara, along the road from Okugawara to Kawara, Isa, Miné-shi.

4 (100m); Nearly halfway between Okugawara and Kawara (about 900m N of Kawara), Isa, Miné-shi.

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* As a result of the law of promotion of unification of township and village recently taken effect, many of *machi* or *cho* (town) and *mura* or *son* (village) are combined together and established new *shi* (city) or new *machi* or *cho* (town).

The former names are indicated immediately before the name of the newly established *shi* or *machi* (or *cho*) as the sub-division of the latter. In the Akiyoshi area the main changes are as follows:

New Miné-shi includes former Ominé-machi, Isa-machi and Ofuku-mura of Miné-gun and Toyodamae-mura of Asa-gun.

New Shuho-cho includes former Kyowa-mura, Beppu-son, Akiyoshi-mura and Iwanaga-mura.

New Mito-cho includes former Ota-machi and Akago-mura of Miné-gun, and Ayagi-mura and Managata-mura of Yoshiki-gun.

12 (160m+); About 300m S of Serita, Beppu, Shuho-cho.
13 (200m−); 900m S of Serita (halfway between Serita and Yobara), Beppu, Shuho-cho.
15 (220m); N of "Nagajakuri" doline, Akiyoshi, Shuho-cho (Just S of the Akiyoshidai bus stop).
62 (220m); On the summit, S of the pass between Shiraiwa and Maki, Ominé, Miné-shi.
97–103: Shigeyasu-quarry, just W of the Shigeyasu station, Ominé, Miné-shi.
97 (110m), XIV-1; near the northern margin of the quarry: **98** (110m+), XIV-2; about 20m N of 97: **99** (Block), obtained at the southern part of the quarry: **100** (120m), XIV-3; about 40m SSW of 97, central part of the quarry: **101** (150m), XIV-5; about 30m SW of 100: **102** (150m+), XIV-6; 20m SW of 101, southwestern margin of the quarry: **103** (130m), XIV-4; 20m SE of 100, central southern part of the quarry.
183–186: Along or around the lane from Irimizu to the north-western part of Daiyama, Ofuku-dai, Ofuku, Miné-shi.
183 (330m), XV-3; about 80m S by E of the "Hinode" quarry (Loc. 765): **184** (320m+), XV-2; 150m W of 183: **185** (340m), XV-4; 85m S of 183: **186** (340m+), XV-5; 160m SEE of 183.
187 (360m); 120m NW of the summit of "Akanta-yama," Ofuku, Miné-shi.
188–191: Northern slope of "Akanta-yama" (bench mark 409.4m), Ofuku, Miné-shi.
188 (320m), XVI-6; about 400m NNW of the summit of "Akanta-yama": **189** (310m), XVI-5; 110m E by N of 188: **190** (270m), XVI-4; 670m NNE of the summit of "Akanta-yama": **191** (240m), XVI-3; 80m E of 190.
194 (Block); Obtained at a place about 850m NW of "Akanta-yama," Ofuku, Miné-shi.
195 (160m); About 800m N by W of "Akanta-yama" (SWW of Serita), Beppu, Shuho-cho.
196 (100m+); 350m S from the junction of the narrow road to Serita and the prefectural highway between Hagiwara and Katada, Beppu, Shuho-cho.
233 (100m+); Remains of a quarry located NE of the Shigeyasu station (330m NE of the station), Ominé, Miné-shi.
235 (110m); 350m NEE of the small irrigation reservoir on the by-path between Kama and Tonogakochi, Kyowa, Shuho-cho.
251 (110m+); W of Tonogakochi, Kyowa, Shuho-cho.
257–264: Along or around the uphill road from Kuroiwa southeastward to Chojagamori, Kuroiwa, Kyowa, Shuho-cho.
257 (190m), XXI-1; about 450m SE of Kuroiwa: **258** (194m), XXI-2; 20m SE of 257: **259** (200m), XXI-3; 30m E by N of 258: **260** (220m), XXI-4; 40m NNE of 259: **261** (230m), 40m NNE of 260: **262** (270m+), XXI-5; 100m NEE of 261: **263** (300m), XXI-8; 350m SEE of 262: **264** (300m−), XXI-7; 50m NE of 263.
265 (100m), XXI-1; 30m SSW of the junction of the road between Minami-kochi and Shibao and the uphill road from Kuroiwa to Chojagamori.
269–273: Along the southern slope of the hill of the 394.5m in height, N of "Kirigadai," Kyowa, Shuho-cho.
269 (350m), XXIII-1; about 100m W of the gentle pass between Shibao and Kaerimizu (the lowest part between the bench mark 394.5m and "Kirigadai"): **270** (355m), XXIII-2; 50m N of 269: **271** (360m), XXIII-3; 15m N of 270: **272** (361m), XXIII-4; about 10m N of 271: **273** (375m), XXIII-5; 50m N of 272.
275–279: Along the steep lane from Shikanode to Kaerimizu, Kyowa, Shuho-cho.
275 (230m), XXV-5; 350m SSE from the junction of the lane to Kaerimizu and the road between Kawaradani and Ebiratoge: **276** (220m), XXV-4; 160m SE of the junction: **277** (165m), XXV-3; 90m SE of the junction: **278** (155m), XXV-2; 60m SE of the junction: **279** (150m), XXV-1; 55m NE of the junction along the road to Abumitoge (bench mark, 272m).
285A–299: Along the eastern slope of the Kaerimizu doline (the western slope of Managatake), Akago, Mito-cho. [All the collecting points 285A–299 are successively arranged from the ponor of the doline almost eastwardly to the top of Managatake]. (Refer also to 812–820)
285A (180m), I-1; east side of the ponor: **285** (195m), I-2: **286A** (205m), I-3: **286** (205m+), I-4: **287** (200m), I-5: **287A, B** (210m), I-6: **288A** (215m), I-7: **288** (217m): **289** (233m), I-8: **290** (240m), I-9: **291** (255m), I-10: **292** (277m), I-11: **293** (290m), I-12: **294** (325m): **295** (345m),

I-13: **296** (360m), I-14: **297** (365m), I-15: **298** (370m), I-16, the top of a hill, located 160m W of the top of Managatake: **299** (360m), 15m E of 298.

300 (280m), XXV-6; 400m NW of the ponor of Kaerimizu doline, Kyowa, Shuho-cho.

303–305: Along or around the uphill path from Narutaki to Tanaiwa, Kyowa, Shuho-cho.
303 (285m), XVII-1; about 200m SW of the pass between Narutaki and Tanaiwa: **304** (295m), XVII-2; 25m E of 303: **305** (295m), XVII-3; 20m NNE of 305.

306, 307: Along the road from Narutaki to the mable quarry which is not worked at present, Beppu, Shuho-cho.
306 (330m), 250m S of the junction of the road from Narutaki to Tanaiwa and that to the quarry: **307** (360m), about 150m S of 306.

310, 311: SW of the pass between Narutaki and Tanaiwa, Kyowa, Shuho-cho.
310 (315m) XVII-4; 100m SW of the pass: **311** (325m), XVII-5; 20m SW of the pass.

312 (280m); On the downhill path and about 550m E from the pass described above.

313–316: Along the uphill path from Ono to "Dekimizu," NW of Tanaiwa, Kyowa, Shuho-cho.
313 (265m), XVIII-5; 170m E by S of Ono in a straight distance: **314** (260m), XVIII-4; 20m W by N of 313: **315** (110m), XVIII-3; 120m W by N of 314: **316** (105m), XVIII-2; 30m W by N of 315.

317 (95m), XVIII-1; 220m SW of 316, Ono, Kyowa, Shuho-cho.

318–322: Along the uphill path from 100m SW of "Hirano-bashi" to "Ryugoho" (bench mark of 425.5m), Beppu, Shuho-cho.
318 (90m), VIII-1; at the junction of the prefectural highway between Kama and Akiyoshi and the path to "Ryugoho": **319** (105m), VIII-2; 20m E of 318: **320** (107m), VIII-3; 20m SE of 319: **321** (198m), about 400m SEE along the pass from 320: **322** (200m), VIII-4; 15m E of 321.

325 (405m), VIII-5; 90m SSE of the summit of "Ryugoho" (bench mark of 425.5m), Akiyoshi, Shuho-cho.

327 (230m), VII-1; On the uphill path from "Seto" to "Ryugoho"; about 900m N of "Seto" quarry.

329–333: Along the northwest-western slope of "Kirigadai," Kyowa, Shuho-cho.
329 (287m), XXII-1; about 800m in a direction of N 60° W from the highest point of "Kirigadai": **330** (305m), XXII-2; 240m SE of 329: **331** (325m), XXII-3; 75m E by S of 330: **332** (345m), XXII-4; 100m E by S of 331: **333** (410m), XXII-5; 50m NW of the highest point of "Kirigadai."

334–336: Around the highest point of "Kirigadai," Kyowa, Shuho-cho.
334 (425m), 40m SSE of the highest point: **335** (425m), 30m SSE of 334: **336** (425m), 30m NE of 334.

337 (280m), XXI-6; SE of Kuroiwa, 70m NWW of 263.

338–342: South-southwestern slope of Takayama (bench mark of 228m), Minamikochi, Kyowa, Shuho-cho.
338 (150m), XX-4: **339** (210m), XX-5: **340** (220m), XX-6; 70m SSW of the summit: **341** (228m), XX-7; the summit of Takayama: **342** (100m), XX-3; at the junction of the uphill lane and the road from Minamikochi to Shibao.

343 (100m), XX-2; 220m SW of 342 along the road between Minamikochi and Shibao.

345, 346: On the top of Nakanodai ("Tonandai"), Kyowa, Shuho-cho.
345 (250m), 300m N of the bench mark, 261.5m: **346** (250m), 200m N of the bench mark.

351–355: Southwest-western slope of Shishidedai, Akago, Mito-cho.
351 (300m), II-5; 150m SWW of the top of Shishidedai: **352** (240m), II-4; 100m NW of the bench mark, 261.5m: **353** (210m), II-3; 100m NW of 352: **354** (210m), II-2; 40m N of 353: **355** (210m), II-1; 100m NW of 354.

357 (160m); 175m NE of 279, along the road from Kawaradani to Abumitoge (bench mark, 272m), Kawaradani, Kyowa, Shuho-cho.

358, 359: Around the top of "Tsugunenoatama" (bench mark, 421.6m), northeastern hill of Ofukudai, Beppu, Shuho-cho.
358 (410m), just on the top: **359** (390m), 100m NWW of 358.

361 (100m); Era quarry, N of Era, Beppu, Shuho-cho.
362 (90m); Northwestern bank of Shirozu-ike, Era, Shuho-cho.
363 (280m+); "Uzura" quarry, located about 1200m W of Yobara, Beppu, Shuho-cho.
365, 366: Along the road runs through the west side of Yobara, Beppu, Shuho-cho.
365 (160m), about 400m NNW of the crossing of roads at the southern outskirts of Yobara: **366** (160m), 120m N of 365.
368–370: Along the road between Serita and Yobara, Beppu, Shuho-cho.
368 (190m), about 700m S of Serita (200m N of 13): **369** (160m+), about 300m S of Serita (almost the same point as 12): **370** (160m), 10m N of 369.
373 (100m−); 120m S by W of the junction of road between Kama and Sako and that between Kajiya and Ono, Kajiya, Kyowa, Shuho-cho.
374–376: Along the western slope of a gentle hill, located to the E of Kajiya, Kyowa, Shuho-cho.
374 (95m), XIX-1; about 400m SSE of a small bridge located to the S of Kajiya: **375** (120m), XIX-2; 190m SE of 374: **376** (210m), XIX-3; 430m E by S of 375.
377, 378: Western slope of "Kasagi-yama" (bench mark, 334m), Kyowa, Shuho-cho.
377 (240m), 360m W by N of the bench mark: **378** (255m), 130m SSE of 377.
379, 380: Western slope of Tanaiwa (bench mark, 302.1m), Kyowa, Shuho-cho.
379 (270m), 350m NWW of the bench mark: **380** (250m), 180m SW of 379.
381, 382: Southwestern slope of Tanaiwa (bench mark, 302.1m), Akiyoshi, Shuho-cho.
381 (240m), 370m SWW of the bench mark: **382** (240m), 60m E of 381.
427 (90m); Small quarry to the W of Iwanaga-hongo, Iwanaga, Shuho-cho.
433–443: Along or around the uphill path from the E of Kyozuka to the pass located NE of "Ryugoho," Akiyoshi, Shuho-cho.
433 (250m), VII-2; about 850m N by E of Kyozuka (bench mark, 245m): **434** (250m+), VII-3; 170m NNW of 433: **435** (270m), VII-4; 200m NW of 434: **436** (280m), VII-5; 50m N by W of 435: **437** (290m), VII-6; 40m N by W of 436: **438** (300m), VII-7; 180m N by W of 437: **439** (365m), VII-10; 520m NW of 439: **440** (335m), VII-9; 380m NNW of 438: **441** (315m), VII-8; 140m N by W of 438: **442** (270m), 270m E of 441: **443** (240m), 120m SSE of 442.
444 (200m); Southeastern wall of "Yanoana" doline, 100 m SE of the lowest point of the doline, Akiyoshi, Shuho-cho.
445, 446: W of "Yanoana" doline, Akiyoshi, Shuho-cho.
445 (200m), 220m W by S of the lowest point of the doline: **446** (210m), 180m NNW of 445.
447–452, and 456: South-southeastern slope of Tanaiwa (or N of "Nagajakuri" doline), Akiyoshi, Shuho-cho.
447 (210m), VIA-1; 250m N by W of the lowest point of "Nagajakuri" doline: **448** (210m), VIA-2; 90m N by E of 447: **449** (250m), VIA-3; 250m N of 448: **450** (260m), VIA-4; 50m N of 449: **451** (280m), VIA-5; 130m N by W of 450 (or 230m SE of the bench mark, 302.1m): **452** (300m), VIA-6; 80m SE of the bench mark, 302.1m.
456, 457: N of "Nagajakuri" doline along the road to "Wakatake-yama," Akiyoshi, Shuho-cho.
456 (230m), 250m N by E of the lowest point of the doline: **457** (230m), 75m E by S of 456.
458–460: NE of "Nagajakuri" doline, Akiyoshi, Shuho-cho.
458 (260m), about 500m NE of the lowest point of the doline: **459** (260m), 130m NE of 458: **460** (270m), 350m NNE of 459.
461–464: Northwestern slope of "Benkei-yama" which is located 600m N of "Minami-yama" (bench mark, 321.4m), Ota, Mito-cho.
461 (330m), V-1: **462** (340m), V-2: **463** (350m), V-3: **464** (350m), V-4.
465 (320m); 40m E of the bench mark, 321.4m of "Minami-yama," Ota, Mito-cho.
467 (290m); About 600m NWW of the bench mark, 321.4m of "Minami-yama," Ota, Mito-cho.
472–475: Along the path runs through the west side of long rally ("Owatari") of north-northeasterly direction, NW of "Kasagi-yama" (bench mark, 334m), Kyowa, Shuho-cho.
472 (260m), 750m NNW of the bench mark of 334m: **473** (250m), 360m NNE of 472: **474** (220m), 250m NNE of 473 (180m NE of the lowest point of a small doline): **475** (225m), 65m NW of 474.
476–479: On the gentle range of almost N-S direction, SE of Kuroiwa, Kyowa, Shuho-cho.

476 (310m), XXI-9; 40m NE of the highest point at the northern part of the range (270m SE of 263): **477** (310m+), XXI-10; 25m SW of 476: **478** (360m), 480m S by W of 477: **479** (360m), 70m S of 478.

480 (230m); 60m W by N of 381, southwestern slope of Tanaíwa (bench mark, 302.1m), Akiyoshi, Shuho-cho.

489, 490: On the top of a hill (bench mark, 319.0m), located about 2000m N by W of the prefectural stad-farm, Isa, Miné-shi.
489 (319m), just on the top: **490** (315m), 50m NE of 489.

491–493: Southern slope of a hill situated just to the N of the hill (bench mark, 319.0m) described above, Isa, Miné-shi.
491 (315m), X-1; 150m N by E of 490: **492** (320m), X-2; 25m N of 491: **493** (320m+), X-3; 70m N of 492.

494, 495: Along the path around the hill described above, Isa, Miné-shi.
494 (300m), about 300m N by W of 493: **495** (300m), 180m NWW of 494.

496, 497: NE of Okugawara, Isa, Miné-shi.
496 (295m), 240m SW of 495 in straight distance: **497** (260m), 300m S by E of 496.

498 (325m); About 70m SW of the top of a hill located about 900m S of "Tsugunenoatama" (bench mark, 421.6m), Isa, Miné-shi. (About 400m NNE of 494 in straight distance).

499 (100m); 1150m SEE from "Hirano-bashi" along the prefectural highway between Kama and Akiyoshi, Akiyoshi, Shuho-cho.

500–502A: Along the uphill road from the NW of Iwanaga-hongo northwest-westward to the hill of 319.0m in height, Iwanaga, Shuho-cho.
500 (80m), XIA-1; 90m NNW from the farm-house situated most north-westerly along the road: **501** (100m), XIA-2: 150m N by W of 500: **502** (105m), XIA-3; 80m NW of 501: **502A** (105m+), XIA-4; 15m NWW of 502.

502 (285m); About 1200m E of the pass between Yobara and Okugawara along the road runs easterly, Isa, Miné-shi.

505, 506: S of the pass between Irimi and Okugawara, Isa, Miné-shi.
505 (280m), 250m S of the pass: **506** (230m), 80m SW of 505.

508 (250m); 380m SSW of the top of Amagoi-yama (bench mark, 373.3m) in straight distance, Isa, Miné-shi.

509 (265m); 380m W by N of the top of Amagoi-yama in straight distance, Isa, Miné-shi.

514 (120m); 1200m W by S of the three-forked road at Kawara, Isa, Miné-shi.

515–520: Along the uphill road from Mizuta southwest-westward to "Iwanagadai," Iwanaga, Shuho-cho.
515 (125m), about 200m SWW of Mizuta: **516** (130m), IX-1; 65m S of 515: **517** (150m), 65m S of 516: **518** (160m), IX-2; 50m S by W of 517: **519** (280m), IX-3; about 1100m SWW of 518: **520** (280m), IX-4; 20m SW of 519.

521–523: Southern slope of a hill located about 500m NE of the hill of 319m in height, Isa, Miné-shi.
521 (320m), X-4; 320m NW of 491 in straight distance: **522** (322m), X-5; 25m N of 521: **523** (320m), X-6; 5m N of 522.

524–526: Along the uphill road from the W of Iwanaga-hongo northwest-westward to "Iwanagadai," Iwanaga, Shuho-cho.
524 (85m), 40m W of the most westerly located farm-house of Iwanaga-hongo (or about 100m S of 427): **524A** (85m+), 20m NW of 524: **524B** (85m+), 30m W of 524: **525** (100m), about 70m W of 524B: **526** (120m), about 180m NWW of 525.

527 (210m); About 200m NNE of the three-forked road along the old road from Hirotani to Naganobori via W of Okubo, Okubo, Ota, Mito-cho.

528 (285m); 390m SSW of the top of "Minami-yama" (bench mark, 321.4m), Ota, Mito-cho.

529 (280m); 360m NE of the top of "Minami-yama" (bench mark, 321.4m), Ota, Mito-cho.

531 (370m); About 50m W of the top of "Kitayama" which is a gentle hill located to the NNW of Chojagamori, Kyowa, Shuho-cho.

532–534: Along the road from Sayama to Taishodo, Akago, Mito-cho.

532 (180m), 570m SSW of the junction of roads from Sayama to Taishodo and to Kagekiyodo: 533 (180m), 400m W by S of 532: **534** (180m), 300m W of 533, just N of Taishodo.

535 (230m); About 1100m NW of Taishodo on the western slope of "Yodanko," a gentle hill located to the N of Taishodo, Akago, Mito-cho.

536–548: Along the uphill path from Sayama to the top of Managatake (Northeastern slope of Managatake), Akago, Mito-cho.

536 (200m), about 550m SSW of the junction of roads to Taishodo and to Managatake: **537** (215m), 110m SW of 536: **538** (220m), III-1; 210m SW of 537: **539** (255m), III-2; 200m SWW of 538: **539A** (260m), III-3; 5m SW of 539: **540A** (265m), III-4; 30m SWW of 539A: **540** (267m), III-5; 5m S of 540A: **541** (275m), III-6; 45m SSW of 540: **542** (300m), III-7; 70m SW of 541: **543** (315m), III-8; 75m SWW of 542: **543A** (315m), III-9; 10m SSE of 543: **544** (335m), III-10; 50m SW of 543: **545** (350m), III-11; 40m SWW of 544: **546** (380m), III-12; 80m SWW of 545 (10m NW of the top of Managatake): **547** (375m), 30m SW of 546: **548** (360m), 120m W by S of 546.

549–552: Northeastern part of "Jigokudai," Kyowa, Shuho-cho.

549 (340m), XXIV-5; 40m N 60°E of the monument of "Jigokudai": **550** (340m), XXIV-4; 150m N 60°E of the monument: **550A** (340m), XXIV-3; 10m N by E of 550: **551** (320m), XXIV-2; 60m NE of 550: **552** (300m), XXIV-1; about 400m N 60°E of 551.

553 (280m); About 600m S 30°W of the top of Managatake, Akago, Mito-cho.

565 (130m); 40m N of the top of a low hill (bench mark, 142.1m), located to the SW of Iwanaga-hongo, Iwanaga, Shuho-cho.

566–568C: Around a hill located about 650m NNE of the hill of 319m in height, Isa, Miné-shi.

566 (320m), X-7; 100m NNW of 523: **567** (320m+), X-8; 75m N of 566: **568** (320m), X-9; 65m N by W of 567: **568A** (320m), X-10; 10m SE of 568: **568B** (320m), X-11; 4m NE of 568A: **568C** (320m), X-12; 10m NE of 568.

569 (110m); Eastern part of the Isa quarry worked by the Ubekosan Co., Isa, Miné-shi.

570–571A: Along the uphill path from the Isa quarry to Konokami-yama (bench mark, 233.0m), Miné-shi.

570 (110m), XIII-1; about 750m SW of the bench mark in straight distance: **570A** (160m), XIII-2; 20m NNE of 570: **571** (170m), XIII-3; 130m NE of 570A: **571A** (170m+), XIII-4; 5m NE of 571.

572 (100m); Kunigyo quarry, Kunigyo, Ominé, Miné-shi.

577 (90m); Small limestone outcrop by the railroad of the Miné-line, about 1450m NNE of the Yoshinori station, Ominé, Miné-shi.

600–602: Along the recently constructed road from the N of Maruyama north by eastward to 1000m W of Kawara, Isa, Miné-shi.

600 (110m), about 150m NW of the junction of road at the N of Maruyama: **601** (140m), 200m N of 600: **602** (160m), 120m N by E of 601.

603 (100m); "Yakusen" quarry, S of Maruyama, Isa, Miné-shi.

604 (100m); No. 5 quarry, Kami-isa, Isa, Miné-shi.

605 (100m); No. 4 quarry, NW of Kami-isa, Isa, Miné-shi.

606, 606A: No. 3 quarry, Isa, Miné-shi.

606 (100m+), XII-1; southwestern part of the quarry: **606A** (100m+), XII-2; 20m SW of 606.

607–612: Along the steep uphill path runs along the ridge between No. 3 quarry and Ubekosan's huge quarry, Isa, Miné-shi (Limestones of 608–612 have already been exhausted).

607 (100m), XII-3; Just W of a house, located 20m N of the railroad: **607A** (100m+), XII-4; 3m N of 607: **608** (115m), XII-5; about 80m N of 607: **609** (135m), XII-6; 90m NNW of 608: **610** (145m), XII-7; 50m NE of 609: **611** (145m+), XII-8; 60m NNW of 609: **612** (145m), XII-9; 60m NW of 611.

613 (100m); Southeastern part of the Ubekosan's quarry (140m W by N of 607), Ominé, Miné-shi (Limestone of 613 has already been exhausted).

614 (100m); 180m SSE of "Shibukura-bashi," W of Shimomura, Isa, Miné-shi.

619 (100m); About 90m SE of "Kunigyo-bashi," N of Kobayashi, Isa, Miné-shi.

623 (140m); About 1400m NEE of the railroad of Miné-line along the valley through which the truck railroad of the Tokuyamasoda Co. is build, N of Satoyamase, Ominé, Miné-shi.

626 (190m); 100m NEE of the Irimi primary school, W of Irimi, Ominé, Miné-shi.

645, 646: NW of Tobinosu, Ota, Mito-cho.
645 (180m), small quarry situated about 500m NWW of the three-forked road at the NW of Tobinosu: **646** (230m), about 300m NW of 645.

647 (190m); Quarry located about halfway between Okubo and Hirabara (or about 400m N by E of the bench mark, 300.2m in straight distance), Ota, Mito-cho.

712 (180m), IV-1; Just E of a spring located at the E of Uéyama, Akago, Mito-cho.

713–715: Northeastern slope of a hill, SW of Uéyama, Akago, Mito-cho.
713 (200m), 150m W of Mr. S. Nakajima's residence along the uphill path: **714** (210m), 120m W of 713: **715** (275m), 250m SSW of 714.

716–720A: Along the uphill road from Uéyama to Kaerimizu, Akago, Mito-cho.
716 (190m), IV-2; 180m W of the farm-house most easterly situated in Uéyama: **716A** (190m), IV-3; 30m W of 716: **717** (190m+), IV-4; 125m W of 716A: **718** (195m), IV-5; 160m W of 717: **719** (195m), IV-6; 80m SW of 718: **720** (205m), IV-7; 260m SW of 719: **720A** (205m), IV-8, 25m SW of 720.

724 (270m); Kitabira mine, located about halfway between Edo and Naganobori, Akago, Mito-cho.

742–746: Along the northeastern slope of "Akanta-yama" (bench mark, 409.4m), Beppu, Shuho-cho.
742 (210m), XVI-2; about 200m SSW of the junction of road between Serita and Yobara and uphill path to "Akanta-yama": **743** (320m), about 400m SWW of 742: **744** (355m), XVI-7; 120m S by W of 743: **745** (380m), XVI-8; 220m SW of 744: **746** (390m), XVI-9; 30m S by W of 745 (or 150m NE of the top of "Akanta-yama").

747 (120m); 100m NE of the junction of recently build and old narrow roads from Serita to Yobara, Serita, Beppu, Shuho-cho.

748 (160m); About 350m W by S of the concrete steps of the shrine located near the center of Yobara (or about 160m S by E of 365), Yobara, Beppu, Shuho-cho.

749 (180m); Isolated outcrop in field which is about 60m NW of the crossing of roads at the southern outskirts of Yobara, Beppu, Shuho-cho.

750–760: Along the uphill road from the crossing of road described above nearly westward to the southern flank of "Akanta-yama"; 750–753, Beppu, Shuho-cho: 754–760, Ominé, Miné-shi.
750 (180m), XXVI-1; 90m W by N of the crossing of the roads: **751** (180m+), XXVI-2; 150m SW of 750: **752** (190m), XXVI-3; 45m SW of 751: **753** (200m), XXVI-4; 50m SE of 752: **754** (210m), XXVI-5; 120m SW of 752: **755** (220m), XXVI-6; 100m W by N of 754: **756** (230m), 30m W of 755: **757** (245m), XXVI-7; 80m W of 756: **758** (260m), XXVI-8; about 100m W by N of 757: **759** (270m), XXVI-9; 110m NWW of 758: **760** (270m), XXVI-10; 90m NW of 759.

765A–765G (290m); "Hinode" quarry, about 900m S of Hagiwara, Ofuku, Miné-shi. [A, B, C, ..., and G represent different cobble or boulder of limestone conglomerate].

766–772: Along the road between Yobara and the W of Irimi (about 100m E of the Irimi primary school), Ominé, Miné-shi.
766 (205m), 400m S by E of the crossing of roads at the southern outskirts of Yobara: **767** (210m), 100m S of 766: **768** (210m), 180m S of 767: **769** (225m), 170m SSW of 768: **769A** (225m), 8m S of 769: **770** (250m), the west side of the pass between Yobara and Irimi (or 120m S of 769A): **771** (205m), 220m SSW of the pass: **772** (195m), 90m SW of 771.

773 (220m); Top of a high hill located to the NNE of Yobara (or SE of Serita), Beppu, Shuho-cho.

775 (350m); About 380m SW of the "Hinode" quarry (or 100m SW of 183), Ofuku, Miné-shi.

776, 777: Along the western slop of a hill located to the NW of "Akanta-yama" (bench mark, 409.4m), Ofuku, Miné-shi.
776 (350m), XV-6; about 360m SW of the "Hinode" quarry: **777** (370m), about 180m SEE of 776.

778 (320m); About 350m S of the "Hinode" quarry (or 280m SWW of 776), Ofuku, Miné-shi.

779 (120m); 400m E by N of a quarry situated to the NE of Maruyama, Isa, Miné-shi.
780 (135m); 100m NNE of the pass between Maruyama and Kawara (or 400m N 55°E of 779), Isa, Miné-shi.
782–785: Along the deep valley of NE-SW direction developed to the SW of Okugawara (or to the N of Amagoi-yama), Isa, Miné-shi.
782 (125m), XXVII–2; 100m SW of the western end of the irrigation reservoir (or 250m SWW of 1): **783** (160m), XXVII–4; 200m SW of 782: **784** (235m), 250m SSW of 783: **785** (145m), XXVII–3; almost vertical cliff, 60m SE of 782.
786 (120m): 580m W of the three-forked road of Kawara, Isa, Miné-shi.
787–789: Southeastern slope of Amagoi-yama, Kawara, Isa, Miné-shi.
787 (150m), about 400m N of the junction of the uphill path, 300m W of the three-forked road of Kawara: **788** (160m), 70m NNE of 787: **789** (170m), 30m N by W of 788.
791, 792: Northeastern slope of Amagoi-yama, Isa, Miné-shi.
791 (300m), XXVII–5; 270m NE of the top of Amagoi-yama (bench mark, 373.3m): **792** (335m), XXVII–6; 130m NEE of the bench mark.
793 (100m); 300m W of the Kawara branch school of the Isa primary school, Kawara, Isa, Miné-shi.
798, 799: Hirotani, Akiyoshi, Shuho-cho.
798 (100m), 10m N of the junction of the sight-seeing road to Shuhodo and the short-cut path to Akiyoshidai: **799** (100m), 50m NW of 798 and at the back of the Katori Hotel.
800 (295m); Western slope of "Kirigadai" and 80m SW of 330.
801 (100m); 160m NE of the three-forked road at Kawara, Toriyama, Isa, Miné-shi.
802–806: Along the road from Hirotani to the W of "Minami-yama" via the W of Okubo: 802, 803, Akiyoshi, Shuho-cho; 804–806, Ota, Mito-cho.
802 (140m), 750m NEE of the Shuhodo bus depot: **803** (160m), 100m NEE of 802: **804** (205m), about 160m N of the junction of paths to the W of "Minami-yama" (bench mark, 321.4m) and to Naganobori: **805** (240m), NNW of 804: **806** (240m), 70m NW of 805.
807 (310m); 200m W by N of the top of "Minami-yama" (bench mark, 321.4m), Ota, Mito-cho.
808, 809: Northeastern slope of "Minami-yama" (bench mark, 321.4m), Ota, Mito-cho.
808 (280m+), 300m NE of the bench mark: **809** (280m+), 80m NNW of 808.
810 (305m); Southeastern slope of "Benkei-yama" (190m SE of 464 or 380m NNW of the top of "Minami-yama"), Ota, Mito-cho.
811 (200m+); 270m NE of the lowest point of the "Yanoana" doline, Akiyoshi, Shuho-cho.
812–820: Along the eastern slope of the Kaerimizu doline (the western slope of Managatake), Akago, Mito-cho (Refer also to 285A–299).
812 (205m)≒286A (I–3): **813** (220m) comes in between 288A (I–7) and 814 (I–8A): **814** (222m), I–8A: **815** (235m) and **816** (235m+) are slightly lower than 290 (I–9) in field: **817** (250m), I–9A: **818** (260m) is slightly upper than 291 (I–10): **819** (310m), I–12A: **820** (370m) is slightly lower than 298 (I–16).
821 (280m); 300m S of the top of a hill, located 160m W of the top of Managatake, Akago, Mito-cho.
822–831: Along the sight-seeing highway from Shuhodo to Akiyoshidai, Akiyoshi, Shuho-cho.
822 (80m), 20m NWW of a house located about 300m N by E of the Shuhodo bus depot: **823** (90m), 85m NW of 822: **824** (100m), 40m NWW of 823: **825** (130m), 100m NW of 824: **826** (140m), 65m NW of 825: **827** (145m), 30m NW of 826: **828** (150m), 20m NNW of 827: **829** (155m), 40m NW of 828, small quarry by the road: **830** (170m), 190m NW of 829: **831** (180m), 260m NW of 830 (or 110m SW of the crossing of roads).
832 (150m); Uphill path from Maki to Yobara; about 800m SW of Shirozu-ike in straight distance, NE of Maki, Beppu, Shuho-cho.
833 (200m); 230m SWW of 832 in straight distance; outcrop in cedar grove, west side of uphill path from Maki to Yobara, Beppu, Shuho-cho.
834 (260m); 560m SW of 832 in straight distance; just W of the crossing of the road from Katada southward to the W of "Tsugunenoatama," the highest point of the Ofukudai

(bench mark, 409.4m) and path from Maki to Yobara, Beppu, Shuho-cho.

835 (90m); South-central part of the Ubekosan's quarry, Ominé, Miné-shi.

836 (120m); Halfway of the incline-truck railroad, laid to the W of the Ubekosan's quarry, Ominé, Miné-shi.

837–839: Along the truck railroad, laid to the upper part of the Ubekosan's quarry, Ominé, Miné-shi.

837 (150m), about 250m NNW in straight distance from the crusher-house located in the south-central part of the quarry: **838** (155m), about 100m NE of 837: **839** (155m), about 50m E of 838.

The Faunal Association of the Species.—The faunal association at each locality of all the species described in this paper is omitted to save the space and the cost of printing. To check the faunal association of the species at each locality the readers are requested to refer to the range and distribution charts inserted in the end of this paper.

The Repository of the specimens.—All the specimens used in this study will be deposited in the Paleontological Repository of the Department of Geology, Kyushu University, Hakozaki, Fukuoka, Japan, except the OZAWA's collection which is kept in the Department of Geology, the University of Tokyo, Hongo, Tokyo, Japan and the HASHIMOTO's collection which is kept in Otemae High School of Kochi Prefecture, Shikoku, Japan.

Description of Species

Part A. Pennsylvanian Fusulinids

Family FUSULINIDAE MÖLLER, 1878

Subfamily STAFFELLINAE MIKLUCHO-MAKLAI, 1949

Genus *Nankinella* LEE, 1933

Nankinella sp.

Pl. 1, figs. 3-5

The shell is minute, with the angular periphery and the umbilical poles. The lateral slopes are convex in the inner volutions, but are concave at maturity at least in one side of the shell. Mature specimens have five volutions. The figured specimen (Pl. 1, fig. 4) of five volutions has an axial length of 0.67 mm and a width of 1.23 mm, with a form ratio of 0.54. The first volution seems to slightly evolute. The second volution involutes. The umbilication begins from as early as the second volution, but the lateral slopes keep convex form to the ultimate volution. The ratios of the half length to the radius vector of the first to fifth volution in the figured specimen (Pl. 1, fig. 4) are 0.7, 0.7, 0.5, 0.5, and 0.5, respectively.

The proloculus is very small, and its outside diameter is hard to be measured exactly. The shell expands rather uniformly. Average radius vectors of the first to fifth volution in the figured three specimens are 63, 114, 242, 387, and 580 microns, respectively. The heights of the chamber very slightly decrease from the center of the shell toward the poles in the inner volutions. In the last one or two volutions, however, the chamber is highest at the center of the shell. After the sudden decreasing toward both slopes it becomes almost uniform in height, then it decreases again at the umbilical area.

The spirotheca is thin, seemingly consisting of four layers. Although the minute structure of the spirotheca is not determined with certainty, it is beyond doubt that there is a diaphanotheca-like clear layer in the spirotheca, which can be observable in some part of the outer volutions. The spirotheca attains a thickness of 17 microns in the fourth and 26 microns in the fifth volution of one specimen (Pl. 1, fig. 4). The spirotheca is of almost uniform thickness in central two-thirds of the shell, but becomes thinner in the axial regions.

The septa are unfluted throughout the length of the shell. The other characters and numbers of the septa are unknown because of the absence of the sagittal section at hand.

The tunnel seems to be low and narrow. The chomata do not present.

Remarks.—*Nankinella* sp. resembles *N. plummeri* THOMPSON from the Mable Fall limestone of Texas. However Texas species has more pointed periphery and

Table 1. Table of Measurements (in Millimeters) of *Nankinella* sp.

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector				
									1	2	3	4	5
1	378	310	1	3	0.95	0.51	0.6	—	.064	.126	.240	.360	.500
2	535	148	1	4	0.67	1.23	0.5	—	.058	.104	.279	.467	.661
3	535	151	1	5	0.35	0.61	0.6	—	.066	.113	.208	.335	

Specimen	Ratio of Hl./Rv.					Thickness of spirotheca				
	1	2	3	4	5	1	2	3	4	5
1	0.8	—	0.5	0.6	0.6	—	—	—	—	.024
2	0.7	0.7	0.5	0.5	0.5	—	—	—	.017	.026
3	0.5	0.6	0.5	0.6		—	.009	.010	.010	

smaller form ratio. In the present species the central portion of the last one or two volutions is roundly pointed with concave lateral slopes, and the chomata do not develop. The statistic data show that both the species are closely related if not conspecific. Until more sufficient material becomes available the final determination should be postponed.

Occurrence.—Nankinella sp. occurs only from the Loc. 378 and 535.

The stratigraphical age of this species is ranging from the Cmα* up to Cmβ*.

Genus *Staffella* OZAWA, 1925

Staffella akagoensis TORIYAMA, n. sp.

Pl. 1, figs. 6–8

The shell of *Staffella akagoensis* TORIYAMA, n. sp. is small and subspherical with rounded periphery, very slightly umbilical axial regions, and straight axis of coiling. Mature specimens of six to seven volutions have a length of 0.73 to 0.82 mm and a width of 1.05 to 1.20 mm. The form ratio is about 0.7. The first two volutions are evolute. From the third volution the shell becomes involute, increasing the axial length rapidly. At maturity the axial regions are very slightly umbilicate, at least on one side of the shell. The ratios of the half length to the radius vector of the first to seventh volution of the holotype are 0.4, 0.4, 0.4, 0.5, 0.5, 0.6, and 0.6, respectively.

The proloculus is very small and spherical and has an outside diameter of 54

* The abbreviations Cl, Cmα, Cmβ, ..., and Puα respectively represent the corresponding fusulinid zone or subzone, the definition of which is given in the Part I of this paper. For briefness' sake these abbreviations are also used in this paper (Part III) for the time unit corresponding to respective zone or subzone. There is no contradiction in this usage in such a stratigraphical unit as the Akiyoshi limestone group which consists almost exclusively of calcareous facies throughout the group and is continuous in deposition except the presumed unconformities below the base of the Plα subzone and the Puα zone.

to 70 microns, averaging 66 microns in three specimens. The shell expands slowly in the first two volutions, but somewhat rapidly and uniformly in the outer ones. Average of the radius vectors of the first to seventh volution of four specimens is 66, 109, 160, 247, 326, 429, and 540 microns, respectively. The heights of the chamber are about the same in central one-third of the shell, but they gradually decrease polewardly.

The spirotheca is fairly thick, consisting of four layers which are seemingly referable to a tectum, a diaphanotheca and inner and outer tectoria. However the minute spirothecal structure cannot be observed in the inner volutions. The diaphanotheca can be observable in some part of the outer volutions. The thickness of the spirotheca in the fifth to seventh volution of the holotype specimen are 17, 24, and 25 microns, respectively. The spirotheca seem to be thickened in the central portion of the outer volutions.

The septa do not flute at all. They are of the same structure as the spirotheca, extending forward at small angles (about 10 degrees) from the normal to the spirotheca. Though the number of the septa cannot be counted due to the poor state of the preservation, it seems that at least 20 or more septa present in the last volution.

The tunnel is low and is rather narrow. Its path is almost straight. The tunnel angles of the second to sixth volutions of the holotype specimen are 18, 10, 15, 12, and 19 degrees, respectively. The chomata are low and asymmetrical, having a height of one-fifth to one-third of the chambers. The tunnel side of the chomata is very steep, but the poleward slopes are gentle. They are obscure in the outer two or three volutions.

Table 2. Table of Measurements (in Millimeters) of *staffella akagoensis* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector						
									1	2	3	4	5	6	7
1*	351	171	1	6	0.73	1.05	0.7	.066	.085	.140	.189	.260	.335	.463	.575
2	351	173	1	7	0.82	1.21	0.7	.070	.077	.128	.214	.355	.425		
3	351	172	1	8	—	1.05	—	.054	.063	.095	.123	.184	.278	.395	.505
4	351	171			—	0.88	—	—	.038	.071	.113	.189	.265	.430	

Specimen	Ratio of Hl./Rv.							Thickness of spirotheca				Tunnel angle				
	1	2	3	4	5	6	7	4	5	6	7	2	3	4	5	6
1*	0.4	0.4	0.4	0.5	0.5	0.6	0.6	—	.017	.024	.025	18	10	15	12	19
2	—	—	0.6	0.6	0.7			—	.014	.019		—	—	—	—	
3								.015	.019	.024	.026					
4								—	.020							

* Holotype specimen.

Remarks.—OZAWA described two species of *Staffella*, *S. mölleri* OZAWA and *S.*

yobarensis OZAWA from the Akiyoshi limestone, of which the latter closely resembles the present species. However the OZAWA's original description (p. 20) on *S. yobarensis* does not coincide with his illustration of Pl. III, fig. 5. His holotype specimen (section number II-24 in his collection) shows that *S. yobarensis* has very massive chomata and considerably thick wall. Generally speaking, *S. yobarensis* is smaller in size and less numerous in the number of volution.

The present species also resembles *Staffella powwowensis* THOMPSON from the Powwow Canyon, Texas. However the latter species has more rounded central portion and a slightly larger form ratio, and the evolute development of the shell is restricted only to the first volution. The umbilical depression is a little stronger in *S. powwowensis*.

Occurrence.—Specimens here referred to *Staffella akagoensis* TORIYAMA, n. sp. occur in Nos. 1 and 5 limestones of Section II (Loc. 355 and 351, respectively). Its stratigraphical range is the Cmα and Cmβ.

Staffella cf. *mollerana* THOMPSON

Pl. 1, fig. 9

1878. *Fusulinella sphaerica* MÖLLER. Acad. Sci. St. Petersburg, Mem., VII° ser., Tome 25, No. 9, pp. 114–117, Pl. 5, figs. 6a–d, Pl. 15, figs. 3a–b.
1935. *Staffella mollerana* THOMPSON. Jour. Paleontology, Vol. 9, p. 113, Pl. 13, figs. 19–23.
1948. *Staffella mollerana* THOMPSON. Univ. Kansas, Pal. Contrib., Protozoa, Art. 1, pp. 29, 30, Pl. 2, figs. 4–8.

As this species is represented by only two specimens the following description cannot be called complete.

The shell is large for the genus and is seemingly spherical with rounded central portion and slightly depressed umbilical poles. The umbilication is very slight in the inner volutions, but is rather strong in the outer two volutions. The figured specimen of six volutions has a length of 1.4 mm and a width of 1.6 mm, attaining a form ratio of 0.9.

The proloculus is small and spherical, having an outside diameter of 106 microns. The first volution is evolute. From the second volution the shell becomes involute. The length of axis increases from the second volution to maturity. In the ultimate volution the polar regions are slightly depressed, at least on one side. The ratios of the half length to the radius vector of the second to sixth volution of the figured specimen are 0.6, 0.7, 0.7, 0.8, and 0.9, respectively. The heights of the chambers are almost the same except in the umbilical area where they decrease. The radius vectors of the first to sixth volution of the figured specimen are 142, 217, 321, 425, 610, and 841 microns, respectively.

The spirotheca is rather thick, and seems to consist of four layers, a tectum, a diaphanotheca-like clear layer and both inner and outer tectoria. The clear layer can be observable from the second volution although it is not discernible in the polar regions even in the outer volutions. The thickness of the spirotheca of the third to sixth volution are 15, 15, 26, and 32 microns, respectively. The spirotheca is nearly the same in thickness from the center of the shell to the poles.

The septa seem to be unfluted throughout the length of the shell. The septal count is unknown.

The tunnel seems to be low and considerably wide. The chomata are very poorly developed or absent in the outer volutions.

Table 3. Table of Measurements (in Millimeters) of *Staffella* cf. *mollerana* THOMPSON

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector					
									1	2	3	4	5	6
1	549	154	1	9	1.38	1.60	0.9	—	.142	.217	.321	.425	.610	.841
2	549	154			0.95	1.33	0.7	.106	.100	.175	.270	.420	.586	

Specimen	Ratio of Hl./Rv.						Thickness of spirotheca				
	1	2	3	4	5	6	2	3	4	5	6
1	—	0.6	0.7	0.7	0.8	0.9	.012	—	.014	.030	.032
2	0.6	—	0.8	0.7	0.8		—	.015	.015	.026	

Remarks.—Because of the insufficiency of the material at hand it is impossible to discuss upon the detailed structure of the shell. From the general appearance of the shell the present species almost coincides with *Staffella mollerana* THOMPSON which was originally described by MÖLLER as *Fusulinella sphaerica* ABICH and was later redefined by THOMPSON as *Staffella mollerana*. MÖLLER's specimen is also very poor, being replaced by the secondary mineralization and oriented not exactly. The present species may probably be conspecific with *S. mollerana* THOMPSON, although further study of this form is need before the final determination can be made.

Occurrence.—This species was collected only from No. 5 limestone of Section XXIV (Loc. 549). So far as the present materials are concerned the stratigraphical range of this species is the Cmα, but it is supposed that the range of this species is more wide.

Subfamily SCHUBERTELLINAE SKINNER, 1931

Genus *Eoschubertella* THOMPSON, 1937

Eoschubertella obscura (LEE et CHEN)

Pl. 1, figs. 10–14

1930. *Schubertella obscura* LEE et CHEN. Mem. Nat. Res. Inst. Geol. China, No. IX, pp. 112, 113, Pl. VI, figs. 12–22.

1941. *Eoschubertella obscura* TORIYAMA. Jour. Geol. Soc. Japan, Vol. 48, No. 579, pp. 566, 567, Text-figs. 10, 11.
1944. *Eoschubertella obscura* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XIX, Nos.1-4 , pp. 77, 78, Pl. VI, figs. 18-22.
1957. *Eoschubertella obscura* IGO. Sci. Repts. Tokyo Kyoiku Daigaku, Sec. C, Vol. 5, No. 47, pp. 187, 188, Pl. III, figs. 9-11.

The shell of *Eoschubertella obscura* is very minute. The number of volution is usually three to three and a half. The shape of the shell is subspherical to short ellipsoidal. The axial length is usually less than 0.5 mm. The width varies from 0.32 to 0.36 mm in the shell having three volutions, and from 0.44 to 0.47 mm in that of three and a half volutions. The form ratio is ranging from 1.2 to 1.3, averaging 1.22 for six specimens.

There are two stages in the development of the shell. The first volution is usually endothyroid, coiling around an axis which makes large angles at that of the later volutions.

The proloculus is small and spherical. Its outside diameter is ranging from 71 to 77 microns, averaging 75 microns in six specimens. The first two volutions are rather tightly coiled, and from the third volution the shell expands considerably rapidly, showing sometimes tendency to evolute. Averages of the radius vector of the first to third volution for eight specimens are 75, 122, and 190 microns, respectively.

Table 4. Table of Measurements (in Millimeters) of *Eoschubertella obscura* (LEE et CHEN)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector			
									1	2	3	3½
1	312	141	1	10	0.45	0.35	1.3	.071	.072	.123	.180	
2	357	291	1	11	0.40	0.34	1.2	.076	.078	.126	.189	
3	362	116	1	12	0.57	0.47	1.2	.075	.069	.117	.204	.290
4	433	261	1	13	0.43	0.32	1.2	—	.083	.123	.203	
5	339	241			0.52	0.44	1.2	—	.066	.123	.190	.250
6	533	315			0.39	0.32	1.2	.076	.080	.123	.189	
7	362	116	1	14	×	0.37	×	.073	.074	.123	.197	
8	514	269			×	0.32	×	.077	.076	.118	.165	

Specimen	Thickn. of spiroth.			Ratio of Hl./Rv.			Septal count		
	1	2	3	1	2	3	1	2	3
1	—	—	—	1.0	1.1	1.4			
2	—	.015	.017	—	1.5	1.4			
3	—	—	.010	1.3	1.2	1.4			
4	.008	.013	.015	0.7	0.9	1.0			
5	—	.011	.016	—	1.5	1.4			
6	—	.010	.016	1.0	1.0	1.1			
7	.007	.009	.014				—	6?	10?
8	—	.010	.012				5?	8?	10?

The spirotheca consists of a tectum and both tectoria. In the spirotheca of the first one or two volutions, however, a single dark homogeneous layer has been only observed. On the other hand, a diaphanotheca-like light layer can be discernible in some part of the last volution. The thickness of the spirotheca of the first to third volution for six specimens averages 8, 13, and 14 microns, respectively.

The septa are almost plane throughout the length of the shell. They are thin and rather widely spaced. The septal counts of the first to third volution are 5?, 6?-8? and 10?, respectively. The chomata do not present, but in some specimens they exist, though very much rudimentary in form.

Remarks.—In their original description of *Schubertella obscura*, LEE and CHEN discriminated some variation in the form of shell of this species, in which the ellipsoidal type is most predominant. The present form is just corresponding the case, having small form ratio of less than 1.4.

Occurrence.—*Eoschubertella obscura* (LEE et CHEN) is common among the Pennsylvanian fusulinids of Akiyoshi limestone group, and collected from No. 2 limestone of Section VII (Loc. 433), No. 5 limestone of Section XX (Loc. 339), and Loc. 312, 357, 358, 362, 514, and 533.

Eoschubertella obscura occurs in both the Cmα and Cmβ zones.

Eoschubertella sp. A

Pl. 1, figs. 15, 16

Eoschubertella sp. A is represented by only three specimens, one is axial and the others are tangential and excentric sections. The shell is ellipsoidal with bluntly rounded ends and is considerably large for the genus. The first volution seems to be endothyroid, coiling at large angles to the later volutions. The axial section attains a length of 0.71 mm and a width of 0.60 mm, with a form ratio of 1.2.

The proloculus is large for the genus, attaining an outside diameter of 104 to 109 microns. The shell expands rather rapidly, except the first volution. Average radius vector of the first to third volution of three specimens is 84, 141, and 242 microns, respectively. The heights of the chambers are almost uniform from the center of the shell to the poles in all but the last volution.

The spirotheca is thin and consists of a tectum and upper and lower tectoria. The lower tectorium usually develops better than the upper one which does not exist in the last volution. The thickness of the spirotheca is 11 microns in the second and 16 microns in the third volution.

The septa are not fluted throughout the length of the shell. The spacing of the septa is unknown due to the absence of the exactly oriented sagittal section.

Table 5. Table of Measurements (in Millimeters) of *Eoschubertella* sp. A

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.
1	465	211	1	15	0.71	0.59	1.2	.104
2	433	263	1	16	0.64	0.46	1.4	—
3	500	216			×	0.42	×	.109

Specimen	Radius vector				Ratio of Hl./Rv.				Thickness of spirotheca		Tunnel angle
	1	2	3	3½	1	2	3	3½	2	3	3
1	.089	.140	.250	.346	1.5	—	1.2	1.2	.011	.016	—
2	.067	.142	.256		1.1	1.3	1.4		—	.012	38
3	.095	.140	.220						.011	—	—

The chomata present only in the outer volutions. The tunnel angles at the third volution is 38 degrees. The tunnel side of the chomata is steep, but the poleward slopes are low and extending more than a half distance to the poles.

Remarks.—Eoschubertella sp. A resembles *E. texana* THOMPSON from the Mable Fall limestone of Texas. They have almost the same shape and size of the shell, large proloculus and almost the same rate of expansion. However the chomata of *E. texana* are a little heavier and more asymmetrical. They may be varieties of the same species, although more material is need to compare both the forms in detail. The final determination should be reserved untill more sufficient material becomes available.

Occurrence.—Eoschubertella sp. A has been collected from No. 2 limestone of Section VII (Loc. 433), No. 1 limestone of Section XI (Loc. 500), and Loc. 465.

Judging from the associated species, the stratigraphical range of this species is supposed to be long, covering both the Cmα and Cmβ zones.

Eoschubertella sp. B

pl. 1, figs. 17, 18

One species of *Eoschubertella* which was obtained from "Hinoura", Kyowa, Shuho-cho has been left unnamed because of the insufficiency of the material.

The shell is fusiform with vaulted median portion and bluntly rounded polar extremities. The axial section of four volutions has a length of 0.76 mm and a width of 0.39 mm, attaining a form ratio of about 2.0. The lateral slopes are almost straight to convex. The shell develops two stages of the growth; the axis of the first volution is almost perpendicular to that of the later volutions.

The proloculus is spherical and small, having an outside diameter of 50 microns. The spirotheca of the proloculus seems to be composed of a single dense layer. The endothyroid first volution is rather tightly coiled, but from the second volution the shell expands slightly rapidly. The heights of the chambers are almost uniform in the inner two volutions, but they are increasing polewardly in the outer ones. The radius vectors of the first to fourth volution in two specimens are 40–55, 95, 139–149, and 202 microns, respectively.

The spirotheca is very thin and seems to consist of a tectum and both tectoria. A diaphanotheca-like clear layer appears inside of the tectum in some part of the second and last volutions, which may be the secondary deposits on the spirotheca. The spirotheca changes in thickness only slightly poleward from the tunnel.

The septa are thin, having the same structure as that of the spirotheca. The septal counts of the first to third volution are 6+, 15 and 17, respectively. The septa do not flute throughout the length of the shell.

The tunnel is low and narrow in the inner volutions, but broadens in the outer ones. Its path is more or less irregular. The tunnel angle is 30 degrees in the last volution of the axial section. The chomata are considerably well developed, especially in the outer two volutions. The tunnel sides of the chomata are steep, while the poleward slopes are gentle and extending more than a half of distance in the inner volutions, and almost to the poles in the outer ones. The heights of the chomata are about a half of those of the chambers.

Table 6. Table of Measurements (in Millimeters) of *Eoschubertella* sp. B

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector			
									1	2	3	4
1	478	146	1	17	0.76	0.39	2.0	.044	.040	.095	.139	.202
2	478	147	1	18	×	0.34	×	.050	.055	.095	.149	

Specimen	Ratio of Hl./Rv.			Thickn. of spiroth.			Tun. ang.	Septal count		
	2	3	4	2	3	4	4	1	2	3
1	1.5	1.9	1.9	.008	.011	.012	30			
2								6 +	15	17

Remarks.—All the species of *Eoschubertella* hitherto described have ellipsoidal to highly inflated fusiform shell which has a small form ratio of less than 1.7. Only exception is *Eoschubertella obscura* var. (LEE et CHEN) which has a form ratio of 2.0. The present species somewhat resembles LEE and CHEN's specimen, but their material and the present one are too insufficient to make detailed comparison. So far as the shape and size of the shell are concerned this species more or less resembles a specimen of *Schubertella kingi* DUNBAR and SKINNER (1937, Pl. 45, fig. 11). However they are different in the spirothecal structure.

Occurrence.—Only locality is Loc. 478, and the stratigraphical range is the Cmα.

Genus *Fusiella* LEE and CHEN, 1930

Fusiella cf. *typica* LEE et CHEN

Pl. 1, fig. 19

1930. *Fusiella typica* LEE et CHEN. Mem. Nat. Res. Inst. Geol., No. 9, p. 108, Pl. II, fig. 1, Pl. VI, figs. 1–6.
1937. *Fusiella typica* LEE. Geol. Soc. China, Bull., Vol. XVI, pp. 80, 81, Pl. II, figs. 7, 8.
1957. *Fusiella typica* IGO. Sci. Repts. Tokyo Kyoiku Daigaku, Sec. C, Vol. 5, No. 47, pp. 188–190, Pl. III, figs. 12–15, 18.

One questionable specimen of *Fusiella* has been found associated with *Fusulina akiyoshiensis* TORIYAMA, n. sp. in the limestone of the east of Narutaki, Kyowa, Shuho-cho.

The shell is slender fusiform with broadly rounded poles and almost straight lateral slopes. The axial length and median width are approximately 1.5 mm and 0.5 mm, respectively, with a form ratio of 3.0. The number of volution is 5.

The proloculus seems to be very small. Its outside diameter is less than 50 microns, though it cannot be measured exactly. The first volution is seemingly coiled at large angles to the later volutions. The second volution is ellipsoidal. From the third volution the shell increases in length rapidly. The ratios of the half length to the radius vector of the third to fifth volution are 1.9, 2.2, and 2.4, respectively. The rate of expansion is very slow. The radius vector of the first to fifth volution are 70, 100, 140, 190, and 310 microns, respectively.

The spirotheca is thin and seems to be composed of a tectum and inner and outer tectoria. Because of the poor state of the preservation the tectum is hardly detected in almost all parts of the shell. In the median part of the fourth volution a diaphanotheca-like clear layer exists, but it cannot be ascertained whether it is a true diaphanotheca or minute calcite veins intruded after the fossilization. The thickness of the spirotheca in the third and fourth volutions is 12 microns.

The septa do not flute throughout the length of the shell. The chomata are very poorly developed only in the third and fourth volutions.

Remarks.—Because of the poor state of the preservation and of insufficiency of the material at hand the above description is very imcomplete and more material is necessary before the definite genric and specific determination is done.

This species resembles most closely *Fusiella typica* LEE et CHEN, the genotype of the genus, but the present species has a doubtful diaphanotheca-like layer in the fourth volution. Until more sufficient material is prepared I classify this species tentatively as *Fusiella* cf. *typica*.

Occurrence.—*Fusiella* cf. *typica* LEE et CHEN has been collected from Loc. 307, the stratigraphical horizon of which is the Cmβ.

Subfamily FUSULININAE RHUMBLER, 1895

Genus *Profusulinella* RAUSER-CERNOUSSOVA and BELJAEV, 1936

Profusulinella beppensis TORIYAMA, n. sp.

Pl. 2, figs. 1–6

The shell of *Profusulinella beppensis* TORIYAMA, n. sp. is small and ellipsoidal to broadly fusiform, possessing a straight axis of coiling, convex lateral slopes, and broadly rounded poles. The number of volution is usually 5, rarely attaining 6. Mature specimens of five volutions are 1.4 to 1.7 mm in length and 0.9 to 1.2 mm in width. The form ratio is 1.4 to 1.6. The first volution is almost spherical, having an axis of coiling almost perpendicular to that of the later volutions. Beyond the second volution the shell becomes ellipsoidal in shape. Average ratios of the half length to the radius vector of the first to fifth volution for five specimens are 1.3, 1.5, 1.5, 1.5, and 1.5, respectively.

The proloculus is small and spherical, rarely ellipsoidal. Its outside diameter is ranging from 91 to 119 microns, averaging 104 microns for eleven specimens. The largest diameter of the ellipsoidal proloculus attains 140 microns. The expansion of the shell is rather slow. Averages of the radius vector of the first to fifth volution of twelve specimens are 98, 164, 253, 374, and 521 microns, respectively. The chambers increase in height only very slightly poleward from the center of the shell.

The spirotheca is thin and is composed of three layers—a tectum, and outer and inner tectoria. The outer tectorium is usually thicker than the inner one. In some part of the last volution a diaphanotheca-like clear layer appears, but it is more dense than the diaphanotheca of typical *Fusulinella*. Average thickness of all three layers of the spirotheca on the center of the tunnel of the second to fifth volution for nine specimens is 13, 15, 18, and 18 microns, respectively.

The septa are thin and are relatively widely spaced. Averages of the septal counts in the first to fifth volution for five specimens are 5, 11, 13, 16, and 19, respectively. The septa do not flute across the central two-thirds to three-fourths of the shell, but they are very weakly fluted in the extreme polar regions. In the central part of the shell the septa are thickened by the continuations of the spirotheca or by the deposits from the chomata.

The tunnel is relatively narrow in the inner volutions and widens gradually outward. Average tunnel angles of the second to fifth volution for three specimens are 23, 26, 28, and 37 degrees, respectively. The chomata do not develop in the first one or two volutions. Beyond the second or third volution outward they usually develop, being not so massive. The heights of the chomata are less than half to one-third of the height of the chambers in the middle of the shell. The tunnel side slopes of the chomata are steep, sometimes overhanging, but the poleward slopes are very gentle, extending one-third to half way to the poles.

Table 7. Table of Measurements (in Millimeters) of *Profusulinella beppensis* TORIYAMA, n. sp.

Speci-men	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector					Ratio of Hl./Rv.				
									1	2	3	4	5	1	2	3	4	5
1*	359	133	2	1	1.43	0.99	1.4	.104	.100	.172	.261	.370	.525	1.1	1.3	1.5	1.6	1.6
2	712	289			1.83	1.21	1.5	.110	.101	.153	.224	.360	.520	1.5	1.5	1.4	1.5	1.7
3	359	134	2	2	×	0.96	×	.119	.109	.188	.298	.417	.548					
4	359	133	2	4	×	0.97	×	.105	.100	.178	.278	.410	.550					
5	359	131	2	5	×	0.91	×	.091	.091	.150	.240	.370	.520					
6	359	131	2	6	×	0.83	×	.091	.092	.142	.221	.321	.455					
					Max.			.119	.109	.188	.298	.417	.590	1.5	1.6	1.7	1.6	1.7
					Min.			.091	.091	.142	.221	.321	.455	1.1	1.3	1.4	1.3	1.4
					Aver.**			.104	.098	.164	.253	.374	.521	1.3	1.5	1.5	1.5	1.5
								11	10	12	12	12	11	3	4	5	5	4

Speci-men	Thickness of spirotheca						Tunnel angle				Septal count				
	0	1	2	3	4	5	2	3	4	5	1	2	3	4	5
1*	.014	—	.013	.014	.018	.023	—	26	33	37					
2	—	—	—	—	.014	.018	—	—	—	—					
3	—	—	—	.014	.019	.018					—	—	—	—	—
4	—	—	.012	.014	.018	.014					4 ?	11	14	20	
5	—	—	—	—	.014	.019					5	11	14	17	
6	—	—	.013	.013	.014	.016					6	11	13	14	21
Max.	.014	—	—	.018	.020	.023	24	26	33		6	12	15	20	21
Min.	.010	—	—	.013	.014	.014	21	25	24		4 ?	10	11	13	16
Aver.	.012	—	.013	.015	.018	.018	23	26	28	37	5	11	13	16	19
	2	—	3	6	9	7	2	3	3	1	5	5	5	5	3

* Holotype specimen.
** Numbers in the lower column of Averages in the Tables 7–95 indicate the number of the specimens used.

Remarks.—The short ellipsoidal shape of the shell, almost unfluted septa, and the endothyroid juvenarium of this species suggest some relationship with some species of *Eoschubertella* such as *E. magna* LEE et CHEN. However it is beyond doubt that the species under consideration is referable to the genus *Profusulinella,* having relatively large size of the shell, numerous number of volution, relatively well developed chomata, and a diaphanotheca-like layer of the spirotheca in the last volution.

Among the species of *Profusulinella, P. fukujiensis* IGO which was very recently described from the Ichinotani formation of central Japan is most closely allied to the present species, but the latter has larger proloculus, more rapid rate of expansion and thinner spirotheca. These differences are, however, not so remarkable, and these two species are biologically very closely related, if not conspecific, with each other, being nearly the same in phylogenetical developement. *P. copiosa* described by THOMPSON (1948) from the Green Canyon group of Powwow Canyon, Texas somewhat closely resembles the present species. These two forms can be distinguished, however, that *P. beppensis* n. sp. has larger size of the shell at maturity, more rounded poles, more numerous number of the volution, smaller proloculus in average, slower rate of expansion, and less numerous septa for the corresponding volutions.

Profusulinella parva (LEE et CHEN) and its variety *P. parva* var. *convoluta* (LEE et CHEN), both from the Huanglung limestone of China also resembles this new species, but the latter has larger size of the shell at maturity, larger proloculus and more rapid rate of expansion of the shell.

Occurrence.—Profusulinella beppensis TORIYAMA, n. sp. is rather common in the Cmα zone and has been collected from No. 1 limestone of Section IV (Loc. 712) and Loc. 359 and 535.

Profusulinella rhomboides (LEE et CHEN)

Pl. 2, figs. 18, 19

1930. *Neofusulinella rhomboides* LEE et CHEN. Mem. Nat. Res. Inst. Geol., No. IX, pp. 119–121, Pl. VIII, figs. 3–6.
1934. *Fusulinella rhomboides* CHEN. Mem. Nat. Res. Inst. Geol., Vol. XIV, pp. 35, 36, Pl. VI, figs. 14, 15.

This species is represented by only each one of axial and sagittal sections. The shell is small and rhombic in shape, having much vaulted median portion and bluntly pointed poles. The lateral slopes are almost straight to slightly convex. The axial section of seven volutions has a length of about 2 mm and a width of 1.45 mm, giving a form ratio of 1.4. The first volution is almost spherical. Beyond the second volution the shell retains a rhombic shape.

The proloculus is small, having an outside diameter of 112 microns. The first three volutions are considerably tightly coiling, but the rate of expansion becomes gradually rapid in the outer volutions. The radius vectors of the first to seventh volution in the axial section measure 89, 130, 189, 280, 378, 530+, and 730+ microns, respectively. The heights of the chambers are almost uniform in the inner volutions and increase poleward slightly in the outer ones.

The spirotheca is thin, consisting of a tectum, a diaphanotheca and outer tectorium. The diaphanotheca appears first in the second volution and is clearly observable throughout the outer volutions, except in the polar regions where it becomes obscure. The combined thickness of the tectum and the diaphanotheca of the first to sixth volution measured at the center of the shell are 7.5, 9.8, 10, 13, and 15 microns, respectively.

Table 8. Table of Measurements (in Millimeters) of *Profusulinella rhomboides* (LEE et CHEN)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector						
									1	2	3	4	5	6	7
1	712	287	2	18	1.97	1.45	1.4	.112	.089	.130	.189	.280	.378	.53+	.73+
2	712	288	2	19	×	0.85	×	$\frac{.105}{.140}$ ×	.087	.154	.221	.302	.406		

Specimen	Ratio of Hl./Rv.							Thickness of spirotheca					
	1	2	3	4	5	6	7	1	2	3	3	4	5
1	1.2	1.5	1.5	1.4	1.5	1.4	1.3	.008	.010	.010	.010	.013	.015
2								—	.010	.013	.017	.014	

Specimen	Tunnel angle			Septal count			
	4	5	6	1	2	3	4
1	19	25?	23				
2				8+	12+	15+	19

The septa are almost unfluted throughout the length of the shell. Because of the absence of the well oriented sagittal section, the spacing and the number of the septa are not known exactly, but so far as the sagittal section at hand (more or less diagonal) is concerned it seems that the septal count is not so large, counting 8+, 12+, 15+, and 19 in the inner four volutions, respectively.

The tunnel is low and narrow in the inner volutions, but widens gradually in the outer volutions, and its path is almost straight. The chomata do not present in the inner two volutions, but rather well developed in the outer ones. The tunnel sides of the chomata are very steep, but the poleward slopes are very gentle, extending polewardly one-fourth to one-third of the distance to the poles.

Remarks.—In their original description LEE and CHEN discriminated three types in this species—the large rhombic, smaller rhombic and elongate types. Of which the first is said to be most predominant. Although the present material at hand is very poor, the characters of the shell and the statistics show that the present form almost coincides with the larger rhombic type. LEE and CHEN did not give any description on the structure of the spirotheca of "*Neofusulinella rhomboides*". Judging from their illustrations, however, their specimens seemingly have not diaphanotheca at any stage of the growth, while in the present specimens, though not sufficient in number, it is clearly observable except in the first and last volutions.

SKINNER and WILDE (1954) recently described and illustrated specimens of a new form of *Profusulinella*, *P. plummeri* from the Big Saline formation of Texas. The spirotheca of that form is also composed of outer tectorium, tectum and diaphanotheca in all except the ultimate whorl. Such being the case, both the present species and *P. plummeri* may probably be intermediate between *Profusulinella* and *Fusulinella* at least in the spirothecal structure.

Because the materials at my disposal are not enough, further study will be necessary for the definite specific determination.

Occurrence.—Profusulinella rhomboides (LEE et CHEN) is very rare in the Akiyoshi limestone group and has been collected only from No. 1 limestone of Section IV (Loc. 712). The stratigraphical horizon of this species is the Cmα zone.

Profusulinella sp. A

Pl. 1, figs. 20, 21

This species is represented by only one axial (not exactly oriented) and one tangential sections. The shell is small and ellipsoidal in shape. The axial section of five volutions has a length of about 1.2 mm and a width of 0.8 mm, with a form ratio of 1.5. It seems that the first one and a half volutions are endothyroid, having an axis of coiling at large angles to that of the later volutions. Beyond the third volution the shell increases in length almost uniformly, displaying elliptical shape in axial profile. The lateral slopes are convex throughout the growth of the shell. The ratios of the half length to the radius vector of the first to fifth volution are 0.8, 0.8, 1.1, 1.3, and 1.4, respectively.

The proloculus is minute, with an outside diameter of 76 microns. The shell expands slowly and almost uniformly. The radius vector of the first to fifth volution of the axial section is 85, 132, 195, 302, and 435 microns, respectively. The heights of the chambers are almost uniform from the center of the shell to the poles.

The spirotheca is typical for the genus. The thickness of the spirotheca of the second to fifth volution measured at the center of the shell of the axial section is 12, 14, 15, and 16 microns, respectively.

The septa are almost unfluted throughout the length of the shell. The septal

Table 9. Table of Measurements (in Millimeters) of *Profusulinella* sp. A

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector				
									1	2	3	4	5
1	352	183	1	20	1.16	0.78	1.5	.076	.085	.132	.195	.302	.435
2	352	182	1	21	0.95	0.84	1.4	—	.085	.129	.217	.335	

Specimen	Ratio of Hl./Rv.					Thickness of spirotheca				Tunnel angle		
	1	2	3	4	5	2	3	4	5	3	4	5
1	0.8	0.8	1.1	1.3	1.4	.012	.014	.015	.016	31	32	43
2	1.2	1.5	1.4	1.5		.011	.012	.017		30	32	

count is unknown. The tunnel is low and broad, being one-third to half as high as the chamber. The tunnel angles of the third to fifth volutions are 30–31, 32, and 43 degrees, respectively. The chomata are well developed except in the early endothyroid stage. The tunnel sides of the chomata are rather steep, but the poleward slopes are very gentle, extending almost to the poles in the inner volutions.

Remarks.—So far as the shape and the form ratio of the shell and the rate of expansion are concerned this species most closely resembles *Profusulinella marblensis* THOMPSON which was collected from the Marble Fall limestone of Llano, Texas. Judging from the original illustration of THOMPSON, the holotype specimen of *P. marblensis* seems to have been recrystallized after the fossilization and the minute structure of its inner part is somewhat obscure. The present species may be different from *P. marblensis* in having heavier chomata and the early endothyroid juvenarium. However, more material is necessary before the definite comparison can be made.

Occurrence.—This form is very rare in No. 4 limestone of section II (Loc. 352) at Shishidedai, where it is associated with *Akiyoshiella ozawai* TORIYAMA and *A.* sp. The stratigraphical horizon of this species is the Cmα.

Genus *Fusulinella* MÖLLER, 1877

Fusulinella simplicata TORIYAMA, n. sp.

Pl. 2, figs. 7–17

Fusulinella simplicata TORIYAMA, n. sp. is small and typical fusiform, having almost straight axis of coiling and bluntly pointed poles. The number of volution is usually 4 or 5, rarely attaining 6. The holotype specimen of five volutions has a length of 2.9 mm and a width of 1.4 mm. The form ratio is ranging from 1.7 to 2.6. In most specimens the first volution is almost spherical, the second one is nearly ellipsoidal, and the outer volutions are fusiform. The ratios of the half length to the radius vector of the first to fifth volution for fourteen specimens average 1.8, 1.9, 2.0, 2.0, and 2.1, respectively. The lateral slopes are convex in the inner three or four volutions, but tend to become almost straight to concave in the outer volutions, especially near to the polar regions.

The proloculus is small and spherical, and its outside diameter is ranging from 95 to 183 microns, averaging 124 microns in fourty-five specimens. The spirotheca of the proloculus is composed of a single homogeneous layer, having an average thickness of 14 microns. The shell coils tightly in the first two volutions. From the third volution onward the shell expands more or less rapidly and uniformly. Average radius vectors of the first to sixth volution for forty-five specimens are

Table 10. Table of Measurements (in Millimeters) of *Fusulinella simplicata* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1*	235	260	2	7	2.90	1.43	2.0	.144	.109	.180	.306	.501	.756	
2	235	255	2	8	2.88	1.20	2.4	.175	.130	.219	.320	.500	.741	
3	577	278	2	9	2.31	0.95	2.4	.107	.123	.189	.312	.510		
4	355	331	2	10	2.30	1.20	1.9	.114	.128	.208	.312	.473	.638	
5	433	267	2	11	2.3+	1.26	1.8	.131	.111	.190	.330	.63?		
6	433	261	2	12	2.9+	1.12	2.6	.108	.095	.151	.236	.392	.614	
7	235	257	2	13	2.44	1.48	1.7	.120	.101	.182	.310	.518	.808	
8	577	279	2	14	×	1.09	×	.141	.109	.180	.265	.387	.567	
9	514	271	2	15	×	1.42	×	.130	.111	.210	.330	.481	.742	
10	235	253	2	16	×	1.26	×	.120	.100	.172	.281	.422	.681	
11	235	254	2	17	×	1.93	×	.129	.113	.195	.292	.491	.784	1.054
							Max.	.183	.16?	.257	.407	.63?	.808	1.054
							Min.	.095	.081	.142	.214	.330	.523	.674
							Aver.	.124	.110	.184	.288	.458	.674	.850
								45	45	45	45	43	32	8

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	Thickness of spirotheca 0	1	2	3	4	5	6
1*	1.7	1.8	1.4	1.5	1.9	.016	—	.014	.016	.018	.018	
2	—	1.4	1.8	2.0	2.3	.014	—	—	.012	.014	.023	
3	1.1	1.9	2.1	2.2		.012	.010	.013	.015			
4	1.7	1.9	1.9	2.0	1.9	—	—	—	.018	.018	.027	
5	1.6	1.8	1.9	1.8		—	—	—	—	—	—	
6	1.7	2.2	2.5	2.5	2.5	—	—	—	—	.015	.020	
7	2.2	2.1	2.4	2.4	1.8	—	—	—	.019	.024		
8						.015	.008	.008	.016	.020	.025?	
9						.014	.010	.012	.018	.020	.020	.024
10						.014	.012	.014	.014	.019	.018	
11						.013	.010	.013	.015	.018	.021	.020
Max.	2.2	2.2	2.5	2.5	2.5	.018	.014	.015	.020	.024	.027	.024
Min.	1.1	1.4	1.4	1.5	1.8	.010	.008	.008	.012	.013	.014	.020
Aver.	1.8	1.9	2.0	2.0	2.1	.014	.011	.013	.016	.018	.021	.022
	12	13	14	11	5	17	17	21	31	29	23	2

Specimen	Tunnel angle 2	3	4	5	Septal count 1	2	3	4	5
1*	—	23	26	30					
2	—	23	28	37					
3	—	—	—						
4	—	23	26	30					
5	—	—	—						
6	20	29	29	37					
7	38	33	44?						
8					9?	12	14	15	16
9					7	13	15	16	18
10					6	9	13	14	15
11					8	13	14	16	16
Max.	38	34	44	53	9	15	16	19	21
Min.	19	23	26	30	6	9	11	14	15
Aver.	24	28	30	42	7	12	14	16	17
	7	12	14	6	18	18	17	15	9

* Holotype specimen

110, 184, 288, 458, 674, and 850 microns, respectively. The chambers are lowest in height immediately above the tunnel, and they increase in height slowly poleward from the tunnel.

The spirotheca is composed of tectum, diaphanotheca, and upper and lower tectoria. The diaphanotheca appears first near the beginning of the second volution and can be seen throughout the length of the shell in the outer volutions. The combined thickness of the tectum and the diaphanotheca of the first to sixth volution for thirty-one specimens averages 11, 13, 16, 18, 21, and 22 microns, respectively. The tectoria decrease in thickness poleward from the edge of the chomata.

The septa are thin and are relatively widely spaced. Average septal counts of the first to fifth volution for eighteen specimens are 7, 12, 14, 16 and 17, respectively. The septa are plane across about the central half to two-thirds of the shell, but they are weakly fluted in the extreme polar regions. In the central part of the shell the septa are covered by the continuation of the tectoria of the spirotheca or by deposits from the chomata.

The tunnel is narrow in the inner one or two volutions, but it widens in the outer volutions. Averages of the tunnel angles of the second to fifth volution for fourteen specimens are 24, 28, 30, and 42 degrees, respectively. The chomata are well developed, except in the last volution where they are sometimes very weak or not developed. Their heights are less than a half of the chambers in the center of the shell. The tunnel sides of the chomata are usually steep, sometimes overhanging, but the poleward slopes are very gentle, extending considerable distance to the poles, especially in the outer volutions.

Remarks.—*Fusulinella simplicata* TORIYAMA, n. sp. is one of the most primitive fusulinellid species among the Akiyoshi fusulinids. In general shape and characters of the shell it seems to be referable to the genus *Profusulinella* rather than to the genus *Fusulinella*. However, the spirotheca of this species has clear diaphanotheca throughout the length of the shell except in the first volution, and there is no doubt about the generic identification of this species, being representing the most primitive stage of the phylogenetic development in the genus *Fusulinella*.

Fusulinella simplicata n. sp. somewhat closely resembles *F. llanoensis* (THOMAS) which was collected from the Big Saline limestone of Llano, Texas. [Topotype specimens has been illustrated by THOMPSON (1948)]. However the latter species is slightly larger in the form ratio, having more acutely pointed poles and heavier chomata, and seems to have a little stronger septal flutings in the axial regions, though the difference in strength is very slight. The rate of expansion of *F. llanoensis* is more rapid than in the species under consideration, although that of the topotype specimen illustrated by THOMPSON (1948, Pl. 26, fig. 13) is almost the same as in the present species. The septal count for the corresponding volution is a little more numerous in *F. llanoensis*. In general *Fusulinella simplicata* n. sp. seems to be phylogenetically more primitive than *F. llanoensis*.

THOMPSON, PITRAT and SANDERSON (1953) described *Fusulinella jamesensis* from the Cache Creek limestone of Ft. St. James in Central British Columbia. Although the joint authors stated that *F. jamesensis* is comprising three different groups, and that it is possible, but not probable, that these three groups represent the same species, it seems better to distinguish them as different species. Because the holotype specimen (Pl. 57, fig. 8) is included in their second group, the specimens belonging to that group (Pl. 57, figs. 8–15 and 21–28) are only considered as *F. jamesensis* for comparison. Such being the case, *Fusulinella simplicata* rather closely resembles *F. jamesensis* in many respects. However, *F. simplicata* has slightly larger proloculus and higher height of the chambers and thinner spirotheca for the corresponding volution than those of *F. jamesensis*. It should also be noted that *F. jamesensis* has very recently been reported by IGO (1957) from the middle part of the *Fusulinella* zone of the Ichinotani formation in central Japan. The Ichinotani form is also distinguished from the present species by its smaller proloculus, and lower height of chambers and less numerous septa for the corresponding volution. In short, *F. simplicata* and *F. jamesensis* are biologically closely related with each other, and they seemingly are of nearly the same stage in the phylogenetical development. Stratigraphically speaking, however, the Canadian form of *F. jamesensis* was reported to occur with *Akiyoshiella toriyamai* T. P. & S., while *A. ozawai*, which is similar to the latter in many respects, occurs in the Cmα zone with *Profusulinella beppensis* TORIYAMA. Moreover, *Fusulinella simplicata* is one of the characteristic to the lower part of the Cmβ zone and *F. jamesensis* of Ichinotani occurs in the middle part of the zone of *Fusulinella*. Therefore, the stratigraphical position of *F. simplicata* n. sp. and the Japanese form of *F. jamesensis* is a little higher than that of the Canadian form of *F. jamesensis*.

Occurrence.—Fusulinella simplicata TORIYAMA, n. sp. is common in the lower part of the Cmβ zone, and occurs in No. 2 limestone of Section VII (Loc. 433), No. 2 limestone of Section XVII (Loc. 304), and Loc. 235, 577, and 514.

Fusulinella cf. *bocki* MÖLLER

Pl. 2, figs. 20–22: Pl. 3, figs. 1, 2

1878. *Fusulinella bocki* MÖLLER. Mem. Acad. Imp. Sci., St. Pétersb., VII^e, sér., tome XXV, pp. 104–107, Pl. V, figs. 3a–g, Pl. XIV, figs. 1–4.

1925. *Fusulinella bocki* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 17, 18, Pl. III, figs. 7, 9, 10.

1927. *Neofusulinella bocki* LEE. Palaeontologia Sinica, Ser. B, Vol. IV, fasc. 1, pp. 16–18, Pl. I, fig. 2; Pl. II, figs. 12–17.
1930. *Neofusulinella bocki* LEE, CHEN and CHU. Mem. Nat. Res. Inst. Geol., No. IX, pp. 121, 122, Pl. VIII, figs. 8–15; Pl. IX, figs. 1–9.
1934. *Fusulinella bocki* CHEN. Mem. Nat. Res. Inst. Geol., No. XIV, pp. 36, 37, Pl. VI, figs. 16–19.
1936. *Fusulinella bocki* HUZIMOTO. Sci. Rep. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 42, 43, Pl. II, figs. 16, 17, 19.
1944. *Fusulinella bocki* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XIX, Nos. 1–4, pp. 70–72, Pl. VI, figs. 3–8.
1945. *Fusulinella bocki* THOMPSON. Amer. Jour. Sci., Vol. 243, pp. 447–450, Pl. 1, fig. 15.

The shell is small fusiform with bluntly pointed poles and steep convex lateral slopes. The axis of coiling is straight. Mature specimens have usually 5 to 6 volutions, attaining a length of approximately 3.2 mm and a diameter of 1.8 mm. Averages of the ratios of the half length to the radius vector of the first to sixth volution for eight specimens are 1.4, 1.6, 1.8, 2.0, 1.9, and 1.9, respectively.

The proloculus is small and spherical and its outside diameter is ranging from 120 to 187 microns, averaging 147 microns for thirteen specimens. The first volution is spherical to subspherical, the second volution is subspherical to ellipsoidal, and beyond the third volution outward the shell retains ellipsoidal shape. The rate of expansion is considerably slow in the first two volutions, but a little rapid in the later three or four volutions. Averages of the radius vector of the first to seventh volution for fifteen specimens are 129, 207, 308, 440, 628, 856, and 1,035 microns, respectively. As the heights of the chamber are almost uniform poleward from the center of the shell, the ratios of the half length to the radius vector change but little during the growth of the shell.

The spirotheca is typical for the genus. The diaphanotheca seems to be appeared near the end of the first volution. It is clearly discernible in the outer volutions. Both outer and inner tectoria are well developed throughout the length of the shell except the last volution where the outer tectorium usually does not present. Averages of the combined thickness of the tectum and the diaphanotheca of the second to sixth volution for fourteen specimens are 12, 15, 16, 18, 23, and 26 microns, respectively.

The septa only weakly flute in the polar regions and do not flute in the central portion of the shell. The spacing of the septa is not so broad. Averages of the septal counts of the first to sixth volution for three specimens are 8, 14, 16, 20, 24, and 27, respectively.

The tunnel is narrow in the inner two or three volutions, but widens gradually. Averages of the tunnel angle of the third to sixth volution for five specimens are 17, 18, 20, and 21 degrees, respectively. The chomata are well developed from the first volution. The tunnel sides of the chomata are very steep, sometimes almost perpendicular, but the poleward slopes are very gentle, extending more than two-

Table 11. Table of Measurements (in Millimeters) of *Fusulinella* cf. *bocki* MÖLLER

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector						
									1	2	3	4	5	6	7
1	357	293	2	20	1.96	1.22	1.6	.145	.112	.191	.280	.414	.592		
2	357	291	2	21	3.0+	1.8+	1.7	.179	.148	.219	.330	.438	.660		
3	357	293	2	23	×	1.87	×	.14?	.130	.218	.311	.458	.660	.900	
4	357	294	3	1	×	1.75	×	.156	.136	.212	.342	.510	.700	.926	
5	304	325	3	2	×	1.92	×	.121/.150 ×	.132	.200	.340	.534	.813	.998	
							Max.	.187	.148	.228	.342	.534	.813	.998	
							Min.	.120	.104	.161	.224	.353	.500	.742	
							Aver.	.147	.129	.207	.308	.440	.628	.856	1.035
								13	12	13	15	15	15	10	4

Specimen	Ratio of Hl./Rv.						Thickness of spirotheca							
	1	2	3	4	5	6	0	1	2	3	4	5	6	7
1	1.7	1.6	2.0	1.9	1.7		—	—	.012	.015	.017	.018		
2	1.3	1.7	2.1	2.3	2.1		—	—	—	.020	.020			
3							—	—	.009	.016	.016	.017	.023	
4							.018	—	.012	.014	.019	.018	.023	
5							—	—	—	.018	.019	.023		
Max.	1.7	1.7	2.1	2.3	2.1	2.0	—	—	.014	.020	.020	.023	.033	.028
Min.	1.2	1.5	1.5	1.7	1.7	1.6	—	—	.009	.012	.012	.014	.019	.024
Aver.	1.4	1.6	1.8	2.0	1.9	1.9	.018	—	.012	.015	.016	.018	.023	.026
	4	5	7	8	8	5	1	—	4	11	14	12	8	2

Specimen	Tunnel angle				Septal count					
	3	4	5	6	1	2	3	4	5	6
1	—	—	26	31						
2	18	23	24							
3					8	12	15	24	24	25?
4					8	16	16	18	—	—
5					7	13	15	19	24	28
Max.	19	23	26	31	8	16	18	24	24	28
Min.	15	14	14	17	7	12	15	18	24	25
Aver.	17	18	20	21	8	14	16	20	24	27
	4	4	5	4	3	3	3	3	2	2

thirds of the distance to the poles in the inner volutions and almost half in the outer ones. The heights of the chomata are more than two-thirds to half of the heights of the chambers.

Remarks.—*Fusulinella bocki* MÖLLER, the genotype of the genus *Fusulinella*, is one of the most well known species among the species of the Tethysian fusulinellids. Many of it had been reported from China and Japan. However, due to the incompleteness of the MÖLLER's original description and illustration, some forms of fusulinellids of large and vaulted shell, which would otherwise be identified to different species, have erroneously been referred to the species under consideration. In 1954, THOMPSON redescribed and illustrated the topotype specimens from Kresty, Government of Tver, Russia, which are well coincident with the original illustration of MÖLLER. There is no doubt that the axial section illustrated by THOMPSON is typical in any respect for the species.

OZAWA also decsribed *Fusulinella bocki* from the Akiyoshi limestone. To my regret I have not been able to find his specimens in his collection. So far as his microphotographs are concerned, it seems that his specimen illustrated as Pl. III, fig. 10 may not be referable at least to this species, which has vaulted fusiform, a form ratio of more than 2.0, concave lateral slopes and not so heavy chomata. LEE (1927) also described "*Fusulinella bocki*" from Kalgan, Inner Mongolia and Penchihu, South Manchuria, but some of them are not conspecific with the species

Table 12. Table showing the differences between *Fusulinella bocki*, *F. biconica* and *F. itoi*.

Species		Number of volution	Length	Width	Form ratio	Poles	Lateral slopes	Outside diameter of Proloculus
F. bocki	Topotype[1]	6	2.2	1.35	1.7	broadly rounded	convex except polar regions where they are slightly concave	112
	Range[2]	5–6 (7–8)	1.8–3.8	0.8–2.0	1.6–2.1			70–150
	Akiyoshi[3]	6–8	3.2	2.1	1.9			146
F. biconica	OZAWA's sp.[4]	6½	3.4	2.2	1.5	broadly rounded	(exclusively) convex	180
	Range	6–8	2.9–4.5	1.8–3.0	1.5–1.7			80–200
	Akiyoshi	6–8	3.2	2.2	1.5			146
F. itoi	Holotype	8	3.6	1.9	1.9	bluntly pointed	straight to concave (except inner volutions)	70
	Akiyoshi	6–7	3.4	1.8	2.1			99

Species		Early volutions	Radius vector at the 5th vol.	Septal count at the 5th vol.	H. of chomata / H. of chamber at the center: Inner vol.	Outer vol.	Distance of poleward extension of chomata from the center: Inner vol.	Outer vol.
F. bocki	Topotype		0.68		$\frac{1}{2}$–$\frac{2}{3}$	$\frac{2}{3}$–$\frac{3}{4}$	$\frac{2}{3}$–1	$\frac{1}{2}$–$\frac{2}{3}$
	Range		0.32–0.70	16–24				
	Akiyoshi		0.63	24				
F. biconica	OZAWA's sp.	sometimes endothyroid	0.64	24	$\frac{1}{2}$–$\frac{2}{3}$	$\frac{1}{3}$–$\frac{1}{2}$	$\frac{2}{3}$–1	$\frac{1}{2}$
	Range		0.50–0.72	21–34				
	Akiyoshi		0.67					
F. itoi	Holotype		0.45	21	$\frac{1}{2}$–$\frac{2}{3}$	$\frac{1}{2}$	1	1
	Akiyoshi		0.47	23				

1) Topotype specimen described and illustrated by THOMPSON.
2) Range of species are measured from all the specimens which have been hitherto described by many authors.
3) In Akiyoshi specimens most of the statistic values are average.
4) As the HAYASAKA's original description is not sufficient and he did not designate the holotype, OZAWA's specimen (section number, II-98), which seems to be most typical for the species, has been preferred.

under consideration.

As LEE (1927, p. 18) discussed already, *Fusulinella bocki* resembles *F. biconica* (HAYASAKA) in many respects. Moreover *Fusulinella itoi* OZAWA which will be described below somewhat resembles either *Fusulinella biconica* or *F. bocki*. So far as the rate of expansion is concerned *Fusulinella subspherica* n. sp., which will also be described below, cannot be distinguished from *F. bocki* or *F. biconica*. So closely these species are related one another it seems to need to discuss the differences between them in some detail.

Generally speaking these species have considerably large size of the shell, the same spirothecal structure which are typical for the genus, well developed heavy chomata and the similar rate of expansion. Therefore it is almost impossible to distinguish them only by sagittal section. For convinience's sake, I summarize the detailed differences between them in the table inserted in the facing page.

The specimens here referred to *Fusulinella* cf. *bocki* MÖLLER have not typical characters as indicated in the table inserted above. As *Fusulinella bocki* and *F. biconica* are closely intimated each other it is supposed that there are many intermediate forms between the typical forms of them. The present form may be in such the case. The present form has not so heavy chomata as seen in the topotype specimen illustrated by THOMPSON. So far as the development of the chomata is concerned it resembles rather closely *F. biconica* from which the present form can be distinguished by the larger form ratio and a slightly smaller size of the shell. As I have not been free from some doubt about the specific determination it seems better to identify the present form tentatively as *F.* cf. *bocki* until more sufficient materials become available.

Occurrence.—Fusulinella cf. *bocki* MÖLLER has been collected from Mo. 2 limestone of Section II (Loc. 354), No. 5 limestone of Section VIII (Loc. 325), No. 1 limestone of Section XI (Loc. 500), No. 2 limestone of Section XVII (Loc. 304), and Loc. 306, 357, and 361.

Judging from the associated species *Fusullinella* cf. *bocki* seems to have a range covering the Cmβ zone and probably the upper part of the Cmα zone.

Fusulinella cf. *pseudobocki* (LEE et CHEN)

Pl. 3, figs. 3, 4

1930. *Neofusulinella pseudobocki* LEE et CHEN. Mem. Nat. Res. Inst. Geol., No. IX, pp. 122, 123, Pl. IX, figs. 10–14, Pl. X, figs. 1–7.
1947. *Fusulinella* cf. *pseudobocki* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XX, Nos. 2–4, pp. 34, 35, Pl. IX, fig. 1.
1957. *Fusulinella pseudobocki* IGO. Sci. Repts. Tokyo Kyoiku Daigaku, Sec. C, Vol. 5, No. 47, pp. 207–209, Pl. VIII, figs. 1–12.

Only three specimens of *Fusulinella* cf. *pseudobocki* have been found. The shell is fusiform and is rather large for this genus. The central portion of the shell is somewhat vaulted and both the poles are bluntly pointed. The axial section has a length of about 3.2 mm and a width of 1.6 mm with a form ratio of 2.0. The shell is ellipsoidal in the first two volutions and is inflated fusiform in the following outer volutions. The ratios of the half length to the radius vector of the first to sixth volution in the specimen 1 are 1.4, 1.7, 1.8, 2.0, 2.0, and 2.1, respectively.

The proloculus is small, having an outside diameter of 92 microns. The rate of expansion is slow in the first volution, but a little rapid and almost uniform in the outer ones. The radius vectors of the first to sixth volution of the said specimen are 113, 175, 269, 406, 576, and 794 microns, respectively. The chambers increase in height polewardly in the outer volutions.

The spirotheca is thin and composed of four layers. The diaphanotheca is not discernible in the first volution, but it is considerably thick and very clear in the outer volutions, except in the last volution where it is not developed again. The combined thickness of the tectum and the diaphanotheca of the third to sixth volution is 15, 17 to 19, 20 to 23, and 24 microns, respectively.

The septa are almost plane in the middle portion of the shell, but are a little strongly fluted in both the polar regions, forming small septal loops. Other characters of the septa are unknown due to the absence of the sagittal section.

The tunnel is low and narrow in the inner volutions, but widens slightly in the outer ones. The tunnel angles of the third to sixth volution are 19, 22, 22, and 24 degrees, respectively. The chomata are well developed from the first volution. The tunnel side slopes are very steep, vertical, or sometimes overhanging, but the poleward slopes are very gentle, extending whole distance to the poles in the inner volutions. They are about half as high as the chambers.

Table 13. Table of Measurements (in Millimeters) of *Fusulinella* cf. *pseudobocki* (LEE et CHEN)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector					
									1	2	3	4	5	6
1	189	145	3	4	3.2+	1.59	2.0	.092	.113	.175	.269	.406	.576	.794
2	376	296	3	3	3.1+	1.49	2.1	—	—	.180	.270	.444	.623	.775
3	357	292			3.05	1.45	2.1	—	—	.238	.345	.440	.660	.858

Specimen	Ratio of Hl./Rv.						Thickness of spirotheca				Tunnel angle			
	1	2	3	4	5	6	3	4	5	6	3	4	5	6
1	1.4	1.7	1.8	2.0	2.0	2.1	.015	.017	.020					
2	—	—	—	1.6	2.0			.019	.023	.024	19?	22	22	24
3	—	—	—	2.1	1.9	2.0	—	—	—	—	13	14	23	

Remarks.—Although there is no sagittal section in the material at hand, the present form is most closely intimated to *Fusulinella pseudobocki* (LEE et CHEN) and may be conspecific with the latter. In their original description and illustration LEE and CHEN did not designate the holotype, and it seems that there are some variations within the species. The present form most closely resembles fig. 12 of Pl. IX which is considered to be most typical in this species. Until more sufficient material becomes available I classify the present form tentatively as *F.* cf. *pseudobocki* LEE et CHEN.

Occurrence.—*Fusulinella* cf. *pseudobocki* is very rare and is known only from No. 3 limestone of Section XIX (Loc. 376), No. 6 limestone of Section XV (Loc. 776), and Loc. 187 and 357.

The stratigraphical range of this species is supposed to be from the upper part of the Cmα to Cmβ zones.

Fusulinella biconica (HAYASAKA)

Pl. 3, figs. 5–10: Pl. 4, figs. 1, 2

1924. *Neofusulinella biconica* HAYASAKA. Sci. Repts. Tohoku Imp. Univ., Second Ser., Vol. III, No. 1, pp. 13, 14, Pl. II, figs. 4–7.
1927. *Fusulinella biconica* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, p. 19, Pl. III, figs. 2-4.
1936. *Fusulinella biconica* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, Pl. II, figs. 15–18.
1945. *Fusulinella* cf. *biconica* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XX, No. 1, pp. 5-7, Pl. I, figs. 10–18.

Fusulinella biconica (HAYASAKA) is the most abundant species among the Akiyoshi fusulinellids. This species was originally described by HAYASAKA from the Omi limestone, Central Japan. The following description is, however, based entirely upon the Akiyoshi specimens, because HAYASAKA's original description and illustrations are not sufficient for the detailed comparison.

The shell of *Fusullinella biconica* is one of the largest shell among the genus *Fusulinella.* The shell is biconical in form, having straight axis of coiling, rounded poles and convex to almost straight lateral slopes. The number of volution is 5 to 8. Mature specimens having seven or eight volutions are 1.8 to 2.9 mm wide and 2.9 to 3.6 mm long. The form ratio is 1.3 to 1.7, averaging 1.5 for twenty-one specimens. Averages of the half length to the radius vector of the first to seventh volution of twenty-six specimens are 1.4, 1.6, 1.7, 1.7, 1.7, 1.6, and 1.6, respectively.

The proloculus is spherical and large for this genus, having thick wall of 17.5 mirons in average which is almost as thick as that of the third or fourth volution. The outside diameter of the proloculus is ranging from 80 to 198 microns, averaging 146 microns for forty-nine specimens. The first one and a half to two volutions are somewhat tightly coiling, with almost spherical axial profile, and the outer volutions increase in height almost uniformly, retaining biconical ellipsoidal form of the shell. Average radius vectors of the first to seventh volution for

Table 14. Table of Measurements (in Millimeters) of *Fusulinella biconica* (HAYASAKA)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7	8
1*	OZAWA'S specimen	II-98	3	5	3.41	2.16	1.6	.180	.153	.260	.383	.550	.750	1.051	1.130	
2	439	200	3	6	2.88	1.85	1.6	.110?	.102	.16?	.242	.364	.530	.741	.960	
3	465	207	3	7	3.6+	2.5+	1.4	.198	.175	.269	.381	.550	.808	1.109	1.33?	
4	529	227	3	8	3.19	1.83	1.7	.160	.125	.210	.325	.486	.700	.961		
5	529	226	3	9	3.03	2.01	1.5	.142	.123	.194	.293	.482	.680	.936		
6	529	228	4	1	×	2.18	×	.160 .183 ×	.151	.230	.330	.501	.740	.970		
7	354	303	4	2	×	2.00	×	.146	.130	.260	.369	.550	.768	1.010		
							Max.	.198	.178	.287	.453	.607	.897	1.109	1.33?	1.483
							Min.	.080	.092	.153	.254	.353	.530	.705	.944	1.323
							Aver.	.146	.130	.210	.324	.476	.673	.896	1.104	1.403
								49	50	51	52	50	49	32	14	2

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7	8
1*	2.0	1.9	1.9	1.8	1.8	1.6	—	.010	—	—	.014	.014	—	—	—	
2	1.0	1.3	1.8	1.8	1.7	1.6	1.5	—	—	—	.012	.014	.020	.024	.024	
3	1.5	1.9	2.0	1.9	1.7	1.6		.020	—	—	.024	—	.024	.028		
4	1.8	1.8	2.0	2.0	1.8	1.6		.018	.008	.014	.017	.020	.021	.025		
5	1.5	1.7	2.1	1.8	1.9	1.6		.014	.010	.014	.015	.015	.019	.025		
6								.018	.008	.011	.013	.019	.019	.022		
7								.019	—	—	.018	.023	.024	.023		
Max.	2.4	2.2	2.2	2.0	1.8	1.7	1.6	.020	.016	.018	.024	.025	.026	.037	.033	
Min.	1.0	1.1	1.3	1.3	1.3	1.3	1.4	.010	.008	.009	.012	.014	.017	.016	.021	
Aver.	1.4	1.6	1.7	1.7	1.7	1.6	1.5	.018	.012	.013	.016	.019	.022	.024	.025	.021
	22	24	26	23	22	16	4	17	13	30	38	43	37	27	9	1

Specimen	Tunnel angle 2	3	4	5	6	Septal count 1	2	3	4	5	6	7	8
1*	19	16	15	21	—								
2	—	—	14	13									
3	—	19	21	21	29								
4	—	20	31	34	27								
5	17	—	19	20	24								
6						7	14	17	18	19	20		
7						7	14	14	21	23			
Max.	26	28	31	34	34	9	19	22	23	26	32		
Min.	16	14	12	13	17	5	10	13	15	18	20		
Aver.	20	21	21	22	25	7	13	17	20	22	27	32	30
	6	17	17	17	12	17	19	18	17	15	8	1	1

* The statistics of the specimen 1 is excluded from the averages.

fifty-two specimens are 130, 210, 324, 476, 673, 896, and 1,104 microns, respectively. The heights of the chambers are almost the same throughout the length of the shell, except in the polar regions where the chambers increase in height a little rapidly.

The spirotheca is typical for the genus, consisting of tectum, diaphanotheca, and outer and inner tectoria. The diaphanotheca can be seen from the first volution if the condition of the preservation is good. Both the inner and outer tectoria are well developed on both surface of the protheca, except in the last volution where they usually do not present. Both tectoria decrease in thickness poleward from the edge of the chomata. Average total thickness of the protheca of the first to seventh volution in forty-three specimens is 12, 13, 16, 19, 22, 24, and 25 microns, respectively.

The septa are almost plane and almost parallel to the axis. The spacing of the septa are rather close. In extreme polar regions the septa sometimes display very weak fluting. Average septal counts of the first to sixth volution for nineteen specimens are 7, 13, 17, 20, 22, and 27, respectively.

The tunnel is narrow in the inner four to five volutions, but gradually widens outward, and its height is half to one-third of the chambers. Average tunnel angles of the second to sixth volution for seventeen specimens are 20, 21, 21, 22, and 25 degrees, respectively. The chomata are well developed from the innermost volution. The tunnel sides of the chomata are vertical to very steep, but the poleward slopes are very gentle in most of volutions, extending down the lateral slopes into the polar regions. No axial filling presents.

Remarks.—This species is most abundant among species of the genus *Fusulinella* of Akiyoshi fusulinids. This is also one of the most easily distinguishable species of *Fusulinella* because of its biconical shape and large size of the shell. However this species more or less closely resembles *Fusulinella bocki*, the genotype of the genus *Fusulinella*. Both have large ellipsoidal shape of the shell, heavy chomata, unfluted septa, and almost the same rate of the growth. LEE (1927) pointed out that the close examination will show that they are specifically distinct, and that *Fusulinella biconica* has smaller form ratio, more numerous number of the septa for the corresponding volution and more slowly expanding whorls. So far as the rate of expansion is concerned, however, there is only slight difference between them which is regarded variation within a species. The detailed comparison is shown in the table inserted in the remarks on *Fusulinella* cf. *bocki* MÖLLER. At any rate, *Fusulinella biconica* and *F. bocki* have close relationship with each other, and it seems that the former is a little highly developed than the latter and that the former might be derived from the latter.

Fusulinella biconica (HAYASAKA) was originally described by HAYASAKA from the Horizons IV and III of the Omi limestone, Echigo (Toyama Prefecture), Central

Japan. In the former he listed *Neofusulinella (Fusulinella) biconica* HAYASAKA (?), *Fistulipora minima* HAYASAKA, and *Batostomella* sp., and from the latter *Neofusulinella (Fusulinella) biconica* HAYASAKA, *Schwagerina (Verbeekina) deprati* YABE, *Fusulina (Schwagerina) brevicula* SCHWAGER, *Fusulina (Pseudofusulina)* cf. *japonica* GÜMBEL, *Doliolina lepida* SCHWAGER, and *Neoschwagerina craticulifera* SCHWAGER.

Although HAYASAKA excluded *Neofusulinella biconica* from the stratigraphical consideration of the Horizon III, he stated in the description of the species that "this species seems to range in somewhat wide vertical extension, although it also seems possible that the blocks at the lower horizon (IV) are allochthonous, because the species is much more numerous at III than at any other horizons." He was also in opinion that the Omi limestone is representing, as a whole, age from about the Uralian to the Permian, probably including the younger Permian. Judging from his illustration of Pl. II, figs. 6 and 7, *Neofusulinella biconica* seems to be found associated with no Permian species. Accordingly it is highly possible that *N. biconica* is a derived fossil in the HAYASAKA's Horizon III. Recent KAWADA's study (1956) has clarified that the species under consideration is limited in the stratigraphic range in his C-2 formation of the Omi limestone which is of the Middle Pennsylvanian age.

Occurrence.—In the Akiyoshi limestone group *Fusulinella biconica* (HAYASAKA) is a good index fossil for the Cmβ zone of the Pennsylvanian section, being most widely distributed species among the Pennsylvanian fusulinids.

More than twenty localities are known for this species, which are Nos. 1 and 2 limestones of Section II (Loc. 355 and 354, respectively), No. 1 limestone of Section III (Loc. 538), Nos. 1 and 10 limestones of Section VII (Loc. 327 and 439, respectively), Nos. 1 and 4 limestones of Section XI (Loc. 500 and 502A, respectively), Nos. 1 and 4 limestones of Section XVII (Loc. 303 and 310, respectively) Nos. 1, 2, 4, and 5 limestones of Section XXV (Loc. 279, 278, 276, and 275, respectively), and Loc. 346, 362, 465, 529, 524A, 524B, 525, 532, and 533.

Fusulinella itoi OZAWA

Pl. 4, figs. 3–6

1925. *Fusulinella itoi* OZAWA. Jour. Coll. Sci., Imp. Univ. Tokyo, Vol. XLV, Art. 6, p. 19, Pl. III, figs. 6–8.

The shell of *Fusulinella itoi* OZAWA is of small to medium size for the genus, attaining a length of 2.0 to 3.7 mm and a width of 1.2 to 2.1 mm. The shell is fusiform with bluntly pointed to somewhat rounded poles. The axis of coiling is straight to slightly curving. The lateral slopes is straight or more or less concave, at least on one side. The form ratio is ranging from 1.8 to 2.0, and shows almost no change during the growth except in the first two volutions. Averages of the ratios of the half length to the radius vector of the first to seventh volution for five specimens are 1.1, 1.9, 2.1, 2.1, 2.1, 2.1, and 2.1, respectively.

The proloculus is spherical and small, having an outside diameter of 73–129 microns, averaging 99 microns for ten specimens. The shell expands rather slowly. The first volution is almost spherical. The second volution is ellipsoidal. From the third volution outward the shell retains almost the same shape throughout the growth. Average radius vectors of the first to seventh volution for fourteen

Table 15. Table of Measurements (in Millimeters) of *Fusulinella itoi* OZAWA

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1*	OZAWA's specimen	II-93	4	3	2.60	1.33	2.0	.103	.090	.152	.251	.340	.455	.590	.710
2	339	239	4	4	2.39	1.16	2.0	.085	.075	.121	.170	.236	.340	.453	.548
3	516	246	4	5	3.38	1.68	2.0	.113	.098	.166	.250	.370	.568	.777	.900
4	377	308			3.69	2.09	1.8	.081	.090	.132	.200	.301	.437	.656	.918
5	339	240	4	6	×	1.06	×	.10?	.081	.122	.211	.291	.430	.55?	
					Max.			.129	.098	.166	.258	.379	.568	.777	.988
					Min.			.073	.080	.121	.172	.236	.340	.453	.548
					Aver.			.099	.090	.143	.232	.322	.474	.631	.847
								10	12	13	14	14	14	12	5

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 2	3	4	5	6	7
1*	—	—	2.4	2.3	2.1	2.1	2.0	.010	.013	.014	.016	.019	
2	1.3	1.6	—	1.6	1.8	2.0	2.2	.012	.014	.014	.018	.019	.023
3	—	2.5	2.2	2.2	2.1	2.1	2.1	—	.014	.016	—	.023	.024
4	1.0	1.6	1.6	2.5	2.8	2.6	2.4	—	—	—	.024	.028	
5								.012	.014	.018	—	—	
Max.	1.3	2.5	2.4	2.5	2.8	2.6	2.4	.014	.016	.018	.024	.028	.024
Min.	1.0	1.6	1.6	1.6	1.8	1.7	1.8	.010	.013	.014	.014	.016	.016
Aver.	1.1	1.9	2.1	2.1	2.1	2.1	2.1	.012	.014	.016	.019	.021	.022
	2	3	3	4	5	5	5	4	8	8	9	7	4

Specimen	Tunnel angle 2	3	4	5	6	7	8	Septal count 1	2	3	4	5	6	7	8
1*	18	16	16	14	16										
2	—	7?	10	17	16	18									
3	13	12	15	17	17										
4	—	13	17	15	20	25	22								
5								6	11	17	23	19+			
Max.	18	16	17	17	20	25		9	15	19	23	26			
Min.	13	7?	8	11	12	15		6	11	15	19	19?			
Aver.	16	12	13	15	16	20	22	8	13	17	21	22	22	27	30
	2	5	6	6	6	3	1	3	3	4	4	4	1	1	1

* The statistics of the specimen 1 is excluded from the averages.

specimens are 90, 143, 232, 322, 474, 631 and 847 microns, respectively. The heights of the chambers are almost equal, except in the polar regions where they are slightly higher than in the median part of the shell.

The spirotheca is thin and is typical in structure for the genus, consisting of a tectum, a diaphanotheca, and outer and inner tectoria. Clear diaphanotheca can be seen from the first volution if the condition of the preservation is good. Both tectoria are well developed except the last volution where they are very poorly developed or lacking. Averages of the combined thickness of the tectum and the diaphanotheca of the second to seventh volution for nine specimens are 12, 14, 16, 19, 21, and 22 microns, respectively. The spirotheca is almost uniform in thickness poleward from the center of the shell.

The septa are almost plane throughout the length of the shell, except in the extreme polar regions where they sometimes very weakly fluted. The septa are the same in structure as the spirotheca. Both sides of the septa are usually coated by the secondary deposits which are continuation of the inner tectorium of the spirotheca. The spacing of the septa is moderate. Average septal counts of the first to fifth volution for four specimens are 8, 13, 17, 21, and 12, respectively.

The tunnel path is almost straight to somewhat irregular. Averages of tunnel angles of the second to seventh volution for six specimens are 16, 12, 13, 15, 16, and 20 degrees, respectively. The tunnel is one-third to almost half as high as the chamber. The chomata are well developed from the second volution. The tunnel sides of the chomata are very steep, perpendicular, or sometimes overhanging. The poleward slopes of the chomata are very gentle, extending into the polar regions. Combined with the outer tectorium, the poleward extension of the chomata is usually thickened, forming the roofs of the spirotheca of the preceding volution.

Remarks.—On its stratigraphic occurrence and its generic referrence, *Fusulinella itoi* OZAWA has been discussed many times by several paleontologists. OZAWA briefly described this species at first from Shiraiwa, Ominé, Miné-shi. In the remark of his description he stated that "it is associated with *Lonsdaleia katoi* n. sp., *Chaetetes* sp., and the Upper Permian fusulines such as *Neoschwagerina shiraiwensis* n. sp., *N. douvillei* OZAWA and *Sumatrina annae.*" OZAWA considered, accordingly, that the age of *Fusulinella itoi* was the Upper Permian. As no species of *Fusulinella* had been reported from the Upper Permian of other localities, the OZAWA's species caused much discussion among paleontologists. THOMPSON (1934, p. 295) was the first who questioned the stratigraphical position of this species because of its close resemblance to *Fusulinella bocki* from the Moscovian of Russia. In 1935 he considered that "*Fusulinella*" *itoi* was Permian in age and referred it with question to the genus *Yangchienia* LEE. On the other hand

HANZAWA (1938) believed that the OZAWA's specimens may have been collected from the clastic pebbles derived from the underlying Moscovian bed, though he did not offer any evidence to support his conclusion. In 1946 THOMPSON (p. 26) discussed again on the generic referrence of this species, prefering to refer the OZAWA's species with question to the genus *Neofusulinella.* In his recent comprehensive studies of American fusulinids THOMPSON (1948, p. 37) again referred this species to *Neofusulinella,* doubting its stratigraphical position.

Although it is unfortunate that I have not been able to find the OZAWA's type specimen, there are still few thin sections labeled "*Fusulinella itoi*" in his collection (section number II, 92-94). In any of them specimen of *Fusulinella itoi* is not associated with such Upper or Middle Permian species as *Yabeina shiraiwensis, Neoschwagerina douvillei,* or *Sumatrina annae* in the same slide, so it is most probable that all the specimens of *Fusuinella itoi* obtained from limestone lense at Shiraiwa are derived fossils as HANZAWA thought in 1938. (There is no doubt about the Upper Permian age of the limestone lenses at Shiraiwa, yielding many typical Upper Permian fusulinids, though there are many limestone lenses in Shiraiwa and I am not sure that from which one OZAWA collected his specimens. By the way all the limestone lenses in Shiraiwa are not contained in the Akiyoshi limestone proper, but they are the members of the Permian Tsunemori group which is composed mainly of shales, sandstones, and their alternations.)

In the Akiyoshi specimens, there are two forms in the size of the shell; the larger one has a length of more than 3.5 mm and a width of about 2.0 mm, while the smaller one to which the OZAWA's syntype belongs has only a length of about 2.5 mm and a width of about 1.3 mm. There is, however, no important difference between them except the rapid expansion of the shell in the former. It may not be probable that two forms are of dimorphism in the species under consideration, because they have almost the same size of the proloculus and the same number of the volution. If more materials are prepared it may be possible to distinguish the larger one from *Fusulinella itoi* s. str. at least as a subspecies.

In general *Fusulinella itoi* has some resemblance to *Fusulinella bocki,* the genotype of the genus, as already pointed out by OZAWA, LEE, THOMPSON and others. But the close comparison will show the differences between them; namely, *Fusulinella bocki* has inflated fusiform and more or less steep convex lateral slopes which tend to become slightly concave only near the poles in the outer volutions, while the lateral slopes of *F. itoi* are almost straight to more or less concave; and the rate of expansion in *F. bocki* is more rapid and the form ratio is different.

Occurrence.—In the Akiyoshi limestone group this species has been found associated with Pennsylvanian species, not with the Permian ones. Therefore there is no doubt about the Pennsylvanian age of this species. This species is the good index fusulinid for the Cmβ zone. Localities are No. 1 limestone of Section VII (Loc. 327), No. 1 limestone of Section IX (Loc. 516), Nos. 5, 6, and 7 limestones of Section XX (Loc. 339, 340, and 341, respectively), Nos. 3 and 4 limestones of Section XXV (Loc. 277 and 276, respectively), and Loc. 307, 377, 378, 504, and 505.

Fusulinella subspherica TORIYAMA, n. sp.

Pl. 4, figs. 7–11

The shell of *Fusulinella subspherica* TORIYAMA, n. sp. is large and almost spherical in shape. The number of the volution is usually 6 to 8, rarely attaining 9. The axis of coiling is almost straight except in the first volution which coils almost perpendicular to the later volutions. The lateral slopes are completely convex, composing subspherical shape of the shell combined with the broadly rounded poles. The form ratio is ranging from 1.0 to 1.2, averaging 1.1 for four specimens. The first volution is spherical. From the second to fourth volution the shell increases in relative length a little slightly rapidly with the growth of individuals, but again decreases in the outer three to four volutions. Average ratios of the half length to the radius vector of the first to eighth volution for four specimens are 1.2, 1.4, 1.4, 1.4, 1.2, 1.2, 1.2, and 1.1, respectively.

The proloculus is spherical and rather large for the genus, with outside diameter of 89 to 154 microns, averaging 125 microns in eleven specimens. The shell expands more or less slowly in the inner three to four volutions, and rapidly but almost uniformly from the fourth volution to maturity. Average radius vectors of the first to eighth volution of twelve specimens are 115, 191, 298, 431, 626, 852, 1,096, and 1,331 microns, respectively. The heights of the chambers are almost uniform from the center of the shell to the poles.

The spirotheca is relatively thick, consisting of a tectum, a diaphanotheca, and outer and inner tectoria. The clear diaphanotheca appears from the first volution and exists throughout the length of the shell. Both outer and inner tectoria are also well developed except in the last volution where they usually do not present. Average thickness of the diaphanotheca plus tectum of the second to eighth volution for nine specimens are 13, 16, 17, 22, 23, 22, and 27 microns, respectively.

The septa are relatively closely spaced and are almost plane throughout the length of the shell. Almost all of the septa are coated by the secondary deposits which continue to the outer tectorium of the preceding whorl. Average septal counts of the first to eighth volution of five specimens are 7, 14, 17, 19, 22, 28, 30, and 31, respectively.

The tunnel is about half as high as the chambers, and its path is rather irregular. Average tunnel angles of the second to seventh volution for four specimens are 17, 14, 16, 16, 13, and 15 degrees, respectively. The chomata are well developed from the second volution to the last one. The tunnel side of the chomata are very steep, vertical, or sometimes overhanging. The poleward slopes are very gentle. The chomata extend almost whole way to the poles in the inner volutions, but about half in the outer two or three volutions. No axial filling presents.

Table 16. Table of Measurements (in Millimeters) of *Fusulinella subspherica* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7	8	9
1*	354	305	4	7	2.71	2.47	1.1	.150	.122	.193	.321	.450	.678	.920	1.180	1.290	
2	533	312	4	8	3.0+	2.75	1.1	.140	.111	.200	.300	.441	.600	.811	1.030		
3	533	313	4	9	×	2.76	×	.102	.083	.145	.240	.391	.530	.740	.963	1.220	1.440
4	346	198	4	10	×	2.87	×	.128	.140	.219	.353	.491	.722	.941	1.210	1.483	
5	354	305	4	11	×	1.83	×	.140	.140	.237	.376	.588	.770				
						Max.		.154	.140	.237	.376	.588	.770	.941	1.210	1.483	
						Min.		.089	.083	.145	.240	.352	.530	.740	.963	1.220	
						Aver.		.125	.115	.191	.298	.431	.626	.852	1.096	1.331	1.440
								11	11	12	12	12	11	6	5	4	1

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	8	Thickness of spirotheca 0	1	2	3	4	5	6	7	8
1*	1.0	1.4	1.4	1.5	1.2	1.1	1.0	1.0	.020	—	.019	.018	.018	.018	.026	.026	.028
2	1.6	1.6	1.5	1.4	1.3	1.3	1.2	1.1	—	—	—	.016	.014	.016	—	.016	.025
3									—	—	.007	.012	.018	.016	.018	.019	.019
4									.019	.010	.014	.014	.015	.020	.024	.026	.037
5									—	—	—	.018	.019	.019			
Max.	1.6	1.6	1.5	1.5	1.3	1.3	1.2	1.1	.020	—	.019	·018	.020	.033	.026	.026	.037
Min.	1.0	1.1	1.4	1.4	1.1	1.1	1.0	1.0	.013	—	.007	.012	.014	.016	.018	.016	.019
Aver.	1.2	1.4	1.4	1.4	1.2	1.2	1.2	1.1	.017	—	.013	.016	.017	.022	.023	.022	.027
	3	3	4	4	4	4	4	3	4	—	4	9	9	9	3	4	4

Specimen	Tunnel angle 2	3	4	5	6	7	8	Septal count 1	2	3	4	5	6	7	8	9
1*	18	10	14	15	11	15										
2	15	13	12	14	11	15	12									
3								7	13	17	19	23	24	28	32	32
4								8	13	19	21	22	31	32	30	
5								8	17	20	23	25	30?			
Max.	18	20	20	21	16	15		8	17	20	23	25	31	32	32	
Min.	15	10	12	14	11	15		6	11	13	14	18	24	28	30	
Aver.	17	14	16	16	13	15	12	7	14	17	19	22	28	30	31	32
	2	3	4	4	3	2	1	5	5	5	5	4	3	2	2	1

* Holotype specimen.

Remarks.—Fusulinella subspherica TORIYAMA, n. sp. is one of the largest species in the genus *Fusulinella*. It has some relationship with *F. biconica* (HAYASAKA) with which the present species occurs together. There is no important difference between them so far as the rate of expansion, the structure and thickness of the spirotheca, the fluting and the number of the septa and the development of the chomata are concerned. The differences which are supposed to be sufficient to distinguish the species are characteristic subspherical shape of the mature shell and the development of endothyroid juvenarium in the species under consideration.

Occurrence.—Fusulinella subspherica TORIYAMA, n. sp. is not common in occurrence. The holotype specimen was collected from No. 2 limestone of Section II (Loc. 354), the western slope of Shishidedai of Akago, Mito-cho, where it is associated with much more common species of *Fusulinella biconica* (HAYASAKA). The stratigraphical horizon of this species is, therefore, safely assigned to the Cmβ zone. The paratype specimens have also been obtained from No. 1 limestone of Section II (Loc. 355), No. 5 limestone of Section VIII (Loc. 325), and Loc. 346, 358, 377, 378, and 533.

Fusulinella spp.

Several species of *Fusulinella* have been observed in the present collection, some of them are supposed to be new species. As the specimens available to me are too insufficient to establish new species, all of them have been left unnamed.

Fusulinella sp. A

Pl. 5, figs. 1–3

The material of this species is very poor, represented by three axial and one diagonal sections, with the result that the following description cannot be called complete. The shell is elongate fusiform and is large for this genus, having a length of approximately 4.1 mm and a width of about 2.3 mm. Form ratio is 1.8. The poles are bluntly pointed and the lateral slopes are almost straight, very slightly convex, or somewhat irregular. The ratios of the half length to the radius vector of the second to seventh volution of a mature individual (specimen 2) are 2.2, 2.4, 2.4, 2.3, 1.9, and 1.8, respectively.

The proloculus is very large for this genus. Its outside diameter is 256 microns in maximum, averaging 210 microns for three specimens. The expansion of the shell is rather rapid. Averages of the radius vectors of the first to sixth volution for four specimens are 160, 248, 362, 513, 719, and 922 microns, respectively. The chambers more or less increase in height polewardly in the inner volutions, but almost uniform in the outer ones.

The spirotheca consists of a tectum, a diaphanotheca, and outer and inner tectoria. The diaphanotheca begins to appear near the end of the first volution.

Both tectoria are well developed. The combined thickness of the tectum and the diaphanotheca is averaging 17 microns in the third, 19 microns in the fourth, 22 microns in the fifth and 31 microns in the sixth volution, respectively.

The septa are almost plane in the middle portion of the shell, but weakly fluted in the polar regions. They seem to be spaced rather widely. Judging from the diagonal section the shell seems to have at least 20 septa in the fifth volution.

The tunnel is low and broad. The tunnel angle is 25 to 28 degrees at the fifth volution. The chomata are fairly well developed in the inner volutions, but rudimentary or absent in the outer ones. The tunnel side slopes of the chomata are not so steep and the poleward slopes are extremely gentle which is hardly distinguished from the outer tectorium.

Table 17. Table of Measurements (in Millimeters) of *Fusulinella* sp. A

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector						
									1	2	3	4	5	6	7
1	354	304	5	1	3.47	1.60	2.2	.190	.143	.232	.350	.513	.701	.92?	
2	312	141	5	2	4.1+	2.25	1.8	—	—	.201	.312	.473	.700	.952	1.220
3	312	141	5	3	×	1.91	×	.256	.187	.276	.398	.565	.793	.996	
4	279	136			3.8+	2.0+	1.9	.184	.150	.281	.387	.500	.680	.82?	

Specimen	Ratio of Hl./Rv.							Thickness of spirotheca						
	1	2	3	4	5	6	7	0	1	2	3	4	5	6
1	1.9	2.4	2.3	2.0	2.1			.019	—	—	.014	.016	.019	.033
2	—	2.2	2.4	2.4	2.3	1.9	1.8	—	—	—	.019	—	.024	.028
3								—	—	.016	.019	.021	.024	
4	—	—	—	1.7	—	2.2		—	—	—	—	—	—	—

Specimen	Tunnel angle					Septal count				
	2	3	4	5	6	1	2	3	4	5
1	25	19	17	25	23					
2	—	—	25	28						
3						7?	16?	20?	17?	20?

Remarks.—Judging from the large size of the shell and poor or rudimentary development of the chomata this species is supposed to be an intermediate form between *Fusulinella* and *Fusulina*. As this species does not resemble any species of *Fusulinella* hitherto described, it may be a new species. It seems, however, better to leave this species unnamed until more sufficient material becomes available.

Occurrence.—*Fusulinella* sp. A. is rare and has been collected from No. 2 limestone of Section II (Loc. 354), No. 1 limestone of Section XXV (Loc. 279) and Loc. 312.

The stratigraphical horizon of this species is clearly the Cmβ zone.

Fusulinella sp. B

Pl. 5, figs. 4–7

Fusulinella sp. B is small and ellipsoidal, having 5 to 7 volutions. The middle portion of the shell is much vaulted. The lateral slopes are straight to slightly convex. The ratios of the half length to the radius vector of the first to fifth volution in four specimens are averaging 1.7, 1.7, 1.7, 1.9, and 1.4, respectively.

The proloculus is rather large for the size of the shell. The outside diameter is ranging from 90 to 132 microns, averaging 114 microns for seven specimens. In the first two or three volutions the shell is rather tightly coiling, and from the third or fourth volution it expands more or less rapidly. Averages of the radius vectors of the first to seventh volution for seven specimens are 94, 149, 230, 323, 470, 572, and 761 microns, respectively. The heights of the chambers are almost uniform from the center of the shell to the poles, retaining almost the same axial profile throughout the entire growth of the shell.

The spirotheca is thin, consisting of a tectum, a diaphanotheca, and outer and inner tectoria. The diaphanotheca cannot be observed in the inner one or two volutions. Tectoria are well developed on both sides of the protheca. The outer tectorium is usually very obscure or absent in the last volution. The combined thickness of the tectum and the diaphanotheca of the second to sixth volution for five specimens is averaging 10, 11, 13, 20, and 22 microns, respectively.

The septa are almost plane, even in both the polar regions. The spacing of the septa is rather wide. The septal count of the first to fourth volution in the illustrated sagittal section is 7, 11, 11, and 17, respectively. The tunnel is narrow and its path is somewhat irregular. The tunnel angles at the third and fourth volutions in four specimens are averaging 16 and 23 degrees, respectively. The chomata are well developed. The tunnel sides of the chomata are considerably steep, but the poleward slopes are very gentle. The poleward extension of the chomata is hardly distinguished from the outer tectorium. The heights of the chomata are almost half as high as the chambers.

Remarks.—Judging from available axial sections this species closely resembles *Fusulinella biconica* (HAYASAKA), but the size of the shell is considerably smaller and the rate of expansion is slower in this species. It may be possible that the present species is a variety of *F. biconica* (HAYASAKA); if not so, both have at least very close relationship with each other. The rate of expansion of this species almost coincides with that of *F. itoi* OZAWA, from which this species can be distinguished by its ellipsoidal shape. So far as its smaller ellipsoidal shape of the shell and its almost unfluted septa are concerned this species more or less resembles some species of *Profusulinella* such as *P. parva* var. *convoluta* (LEE et CHEN) from the Huanglung limestone of China and *P. fittsi* (THOMPSON) from the Atoka

Table 18. Table of Measurements (in Millimeters) of *Fusulinella* sp. B

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1	376	296	5	4	1.46	1.0+	1.5	.104	.091	.126	.190	.291	.440	.52+	
2	304	324	5	5	1.3+	0.95	1.4	.132	.103	.18+	.287	.405			
3	187	142	5	6	2.03	1.46	1.4	.122	.107	.160	.237	.331	.460	.611	.766
4	433	261	5	7	×	1.06	×	.101	.100	.165	.240	.342	.520		
							Max.	.132	.107	.18+	.287	.405	.520	.611	.766
							Min.	.090	.073	.123	.190	.342	.440	.52+	.756
							Aver.	.114	.094	.149	.230	.323	.470	.572	.761
								7	7	7	7	7	5	3	2

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
1	—	—	—	1.8	—	1.6		.016	—	—	.010	.013	.023		
2	—	1.5	1.6	1.7				—	—	.009	.014	.015	.022		
3	—	—	—	—	1.4	—	1.5	—	—	.010	.010	.010	.014	.021	.016
4								—	—	—	—	.013	.020		
Max.	1.9	1.8	2.1	2.3	1.5			—	—	.010	.014	.015	.023	.022	
Min.	1.5	1.5	1.6	1.6	1.4			—	—	.009	.010	.010	.014	.021	
Aver.	1.7	1.7	1.7	1.9	1.4	1.6	1.5	.016	—	.010	.011	.013	.020	.022	
	2	3	3	4	2	1	1	1	—	2	3	5	5	2	

Specimen	Tunnel angle 1	2	3	4	Septal count 1	2	3	4
1	—	—	14					
2	18	19	23	28				
4					7	11	11	17

formation of Oklahoma. However, as stated in the above description, this species has clear diaphanotheca in all except the inner one or two volutions, and is distinguished from typical species of *Profusulinella*.

As recently pointed out by SKINNER and WILDE (1954) some of advanced forms of *Profusulinella* sometimes possesses diaphanotheca in the spirotheca of all except the ultimate volution. Accordingly the present species is considered to be transitional from *Profusulinella* to *Fusulinella*. Further study on more sufficient materials is necessary for the definite generic and specific assignment of this form.

Occurrence.—*Fusulinella* sp. B has been collected from No. 2 limestone of Section VII (Loc. 433), No. 6 limestone of Section XV (Loc. 776), No. 2 limestone of Section XVII (Loc. 304), No. 3 limestone of Section XIX (Loc. 376), and Loc. 187.

The stratigraphical range is covering both the Cmα and Cmβ subzones.

Fusulinella sp. C
Pl. 5, figs. 8-10

The shell of *Fusulinella* sp. C is small and ellipsoidal, having a straight axis of coiling. The lateral slopes are very gently convex, but never concave. Both the extremities are very broadly rounded. The number of the volution is usually 5, rarely 6. An individual (specimen 1) of five volutions has a length of 2.6 mm and a width of 1.3 mm. Average of the form ratio for seven specimens is 1.8. The first volution is spherical to subspherical. Beyond the second volution the shell retains ellipsoidal shape throughout the growth. Average ratios of the half length to the radius vector of the first to fifth volution for eight specimens are 1.5, 2.0, 2.0, 2.1, and 1.9, respectively.

The proloculus is small and spherical. Its outside diameter is ranging from 82 to 113 microns, averaging 99 microns for five specimens. The shell coils rather closely in the first three volutions, but considerably rapid in the outer two or three volutions. Averages of the radius vector of the first to fifth volution for eight specimens are 89, 142, 229, 352, and 539 microns, respectively. The heights of the chambers increase only slightly poleward from the center of the shell.

The spirotheca is thin and is typical for the genus. The diaphanotheca appears from the first volution. Both tectoria are well developed except in the last volution where they are poorly developed or absent. The outer tectorium which decreases in thickness poleward from the edges of the chomata is hardly distinguishable from the poleward extension of the chomata. Average combined thickness of the tectum and the diaphanotheca of the first to fifth volution for eight specimens is 10, 12, 14, 16, and 20 microns, respectively.

The septa are almost plane and parallel to the axis of coiling. In the polar regions the septa flute very weakly. The spacing and the number of the septa are unknown because of the absence of the well oriented sagittal section.

The tunnel is narrow in the inner two or three volutions, but gradually widens outward. The height of the tunnel is one-third to half of the chambers. Average tunnel angles of the third to fifth volution for three specimens are 21, 23, and 25 degrees, respectively. The chomata are well developed. The tunnel sides of the chomata are very steep, vertical, or sometimes overhanging, but the poleward slopes are very gentle, extending down the lateral slopes into the polar regions.

Remarks.—This species resembles *Fusulinella biconica* (HAYASAKA), but is distinguished from the latter by its more elongate ellipsoidal form, larger form ratio, smaller proloculus, and slower rate of expansion. This species also resembles *Fusulinella bocki* MÖLLER which has almost the same form ratio. However the latter has more inflated fusiform, more steep convex lateral slopes, better developed chomata, and more rapid expansion of the shell.

Table 19. Table of Measurements (in Millimeters) of *Fusulinella* sp. C

Speci-men	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector				
									1	2	3	4	5
1	478	147	5	8	2.57	1.29	2.0	.094	.085	.137	.231	.370	.600
2	549	154	5	9	2.3+	1.29	1.8	.113	.100	.160	.246	.387	.581
3	535	149	5	10	1.89	1.1+	1.7	.085	.080	.128	.217	.302	.440
							Max.	.113	.104	.160	.270	.410	.650
							Min.	.082	.072	.123	.210	.302	.440
							Aver.	.099	.089	.142	.229	.352	.539
								7	8	8	8	8	8

Speci-men	Ratio of Hl./Rv.					Thickness of spirotheca					Tunnel angle		
	1	2	3	4	5	1	2	3	4	5	3	4	5
1	1.9	2.9	2.7	2.6	2.2	.009	.014	.018	.019	.028	23	24	27
2	2.0	2.0	1.5	—	1.9	—	—	—	.014	.015	—	—	—
3	1.4	1.8	1.8	1.9	1.9	.010	.012	.013	.014	.016	19	27	—
Max.	2.0	2.9	2.7	2.6	2.2	.010	.014	.018	.019	.028	23	27	27
Min.	1.0	1.2	1.5	1.6	1.6	.009	.010	.011	.013	.015	19	19	23
Aver.	1.5	2.0	2.0	2.1	1.9	.010	.012	.014	.016	.020	21	23	25
	7	7	7	6	8	2	4	6	8	8	2	3	2

Generally speaking *Fusulinella* sp. C is presumed to be an earlier form of the genus, because this species is considered to be morphologically more primitive than *Fusulinella biconica* (HAYASAKA) or *F. bocki* MÖLLER and its stratigraphical occurrence is limited to the Cmα zone as listed below.

Occurrence.—Fusulinella sp. C is rather rare in the Akiyoshi limestone group. It has been collected from the following three localities, all of them are referred to the Cmα zone. No. 5 limestone of Section XXIV (Loc. 549) and Loc. 478 and 535.

Fusulinella sp. D

Pl. 5, figs. 11, 12

The shell is fusiform with more or less pointed ends. The lateral slopes are convex in the inner volutions, but concave at least in one side of the outer volutions. The shell of three volutions has a length of 0.88 to 0.95 mm, and a width of 0.52 to 0.55 mm, with a form ratio of 1.6 to 1.8.

The proloculus is spherical and is very large for the genus, attaining an outside diameter of 137 to 145 microns. The wall of the proloculus consists of a single homogeneous layer which has a thickness of less than 10 microns. The first volution is almost spherical in shape, and beyond the second volution the shell increases in length, retaining a fusiform. The rate of expansion is rather moderate. The radius vectors of the first to third volution are 113–137, 180–189, and 270–274 microns, respectively. The heights of the chambers are uniform in the spherical first volution, but increasing polewardly in the outer ones.

The spirotheca is thin and composed of a tectum, a diaphanotheca, and outer and inner tectoria. The diaphanotheca begins to appear from the last part of the first volution, but disappears again in the last part of the last volution. Both tectoria are well developed except in the last volution where they are poorly developed or absent. The combined thickness of the tectum and the diaphanotheca of the second and third volutions is 11–12 and 12–13 microns, respectively.

The septa do not flute even in both the polar regions. The spacing and the number of septa are unknown because of the absence of sagittal section.

The tunnel is low and narrow and its path is somewhat irregular. The chomata are well developed from the first volution. The heights of the chomata are one-third to almost half as high as chambers. The tunnel side of the chomata is very steep to almost vertical, but the poleward slopes are very gentle, extending almost to the poles in the outer two volutions. The tunnel angles of the first to third volution are 20, 15–16, and 13–15 degrees, respectively.

Table 20. Table of Measurements (in Millimeters) of *Fusulinella* sp. D

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector		
									1	2	3
1	577	280	5	11	0.88	0.55	1.6	.145	.137	.180	.270
2	355	332	5	12	0.95	0.52	1.8	.137	.113	.189	.274

Specimen	Ratio of Hl./Rv.			Thickness of spirotheca				Tunnel angle		
	1	2	3	0	1	2	3	1	2	3
1	1.2	1.8	1.7	.009	.009	.012	.012	20?	16	13
2	1.2	1.4	1.7	—	—	.011	.013	—	15	15

Remarks.—Having a considerably large proloculus for the size of the shell, this species may be either a megalospheric or an immature form of some species of *Fusulinella*. This species more or less resembles *Profusulinella fittsi* (THOMPSON) which was originally described as a species of *Fusulinella*. However the said species has much massive chomata, while the present species has clear diaphanotheca even in the spirotheca of the first volution. One specimen of *Fusulinella bocki* MÖLLER which was illustrated as Pl. IX, fig. 1 by LEE and CHEN (1930) also resembles the present form. As stated already, some specimens of LEE and CHEN seem to be not conspecific with the topotype specimen of *F. bocki* redescribed and re-illustrated by THOMPSON (1954). Having small size and fusiform of shell, large proloculus, unfluted septa, and heavy chomata, the present form and LEE and CHEN's fig. 1 may be conspecific. The final generic and specific assignment of this form should be reserved until more sufficient material becomes available.

Occurrence.—*Fusulinella* sp. D has been collected from No. 1 limestone of Section II (Loc. 355), No. 6 limestone of Section XV (Loc. 776) and Loc. 577. It is supposed that the stratigraphical range of this species is covering both of the Cmα and Cmβ zones.

Genus *Fusulina* FISCHER DE WALDHEIM, 1829

Fusulina akiyoshiensis TORIYAMA, n. sp.

Pl. 5, figs. 13-15

The shell is of moderate size and is highly inflated fusiform, having a straight axis of coiling, convex to almost straight lateral slopes and bluntly pointed poles. Although the last whorl has been broken away, the holotype specimen of seven volutions is estimated to have a length of about 4.2 mm and a width of about 2.9 mm. The form ratio is approximately 1.4.

The proloculus is spherical and moderate in size, having an outside diameter of 160 to 195 microns. The wall of the proloculus is composed of structureless dense layer which has a thickness of 16 microns that is almost equal in thickness to that of the third or fourth volution. The first one or two volutions are closely coiling, and then the shell expands a little rapidly. Averages of the radius vector of the first to seventh volution for seven specimens are 159, 256, 387, 567, 825, 1,117, and 1,363 microns, respectively. The heights of the chambers are almost uniform from the equator to the poles, resulting in that the ratios of the half length to the radius vector change but little during the growth of the shell.

The spirotheca is typical for the genus, consisting of a tectum, a diaphanotheca, and outer and inner tectoria. The diaphanotheca are well developed and can be observable from the first volution. Both tectoria are also well developed throughout the length of the shell, except in the last volution where they are very poorly developed or absent. Averages of the combined thickness of the tectum and the diaphanotheca of the first to seventh volution are 11, 12, 15, 17, 18, 22, and 27 microns, respectively. In a zone of each side of the tunnel the epithecal deposits are very strong, taking a form of chomata. In some parts of the shell these epithecal deposits are coating thickly the septa as well as the roofs and floors of the chambers, leaving small circular to irregular openings in the sagittal sections.

The septa are considerably strongly fluting, especially in both polar regions where they form many septal loops. In the central part of the shell closed chamberlets formed by the fluting of the septa are half to two-thirds as high as the chambers. The septa are not so closely spaced. The septal counts in one sagittal section of six volutions are 8, 15, 20, 27, 31, and 36, respectively.

The tunnel is narrow and its path is slightly irregular. It widens very slowly during the growth. The tunnel angles of the holotype specimen are 8, 11, 12, 13, and 13 degrees, respectively, in the second to sixth volution.

Table 21. Table of Measurements (in Millimeters) of *Fusulina akiyoshiensis* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1*	327	320	5	13	4.15	2.9+	1.4	.180	.151	.249	.364	.538	.789	1.073	1.40+
2	307	317			4.34	2.98	1.5	—	—	.287	.436	.698	.957	1.250	1.440
3	327	320	5	14	×	2.7+	×	.16+	.132	.213	.333	.492	.713	1.002	1.260
4	327	323	5	15	×	2.68	×	.16+	.198	.286	.437	.600	.851	1.110	1.350
							Max.	.195	.198	.287	.437	.698	.957	1.250	1.440
							Min.	.160	.132	.213	.333	.480	.713	1.002	1.260
							Aver.	.173	.159	.256	.387	.567	.825	1.117	1.363
								6	6	7	7	7	6	5	4

Specimen	Ratio of Hl./Rv. 2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
1*	—	—	1.7	1.6	1.6	1.5	.016	.011	—	.011	.014	.018	.021	.024
2	1.5	1.5	1.5	1.6	1.5	1.5	—	—	.013	.017	.018	.019	.022	.029
3							—	—	.012	.014	.014	.016	.024	
4							—	—	—	.018	.020	.023		
Max.		1.8	1.8	1.6	1.6	1.5	—	—	.013	.018	.021	.023	.024	.029
Min.		1.5	1.5	1.6	1.5	1.5	—	—	.012	.011	.014	.016	.019	.024
Aver.	1.5	1.7	1.7	1.6	1.6	1.5	.016	.011	.012	.015	.017	.018	.022	.027
	1	2	3	2	2	2	1	1	3	6	6	6	4	2

Specimen	Tunnel angle 2	3	4	5	6	Septal count 1	2	3	4	5	6
1*	8	11	12	13	13						
3						—	—	—	25	30	34
4						8	15	20	27	31	36

* Holotype specimen.

Remarks.—This is one of the stratigraphically most important species in the Akiyoshi fusulinid fauna, being only the species of genus *Fusulina* found in the Akiyoshi limestone group. In general appearance this species resembles *Fusulina girtyi* (DUNBAR and CONDRA). However the latter species has more numerous number of volution, more strongly fluted septa, and less numerous septa for the corresponding volution, while *Fusulina akiyoshiensis* has slightly more rapid rate of expansion than that of *F. girtyi.*

Fusulina curta which was described by THOMPSON (1945) from the Pennsylvanian Youghall formation of the Juniper Mountain, Colorado also resembles the species under consideration. But the latter has slightly larger size of the shell at maturity though less numerous in number of volution, and septal fluting is weaker in the latter. Also the septal counts for the corresponding volution are less numerous in this species except in the sixth volution.

THOMPSON (1948) recently described a new species (Pl. 32, fig. 8) from the Cuchillo Negro formation of Mud Spring Mountain, New Mexico, which has been left unnamed and without description probably because of the insufficiency of the material. *Fusulina akiyoshiensis* n. sp. resembles that species more closely than any other species of *Fusulina*. However *Fusulina akiyoshiensis* n. sp. is larger at maturity though both are almost the same in the number of volution, and the present species seems to have slightly larger proloculus and slightly stronger septal fluting, especially in the polar regions, which can be observed in the tangential section.

It should be noted that *Fusulina* n. sp. THOMPSON is representing one of the transitional stage in the phylogentical development from *Fusulinella* to *Fusulina*, occuring associated with such highly developed species of *Fusulinella* as *F.* cf. *iowensis* THOMPSON which has some resemblance to *Fusulinella bocki* or *F. biconica*.

THOMPSON (1945, 1948) and MOORE and THOMPSON (1949) discussed in detail on the fusulinid zones in North America and established five fusulinid zones in the Pennsylvanian System. Of which the lower part of the zone of *Fusulina* in the Mid-Continent region is characterized by the combination of the advanced form of *Fusulinella* and the primitive types of *Fusulina*. The co-existence of *Fusulina* n. sp. THOMPSON and *Fusulinella* cf. *iowensis* THOMPSON cited above is just the case of the lower Desmoinesian fusulinid assemblage.

As described above the present species of *Fusulina* is considered to be one of the most primitive species among the genus *Fusulina*, and occurs associated with such *Fusulinella* as *F. biconica* and *F. itoi* which, as already stated, seem to represent highly developed stage of *Fusulinella*, having large size of the shell and numerous number of volution for the genus, and well developed chomata and epitheca. Interesting enough that the Akiyoshi fusulinid fauna displays almost the same assemblage of fusulinid as that of the lower Desmoinesian fusulinid fauna of the Mid-Continent of North America.

Occurrence.—Fusulina akiyoshiensis TORIYAMA, n. sp. is rare in occurrence, and has been collected only from No. 1 limestone of Section VII (Loc. 327) and Loc. 307.

This species is one of the characteristic of the upper part of the Cmβ zone.

Part B. Permian Fusulinids

Family FUSULINIDAE MÖLLER, 1878
Subfamily OZAWAINELLINAE THOMPSON and FOSTER, 1937
Genus *Ozawainella* THOMPSON, 1935
Ozawainella akiyoshiensis TORIYAMA, n. sp.

Pl. 6, figs. 1–4

Only two specimens of undescribed form of *Ozawainella* have been obtained in my collection. Although they are very insufficient in number to justify the establishment of a new species, this form is so characteristic in its axial profile that I describe it as a new species.

The shell of *Ozawainella akiyoshiensis* TORIYAMA, n. sp. is small and thickly lenticular in shape, with acutely angular periphery, almost straight lateral slopes, and very obtuse polar extremities. Larger specimen of the illustrated axial section is 0.73 mm in length and 1.58 mm in width, giving a form ratio of 0.46. The inner two volutions seem to assume less angular periphery. The outer three volutions are almost the same in axial profile.

The proloculus is seemingly spherical and 66 microns in approximate outside diameter. The shell expands moderately in the inner two volutions but rather rapidly in the outer three volutions. The radius vectors of the first to fifth volution of one of the illustrated axial section are 110, 190, 317, 448, and 724 microns, respectively. Those of the second to fifth volution of another specimen are 170, 310, 472, and 717 microns, respectively.

The thin spirotheca appears to have four-layered type of the spirotheca although its minute structure cannot be made out due to the secondary replacement. The thickness of the spirotheca in the second to fifth volution in two specimens is 13, 14, 17, and 20–21 microns, respectively.

The septal arrangement and their nature are not known because no sagittal section is available. However, it is at least certain that they are completely plane throughout the length of the shell.

The tunnel is narrow with nearly straight pass. The tunnel angles of the second and third volutions are 14 and 14–18? degrees, respectively. The chomata appear to be present at least in the outer volutions.

Remarks.—The genus *Ozawainella* is distinguished from closely similar genera of the subfamily Ozawainellinae by its angular periphery throughout the shell, involute shell, and the more or less uniform axial profile of all the volutions. *Ozawainella akiyoshiensis* TORIYAMA, n. sp. displays these characteristics exceedingly well, and is, at the same time, distinguished from similar species by its rapid expansion of the shell. However, materials available to me are very insufficient, and more

Table 22. Table of Measurements (in Millimeters) of *Ozawainella akiyoshiensis* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector					
							1	2	3	4	5	5½
1*	523	113	0.65	1.43	0.5	—	—	.170	.310	.472	.717	
2	523	114	0.73	1.58	0.5	.066	.110	.190	.317	.448	.724	.850

Specimen	Ratio of Hl./Rv.					Thickness of spirotheca				Tunnel angle			Pl.	fig.
	1	2	3	4	5	2	3	4	5	2	3	4		
1*	—	—	0.4	0.4	0.5	—	—	.017	.020	14	14		6	2,4
2	0.8	0.7	0.6	0.6	0.5	.013	.014	—	.021	—	18	11	6	1,3

* Holotype specimen.

materials must be added to make true nature of this species clear.

Occurrence.—Ozawainella akiyoshiensis TORIYAMA, n. sp. is only known from No. 6 limestone of Section X (Loc. 523) which is referred to the Pmβ subzone. The stratigraphical range of this species may probably be more wide.

Subfamily STAFFELLINAE MIKLUCHO-MAKLAI, 1949

Genus *Nankinella* LEE, 1933

Nankinella nagatoensis TORIYAMA, n. sp.

Pl. 6, figs. 5–13

A number of specimens of an undescribed form of the genus *Nankinella* have been obtained in my collections from the Plα and Plβ subzones.

The shell of *Nankinella nagatoensis* TORIYAMA, n. sp. is small and planispiral throughout its growth. The periphery is more or less angular in the outer volutions but is narrowly rounded in the inner ones. The axial ends seemingly do not umbilicate in most of specimens. Mature specimens of six to seven volutions are 0.9 to 1.7 mm long and 1.4 to 2.2 mm wide, giving a form ratio of 0.6 to 0.7 for four specimens. Averages of ratios of the half length to the radius vector of the first to seventh volution in eight specimens are 0.6, 0.6, 0.7, 0.7, 0.7, 0.8, and 0.7, respectively.

The proloculus is seemingly spherical, with an outside diameter of 79 to 187 microns, averaging 117 microns for six specimens. The expansion of the shell is slow in the inner two to three volutions, but becomes slightly rapid in the following outer volutions. The chambers are highest immediately above the tunnel, decreasing in height polewardly. Average radius vectors of the first to seventh volution of eleven specimens are 115, 195, 307, 438, 607, 753, and 949 microns, respectively.

The spirotheca is thin. Its minute structure is hardly observable probably

Table 23. Table of Measurements (in Millimeters) of *Nankinella nagatoensis* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1	300	1858	1.31	2.20	0.6	—	.095	.190	.383	.552	.717	.883	1.058
2	331	670	1.4	2.1	0.7	—	—	—	.29	.43	.60	.78	1.03
3	757	1239	1.7	—	—	.080	.104	.200	.276	.368	.561	.686	—
4*	497	1623	1.18	1.63	0.7	.079	.92	.162	—	.421	.567	.674	.790
5	2	2112	1.20	1.65	0.7	.092	.138	.230	.338	.463	.628	.766	.92
6	314	1044	0.92	1.44	0.6	—	—	.184	.270	.392	.577	.714	
7	380	1571	0.77	1.18	0.7	.141	.129	.218	.359	.491	.613		
8	103	109	×	0.50	×	—	.110	.180	.260				
9	103	109	×	0.67	×	.187	.141	.224	.338				
					Max.	.187	.141	.230	.383	.552	.717	.883	1.058
					Min.	.079	.092	.162	.260	.368	.561	.674	.790
					Aver.	.117	.115	.195	.307	.438	.607	.753	.949
						6	9	11	11	10	9	7	4

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
1	—	—	—	0.5	0.5	0.6	0.6	—	.013?	.016	.019	—	.022	.020	.019
2	—	—	—	1.0	0.9	0.8	0.7	—	.013	.014	.018	.022	.028	.024	
3	—	—	—	0.7	0.7	0.9		—	—	.018	.020	.020	.020	.025	.027
4*	0.8	0.8	—	0.7	0.7	0.8	0.8	.012?	.013	.014	.014	.014	.018	.020	.022
5	—	—	0.7	0.7	0.7	0.7	0.7	—	—	—	—	—	.020	.020	
6	0.5	0.6	0.6	0.6	0.7			—	—	.011	—	.018	.030		
7	—	0.7	0.7	0.8				—	.013	.014	.018	.021			
8								—	.012	.016	.014				
9								.012	.011	.012	.018				
Max.	0.8	0.8	1.0	0.9	0.8	0.9	0.8	—	.013	.018	.021	.028	.030	.025	.027
Min.	0.5	0.5	0.6	0.5	0.5	0.6	0.6	—	.011	.011	.014	.014	.018	.020	.019
Aver.	0.6	0.6	0.7	0.7	0.7	0.8	0.7	.012	.012	.015	.018	.021	.023	.022	.023
	3	4	6	8	7	5	4	2	6	10	9	7	7	5	3

Specimen	Tunnel angle 2	3	4	5	6	7	Septal count 1	2	3	Pl.	fig.
1	—	—	—	16	—	11?				6	5
2	—	16	15	18	15					6	6
3	—	20?	17	20	20?					6	7
4*	—	13	12	12	13					6	8
5	18?	—	—	14?						6	9
6	—	—	—	14						6	10
7	—	—	14	18						6	11
8							—	11	12		
9							8?	11?	18		
Max.	—	20?	17	20	20						
Min.	—	13	12	12	13						
Aver.	18	16	15	16	16	11?					
	1	3	4	7	3	1					

* Holotype specimen.

because of recrystallization. However, a diaphanotheca-like thin and less dense layer is partly seen in a very limited part of the spirotheca. Average thickness of the spirotheca of the first to seventh volution for ten specimens is 12, 15, 18, 21, 23, 22, and 23 microns, respectively.

The septa is rather thick and unfluted throughout the length of the shell. Its minute structure is also unknown even under the high magnification of the microscope. As no sagittal section of fully grown shell is available, averages of the septal counts of the successive volutions are not known, but 8?, 11?, and 12–18 septa are counted in the first to third volution of two immature specimens, respectively.

The tunnel is rather high and narrow, with nearly straight path. Although the tunnel angles is hard to be measured with certainty, average tunnel angles of the second to sixth volution in seven specimens are 18?, 16, 15, 16, 16, and 11 degrees, respectively.

Remarks.—Only a few species of *Nankinella* have been described in this country; namely, *N. discoides* (LEE) described by HANZAWA (1950) from the Maiya formation of the Kitakami massif, Northeast Japan and *N.* cfr. *plummeri* THOMPSON and *N.* sp. described by IGO (1957) from the Ichinotani formation of the Fukuji district, Central Japan are only representatives. Although the specimens of *Nankinella nagatoensis* TORIYAMA, n. sp. at my disposal are not sufficient and their preservation is not good, the present species is easily distinguished from *N. discoides* (LEE), *N. inflata* (COLANI), *N. plummeri* THOMPSON and their allied forms in the dimension of the shell and the rate of expansion for the corresponding volution. *N. nagatoensis* TORIYAMA, n. sp. somewhat resembles *N. chaputi* (CIRY) which was collected from Culuk of Turkey and originally referred to the genus *Staffella*, but differs from the latter in having less numerous volutions, slightly larger proloculus, relatively larger radius vector for the corresponding volution and thinner spirotheca. *N. chaputi* (CIRY) seemingly has very heavy axial fillings which do not occur in the present species. No other Asiatic species is comparable with *N. nagatoensis* TORIYAMA n. sp.

Having small size of the shell, rather less numerous volutions for the genus, and the typical ozawainellid young stage, the present species is considered to be an intermediate form from *Ozawainella* to *Staffella*.

Occurrence.—Nankinella nagatoensis TORIYAMA n. sp. is sparsely disseminated in the following localities: No. 2 limestone of Section X (Loc. 492), No. 4 limestone of Section XIV (Loc. 103), No. 4 limestone of Section XVIII (Loc. 314), No. 3 limestone of Section XXII (Loc. 331), No. 1 limestone of Section XXIV (Loc. 552), No. 6 limestone of Section XXV (Loc. 300), No. 7 limestone of Section XXVI (Loc. 757), and Loc. 2, 380 and 497.

Excepting a doubtful occurrence in the Loc. 2, the stratigraphical range of this species is relatively short and restricted in the Plα to Plγ subzones.

Nankinella spp.

Form A

Pl. 6, figs. 14, 15

Form B

Pl. 6, figs. 16, 17

Form C

Pl. 6, figs. 18, 19

In addition to the form described above, a number of specimens referable to the genus *Nankinella* have been obtained in separated localities of the Akiyoshi limestone group. They seem not to belong to one species but are referred to at least three species or more. However, specimens available to me are very insufficient, and more additional sections must be prepared before their nature can be

Table 24. Table of Measurements (in Millimeters) of *Nankinella* spp.

Form	Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	Ratio of Hl./Rv. 1	2	3	4	5
A	1	287	2173	0.69	1.10	0.6	—	.112	.164	.251	.400	.665	—	0.6	0.7	0.7	0.5
A	2	287	2173	0.46	0.91	0.5	—	.067	.116	.184	.307	.463	—	0.5	0.6	0.6	0.5
B	3	103	101	0.44	0.89	0.5	.090	.070	.165	.290	.498		0.7	0.6	0.5	0.4	
B	4	103	102	0.59	1.00+	0.5	—	—	.161	.250	.391	.620	0.4	0.5	0.6	0.5	
B	5	103	102	0.59	0.88	0.7	—	.110	.250	.368	.490		0.6	0.5	0.6	0.6	
B	6	103	105	0.44	0.67	0.7	.071	.071	.141	.222	.370		—	0.5	0.5	0.7	
C	7	319	1053	0.37	0.93	0.4	.070	.120	.200	.300	.491		—	0.5	0.4	0·5	
C	8	265	1517	0.41	0.89	0.5	.10?	.103	.181	.291	.500		0.8	0.6	0.5	0.4	
C	9	552	1634	0.39	0.79	0.5	—	.116	.184	.273	.415		0.5	0.5	0.6	0.6	
C	10	315	1047	0.35	0.70	0.5	.086	.077	.113	.205	.326		1.0	1.0	0.8	0.6	
C	11	315	1045	×	0.94	×	.066	.070	.114	.156	.244						

Form	Specimen	Thickness of spirotheca 1	2	3	4	5	Tunnel angle 2	3	4	5	Septal count 2	3	4	Pl.	fig.
A	1	—	.012	.013	.014	.016	21	21	19					6	14
A	2	.010	.012	.013	.013	.014	—	20	19	17?					
B	3	.010	.014	.019	.019		—	20	20?					6	16
B	4	.013	.014	.016	.019?		15	18							
B	5	.011	.014	.014	.016		—	18	22?						
B	6	—	.010	.014	.019		19	16						6	17
C	7	—	.014	.019	.021		—	27?						6	18
C	8	.012	.013	.015	.019		—	22?							
C	9	.012	.014	.016	.018		—	21	19						
C	10	—	.012	.016	.021		16	25						6	19
C	11	—	.010	.011	.017						9	10	13		

understood with certainty and before their relationship with other species can be clarified. Nevertheless, for the sake of completeness, I am illustrating some of them and giving statistical data obtained from them.

Occurrence.—Form A has been obtained from No. 5 limestone of Section I (Loc. 287) and No. 2 limestone of Section XXI (Loc. 258). The stratigraphical range of Form A is fairly long, ranging from the Plα to Pmα.

Form B was collected only from No. 4 limestone of Section XIV (Loc. 103). The stratigraphical age of this form is considered to be the Plα.

Form C was obtained from No. 2 limestone of Section VIII (Loc. 319) and No. 3 limestone of Section XVIII (Loc. 315), No. 1 limestone of Section XX (Loc. 265), and No. 1 limestone of Section XXIV (Loc. 552). Its stratigraphical range is the Plβ.

Genus *Staffella* OZAWA, 1925

Staffella yobarensis OZAWA

Pl. 6, figs. 20–28

1925. *Staffella yobarensis* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, p. 20, Pl. III, figs. 1b, 5.

The shell of *Staffella yobarensis* OZAWA is small and subelliptical, with broadly rounded periphery. The axis of coiling is the shortest diameter, but the axial regions are not depressed. Mature specimens of four to five and a half volutions are 0.49 to 0.69 mm in length and 0.64 to 0.98 mm in width, giving a form ratio of 0.7 to 0.8. The first volution seemingly is evolute. Beyond the second volution the shell becomes involute. Average ratios of the half length to the radius vector of the first to fifth volution in three specimens are 0.8, 0.6, 0.7, 0.7, and 0.8, respectively.

The proloculus is minute and spherical. Its outside diameter varies from 50 to approximately 120 microns, averaging 79 microns in eleven specimens. The expansion of the shell becomes gradually rapid from the first volution to the last. Average radius vectors of the first to fifth volution for thirteen specimens are 85, 149, 233, 335, and 463 microns, respectively. The chambers are highest immediately above the tunnel. In the outer volution they are nearly the same in height in the central half of the shell, decreasing in height only slightly toward the poles, but in the inner one to two volutions they rapidly decrease in height poleward.

The spirotheca is thin and seemingly has a four-layered structure of *Fusulinella*-type. In some part of outer volutions a relatively thick diaphanotheca-like layer seems to exist, but it is not certain whether or not that is it corresponding to diaphanotheca observed in other fusulinids having the typical four-layered spirotheca. Averages of the thickness of all layers of the spirotheca in the first to fifth volution for seven specimens are 11, 14, 17, 20, and 27 microns, respectively.

The septa seem to be the same in structure as the spirotheca, although their minute structure is hardly observable. They are unfluted throughout the length of the shell. Although most of the septa are almost perpendicular to the surface of the spirotheca, some of them are slightly arching anteriorly. The septal counts of the first to fourth volution in one of the illustrated sagittal section (Pl. 6, fig. 25) are 6, 12, 13, and 14, respectively.

The tunnel is narrow, but rather high, with nearly straight pass. Average tunnel angles of the first to fourth volution of five specimens are 22, 25, 24, and 22 degrees, respectively. Seemingly the chomata are very massive and asymmetrical, with considerably steep tunnel sides and low lateral slopes.

Table 25. Table of Measurements (in Millimeters) of *Staffella yobarensis* OZAWA

Speci-men	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector					Ratio of Hl./Rv.				
							1	2	3	4	5	1	2	3	4	5
1	101	1510	0.68	0.82	0.8	.065	.086	.150	.203	.307	.440	0.8	0.7	0.7	0.7	0.8
2	553	1644	0.51	0.64	0.8	.108	.100	.165	.250	.356		—	0.6	0.8	0.7	
3	553	1644	×	0.77	×	.089	.089	.156	.251	.36+						
4	552	1637	×	0.82	×	.06?	.095	.184	.276	.401						
					Max.	.120	.100	.193	.276	.401	.574	—	0.7	0.8	0.7	0.8
					Min.	.050	.064	.111	.179	.264	.400	—	0.5	0.6	0.7	0.7
					Aver.	.079	.085	.149	.233	.335	.463	0.8	0.6	0.7	0.7	0.8
						11	13	13	13	12	8	1	3	3	3	2

Speci-men	Thickness of spirotheca						Tunnel angle					Septal count				Pl.	fig.
	0	1	2	3	4	5	1	2	3	4	5	1	2	3	4		
1	—	—	.013	.016	.016	.027	—	24	24	25	20					6	20, 24
2	.010?	.012	.012	.015	.020		22	25?	27	22						6	21, 23
3	.008	.012	.013	.015	.018							6	12	13	14	6	22, 25
4	—	.011	.014	.019	.019?							10?	11	13	17	6	26
Max.	.014	.012	.018	.022	.026	.027		25	27	25		10	13	13	18		
Min.	.008	.010	.012	.015	.016	.026		24	20	17?		6	11	13	14		
Aver.	.011	.011	.014	.017	.020	.027	22	25	24	22	20	8	12	13	15		
	3	4	6	5	7	3	1	4	5	4	1	3	3	2	3		

Remarks.—*Staffella yobarensis* OZAWA is one of the smallest form of the genus. Although OZAWA did not designate the holotype, fig. 5 of Pl. III is seemingly most typical among the syntype specimens, and I, therefore, designate fig. 5 of Pl. III in the original illustration as the lectotype of this species. My specimens collected from scattered localities in the Akiyoshi limestone group well agree with the OZAWA's original in all the essential characters.

Staffella yobarensis OZAWA somewhat resembles *S. ozawai* LEE et CHEN reported from the Huanglung ilmestone of South China, but differs from the latter in having less rounded external form, less numerous volutions and thinner spirotheca. The umbilical area of the latter is never depressed, but being exclusively rounded.

Staffella yobarensis OZAWA has also been reported from the Taishaku limestone of Southwest Japan and the Kitakami massif of Northeast Japan, although none of them has been described.

Occurrence.—Staffella yobarensis OZAWA has been found in the following localities: No. 4 limestone of Section X (Loc. 521), No. 5 limestone of Section XIV (Loc. 101), No. 1 limestone of Section XXIV (Loc. 552), No. 7 limestone of Section XXVI (Loc. 757), and Loc. 380 and 553. The stratigraphical range of *Staffella yobarensis* is seemingly short, being restricted to the Plβ.

Staffella mölleri OZAWA

Pl. 6, figs. 29–34

1925. *Staffella mölleri* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 19, 20, Pl. II, fig. 9.
1938. *Staffella mölleri* RAUSER-CERNOUSSOVA. Travaux l'Inst. Geol. Acad. Sci. U. S. S. R., Tome VII, pp. 104, 105, Pl. II, fig. 12.

Staffella mölleri OZAWA is rather large for the genus, and has subellipsoidal shell, with depressed axial regions, rounded periphery and straight axis of coiling. Mature specimen of six volutions is 0.95 mm long and 1.69 mm wide, giving a form ratio of 0.56. The inner three to four volutions seem to be involute and the outer two volutions become evolute with the umbilicate polar ends.

The proloculus seemingly is small and spherical, with an outside diameter of 87 to 148 microns, averaging 135 microns in three specimens. The shell expands slowly and almost uniformly. Average radius vectors of the first to sixth volution of four specimens are 145, 233, 346, 487, 651, and 781 microns, respectively. Those of the first to fifth volution of the OZAWA's holotype* are 138, 214, 321, 462, and 643 microns, respectively. The chambers are highest above the tunnel, decreasing only slightly toward the poles excepting for the umbilicate polar extremities.

The spirotheca is moderately thick, but the secondary mineralization destroyed most minute spirothecal structures. In the illustrated axial section a diaphanotheca-like light layer is partly seen in the outer volutions. The thickness of the spirotheca in the first to sixth volution in four specimens averages 12, 16, 19, 24, 27, 27, and 29 microns, respectively. That of the first to fifth volution of the holotype specimen is 19, 21, 27, 29, and 49 microns, respectively.

The septa are moderately thin. Their structure is also not determined with certainty, but seemingly is of the same as the spirotheca. The septal counts of the second to fourth volution in the illustrated sagittal section are approximately

* Although OZAWA did not designate the holotype specimen, he illustrated only one axial section (section number II-90 in his collection). Therefore his figure (Plate II, fig. 9) should naturally be the holotype.

14, 15, and 18, respectively.

The tunnel is low and relatively narrow, with somewhat irregular path. Average tunnel angles of the second to seventh volution in three specimens are 25, 21, 18, 16, 15, and 17 degrees, respectively. Those of the second to fourth volution of the holotype specimen are 17, 18, and 24 degrees, respectively. The chomata are low and highly asymmetrical, with steep tunnel sides and gentle poleward slopes.

Table 26. Table of Measurements (in Millimeters) of *Staffella mölleri* OZAWA

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector					
							1	2	3	4	5	6
1	OZAWA'S specimen	II-90	0.78	1.26	0.6	.120	.138	.214	.321	.462	.643	
2	OZAWA'S specimen	II-90	×	0.96	×	.095	.086	.150	.240	.362	.491	
3	452	1880	0.95	1.69	0.6	—	.15?	.231	.330	.475	.610	.781
4	452	1877	1.10	1.30	0.8	.158	.129	.230	.37?	.510	.691	
5	522	1631	—	1.20+	—	.159	.172	.270	.390	.531		
6	553	1641	×	0.92	×	.087	.129	.200	.294	.430		

Specimen	Ratio of Hl./Rv.						Thickness of spirotheca						
	1	2	3	4	5	6	0	1	2	3	4	5	6
1	0.7	0.9	0.8	0.7	0.7		—	.019	.021	.027	.029	.049	
2							.009	.011	.013	.021?	.021	.028	
3	0.7	0.7	0.7	0.6	0.6	0.6	—	—	.014	.019	.025	.027	.029
4	0.9	1.0	1.0	0.8	0.8		—	—	.024	.025	.031		
5	0.9	1.0	1.0	1.0			—	—	.013	.016	.023?		
6							—	.012	.013	.016	.018	.026	

Specimen	Tunnel angle						Septal count				Pl.	fig.
	2	3	4	5	6	7	1	2	3	4		
1	17	18	24								6	29
2							7	10	12	15	6	30
3	18	17	16	—	15	17					6	31
4	—	—	19	16							6	32
5	31?	24	19								6	33
6							—	14?	15	18	6	34

Remarks.—*Staffella mölleri* OZAWA is very rare in my collection, represented by only several specimens, but all the characteristics observed in the present specimens well agree with those of the holotype. As pointed out by OZAWA, *Staffella mölleri* resembles *S. sphaerica* v. MÖLLER (non ABICH) [=*S. moellerana* THOMSON], but differs from the latter in having smaller shell and less numerous septa. OZAWA also remarked that *S. mölleri* somewhat resembles *S. sphaeroidea* (v. MÖLLER) and *S. quadrata* (DEPRAT) in the rate of expansion. However, *S. sphaeroidea* (v. MÖLLER) has more spherical form of the shell and *S. quadrata* (DEPRAT) is not congeneric with the present species, but belongs to the genus *Pseudostaffella*.

S. mölleri OZAWA shows some resemblances to *S. atokensis* THOMPSON from the lower part of the Atoka formation of Oklahoma and *S. hollingsworthi* THOMPSON from the Boggy formation of Oklahoma, as once pointed out by THOMPSON (1935A). However, these two American forms were referred to the genus *Pseudostaffella* by the same author (1948).

At any rate, enough information for detailed specific comparison is not available from the present material, and future study will be necessary.

Occurrence.—The OZAWA's holotype (section II-90 in his collection) came from the southeast of Shibao (more exact locality is not known). The present specimens were collected from No. 6 limestone of Section VIA (Loc. 452) and from the Loc. 553, the southern slope of Managatake. The stratigraphical range of this species is seemingly long, ranging from the Cmβ to the Plβ.

Subfamily SCHUBERTELLINAE SKINNER, 1931

Genus *Schubertella* STAFF and WEDEKIND, 1910

Schubertella kingi DUNBAR and SKINNER

Pl. 7, figs. 1–8

1937. *Schubertella kingi* DUNBAR and SKINNER. Univ. Texas, Bull. 3701, pp. 610, 611, Pl. 45, figs. 10–15.
1946. *Schubertella kingi* THOMPSON and WHEELER. Geol. Soc. Amer. Mem. 17, pp. 24, 25, Pl. 8, figs. 6–10.
1946. *Schubertella kingi* THOMPSON and HAZZARD. Ditto., pp. 40, 41, Pl. 10, figs. 1–9.
1954. *Schubertella kingi* THOMPSON. Univ. Kansas, Paleont. Contrib., Protozoa, Art. 5, pp. 33, 34, Pl. 5, figs. 11–42; Pl. 7, figs. 11–13.
1957. *Schubertella kingi* IGO. Sci. Repts. Tokyo Kyoiku Daigaku, Sec. C, Vol. 5, No. 47, pp. 192–194, Pl. IV, fig. 9–15.

Schubertella kingi DUNBAR and SKINNER was originally described from the Hueco limestone and the Wolfcamp formation of Mid-Continent region of North America. THOMPSON (1954) recently redescribed the species in detail and clarified that individual variations within the species are considerably great.

From widely separated localites in the Akiyoshi limestone group, I have obtained numerous specimens of rather short obtuse form of *Schubertella*, along with few specimens of slender one. The latter of which well agrees in all the essential characters with *Schubertella kingi* originally described by DUNBAR and SKINNER from the Hueco limestone of Texas. Whereas the short form differs from the slender one in the form ratio and the radius vectors of the successive volutions with considerable degrees, and I (1954), therefore, distinguished this form from the slender one as a new species, "*Schubertella japonica* n. sp." in the stratigraphical part of the geology of Akiyoshi which was published before I received a copy of THOMPSON's monograph on the American Wolfcampian fusulinids.

THOMPSON pointed out that the American form of *Schubertella kingi* comprises two groups of specimens with some slight difference, and that individual variations within each group are as great as any consistent differences found between the two groups. Both of the two groups contain both slender and short fusiform specimens, although the group of specimens obtained from the Cottonwood limestone and Florena shale of Kansas and the Coleman Junction limestone of Texas is containing short fusiform specimens relatively more abundantly.

As most of the Akiyoshi specimens under consideration are almost identical with the less slender form found in the two groups collected from Texas and Kansas, they should be referred to the same species.

Schubertella kingi was so fully described and illustrated by DUNBAR and SKINNER (1937) and THOMPSON (1954) that no further description is need on this species, except for giving the statistical data of the Akiyoshi specimens.

Table 27. Table of Measurements (in Millimeters) of *Schubertella kingi* DUNBAR and SKINNER

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector					Ratio of Hl./Rv.			
							1	2	3	4	5	1	2	3	4
1	258	619	0.83	0.40	2.1	.050	.052	.080	.135	.120		1.5	1.8	2.3	2.1
2	258	620	0.74	0.43	1.7	.051	.050	.089	.141	.230		1.4	1.9	1.8	1.7
3	606A	1689	0.89	0.38	2.3	.06?	.043	.075	.111	.198		—	—	—	2.3
4	100	2127	—	0.37	—	.041	.050	.080	.111	.170		0.9	1.3	1.9	2.2
5	296	1404	0.88	0.36	2.5	.039	.032	.060	.096	.152		1.4	1.3	1.5	2.1
6	265	1516	×	0.49	×	.051	.069	.129	.230						
7	100	2122	×	0.50	×	.040	.043	.072	.126	.187	.280				
8	262	626	×	0.59	×	.041	.042	.065	.103	.166	.310				
				Max.		.072?	.077	.129	.230	.285	.310	1.5	1.9	2.8	2.7
				Min.		.039	.030	.050	.080	.120	.274	0.9	0.9	1.3	1.7
				Aver.		.023	.053	.088	.139	.196	.288	1.2	1.5	1.9	2.1
						17	21	21	21	17	3	7	9	9	10

Specimen	Thickness of spirotheca					Tunnel angle			Septal count					Pl.	fig.
	1	2	3	4	5	2	3	4	1	2	3	4	5		
1	—	—	.016	.016		—	27	39						7	1
2	.008	.011	.014	.016		—	33							7	3
3	—	—	—	.015		—	26							7	2
4	—	—	—	.016	.018	—	27?							7	4
5	—	—	.011	.014	.019	38	40							7	5
6	.011	.011	.014						8	12	15			7	6
7	—	—	—	.011	.014				—	13	15?	17		7	7
8	—	.009	.010	.014	.017				7	10?	10	12	—	7	8
Max.	.011	.016	.018	.027	.021	38	38	40	8	13	15	17			
Min.	.008	.007	.009	.011	.014	35	22	34	7	10	10	12			
Aver.	.010	.010	.013	.016	.017	37	29	37	8	12	13	14	14		
	3	7	15	15	5	2	11	6	2	4	4	3	1		

Occurrence.—Schubertella kingi DUNBAR and SKINNER occurs in the following localities: Nos. 14 and 16 limestones of Section I (Loc. 296 and 299, respectively), Nos. 4, 7, and 8 limestones of Section IV (Loc. 717, 720, and 720A, respectively), No. 3 limestone of Section V (Loc. 463), No. 3 limestone of Section VI (Loc. 449), No. 2 limestone of Section X (Loc. 492), Nos. 2 and 3 limestones of Section XII (Loc. 606A and 607, respetively), No. 3 limestone of Section XIV (Loc. 100), No. 1 limestone of Section XX (Loc. 265), Nos. 2 and 5 limestones of Section XXI (Loc. 258 and 262, respectively), No. 1 limestone of Section XXIII (Loc. 269), and Loc. 459, 553 and 619.

The stratigraphical range of *Schubertella kingi* DUNBAR and SKINNER is more or less longer in the Akiyoshi limestone group than in Texas and Kansas, ranging from the Plβ to Pmβ subzone.

Schubertella sp. A

Pl. 7, figs. 9–11

Few specimens referable to the genus *Schubertella* have been obtained from No. 3 limestone of Section XIV (Loc. 100) and Loc. 495 and 498, from which, however, enough information is not available for the specific description and comparison with previously described forms. For the sake of completeness I am illustrating few of them and giving their statistical data.

Table 28. Table of Measurements (in Millimeters) of *Schubertella* sp. A

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector					Ratio of Hl./Rv.				
							1	2	3	4	4½	1	2	3	4	5
1	100	2122	0.79	0.40	2.0	—	.043	.086	.144	.232		1.0	0.8	1.4	1.7	
2	495	1120	1.23	0.47	2.7	.064	.061	.097	.143	.225	.248	1.1	1.2	2.0	2.4	2.6
3	495	1120	×	0.58	×	—	.050	.091	.134	.214						

Specimen	Thickness of spirotheca				Tunnel angle			Septal count			Pl.	fig.
	1	2	3	4	2	3	4	2	3	4		
1	—	—	.014	.018	24	37					7	9
2	.008	.009	.013	.021	—	—	41?				7	10
3	.009	.010	.013	.018				11?	14?	18?	7	11

Subfamily FUSULININAE RHUMBLER, 1895

Genus *Quasifusulina* CHEN, 1934

Quasifusulina sp. A

Pl. 19, figs. 12–17; Pl. 20, figs. 1–5

Only a few specimens here referred to *Quasifusulina* sp. A were obtained from limestones of five scattered localities of the Akiyoshi limestone group.

These specimens seem to represent an undescribed species. However, the present materials are not sufficient to give a full description of this form. I briefly describe this species and illustrate some of specimens studied.

The exact axial profile of the shell is unknown, because no well-oriented axial section is available. However, one of the axial section (Pl. 19, fig. 14) is more than 3.5 mm in half length and 1.4 mm in width, giving a presumable form ratio of 4.3, and, therefore, the shell perhaps has elongate fusiform or subcylindrical form, with more or less arcuate axis of coiling.

The proloculus is moderate for the size of the shell, with an outside diameter of 154 to 408 microns, averaging 247 microns in eight specimens. The shell very tightly coils in the first two volutions and the rate of expansion becomes gradually rapid from the third volution to maturity. Average radius vectors of the first to seventh volution for ten specimens are 168, 237, 348, 504, 665, 842, and 1,118 microns, respectively. The chambers seem to be almost the same in height throughout the length of the shell except the polar extremities.

The spirotheca is very thin, consisting of a tectum and a lower light layer. The keriothecal structure is hardly observable in the lower, light layer of most specimens, but it is at least discernible in some part of the outer volutions of some specimens, although it is very faint and fine. Average thickness of the spirotheca of the first to sixth volution of ten specimens is 14, 16, 21, 27, 34, and 34 microns, respectively. The proloculus wall is also very thin and structureless, averaging 15 microns in thickness for five specimens.

The septa are very thin and numerous. In one of the illustrated sagittal section (Pl. 20, fig. 3) 12, 17, 21, 26, 34, 38, and 41 septa are counted in the first to seventh volution, respectively. The true nature of the septal fluting is not well understood, but the septa seemingly flute considerably intensely and regularly throughout the length of the shell, forming chamberlets which are almost reaching to the tops of the chambers.

The tunnel seems to be low and relatively wide, perhaps with an irregular path. The tunnel angles are not measured exactly. The chomata seemingly are absent, and may be very redimentary if present. In one tangential section considerably heavy secondary deposits fill the chambers along the axial regions of the outer volutions except in the last one.

Remarks.—Specimens of *Quasifusulina* sp. A have the slowest rate of expansion among the species of *Quasifusulina* hitherto described, and may be referable to an undescribed form of the genus.

As already pointed out by many workers of fusulinid forminifers, there are different opinions in regard to the spirothecal structure of the genus *Quasifusulina*, especially to the existence of alveolar structure in the spirotheca. So far as the Akiyoshi specimens are concerned, the alveolar keriotheca is discernible at

Table 29. Table of Measurements (in Millimeters) of *Quasifusulina* sp. A

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector						
							1	2	3	4	5	6	7
1	338	1414	5.84	1.72	3.4	.263	.205	.319	.445	.610	.850		
2	320	1411	3.7+	1.14	3.2	.184	.123	.184	.307	.491	—		
3	787	1438	5.85+	1.37	4.3+	.176 / .204 ×	.273	.390	.540	.705			
4	716A	1434	6.16+	1.66	3.7	—	—	—	.27?	.400	.613	.810	
5	713	1432	5.7+	2.12	2.6+	.252	.178	.230	.326	.451	.628	.867	1.132
6	320	1411	×	1.16	×	—	—	.162	.270	.475	.628		
7	713	1433	×	1.96	×	.200+	.135	.205	.320	.433	.613	.820	1.058
8	716A	1435	×	1.65	×	.203 / .251 ×	.153	.218	.344	.528	.683	.880	
9	716A	1434	×	1.53	×	.208	.156	.242	.347	.475	.628	.830	
				Max.		.408	.273	.390	.540	.705	.850	.880	1.165
				Min.		.154	.123	.162	.270	.400	.613	.810	1.058
				Aver.		.247	.168	.237	.348	.504	.665	.842	1.118
						8	8	9	10	10	8	8	3

Specimen	Ratio of Hl./Rv.							Thickness of spirotheca							
	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
1	1.0	2.1	2.2	2.8	3.1			.017	.017	.018	.029	.042	.052		
2	2.9	3.6	3.4	3.1				.015	.014	.015	.027	.033			
3	—	—	4.7	4.6	4.9			.017	.015	.017	.018	.026			
4	—	—	—	—	4.8	4.3		—	—	—	.021	.024	.039	.041	
5	1.9	2.1	2.2	2.3	2.4	2.4	2.5	.013	.010	.013	.014	.023	.025	.037	.032
6								—	—	.014	.018	.022?	.029?		
7								—	—	.015	.022	.027	.029	.030	.029
8								.013	—	—	.017	.026	—	.027	
9								—	—	.017	.021	.026	.027		
Max.	2.9	3.9	4.7	4.6	4.9	4.3		.017	.017	.018	.029	.042	.052	.041	.032
Min.	1.9	2.1	2.2	2.3	2.4	2.4		.013	.010	.013	.014	.022	.025	.027	.029
Aver.	2.2	2.6	3.1	3.2	3.8	3.4	2.5	.015	.014	.016	.021	.027	.034	.034	.031
	3	3	4	4	4	2	1	5	4	7	10	10	7	5	2

Specimen	Tunnel angle					Septal count							Pl.	fig.
	1	2	3	4	5	1	2	3	4	5	6	7		
1	25	—	27	35	28								19	12
2	—	—	—	37									19	13
3	16	22	33	45									19	14
4	—	—	51?	65?	61?								20	1
5	32	24?	27?	35	32								20	2
6						—	16?	21?	27?				19	16
7						12	17	21	26	34	38	41	20	3
8						18?	22?	25?	28?				20	4
9						—	—	—	—	—	—	—	20	5
Max.	32	24	51?	65?	61?	18?	22?	25?	28?					
Min.	16	22	27	35	28	12	16?	21	26					
Aver.	24	23	35	43	40	15	18	22	27	34	38	41		
	3	2	4	5	3	2	3	3	3	1	1	1		

least in some part of the outer volutions of some specimens. Therefore, it may be concluded that the extreme fineness of alveoli and the thinness of the spirotheca make difficult to observe them under the microscope, and that a slight difference in the condition of the preservation and in the thickness of the section studied may give rise to rather markedly different impressions on the spirothecal structures.

Further materials will be necessary before a definite specific assignment can be made.

Occurrence.—As mentioned above *Quasifusulina* sp. A has been obtained from five localities; No. 3 limestone of Section IV (Loc. 716A), No. 3 limestone of Section VIII (Loc. 320), No. 4 limestone of Section XX (Loc. 338), and Loc. 713 and 787. The stratigraphical range of this species is the Plα and Plβ.

Subfamily SCHWAGERININAE DUNBAR and HENBEST, 1930

Genus *Triticites* GIRTY, 1904

Triticites suzukii (OZAWA)

Pl. 7, figs. 12–23

1925. *Schellwienia suzukii* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XIV, Art. 6, pp. 43, 44, Pl. IV, fig. 2.

The shell is inflated fusiform and small for the genus, with sharply pointed polar ends, almost straight to convex lateral slopes, and straight axis of coiling. Mature shells of five to five and a half volutions are 1.7 to 2.1 mm long and 0.7 to 0.9 mm wide, giving a form ratio of 2.2 to 2.4. The first volution is almost spherical in shape; the following one to two volutions are short fusiform with rounded poles, and those beyond the third or the fourth are inflated fusiform. Averages of the ratios of the half length to the radius vector of the first to fifth volution of five specimens are 1.4, 1.6, 1.9, 2.1, and 2.2, respectively.

The proloculus is small and spherical in shape. Its outside diameter measures 88 to 152 microns, averaging 117 microns for twelve specimens. The shell expands slowly in the inner two or three volutions, but rapidly in the outer ones. Average radius vectors of the first to fifth volution of twelve specimens are 93, 138, 203, 309, and 440 microns, respectively. The heights of the chambers are about the same throughout the shell, excepting in the extreme polar regions where the chambers increase in height rapidly.

The spirotheca is moderately thick for a form of *Triticites* of this size. It consists of a tectum and a keriotheca. The alveolar structure of the latter is, however, hard to discern in the inner volutions of almost all the specimens and in the outer volutions of some specimens. Average thickness of the spirotheca in the first to fifth volution of ten specimens is 11, 19, 21, 33, and 42 microns, respec-

Table 30. Table of Measurements (in Millimeters) of *Triticites suzukii* (OZAWA)

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5
1*	OZAWA's specimen	II–26	0.90	0.53	1.7	.140	.118	.186	.284		
2*	OZAWA's specimen	II–26	×	0.60	×	.120	.113	.195	.278		
3	607	824	2.14	0.93	2.3	.133	.100	.151	.210	.341	.520
4	607	825	1.99	0.91	2.2	.118	.093	.135	.210	.280	.410
5	607	827	1.96	0.85	2.3	.152	.104	.153	.225	.350	.520
6	570A	800	1.66	0.69	2.4	.118	.083	.134	.200	.294	.411
7	607	826	×	0.83	×	.104 × .184	.100	.150	.221	.360	
8	607	823	×	0.87	×	.110	.100	.152	.210	.320	
9	570A	799	×	0.84	×	.095	.084	.123	.190	.274	.460
10	570A	799	×	0.79	×	.117	.080	.110	.172	.250	.361
					Max.	.152	.107	.156	.225	.360	.520
					Min.	.088	.080	.110	.170	.250	.360
					Aver.	.117	.093	.138	.203	.309	.440
						12	12	12	12	12	9

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	Thickness of spirotheca 0	1	2	3	4	5
1*	1.6	1.9	1.8			.011	.014	.014	.019		
2*						—	.010	.018			
3	1.2	1.5	2.1	2.3	2.2	.014	—	.024	.033	.042	.056
4	—	1.4	1.6	1.8	2.1	—	.011	.015	.022	.032	.041
5	1.3	1.4	1.7	1.9	1.9	.012	.012	.016	.022	.032	.039
6	1.0	1.3	1.8	2.1	2.3	—	.011	.014	.019	.032	.050
7						—	—	.019	.028	.047	
8						—	—	.020	.024	.036	.046
9						.012	.011	.016	.017	.024	.048
10						—	.011	.012	.012	—	.027
Max.	2.0	2.3	2.2	2.3	2.3	.014	.011	.024	.033	.047	.056
Min.	1.0	1.4	1.6	1.8	1.9	.012	.011	.012	.012	.018	.029
Aver.	1.4	1.6	1.9	2.1	2.1	.013	.011	.019	.021	.033	.042
	4	5	5	5	4	4	6	8	10	9	8

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5	Pl.	fig.
1*	28	33	37								7	22
2*						7	10	12			7	23
3	—	33	37	39	42						7	12
4	27	—	39	34							7	13
5	—	18	33	33	38						7	14
6	—	24	33	33	37						7	15
7						7	11	13	15		7	18
8						7	11	11	13		7	19
9						6	10	13	17	17	7	20
10						10	14	14	13	16	7	21
Max.	—	31	39	39	42	10	14	14	17	20		
Min.	—	18	33	33	37	6	10	11	13	16		
Aver.	27	27	36	36	39	8	12	13	15	18		
	1	4	5	5	3	5	5	5	5	3		

* The statistics of the specimens 1 and 2 is excluded from the averages.

tively. The proloculus wall, which is seemingly composed of a single homogeneous layer, is 12 to 14 microns, averaging 13 microns for four specimens.

The septa are relatively thick in comparison to the size of the shell. The spirotheca seems to extend downward to form the septa with only slightly diminishing thickness. The septa are almost straight in the central portion of shell, and they are weakly fluted in the polar regions. Averages of the septal counts of the first to fifth volution of five specimens are 8, 12, 13, 15, and 18, respectively.

The tunnel is low and broad, and its path is almost straight. Averages of the tunnel angles of the first to fifth volution of ten specimens are 27, 27, 36, 36, and 39 degrees, respectively. The chomata are well defined almost throughout the shell. In the first volution of some specimen, however, the chomata are hard to be discernible. They are about one-fourth to one-third as high as the chambers in the inner volutions, but about half in the outer ones. The tunnel sides of the chomata are relatively steep, but the poleward slopes are gentle, extending only slightly to the poles.

Remarks.—*Triticites suzukii* (OZAWA) was originally described from Kamiryo, Ominé, Miné-shi. However, the OZAWA's original description is very brief and the type specimen (Pl. IV, fig. 2, section II–26 in his collection) is not well-oriented. The above description is, therefore, entirely based on the present collection.

The minute structures of the spirotheca of the original specimens are not fully understood, because OZAWA illustrated only two specimens—one is sagittal and the other is axial (considerably diagonal), and I cannot find any other specimen in his collection. Moreover, his specimens seem to be not fully grown shell, having only three volutions. The spirotheca of the type specimen (right-below of fig. 2 of Plate IV) seemingly consists of a thin tectum and a thick lower layer in which alveolar structure is hardly discernible.

The statistical data obtained from the present material show that the present specimens are almost conspecific with the OZAWA's original specimens, though the latters are slightly rapid in the expansion of the shell.

Triticites suzukii somewhat resembles *T. schwageriniformis* RAUSER-CERNOUSSOVA described from Samara Bend and Trans-Volga Region in the shell form, the septal fluting and the rate of expansion, but it differs from the latter in having less numerous volution, more or less larger size of the proloculus and less massive chomata.

Triticites suzukii is also closely similar to *T. regularis* var. *chinensis* CHEN from the Chuanshan limestone of South China, but the former is distinguished from the latter in nature and degrees of the septal fluting and less slender form.

This species also resembles *T. primigenius* RAUSER-CERNOUSSOVA, BELJAEV and REITLINGER in some respects. Its proloculus is, however, larger in size, its septal fluting is slightly stronger in the axial regions, and its shell is more or less slender in shape.

From the evolutionary points of view *Triticites suzukii* is considered to be rather primitive in the genus *Triticites*. Nevertheless, it is beyond doubt that it occurs in the base of the Permian part of the Akiyoshi limestone group. It may, therefore, be a representative of offshoot of the persistent primitive member of the group, or may be in the retrogressive trend of evolution.

Occurrence.—OZAWA considered *Triticites suzukii* was the Upper Permian in age, but there is no evidence to verify his contention. The present specimens occur in the Plα and Plβ subzones. It is obtained in the following localities: No. 5 limestone of Section III (Loc. 540), No. 3 limestone of Section XII (Loc. 607), No. 2 limestone of Section XIII (Loc. 570A), and Loc. 15.

Triticites tantula TORIYAMA, n. sp.

Pl. 7, figs. 24–34

The shell of *Triticites tantula* TORIYAMA, n. sp. is small and inflated fusiform, with almost straight axis of coiling, slightly irregular convex lateral slopes, and bluntly pointed poles. Mature shell attains three to four volutions, and four and a half volutions at the largest. The axial length is 1.3 to 2.2 mm and the median width is 0.70 to 1.07 mm, giving a form ratio of 1.6 to 2.3. Average form ratio of eleven specimens is 1.9. The first volution is almost spherical to ellipsoidal in shape; the following one or two volutions are short fusiform with more or less sharply pointed poles, and the outer volutions have very slightly extended poles. Averages of the ratios of the half length to the radius vector of the first to fourth volutions for fifteen specimens are 1.7, 1.9, 1.9, and 1.9, respectively.

The proloculus is spherical and large for the size of the shell. Its outside diameter measures 124 to 252 microns, averaging 182 microns for thirty-one specimens. The shell expands slowly in the first volution but uniformly and rather rapidly from the second volution to maturity. Averages of the radius vector of the first to fourth volution of thirty-one specimens are 146, 233, 360, and 505 microns, respectively.

The spirothecal structure is typical of the genus, and the keriotheca with fine alveoli is considerably thick for the size of the shell. About 7 alveoli are observable in a distance of 100 microns in the fourth volution of the holotype specimen. In some specimens, however, the minute structure of the spirotheca is hardly observable. The proloculus wall, which seemingly consists of a single homogeneous dense layer, measures 12 to 21 microns, averaging about 17 microns for seventeen specimens. Average thickness of the spirotheca of the first to fourth volution for twenty-five specimens is 18, 26, 36, and 48 microns, respectively.

The septa are thin and moderately spaced. The pycnotheca is observable in some of the septa of the outer volutions, but is hard to be distinguishable in the others. Average septal counts of the first to fourth volution for nine specimens are 8, 13, 17, and 16, respectively. Narrow septal fluting is confined to the extreme polar regions, but more wide and irregular fluting extends to the maigins of the tunnel.

The tunnel is narrow in the first volution, but expands in width beyond the second volution. The path of the tunnel is almost straight. Averages of the

Table 31. Table of Measurements (in Millimeters) of *Triticites tantula* TORIYAMA, n. sp.

Specimen	Loc.	Rg.No.	L.	W.	R.	Prol.	Radius vector				Ratio of Hl./Rv.			
							1	2	3	4	1	2	3	4
1*	607	826	2.21	0.96	2.3	.186	.132	.220	.361	.520	1.7	2.1	2.2	2.3
2	570A	799	1.96	0.99	2.1	.192	.136	.221	.340	.559	1.5	1.6	1.8	1.7
3	492	1115	1.58	0.73	2.2	.219	.144	.205	.307	.420	2.4	2.5	2.9	
4	334	676	0.95	0.54	1.8	.156	.118	.182	.300		1.7	1.8	1.6	
5	330	655	×	1.00	×	.165	.119	.187	.353	.513				
6	607	833	×	0.99	×	.124	.116	.169	.288	.436				
7	607	833	×	0.87	×	.144	.107	.202	.307	.479				
8	343	688	×	0.88	×	.208	.200	.307	.460					
9	570A	804	×	0.82?	×	.161	.146	.210	.31?					
10	548	1186	×	0.90	×	.184	.153	.23?	.37?					
11	343	695	×	0.76	×	.194	.180	.276	.371					
				Max.		.252	.200	.307	.546	.670	2.4	2.5	2.9	2.3
				Min.		.124	.107	.155	.262	.361	1.3	1.3	1.4	1.5
				Aver.		.182	.146	.233	.360	.505	1.7	1.9	1.9	1.9
						31	31	31	29	13	14	15	15	6

Specimen	Thickness of spirotheca					Tunnel angle				Septal count				Pl.	fig.
	0	1	2	3	4	1	2	3	4	1	2	3	4		
1*	.013	.016	.024	.047	.045	24	47	45	50					7	24
2	.017	.021	.029	.040	.062	34	32	36						7	25
3	.019	.015	.018	.045		24	22							7	26
4	.018	.018	.024	.028		26	29							7	27
5	.012	.014	.019	.024	.037					—	15	17?	11?	7	28
6	.014	.014	.016	.030	.033					8	12	12+	14+	7	29
7	—	.015	.022	.037	.046					—	12	12	17	7	30
8	.018	.019	.027	.032	—					9	14	17		7	31
9	.016	.016	.019	.025	.040					7	11	12?	15?	7	32
10	.015	.014	.020	.032	—					9	15	21		7	33
11	.015	.014	.019	.020	.041					8	14	16		7	34
Max.	.021	.028	.048	.061	.059	35	47	45	52	9	15	21	17		
Min.	.012	.013	.016	.024	.033	24	22	24?	31	7	11	12	14		
Aver.	.017	.018	.026	.036	.048	28	31	34	44	8	13	17	16		
	17	22	25	23	8	8	14	12	3	8	9	7	2		

* Holotype specimen

tunnel angles in the first to fourth volution of fourteen specimens are 29, 31, 34, and 44 degrees, respectively. The chomata are narrow and relatively low. They are about half as high as the chambers in the first two volutions, but about one-third in the outer ones. The poleward slopes of the chomata are gentle in the inner volutions, but become steep in the outer ones.

Remarks.—*Triticites tantula* TORIYAMA, n. sp. resembles *T. suzukii* (OZAWA) somewhat closely. However, *T. tantula* has a larger proloculus, higher chambers for the corresponding volutions, and more strongly fluted septa. In the shell of *Triticites suzukii* the septal fluting is confined only to the polar extremities and almost plane in the mid-portion, but in this species more wide and irregular fluting extends to the margins of the tunnel.

Occurrence.—The stratigraphical occurrence of *Triticites tantula* TORIYAMA, n. sp. is limited to the Plα and Plβ subzones. It is known from the following localities: No. 2 limestone of Section X (Loc. 492), No. 3 limestone of Section XII (Loc. 607), Nos. 1 and 2 limestones of Section XIII (Loc. 570 and 570A, respectively), No. 2 limestone of Section XXII (Loc. 330), No. 4 limestone of Section XXIII (Loc. 272), and Loc. 334, 368, 548, and 619.

Triticites isaensis TORIYAMA, n. sp.

Pl. 7, figs. 35–50

The shell of *Triticites isaensis* TORIYAMA, n. sp. is small and inflated fusiform with straight axis of coiling, convex lateral slopes and bluntly pointed poles. Mature specimens of five volutions are 2.3 to 3.2 mm long and 1.2 to 1.5 mm wide, giving form ratios of 2.0 to 2.3. The shell is short in early volutions and becomes slightly more highly elongate as maturity is approached. The ratios of the half length to the radius vector of the first to fifth volution for twelve specimens are 1.9, 2.0, 2.2, 2.3, and 2.1, respectively.

The proloculus is small but moderate in relative size, with an outside diameter of 98 to 258 microns, averaging 157 microns in thirty-nine specimens. The shell tightly coils in the inner one and a half to two volutions and becomes more or less rapid in the rate of expansion in the outer volutions. Average radius vectors of the first to sixth volution for thirty-nine specimens are 129, 206, 327, 506, 672, and 794 microns, respectively. The chambers are almost the same in height in central half to two-thirds of the shell and increase slightly toward the polar ends where they are highest.

The spirotheca is typical of the genus in structure and is rather thick for this size of the shell. Averages of the thickness of the spirotheca in the first to fifth volution of twenty-six specimens are 15, 21, 30, 44, and 56 microns, respectively. Although fine alveoli can be seen distinctly in the outer volutions, they

Table 32. Table of Measurements (in Millimeters) of *Triticites isaensis* TORIYAMA, n. sp.

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1*	607	828	7	35	3.17	1.40	2.3	.154	.110	.199	.261	.410	.610	.800
2	607	825	7	36	3.17	1.44	2.2	.190	.119	.210	.339	.519	.780	
3	319	1053	7	37	2.40	1.16	2.1	.189	.120	.211	.340	.590		
4	607	831	7	38	2.85	1.43	2.0	.116	.092	.127	.202	.307	.528	
5	570A	804	7	39	2.62	1.3+	2.0	.122	.095	.160	.300	.560	.761	
6	607	828	7	40	2.40	1.15	2.1	.124 .153 ×	.100	.160	.259	.421	.610	
7	547	797	7	41	2.31	1.07	2.2	.196	.153	.285	.430			
8	570A	798	7	42	×	1.31	×	.180	.150	.230	.361	.60?	.87?	
9	444	717	7	43	×	1.72	×	.124 .165 ×	.120	.176	.281	.460	.73?	
10	607	833	7	44	×	1.41	×	.158	.129	.199	.294	.454	.690	
11	607	823	7	45	×	1.56+	×	.176	.139	.209	.331	.520	.730	
12	570A	806	7	46	×	1.25+	×	.120	.086	.123	.220	.363		
13	607	824	7	47	×	1.12	×	.175	.149	.211	.360	.520		
14	444	720	7	48	×	1.16	×	.144	.111	.191	.310	.500		
15	444	719	7	49	×	1.49	×	.10?	.100	.189	.320	.570		
							Max.	.258	.200	.307	.507	.754	.990	.867
							Min.	.098	.092	.123	.202	.307	.430	.710
							Aver.	.157	.129	.206	.327	.506	.672	.794
								39	39	39	39	35	21	4

Specimen	Thickness of spirotohca 0	1	2	4	4	5	6	Ratio of Hl./Rv. 1	2	3	4	5	6
1*	.013	.016	.017	.022	.040	.050	.063	2.3	2.2	2.5	2.5	2.6	
2	.013	.014	.024	.038	.047	.042		1.6	1.8	1.7	2.0	2.0	
3	.014	.007	.021	.033	.037			2.3	2.5	2.5	2.1		
4	—	.014	.014	.026	.028	.047		2.1	2.3	2.4	2.5	2.1	
5	—	.017	.020	.032	.056	.076		1.2	1.4	1.8	—	1.8	
6	—	.014	.023	.033	.042			2.2	2.6	2.4	2.6		
7	.015	.017	.021	.043				1.8	2.4	2.6			
8	.016	.014	.029	.036	.067								
9	—	.012	.024	.028	.047	.044							
10	.012	.014	.020	.030	.042	.046							
11	.013	.012	.021	.026	.041								
12	.011	.010	.014	.029	.050								
13	.013	.015	.015	.025	.034								
14	.012	.013	.014	.024	.052								
15	—	.015	.016	.024	.034	.046							
Max.	.019	.021	.029	.043	.067	.086		2.3	2.6	2.6	2.6	2.6	
Min.	.011	.007	.014	.020	.028	.042		1.2	1.3	1.4	1.5	1.8	
Aver.	.014	.015	.021	.030	.044	.056		1.9	2.1	2.2	2.3	2.1	1.9
	17	19	24	26	23	10		11	12	11	9	6	1

Specimen	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5
1*	—	—	—	37	35						
2	—	20	30	35							
3	27	32	32	31							
4	—	24	25	28	34	33					
5	29	30	32	29							
6	—	34	31	31	31						
7	27	24	25								
8							7	13	15	23	
9							6	11	11	14	16
10							8	11	15	16	21
13							7	13	14	16	
14							7	11	14	17	
15							8	13	14	16	
Max.	29	34	39	37	35		8	17	19	23	31
Min.	27	20	25	28	31		6	11	11	14	16
Aver.	28	26	31	33	33	33	3	13	15	18	23
	3	7	8	7	3	1	9	9	9	8	3

* Holotype specimen

are not seen in the first two volutions of most specimens. The proloculus wall is thin and seems to be composed of a single homogeneous layer, measuring 11 to 19 microns, and averaging 14 microns in seventeen specimens.

The septa are thin, rather closely spaced, and fluted almost throughout the length of the shell. The septal fluting is however weak in the equatorial zone of the shell where closed chamberlets do not extend to the top of the chambers. Average septal counts of the first to fifth volution in nine specimens are 8, 13, 15, 18, and 23, respectively.

The tunnel is low and narrow in the inner two volutions and becomes gradully wide in the succeeding ones. Average tunnel angles of the first to fifth volution in eight specimens are 28, 26, 31, 33, and 33 degrees, respectively. The tnnnel path is almost straight. The chomata are recognizable throughout the shell except for the last volution of some specimens. They are asymmetrical in the first two volutions with steep tunnel sides and gentle poleward slopes but become about symmetrical in cross section in the outer volutions.

Remarks.—Triticites isaensis TORIYAMA, n. sp. is one of smaller forms of the genus *Triticites* if not the smallest. The general features of the shell of this species are, however, seemingly not representing the primitive stage but is in rather progressive stage of the evolutionary development within the genus *Triticites.* The magnitude of the septal fluting and of development of the chomata shows that *Triticites isaensis* n. sp. is one of the transitional form from the genus *Triticites* to *Schwagerina.*

There is no species to which *Triticites isaensis* n. sp. is comparable. This species is somewhat unique, having small size of the shell and considerably intense septal fluting.

Occurrence.—Triticites isaensis TORIYAMA, n. sp. occurs relatively abundantly in the following localities: No. 4 limestone of Section IV (Loc. 717), No. 2 of Section VIII (Loc. 319), No. 4 of Section IX (Loc. 520), No. 3 of Section XII (Loc. 607), No. 2 of Section XIII (Loc. 570A) and several localities which do not belong to any section (Loc. 62, 444, 456, 547, and 548). *Triticites isaensis* TORIYAMA, n. sp. is restricted to the Plα subzone in the stratigraghical range, but it seemingly ranges up to the Plβ subzone.

Triticites cf. *petschoricus* RAUSER-CERNOUSSOVA, BELJAEV and REITLINGER, 1936

Pl. 8, figs. 1, 2

1936. *Triticites petschoricus* RAUSER-CERNOSSOVA, BELJAEV u. REITLINGER. Acad. Sci. U. S. S. R., Transaction, Com. Polar Regions, Fasc. 28, pp. 188–190 (p. 235), Taf. II, fig. 14; Taf. III, figs. 3, 4.

The specimens from No. 5 limestone of Section IV are considerably similar to the holotype of *Triticites petschoricus* RAUSER-CERNOUSSOVA, BELJAEV and REITLINGER from Petschoraland, western foot of Nothern Ural. Represented by only three sections, one axial, one sagittal and one tangential, they are not enough for the exact identification. Therefore I have tentatively identified them with this species and described and illustrated the species for completeness' sake. The following description is based entirely on the Akiyoshi specimens.

The shell is elongate fusiform in shape, with straight axis of coiling, convex to almost straight lateral slopes, and broadly rounded polar ends. The axial section (Pl. 8, fig. 1) of three and a half volutions has a length of 4.8 mm and a presumable width of 2.2 mm, giving a form ratio of 2.2.

The proloculus is large for the size of the shell, attaining an outside diameter of 280 microns in the axial section and 312 microns in the sagittal section. The shell expands rapidly from the first volution to maturity. The radius vectors of the first to third volution of the axial section are 285, 475, and 816 microns, respectively, and those of the first to fifth volution of the sagittal section are 273, 510, 980, 1,306, and 1,630 microns, respectively.

The spirotheca is thick and coarsely alveolar. However, alveoli cannot be distinguished in the first volution as well as in the proloculus wall. The thickness of the spirotheca of the first to fifth volution in the sagittal section measures 28, 49, 78, 78, and 86 microns, respectively. The proloculus wall of the same section is 27 microns thick.

The septa are also thin, composed of the tectum and the pycnotheca. They are plane in the middle portion of the shell, and are weakly fluting in the polar regions, where they form broad septal loops in the axial section. The septal counts of the first to fifth volution of the sagittal section are 9, 26, 27, 34, and 33?, respectively.

The tunnel is broad throughout the growth, with almost straight path. The chomata are developed in the first two volutions but do not occur in the outer ones. The tunnel angles of the first and second volutions are 37 and 34 degrees, respectively.

Remarks.—The present specimens may probably be identified with *Triticites petschoricus* RAUSER-CERNOUSSOVA, BELJAEV and REITLINGER, becuse they have all the features characteristic to that species—broad spiral of the shell, large proloculus, poorly developed chomata, and weakly fluted septa. However, the present materials are so insufficient that I hold the identification as tentative until more sufficient material becomes available.

Occurrence.—This species is collected only from No. 5 limestone of Section IV (Loc. 718), west of Ueyama, Akago, Mito-cho. Although it occurs with no species of fusulinids the stratigraphical age may be the Plα and Plβ because No. 5 limestone conformably overlies No. 4 limestone in which *Pseudoschwagerina muongthensis* (DEPRAT), *Triticites simplex* (SCHELLWIEN), and *T. isaensis* TORIYAMA, n. sp. occur, and underlies the No. 6 limestone of the Plβ subzone.

Triticites noinskyi RAUSER-CERNOUSSOVA var. *paula* TORIYAMA, n. var.

Pl. 8, figs. 3–16

Compare:

1938. *Triticites noinskyi* RAUSER-CERNOUSSOVA. Travaux l'Institut géologique, Acad. Sci. U. S. S. R., Tome VII, pp. 109, 110 (p. 155), Pl. III, figs. 5, 6.

The shell of *Triticites noinskyi* var. *paula* n. var. is rather small for the genus, and is moderately inflated fusiform in shape. The lateral slopes are convex to almost straight and very slightly concave in the outer parts of some specimens. The axis of coiling is almost straight. Both the extremities are obtusely pointed. The number of the volution is usually 5 or 6, very rarely 6½ or 7. The shell of six volutions is 3.2 to 4.6 mm long and 1.5 to 2.1 mm wide, giving a form ratio of 1.9 to 2.7. The shell maintains a closely similar shape throughout its growth except in the first two volutions where it is subspherical to ellipsoidal in shape. The ratios of the half length to the radius vector of the first to sixth volution in fifteen specimens are 1.8, 1.9, 2.1, 2.2, 2.3, and 2.2, respectively.

The proloculus is spherical in shape and moderate in size for the size of the shell. Its outside diameter measures 96 to 232 microns, averaging 166 microns for thirty-eight specimens. The first one and a half to two, sometimes two and a half, volutions tightly coil, followed by moderately rapidly expanding outer volutions. Average radius vectors of the first to sixth volution in forty-two specimens are 137, 214, 335, 516, 762, and 1,037 microns, respectively. The chambers are nearly uniform in height in the central half to two-thirds of the shell and increase slightly to moderately toward the polar ends of the outer volutions.

The spirotheca is thick and very finely alveolar. Alveoli are sometimes too fine to observe. Averages of the thickness of the spirotheca of the first to sixth volution of thirty-one specimens are 16, 23, 35, 52, 79, and 83 microns, respectively. The proloculus wall is seemingly structureless, and is 10 to 24 microns thick, averaging 17 microns in fourteen specimens.

The septa are rather closely spaced, and are composed of the downward deflection of the tectum and distinct pycnotheca. They are fluted almost to the tops of the chambers in the polar extremities, forming many septal loops in the axial sections, but the fluting gradually decreases in height toward the tunnels, where it is weak at the base of the septa. Average septal counts in the first to sixth volution of eleven specimens are 9, 15, 18, 21, 25, and 25, respectively.

The tunnel is narrow, with about straight path. Average tunnel angles of

Table 33. Table of Measurements (in Millimeters) of *Triticites noinskyi* RAUSER-CERNOUSSOVA var. *paula* TORIYAMA, n. var.

Specimen	Loc.	Rg.No.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1	257	612	3.90	1.75	2.2	.160	.121	.213	.292	.445	.700	.921
2	473	739	4.6?	1.84	2.5	.188	.147	.224	.368	.592	.858	—
3	571A	814	4.15	1.95	2.1	.123	.101	.135	.230	.365	.604	.960
4	103	101	4.25	1.55	2.7	.180	.145	.220	.331	.520	.775	
5	103	105	4.6?	1.95	2.4	.152	.120	.210	.322	.510	.770	1.040
6	568B	1197	3.7+	2.02	1.8+	.170	.120	.211	.307	.500	.745	1.120
7	571A	822	4.02	2.04	2.0	.142	.123	.215	.377	.615	.966	
8	547	791	×	1.8+	×	.141	.120	.187	.320	.522	.320	
9	568B	1198	×	1.93	×	.172/.232 ×	.162	.254	.392	.592	.870	
10	571A	822	×	1.45	×	.096	.089	.134	.230	.395	.644	
11	473	740	×	1.93	×	.202	.169	.276	.430	.644	.860	
12	473	738	×	1.74	×	.232	.178	.285	.457	.686	.843	
13	103	109	×	1.65	×	.186	.152	.241	.380	.582	.680	
					Max.	.232	.178	.288	.470	.720	1.620	1.380
					Min.	.096	.088	.124	.204	.353	.560	.803
					Aver.	.166	.137	.214	.335	.516	.762	1.037
						38	37	40	42	41	39	22

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6
1	1.7	1.6	2.0	1.8	1.9	2.0	.014	.019	.026	.037	.056	.090	
2	2.1	2.4	2.5	2.4	2.7		.013	.016	.024	.040	.055	.060	
3	1.9	2.4	2.0	2.6	2.6	2.4	.010	—	.014	.022	.041	.076	.099
4	—	—	2.4	2.0	2.8		.019	—	.024	.047	.070	.117	
5	—	2.1	2.1	1.9	2.3	2.2	.021	.019	.024	.038	.047	.059	.073
6	1.3	1.5	2.1	2.2	2.3	2.0	—	—	.017	.032	.056	.085	.089
7	2.0	2.3	2.6	2.4	2.6		—	.015	—	.039	.060	.081	
8							—	—	.024	.036	.041	.073	
9							.016	.016	.025	.041	.044	.066	
10							—	.011	.016	.022	.060	.071	
11							—	—	.017	.044	.072	.064	
12							—	.021	.035	.039	.066	.078	
13							—	.019	.028	.035	.051	.071	
Max.	2.1	2.4	2.6	2.6	2.8	2.4	.024	.021	.033	.048	.080	.117	.117
Min.	1.3	1.5	1.4	1.6	1.7	2.0	.010	.011	.014	.018	.032	.050	.054
Aver.	1.8	1.9	2.1	2.2	2.3	2.2	.017	.016	.023	.035	.052	.079	.083
	12	14	15	15	14	9	14	23	26	31	31	23	12

Specimen	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5	6	Pl.	fig.
1	34	33	—	39	52								8	3
2	31	27	41	41	51								8	4
3	—	35?	32	35	36	36							8	6
4	43?	—	43	43	44								8	7
5	—	—	38	45	46	56							8	8
6	—	—	26	34	40	43?							8	9
7	—	30	43	47	45								8	10
8							—	—	—	—	—		8	11
9							10	17	18	21	22	24	8	12
10							7?	11?	12?	18			8	13
11							10	15	20	26	32?		8	14
12							8	16	19	20?			8	15
13							10	14	15	23	26?		8	16
Max.	43	38	43	45	52	56	10	17	21	26	32	26		
Min.	26	27	26	35	35	36	7?	11?	12	18	22	24		
Aver.	34	33	37	40	43	46	9	16	18	21	25	25		
	5	7	11	11	9	5	10	11	9	8	6	3		

the first to sixth volution in eleven specimens are 34, 33, 37, 40, 43, and 46 degrees, respectively. The chomata are moderately developed throughout most of the shell, but obscure or rudimentary in the ultimate volution of some specimens. They are highly asymmetrical in cross section in the inner volutions, with steep tunnel-side slopes and gentle poleward ones. In the outer volutions they are less asymmetrical, and become even almost symmetrical in some specimens.

Remarks..—I have obtained from the Plα, Plβ and Plγ subzones of the Akiyoshi limestone group numerous specimens of small and short form which are nearly identical with, but slightly different from the holotype of *Triticites noinskyi* RAUSER-CERNOUSSOVA. The latter species was described from the I_1 horizone of the "Upper Carboniferous" rocks of Samara Bend, which seemingly is considered to be the Lower Permian in age. The only difference between the holotype (Pl. III, fig. 6) of *Triticites noinskyi* RAUSER-CERNOUSSOVA and the present variety is less slender and smaller form of the shell of the latter.

This species most closely resembles a part of *Triticites subobsoleta* (OZAWA). OZAWA (1925) illustrated six specimens of that species as Pl. V, fig. 2, Pl. IX, figs. 2, 4, 5?, 6, and 7, but did not designate the holotype. Some of them seemingly, however, are not conspecific with others. Although the specimen* illustrated as Pl. V, fig. 2 was later referred by HUZIMOTO to *Schwagerina parvula* (SCHELLWIEN), it is most closely, if not conspecific, allied to the present species.

This species is somewhat similar to *Triticites secalicus* var. *samarica* RAUSER-CERNOUSSOVA also from the I_1 horizon of Samara Bend, but can be distinguished from the latter by its ellipsoidal shape of the shell with bluntly rounded poles.

Occurrence.—The stratigraphical occurrence of this species is considerably long, ranging from the Plα to Plγ subzones, but is rather rare in the Plα subzone and more common in the Plβ and Plγ subzones. The following localities are known; No. 3 limestone of Section IX (Loc. 519), No. 11 limestone of Section X (Loc. 568B), No. 2 limestone of Section XII (Loc. 606A), No. 4 limestone of Section XIII (Loc. 571A), No. 4 limestone of Section XIV (Loc. 103), No. 4 limestone of Section XVIII (Loc. 314), No. 1 limestone of Section XXI (Loc. 257), No. 1 limestone of Section XXIII (Loc. 269), and Loc. 473 and 547.

Triticites michiae TORIYAMA, n. sp.

Pl. 8, figs. 17-23

The shell of *Triticites michiae* TORIYAMA, n. sp. is moderate in size and inflated fusiform, with straight axis of coiling, straight to convex lateral slopes, and broadly pointed polar ends. The holotype specimen of six volutions is 5.15 mm long

* It is unfortunate that I have not been able to find this specimen in the OZAWA's collection.

and 2.41 mm wide, giving a form ratio of 2.1. Another specimen of six and a half volutions is, though not well oriented, approximately 4.7 mm? long and 2.1 mm? wide. The shell is almost the same in axial profile throughout its growth except in the first volution which is short ellipsoidal in shape. Average ratios of the half length to the radius vector of the first to sixth volution for three specimens, including the holotype, are 1.5, 1.9, 2.1, 2.0, 1.9, and 2.0, respectively.

The proloculus is spherical in shape and is small for the size of the shell, with an outside diameter of 138 to 210 microns, averaging 165 microns in twelve specimens. The shell increases in height slowly in the first two or three volutions but rapidly and almost uniformly in the outer ones. The ultimate volution of mature specimens seemingly decreases in height slightly. Average radius vectors of the first to sixth volution in twelve specimens are 142, 237, 382, 618, 922, and 1,122 microns, respectively. The chambers are almost the same in height throughout the length of the shell, and become only slightly higher in the polar ends of the outer volutions.

The spirotheca is remarkably thin for this genus, consisting of a tectum and a well defined keriotheca. The alveoli of the keriotheca is moderately coarse, and can be distinguished in all but the inner one or two volutions. 5 to 6 alveoli are observed in a space of 100 microns in the spirotheca of the outer volutions. Average thickness of the spirotheca in the first to sixth volution in twelve specimens is 17, 25, 36, 56, 56, and 57 microns, respectively. The proloculus wall, which is seemingly composed of a single homogeneous layer, is also thin, averaging 18 microns in thickness in four specimens.

The septa are also thin and moderately spaced. Averages of the septal counts in the first to fifth volution of eight specimens are 9, 16, 20, 23, and 25, respectively. The septa are composed of a downward deflection of the tectum and thin pycnotheca, the latter of which is sometimes hard to distinguish. The septa are only moderately fluted in the extreme polar regions and practically plane across the central two-thirds to three-fourths of the shell.

The tunnel is narrow in the inner volutions but moderately wide in the outer ones. The tunnel path is somewhat irregular, at least so in the holotype specimen. Average tunnel angles of the second to sixth volution of three specimens are 27, 29, 33, 37, and 40 degrees, respectively. The chomata are well developed throughout all except the last volution. They are asymmetrical, with steep to overhanging tunnel sides and steep to gentle poleward slopes. The chomata are about one-third to half as high as the chambers in outer volutions.

Remarks.—Because *Triticites michiae* TORIYAMA, n. sp. is rare in its occurrence and I have not been able to obtain additional specimens, materials at my disposal are not sufficient for the precise comparison. Seemingly, however, the relative thinness of the spirotheca for the size of the shell of this form is remarkable, by

Table 34. Table of Measurements (in Millimeters) of *Triticites michiae* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1*	330	658	5.15	2.41	2.1	.168	.126	.230	.383	.641	.920	1.196	
2	489	746	4.7?	2.1?	2.2	.149	.107	.156	.267	.466	.690	1.000	1.296
3	330	660	3.32	1.84	1.8	.138	.100	.158	.245	.392	.613	.867	
4	330	657	×	2.27	×	.172	.187	.307	.482	.760	1.071		
5	330	665	×	2.70	×	.187	.172	.307	.507	.852	1.251		
6	330	655	×	1.98	×	.191	.166	.257	.383	.613	.920	1.098	
7	489	746	×	2.4+	×	.209	.178	.307	.507	.828	1.24?		
				Max.		.210	.187	.307	.507	.852	1.251	1.470	
				Min.		.138	.100	.158	.245	.392	.613	.867	
				Aver.		.165	.142	.237	.382	.618	.922	1.122	1.296
						12	12	12	12	12	10	5	1

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6	7
1*	1.4	1.7	1.9	1.9	1.9	2.3	—	.012	.036	.039	.064	.073	.051	
2	1.6	2.1	2.1	2.1	2.0	1.9	—	.013	.017	.026	.032	.040	.062	.060
3	1.4	1.9	2.2	2.1	1.8	1.7	—	.016	.022	.029	.043	.051	.059	
4							—	—	.029	.056	.067	.032		
5							—	.017	.023	.039	.066	.074		
6							.020	.017	.022	.046	.056	.056		
7							.013	.019	.032	.039	.073			
Max.	1.6	2.1	2.2	2.1	2.0	2.3	.026	.021	.036	.046	.073	.073	.062	
Min.	1.4	1.7	1.9	1.9	1.8	1.7	.014	.011	.017	.026	.032	.032	.051	
Aver.	1.5	1.9	2.1	2.0	1.9	2.0	.018	.017	.025	.036	.056	.056	.057	.060
	3	3	3	3	3	3	4	10	12	12	12	9	3	1

Specimen	Tunnel angle 2	3	4	5	6	Septal count 1	2	3	4	5	Pl.	fig.
1*	32	30	32	39	40						8	17
2	25	32	32	35	39						8	18
3	25	25	34	37							8	19
4						9	19	24	24	30	8	20
5						10	15	17	21	23	8	21
6						9	15	19	22	23	8	22
7						12	17	24	28		8	23
Max.	32	32	34	39	40	12	19	24	28	30		
Min.	25	25	32	35	39	8	14	17	19	20		
Aver.	27	29	33	37	40	9	16	20	23	25		
	3	3	3	3	2	8	8	8	8	5		

* Holotype specimen

which it may be distinguished from the similar forms of the genus.

Triticites michiae n. sp. is closely similar to *T. subventricosus* DUNBAR and SKINNER from the basal Wolfcampian of Glass Mountains, Texas, but can be separated from the Texas form by less slender shape of the shell, a little smaller proloculus, thinner spirotheca and less numerous septa. Another American species of *Triticites* which bears some resemblance to the species under consideration is *T. confertus* THOMPSON, which has very recently been described from the Wolfcampian of Texas and Kansas, but the latter has smaller proloculus, more massive chomata and thicker spirotheca than those of the former.

Triticites michiae n. sp. somewhat resembles *T. ozawai* TORIYAMA, n. sp. in the size of the shell, the weak fluting of the septa and the development of the chomata, but differs from the latter in having less slender form and thinner spirotheca of the present form.

The specific name is dedicated to Mrs. Michie TORIYAMA, who heartily helped me in various ways during this study.

Occurrence.—Triticites michiae TORIYAMA, n. sp. is rare in the limestone of No. 2 of Section XXII (Loc. 330) and of Loc. 489. So far as known the stratigraphical range of *T. michiae* TORIYAMA, n. sp. is restricted to the Plα subzone.

Triticites ozawai TORIYAMA, n. sp.

Pl. 8, fig. 24; Pl. 9, figs. 1–7

1927. *Schellwienia montipara* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 40, 41, Pl. IX, fig. 1.

Because the specimens referred by OZAWA to *Schellwienia montipara* are neither conspecific with *Alveolina montipara* EHRENBERG nor with *Fusulina montipara* MÖLLER, I have ditinguished the OZAWA's *montipara* as a new species, *Triticites ozawai* n. sp. The following description is based on the OZAWA's type specimen and several specimens collected by myself.

The shell of *Triticites ozawai* TORIYAMA, n. sp. is elongate fusiform in shape, with straight axis of coiling, convex lateral slopes and bluntly rounded poles. The number of the volution is 5 in most specimens, and rarely attains 5½. The largest specimen, the holotype, attains 5.3 mm in length and 2.4 mm in width, giving a form ratio of 2.2. Other specimens of five to five and a half volutions are 4.1 to 4.8 mm long and 1.8 to 2.2 mm wide, giving form ratios of 2.2 to 2.6. The first one or two volutions have the short axis of coiling. Beyond the second or third volution the axial ends become extended. Average ratios of the half length to the radius vector of the first to fifth volution of eight specimens are 2.0, 2.1, 2.4, 2.4, and 2.4, respectively.

The proloculus is moderate in size, and 130 to 214 microns in outside diameter, averaging 171 microns in thirteen specimens. The shell coils tightly in the first one and a half to two volutions, and expands rather rapidly but uniformly in the outer volutions. The radius vectors of the first to fifth volution of fifteen speci-

Table 35. Table of Measurements (in Millimeters) of *Triticites ozawai* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector					
							1	2	3	4	5	6
1*	OZAWA'S specimen	I-80	5.30	2.40	2.2	.205	.150	.219	.369	.581	.860	1.260
2	263	635	4.80	1.83	2.6	.135	.110	.179	.291	.522	.810	
3	263	640	4.11	1.82	2.3	.160	.189	.268	.409	.660	1.010	
4	264	643	3.81	1.70	2.2	.176	.190	.299	.486	.740	1.029	
5	539	762	4.72	1.97	6.4	.172	.129	.208	.383	.598	.921	
6	330	661	3.90	1.70	2.3	.166 × .188	.147	.240	.392	.662		
7	539	763	×	1.82	×	.213	.181	.285	.452	.665	.963	
8	263	636	×	1.95	×	.130	.111	.172	.290	.480	.810	
					Max.	.214	.190	.299	.486	.763	1.029	1.340
					Min.	.130	.110	.172	.291	.480	.810	1.260
					Aver.	.171	.145	.241	.408	.658	.976	1.300
						13	14	15	15	15	12	2

Specimen	Ratio of Hl./Rv.						Thickness of spirotheca						
	1	2	3	4	5	6	0	1	2	3	4	5	6
1*	1.5	2.1	1.8	2.2	2.0	2.2	.019	—	.019	.050	.058	.070	.103
2	1.7	2.1	2.9	3.2	3.0		—	.014	.014	.042	.047	.068	
3	2.7	2.5	3.0	2.5	2.1		—	.030?	.040?	.042	.075	.085?	
4	—	—	—	2.3			.019	.021	.022	.042	.070	.090	
5	—	1.9	2.0	2.2	2.3		.012	.012	.021	.025	.060	.049	
6	1.6	2.2	2.3	2.7			.016	.020	.024	.041	.055		
7							.015	.011	.024	.027	.056	.069	
8							.014	.014	.014	.024	.052	.085	
Max.	2.7	2.5	3.0	3.2	3.0		.019	.030?	.040?	.050	.078	.090	
Min.	1.5	1.8	1.7	1.9	2.0		.012	.011	.014	.024	.036	.049	
Aver.	2.0	2.1	2.4	2.4	2.4	2.2	.015	.016	.021	.034	.060	.074	
	4	6	7	8	4	1	9	12	14	14	14	11	

Specimen	Tunnel angle					Septal count					Pl.	fig.
	1	2	3	4	5	1	2	3	4	5		
1*	—	20	43	50	56						8	24
2	—	—	35	48	57						9	1
3	—	27	40	53	61						9	2
4	—	21	27	49	34						9	3
5	—	23	22	37	48						9	4
6	17	21	31	32							9	5
7						8	14	17	20	21	9	6
8						8	13	14	14	16	9	7
Max.	24	33	43	53	61	11	16	19	24	28		
Min.	17	20	22	32	34	8	13	14	14	16		
Aver.	21	26	32	43	48	9	14	17	20	23		
	2	6	7	6	5	4	5	5	4	4		

* Holotype specimen

mens average 145, 241, 408, 658, and 976 microns, respectively. The chambers are lowest above the tunnel and remain nearly the same in height throughout the central half of the shell, increasing more or less rapidly toward the poles.

The spirotheca is typical for the genus, consisting of a tectum and a coarsely alveolar keriotheca. About 4 alveoli can be observed in a distance of 100 microns of the spirotheca of the ultimate volution. The spirotheca of the inner volutions is rather thin, in which alveoli are somewhat indistinct. Average thickness of the spirotheca of the first to fifth volution in fourteen specimens is 16, 21, 34, 60, and 74 microns, respectively.

The septe are thin and are composed of the downward deflection of the tectum and well defined pycnotheca. They are almost plane throughout the middle portion of the shell but are weakly fluted in the polar regions. Averages of the septal counts in the first to fifth volution for five specimens are 9, 14, 17, 20, and 23, respectively.

The tunnel is narrow in the inner two or three volutions and becomes wide in the outer two or three volutions. Its path is almost straight. Average tunnel angles of the first to fifth volution in seven specimens are 21. 26, 32, 43, and 48 degrees, respectively. The chomata are well defined throughout the shell except for the last volution of some specimens. They are small and highly asymmetrical in early volutions and become narrower and slightly to moderately asymmetrical in the outer ones. They are about half as high as the chambers in almost all the volutions.

Remarks.—As discussed in some detail by DUNBAR and SKINNER (1936) *Alveolina montipara* EHRENBERG (1854) is not a species of *Triticites* but belongs to the genus *Schwagerina*, and all the species referred to *Triticites montipara* MÖLLER later than 1880, depending on MÖLLER's interpretation instead of a study of EHRENBERG's original material, are considered to have been misidentified.

Having found a species in the limestone of Kawanobori-mura, southern Kyushu, which was considered by him to be conspecific with *montipara* of MÖLLER, HUZIMOTO (1937) established a new specific name, *Triticites kawanoboriensis*, in which OZAWA's *Schellwienia montipara* was also included.

However, OZAWA's *Schellwienia montipara*, which is represented by only one specimen (section I-80 in his collection, illustrated here as Pl. 8, fig. 24), is neither conspecific with *Triticites montipara* MÖLLER nor with *T. kawanoboriensis* HUZIMOTO. A new specific name is therefore required for the *montipara* of OZAWA and for forms found in the Akiyoshi limestone group which are identified with OZAWA's *montipara*. I propose here *Triticites ozawai* n. sp. for this form.

Triticites ozawai TORIYAMA, n. sp. somewhat resembles *T. whitei* RAUSER-CERNOUSSOVA, BELJAEV, and REITLINGER from Petschoraland of Northern Ural but is distinguished from the latter in having more slender form of the shell, somewhat stronger septal fluting in the polar regions and more rapid expansion of the shell.

Triticites ozawai TORIYAMA, n. sp. is also similar with *T. pygmaeus* (DUNBAR and CONDRA) from the Glass Mountains, Texas. Compared with the latter, however, it has much less developed chomata, a little larger proloculus, and larger radius vector for the corresponding volutions.

Occurrence.—So far as known the stratigraphical occurrence of *Triticites ozawai* TORIYAMA, n. sp. is limited only to the lowest Permian fusulinid subzone (Plα). OZAWA reported *Schellwienia montipara* from the Tombstone region on the Akiyoshi plateau, but he did not show the exact locality. In the present study Section XXIV (Jigokudai) is located in the Tombstone region, but I have not been able to find the species under consideration in and around Section XXIV.

My collection of *Triticites ozawai* TORIYAMA, n. sp. was collected from the following localities: Nos. 2 and 3 limestones of Section III (Loc. 539 and 539A, respectively), No. 8 limestone of Section VII (Loc. 441), Nos. 7 and 8 limestones of Section XXI (Loc. 264 and 263, respectively), No. 2 limestone of Section XXII (Loc. 330), and Loc. 15.

Triticites simplex (SCHELLWIEN)

Pl. 9, figs. 8–25

1908. *Fusulina simplex* SCHELLWIEN. Palaeontographica, Vol. LV, pp. 179–182, Pl. XVIII, figs. 4–6, 12.
1927. *Schellwienia simplex* LEE. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 1, pp. 40–42, Pl. V, figs. 6–11, 13.
1934. *Triticites simplex* CHEN. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 2, pp. 24, 25, Pl. I, figs. 16, 17, 21.
1936. *Triticites simplex* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 48, 49, Pl. IV, figs. 1–6.
1938. *Triticites simplex* HUZIMOTO. Japan. Jour. Geol. Geogr., Vol. XIV, pp. 119, 120, Pl. VIII, figs. 9–17.
1938. *Triticites simplex* RAUSER-CERNOUSSOVA. Travaux l'Institut géologique, Acad, Sci. U. S. S. R. Tome VII, pp. 111, 112, Pl. III, figs. 7, 8.

The shell of *Triticites simplex* (SCHELLWIEN) is typical fusiform in shape and is of moderate size for the genus. Its lateral slopes are convex to almost straight and become sometimes even slightly concave, especially so in the outer one or two volutions. The polar ends are narrowly to moderately rounded. The axis of coiling is almost straight in most of specimens but slightly arching in others. Mature specimens of five to five and a half volutions are 3.4 to 5.7 mm long and 1.6 to 2.7 mm wide, giving form ratios of 1.7 to 2.9. The first volution is subspherical to short ellipsoidal in shape, but the axis of coiling becomes extended more or less slowly in the following two or three volutions and rapidly in the last one or two volutions. Average ratios of the half length to the radius vector of the first to fifth volution in thirty-six specimens are 1.7, 1.9, 2.1, 2.1, and 2.4, respectively.

The proloculus is spherical in shape in most of specimens but subspherical in some ones. It is of moderate size for this size of the shell. Its outside diameter ranges from 140 to 310 microns, averaging 228 microns in ninety-three specimens. The first one and a half to two volutions are rather tightly coiled and in the succeeding volutions the radius vectors increase moderately rapidly and uniformly. The radius vectors of the first to fifth volution in ninety-eight specimens average 191, 304, 483, 737, and 1,019 microns, respectively. The chambers are lowest above the tunnel and gradually increase in height toward the polar ends.

The spirotheca is rather thin for specimens of *Triticites* of this size. The thickness of the spirotheca increases slowly but rather uniformly from the first to fifth volution. Average thickness of the spirotheca in the first to fifth volution of seventy-four specimens is 20, 29, 46, 63, and 71 microns, respectively. The spirotheca consists of a tectum and a finely alveolar keriotheca. Alveoli are very distinct in the outer volutions of most specimens but hard to be seen in the inner volutions of some specimens. The proloculus wall is moderately thick, averaging 20 microns for fifty-four specimens. No distinct feature can be observed in it.

Table 36. Table of Measurements (in Millimeters) of *Triticites simplex* (SCHELLWIEN)

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector					
							1	2	3	4	5	6
1	330	654	5.57	2.25	2.5	.222	.176	.310	.475	.736	1.052	
2	330	656	5.36	1.88	2.9	.251	.211	.332	.513	.727	1.034	
3	550A	1190	5.70	2.17	2.4	.208	.166	.230	.356	.530	.800	
4	472	732	4.72	2.10	2.3	.205	.153	.230	.389	.631	.920	
5	263	634	5.20	2.36	2.2	.205	.200	.359	.570	.880	1.290	
6	263	635	5.79	2.63	2.2	.250	.200	.361	.599	.920	1.289	
7	257	614	5.1+	1.99	2.6	.275	.219	.330	.491	.700	.971	
8	263	636	4.9+	2.17	2.3	.218	.167	.290	.470	.739	.891	
9	445	724	4.1+	1.95	2.1	.296	.236	.338	.507	.760	1.050	
10	445	723	×	2.14	×	.22+	.200	.330	.525	.788	1.200	
11	259	1029	×	2.10	×	.196 .220 ×	.181	.301	.480	.741	1.010	
12	263	640	×	1.78	×	.200 .240 ×	.201	.331	.549	.919		
13	263	638	×	1.69	×	.210	.19?	.289	.500	.810		
14	257	612	×	1.72	×	.230	.191	.300	.441	.700	.920	
15	257	617	×	1.9+	×	.310	.239	.349	.570	.890		
16	259	1030	×	2.17	×	.26?	.241	.369	.551	.881		
17	259	1029	×	2.04	×	.229	.259	.368	.530	.770	1.069	
18	472	734	×	2.16	×	.200	.170	.281	.520	.70?	1.010	
					Max.	.310	.259	.410	.613	.993	1.290	1.337
					Min.	.140	.135	.180	.294	.491	.733	1.020
					Aver.	.228	.191	.304	.483	.737	1.019	1.212
						93	97	98	98	95	65	4

Specimen	Ratio of Hl./Rv.					Thickness of spirotheca					
	1	2	3	4	5	0	1	2	3	4	5
1	2.2	2.3	2.4	2.7	2.7	.019	.021	.034	.046	.051	.041
2	1.9	2.0	2.2	2.1	2.6	.018	.019	.025	.034	.066	.042
3	—	2.4	2.5	2.5	2.7	.012	.015	.027	.049	.067	
4	2.4	2.4	2.8	2.6	2.7	.021	—	.024	.024	.056	.080
5	1.3	1.2	1.5	1.6	1.8	.024	.020	.040	.057	.080	.098
6	1.8	2.2	2.0	2.1	2.3	.028	.019	.033	.058	.070	.080
7	1.2	1.8	2.1	2.2	2.3	.023	.033	.042	.061	.080	.080
8	—	2.2	1.9	2.2	2.5	.019	.024	.028	.057	.061	
9	1.4	2.0	2.0	1.9	2.0	.019	.024	.027	.044	.079	.089
10						—	.016	.027	.064	.073	.094
11						.018	.024	.035	.049	.066	.071
12						.021	.019	.033	.047	.070	
13						.021	.019	.019	.047	.052	
14						.014	.024	.033	.037	.075	.089
15						.019	.028	.028	.061	.085	
16						—	—	.037	.047	.058	
17						.020	—	.033	.047	.075	.075
18						.019	.017	.021	.037	.040	.056
Max.	2.4	2.4	2.8	2.9	2.8	.028	.033	.047	.064	.094	.108
Min.	1.0	1.2	1.5	1.5	1.6	.010	.012	.019	.028	.039	.037
Aver.	1.7	1.9	2.1	2.1	2.4	.020	.020	.029	.046	.063	.071
	28	34	36	36	26	54	53	74	73	72	47

Specimen	Tunnel angle					Septal count					Pl.	fig.
	1	2	3	4	5	1	2	3	4	5		
1	21	22	31	42	44						9	8
2	24	26	27	39							9	9
3	22	31	34								9	10
4	—	26	29	38	47						9	11
5	—	22	25	31	44						9	12
6	18	20	20	29	36						9	13
7	23	23	26	38	—						9	14
8	—	25	40	40							9	15
9	—	22	33	31							9	16
10						9	16	16	19	22	9	17
11						8	13	16	20	20	9	18
12						11	14	13	16		9	19
13						9	13	18	20		9	20
14						11	20	25	28	25	9	21
15						11	22	27	28		9	22
16						11	23	23	24		9	23
17						10	19	18+	21	24	9	24
18						6	14	15	20	22	9	25
Max.	27	38	40	44	44	11	23	27	28	33		
Min.	18	20	20	25	30	6	13	23	16	20		
Aver.	24	24	29	38	39	9	17	19	21	24		
	11	27	31	27	13	31	34	31	27	14		

The septa are thin and closely spaced in the first one and a half to two volutions, but farther apart in the succeeding volutions. The septal counts of the first to fifth volution in thirty-four specimens average 9, 17, 19, 21, and 24, respectively. The septal fluting is developed moderately throughout the shell at least up to the margins of the tunnel. Adjacent to the tunnel, however, the fluting is very weak, confined only to the extreme lower margin of the septa. It is more intense in the end zones of the shell where the tops of the septa are affected by the fluting and many septal loops are seen in the axial profiles.

The tunnel is low and narrow in the earlier part of the shell, but, gradually widens in the outer volutions. Its path is nearly straight but more or less irregular in some specimens. Average tunnel angles of the first to fifth volution in thirty-one specimens are 24, 24, 29, 38, and 39 degrees, respectively. The chomata are developed throughout the volutions. In the inner two or three volutions of most specimens they are low and highly asymmetrical, with steep tunnel sides and gentle poleward slopes, extending about half to one-fourth of the distance from the tunnel to the polar extremities. In the succeeding volutions they become narrow and less asymmetrical, having a height of about as half as the chambers.

Remarks.—Triticites simplex (SCHELLWIEN) is one of the most prolific species among the Akiyoshi fusulinids and the above description is entirely based on my collection obtained from numerous localities on the Akiyoshi and Ofuku plateaux.

Triticites simplex (SCHELLWIEN) has often been reported by many workers from the Lower Permian and Upper Pennsylvanian rocks of the Tethys Sea region. It is also rather widely distributed in the Lower Permian and Upper Pennsylvanian (Uralian) rocks in this country, but only few forms have been described and illustrated.

In his original description of *Fusulina simplex* illustrated SCHELLWIEN only four specimens (Pl. XVIII, figs. 4–6, 12), one axial from C_3 of Donetz, one sagittal from Middle Russland and two free specimens. Of which, fig. 6 seemingly is not referable to this species, having much more slender shell than that of figs. 4 and 12. Although SCHELLWIEN did not designate the holotype, it is clear that fig. 4 of Pl. XVIII must be the type specimen of this species because of being only the axial section in the original illustration.

The Akiyoshi form is almost identical with the SCHELLWIEN's type specimen in all the important characters of the shell except for that the latter has slightly slower rate of the growth and slightly weaker septal fluting in the equatorial region of the shell.

HUZIMOTO (1936) described and illustrated *T. simplex* from the Kwanto-massif, but any of his specimens is not exactly well oriented, and is not suitable for specific comparison. He (1937) also illustrated the same species from Kawanoborimura, Kyushu, but all of his specimens are clearly so much affected by later deformation that they are not adequate for detailed discussion.

Triticites simplex (SCHELLWIEN) somewhat resembles *T. haydeni* (OZAWA), *T. petschoricus* RAUSER-CERNOUSSOVA, BELJAEV and REITLINGER, and *T. noinskyi*, RAUSER-CERNOUSSOVA var. *paula* n. var., but is distinguished from these forms by its relatively massive chomata, degree of the septal fluting and somewhat rapid expansion of the shell.

Triticites simplex (SCHELLWIEN) was originally reported from the Schwagerinen-schichten (Sakmarian or Wolfcampian) and the Cora-schichten (the upper part of the Uralian s. str.) of Russia. In this country, since the discovery of the Uralian formation in Central and Southwest Japan in 1952, many workers reported the existence of the Uralian formation, in some of which the occurrence of *T. simplex* and its allies has been considered to be a paleontological proof of the Uralian age. However, at least in the Akiyoshi limestone group, *T. simplex* is most prolific in the basal Permian, and the lower part of the Plα subzone comprises almost exclusively of species of *Triticites*. Therefore, an occurrence of *T. simplex* and its allies does not necessarily mean the Uralian age of the formation. In short, it must be careful to determine whether the limestone containing only *Triticites simplex* and its allies is referable to Sakmarian (or Wolfcampian) or to Uralian, and the strict and detailed paleontological consideration will be need for the age-determination.

Occurrence.—Triticites simplex (SCHELLWIEN) was collected from the following localities, some of which do not belong to any of Section described in Part I: Nos. 2, 3, and 4 limestones of Section IV (Loc. 716, 716A, and 717, respectively), No. 4 limestone of Section IX (Loc. 520), No. 4 limestone of Section XIV (Loc. 103), No. 2 limestone of Section XX (Loc. 343), Nos. 1, 3, 5, and 8 limestons of Section XXI (Loc. 257, 259, 262, and 263, respectively), No. 2 limestone of Section XXII (Loc. 330), No. 4 limestone of Section XXIV (Loc. 550A), and Loc. 15, 251, 445, 446, 456, 467, and 472.

This species is characteristic to the lowest subzone (Plα) of the Permian part of the Akiyoshi limestone group, but it ranges up into the Plβ subzone, although it is very few in occurrence.

Triticites haydeni (OZAWA)

Pl. 10, figs. 1–9

1925. *Schellwienia haydeni* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 39, 40, Pl. IX, figs. 8, 9.

OZAWA described and illustrated *Schellwienia haydeni* from Ueyama (Uyeyama), Akago, Mito-cho. Although I have not been able to find the species around Ueyama, I have obtaind numerous specimens which are safely identified with the OZAWA's type specimen (fig. 9 of Pl. IX, section II–37 in the OZAWA's collection) from the eastern flank of Managatake, Akago, the southwestern flank of Konokamiyama, Isa-mashi, and other two localities. The following description is entirely based on the present materials.

The shell of *Triticites haydeni* (OZAWA) is of medium size and elongate fusiform, with convex to slightly concave lateral slopes, straight to slightly arching axis of coiling, and narrowly rounded polar extremities. Mature shells of five to six volutions are 4.0 to 6.1 mm long and 1.6 to 2.3 mm wide, giving form ratios of 2.4 to 3.3. The first volution is short, but the axis of the succeeding ones increases in relative length rapidly. Average ratios of the half length to the radius vector of the first to sixth volution of ten specimens are 1.5, 1.9, 2.0, 2.3, 2.6, and 2.6, respectively.

The proloculus is small and spherical, with an outside diameter of 108 to 240 microns, averaging 193 microns for twenty-two specimens. The shell is tightly coiled in the first two volutions, but expands rather rapidly in the outer ones. Average radius vectors of the first to sixth volution for twenty-eight specimens are 147, 230, 350, 545, 812, and 1,064 microns, respectively. The chambers are about the same in height in the cenral half to two-thirds of the shell and increase rapidly as the polar ends are approached.

The spirotheca is rather thin, consisting of a distinct tectum and a finely alveolar keriotheca. Alveoli of the latter, however, cannot be seen in the inner one or two volutions. Average thickness of the spirotheca in the first to sixth volution of twenty-two specimens is 17, 23, 35, 55, 75, and 81 microns, respectively. The proloculus wall, seemingly structureless, is rather thick, averaging 21 microns in six specimens.

The septa are thin and moderately widely spaced. Average septal counts of the first to fifth volution of five specimens are 8, 17, 20, 24, and 25, respectively. The distinct pycnotheca is well observed almost throughout the volutions. The septa are more or less strongly fluted in the end zones, but are almost plane or very weakly fluted in the middle portion of the shell where the fluting does not reach the tops of the septa.

The tunnel is low and narrow in the inner volutions but widens as the shell grows. Its path is almost straight in some specimens but irregular in others. Average tunnel angles of the first to fifth volution in eight specimens are 24, 29, 36, 41, and 45 degrees, respectively. The chomata are low and highly asymmetrical in the inner three to four volutions but become moderately high and less asymmetrical. They do not occur in the outer volutions of some specimens.

Remarks.—In his original description of *Schellwienia haydeni*, OZAWA (1925) remarked the differences between *S. prisca* var. *parvula* SCHELLWIEN and the species under consideration, expecting to find the intermediate forms between them. The present species is undoubtedly distinguished from *Schwagerina parvula* (SCHELLWIEN) in having more slender and larger shell, more weakly fluted septa and the development of the chomata.

Although the present species is clearly an intermediate form from the genus

Triticites to genus *Schwagerina*, and DUNBAR and SKINNER (1937) and DUNBAR and HENBEST (1942) referred the present species to the genus *Schwagerina*, it seemingly is more pertinent to refer it to the genus *Triticites*.

Table 37. Table of Measurements (in Millimeters) of *Triticites haydeni* (OZAWA)

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector					
							1	2	3	4	5	6
1*	OZAWA's specimen	II-37	4.61	1.50	3.1	.155	.130	.202	.330	.537	.813	
2	540	771	5.47	1.90	2.9	.203	.158	.236	.351	.500	.745	1.000
3	540	774	5.53	1.77	3.1	—	.140	.262	.409	.641	.935	
4	543	1155	5.47	1.93	2.8	.161	.144	.218	.344	.574	.949	1.130
5	543	1152	5.3+	2.15	2.5	.231	.170	.229	.313	.47?	.791	1.116
6	540	770	×	2.04	×	.156	.132	.195	.340	.650	.959	
7	543	1153	×	2.30	×	.210	.187	.282	.482	.736	1.080	
				Max.		.240	.210	.320	.485	.736	1.080	1.200
				Min.		.108	.100	.156	.264	.395	.660	.920
				Aver.		.193	.147	.230	.350	.545	.812	1.064
						22	26	27	28	26	26	8

Specimen	Ratio of Hl./Rv.						Thickness of spirotheca						
	1	2	3	4	5	6	0	1	2	3	4	5	6
1*	—	—	2.3	2.7	3.0		.012	.015	.019	.032	.045	.044	
2	1.0	1.7	1.7	1.9	2.7	3.2	.033	.021	.021	.040	.040	.055	.072
3	1.8	2.1	2.0	2.4	2.9		—	.019	.024	.044	.049	.071	
4	1.9	2.6	2.4	2.6	3.2		—	.015	.025	.042	.076	.067	
5	0.9	1.6	2.0	2.3	2.4	2.4	—	.014	.015	.019	.043	.071	.072
6							—	—	.017	.030	.056	.071	
7							.018	.026	.029	.057	.076	.071	
Max.	1.9	2.6	2.4	2.8	3.2	3.2	.033	.026	.030	.057	.084	.103	.117
Min.	0.9	1.5	1.7	1.9	1.8	2.3	.012	.009	.015	.019	.034	.043	.067
Aver.	1.5	1.9	2.0	2.3	2.6	2.6	.021	.017	.023	.035	.055	.075	.081
	8	10	10	10	10	6	6	11	19	22	21	20	6

Specimen	Tunnel angle					Septal count					Pl.	fig.
	1	2	3	4	5	1	2	3	4	5		
1*	22	24	33	45							10	9
2	21	22	30	33	46						10	1
3	—	32	38	52							10	2
4	24	30	40	42	53						10	3
5	26	31	39								10	4
6						9	16	19	22	24	10	5
7						10	21	22	23	26	10	6
Max.	33	32	40	52	53	10	21	23	24	26		
Min.	21	22	33	33	38	6	12	16	18	24		
Aver.	24	29	36	41	45	8	17	20	24	25		
	5	8	8	7	4	5	5	4	4	3		

* The statistics of the specimen 1 is excluded from the averages.

All the characteristics observed in the present materials are well in accord with those of the OZAWA's type specimen (II-37 in the OZAWA's collection).

Occurrence.—Except the OZAWA's report from the Akiyoshi limestone, *Triticites haydeni* (OZAWA) has never been reported in this country.

My collection of *T. haydeni* (OZAWA) was gathered from the following localities: Nos. 5, 8, and 9 limestones of Section III (Loc. 540, 543, and 543A, respectively), No. 1 limestone of Section XIII (Loc. 570), No. 4 limestone of Section XIV (Loc. 103), and Loc. 15.

Triticites biconica TORIYAMA, n. sp.

Pl. 10, figs. 10–25

The shell of *Triticites biconica* TORIYAMA, n. sp. is inflated fusiform in shape and is rather small for the genus, with almost straight axis of coiling, convex lateral slopes, and bluntly pointed poles. The number of the volution is usually 5 or 6, rarely 7 in some specimens. The shell of five to six volutions is 3.2 to 4.4 mm long and 1.1 to 2.3 mm wide, giving form ratios of 1.6 to 2.2. The first one or two volutions are subspherical to short ellipsoidal in shape. As the shell grows the axis of coiling becomes only slighty extended, resulting in almost the same form ratio from the third volution to maturity. Average ratios of the half length to the radius vector of the first to sixth volution in twelve specimens are 1.3, 1.8, 1.9, 2.0, 2.0, and 1.9, respectively.

The proloculus is small and spherical in shape, having an outside diameter of 82 to 196 microns and averaging 136 microns in thirty-two specimens. The shell is tightly coiled in the first two volutions but rapidly and uniformly expands from the third volution to maturity. Average radius vectors in the first to sixth volution of thirty-two specimens are 112, 177, 291, 489, 765, and 1,035 microns, respectively. The chambers are almost uniform in height and increase only slightly toward the polar area.

The spirotheca is typical for the genus, consisting of a tectum and rather a coarsely alveolar keriotheca. In the first one and a half to two volutions of some specimens alveoli of the keriotheca are hardly distinguished. Average thickness of the spirotheca in the first to seventh volution of twenty-six specimens is 16, 19, 30, 49, 70, 67, and 81 microns, respectively. The proloculus wall is seemingly composed of a single homogeneous layer, averaging 20 microns in thickness in ten specimens.

The septa are rather thick and moderately spaced. They are composed of the downward deflection of the tectum and the thick pycnotheca, the latter of which is, however, very obscure or hard to observe. The septal fluting is very weak in the tunnel area where it is mainly confined to the lower parts of the chambers.

Table 38. Table of Measurements (in Millimeters) of *Triticites biconica* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1	571A	811	10	10	3.70	1.93	1.9	.104	.107	.175	.273	.448	.736	1.067	
2	540	767	10	11	3.90	2.05	1.9	.121	.110	.163	.276	.460	.810	1.135	
3*	540	777	10	12	4.4+	2.35+	1.9	.112	.087	.122	.187	.300	.520	.860	1.170
4	540	769	10	13	3.88	2.0+	1.9	.172	.123	.210	.309	.520	.780	.98?	
5	540	773	10	14	3.83	2.08	1.8	.165	.132	.181	.291	.462	.781	1.101	
6	543A	1160	10	15	3.16	1.67	1.9	.095	.082	.130	.242	.480	.981		
7	540A	784	10	16	3.45	1.63	2.1	.093	.078	.120	.201	.360	.710		
8	540A	785	10	20	×	2.05	×	.176	.139	.249	.428	.767	1.029		
9	540	767	10	21	×	2.38+	×	.140	.139	.211	.320	.582	.951	1.260	
10	571A	813	10	22	×	2.18	×	.128	.101	.173	.307	.484	.831	1.160	
11	540A	786	10	23	×	2.22	×	.122	.131	.219	.360	.609	1.010		
12	540A	785	10	24	×	2.0+	×	.082	.074	.135	.284	.580	.990		
						Max.		.196	.153	.249	.475	.860	1.160	1.260	1.230
						Min.		.082	.074	.120	.187	.300	.520	.860	1.170
						Aver.		.136	.112	.177	.291	.489	.765	1.035	1.200
								32	31	32	32	32	30	16	2

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
1	1.8	1.9	2.1	2.3	1.9	1.8		—	—	.025	—	.055	.088	—	
2	1.5	1.8	1.8	1.7	1.6	1.8		—	—	.017	.031	.051	.073	.064	
3*	—	1.4	1.7	1.6	1.9	1.9	1.9	.015	—	.011	.019	.021	.045	.061	.067
4	1.0	1.1	1.3	1.5	1.4	2.0		.022	.020	.025	.041	.047	.066		
5	1.0	—	1.4	1.5	1.5	1.8		.021	.014	.017	.040	.080	.092	.087	
6	1.3	—	—	2.5	1.7			—	—	.012	.022	.052	.097		
7	1.2	1.8	2.4	2.7	2.4			—	—	.011	.016	.033	.039		
8								.027	—	.026	.036	.073	.065		
9								.027	—	.028	.037	.058	.070	.061	
10								—	.011	.016	.028	.043	.094	.063	
11								—	.011	.018	.028	.057	.074		
12								—	.014	.020	.031	.041	.063		
Max.	1.9	2.2	2.5	2.9	2.8	2.3		.027	.020	.028	.048	.072	.097	.087	
Min.	1.0	1.1	1.3	1.5	1.4	1.8		.013	.010	.009	.014	.021	.037	.052	
Aver.	1.3	1.8	1.9	2.0	2.0	1.9	1.9	.020	.016	.019	.030	.049	.070	.067	.081
	9	9	11	12	11	8	1	10	12	24	24	26	24	11	2

Specimen	Tunnel angle 1	2	3	4	5	6	7	Septal count 1	2	3	4	5	6
1	—	26	—	26	41	50?							
2	—	20	20	24	33	32							
3*	—	—	21	23	30	38	40						
4	—	21	32	32	34								
5	—	22	23	29	32								
6	—	25	30	33									
7	—	30?	32	31									
8								7	14	15	19		
9								7	13	18	22	23	25
10								7	12	15	21	23	29
11								—	12?	17	19	23	
12								6	13	14	18	23	
Max.		30	32	33	42	50		8	17	20	22	23	29
Min.		18	21	23	30	32		6	10	13	16	17	25
Aver.	19	24	26	28	36	40	40	7	13	16	19	21	28
	1	8	8	9	7	3	1	9	11	9	8	7	3

* Holotype specimen

In some specimens the septa are almost plane in the middle portion of the shell. In the polar areas of most specimens the septal fluting is well defined. Average septal counts in the first to sixth volution of eleven specimens are 7, 13, 16, 19, 21, and 28, respectively.

The tunnel is narrow in the inner four volutions, increasing in width more or less rapidly beyond the fifth volution. Average tunnel angles in the second to sixth volution of nine specimens are 24, 26, 28, 36, and 40 degrees, respectively. The chomata are well defined throughout all except the last volution of some specimen. They are asymmetrical in cross section. The tunnel side slopes are steep or even overhanging, but the poleward slopes are very gentle, extending to near the poles in the inner volutions.

Remarks.—The above description is based on numerous specimens obtained from Nos. 4, 5, and 9 limestones of Section III along the eastern slope of Managatake in the northeastern corner of the Akiyoshi plateau.

Triticites biconica n. sp. most closely resembles *T. kawanoboriensis* HUZIMOTO from the Lower Permian limestone of Kawanobori-mura, Oita Prefecture, Southern Kyushu. The latter species was set up by HUZIMOTO (1937) for the forms which had long been erroneously identified with *Alveolina montipara* EHRENBERG by MÖLLER and the subsequent workers since 1874. However HUZIMOTO's original specimens from Kawanobori-mura are not enough for detailed comparison, and he did not designate the holotype. The size of the proloculus, the thickness of the spirotheca, and the numbers of the septa of *Triticites biconica* n. sp. resemble those of *T. kawanoboriensis*, but distinguished from the latter by its more inflated shell, tightly coiled inner volutions, and more massive chomata. The shell of *T. kawanoboriensis* seemingly is more slender in shape, because axial sections illustrated by HUZIMOTO (figs. 1 and 3 of Pl. VII) are not well oriented. Both the species are, at any rate, very closely allied with each other, if not conspecific.

Among the American species of *Triticites*, *T. confertus* THOMPSON from Texas and Kansas is similar to the present species in some respects, but can be distinguished by larger proloculus, less numerous volution, more rapid expansion of the shell and less massive chomata of the present species.

Occurrence.—Triticites biconica TORIYAMA, n. sp. is abundant in the Plα and Plβ subzones of the Akiyoshi limestone group and seemingly ranges up into the lower part of the Plγ subzone. It was collected from the following localities: Nos. 4, 5, and 9 limestones of Section III (Loc. 540A, 540, and 543A, respectively), No. 4 limestone of Section XIII (Loc. 571A), and Loc. 445 and 619.

Triticites obai TORIYAMA, n. sp.

Pl. 11, figs. 1–7

The shell of *Triticites obai* TORIYAMA, n. sp. is typical fusiform, with bluntly pointed poles, convex to almost straight lateral slopes, and straight axis of coiling. Mature shells of five to six volutions are 3.4 to 4.7 mm long and 1.3 to 2.3 mm wide, giving form ratios of 2.0 to 2.7. The shell is subspherical to ellipsoidal in the early stage of the growth and the axis of coiling becomes gradually extended as the shell grows. Average ratios of the half length to the radius vector of the first to sixth volution in twelve specimens are 1.4, 1.9, 2.0, 2.2, 2.3, and 2.3, and 2.3, respectively.

The proloculus is spherical and minute, with outside diameters of 108 to 192 microns, averaging 158 microns in twenty-eight specimens. The shell expands considerably slowly in the first two volutions but in the succeeding ones the rate of expansion becomes rapid and almost uniform. Average radius vectors of the first to sixth volution for twenty-eight specimens are 120, 189, 303, 465, 693, and 985 microns, respectively. The chambers are nearly uniform in height except in the extreme polar ends where they become slightly higher.

The spirotheca is thin and finely alveolar. Alveoli are hardly observable in the inner volutions of most specimens. Average thickness of the spirotheca in the first to sixth volution for nineteen specimens is 16, 20, 29, 45, 60, and 68 microns, respectively. The proloculus wall is also thin, seemingly consisting of a structureless single layer. Although it is difficult to measure its thickness exactly, average thickness of the proloculus wall of six specimens is 15 microns.

The septa are rather thick and closely spaced, the base of which is composed of the pycnotheca and the short downward deflection of the keriotheca. Average septal counts of the first to sixth volution in eight specimens are 9, 14, 18, 20, 23, and 26, respectively. In one specimen the seventh volution has 29 septa. The septal fluting is strong for the genus. It extends to the tops of the chambers in the polar regions but is confined to the lower half of the septa in the central portion of the shell where closed chamberlets are formed about or a little more than half as high as the chambers. The septa are almost plane at the tops of the chambers above the tunnel.

The tunnel is low and narrow in the inner volutions and becomes gradually wide in the outer ones. It path is almost straight in most if not all of the specimens. Average tunnel angles of the first to sixth volution of twelve specimens are 26, 25, 28, 31, 36, and 44 degrees, respectively. The chomata are asymmetrical in cross section in the earlier volutions but symmetrical or slightly irregular in the outer ones. They do not present in the last volution of some specimens.

Table 39. Table of Measurements (in Millimeters) of *Triticites obai* TORIYAMA, n. sp.

Speci-men	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1*	343	690	4.29	1.82	2.4	.160	.132	.202	.304	.475	.712	.987	
2	343	689	4.13	1.84	2.3	.161	.138	.202	.322	.491	.736	.996	
3	343	688	3.75	1.72	2.2	.140	.120	.166	.276	.392	.653	.890	
4	343	690	4.61	2.25	2.1	.158	.150	.236	.353	.522	.810	1.098	
5	343	694	×	2.0±	×	.147	.126	.208	.350	.490	.681	.935	
6	343	690	×	2.16	×	.125	.107	.169	.294	.460	.660	.980	1.200
7	343	697	×	2.05	×	.174/.234 ×	.184	.276	.414	.598	.880	1.208	
						Max. .192	.153	.276	.414	.598	.880	1.208	
						Min. .108	.100	.153	.254	.392	.600	.840	
						Aver. .158	.120	.189	.303	.465	.693	.985	
						28	28	28	28	28	25	13	

Speci-men	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6	7
1*	1.4	1.8	1.9	2.0	2.0	2.3	—	—	—	—	.046	.056	.064	
2	1.6	1.5	1.7	1.9	1.8	2.2	—	—	—	.022	.051	.077	.066	
3	1.2	1.5	1.6	1.8	1.7	2.1	.012	.020	.027	.048	.072	.052		
4	2.2	2.2	2.2	2.5	2.5	2.2	—	.017	.019	.030	.065	.077	.084	
5							—	.016	.021	.030	.032	.062	.059	
6							—	—	.015	.027	.046	.048	.066	.056
7							.011	.017	.018	.034	.047	.094	.079	
Max.	2.2	2.8	3.0	2.6	2.9	2.8	.019	.020	.027	.048	.072	.077	.084	
Min.	1.2	1.5	1.6	1.8	1.7	2.1	.011	.011	.015	.019	.032	.036	.059	
Aver.	1.4	1.9	2.0	2.2	2.3	2.3	.015	.016	.020	.029	.045	.060	.068	
	9	10	10	10	12	5	6	8	15	19	19	17	9	

Speci-men	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5	6	7	Pl.	fig.
1*	—	25	30	32	36	54?								11	1
2	—	18	25	28	37	32								11	2
3	—	34	30	28	36	42								11	3
4	26	23	31	33	43									11	4
5							8	14	17?	23?	25?	26?		11	5
6							9	12	17	17	20?	27?	29?	11	6
7							9	14	22	21	21	26		11	7
Max.	26	34	31	34	43	54	9	16	22	23	25	27			
Min.	25	16	21	27	31	32	7	12	17	17	20	26			
Aver.	26	25	28	31	36	44	9	14	18	20	23	26			
	2	11	11	12	9	4	7	8	8	8	4	3			

* Holotype specimen.

Remarks.—*Triticites obai* TORIYAMA, n. sp. somewhat resembles *T. paraarcticus* RAUSER-CERNOUSSOVA from Samara Bend but differs from the latter in having smaller size and less elongate form of the shell, weaker septal fluting, and more distinct chomata.

T. obai n. sp. also resembles *T. parvula* (SCHELLWIEN) in some respects. SCHELLWIEN gave a very brief description and illustrated only two specimens of that form from which sufficient information is not available for the specific comparison. However, *T. parvula* seemingly is more slender in form, and its chomata are less distinct, especially so in the outer volutions. The present specimens are almost identical with a part of *Schellwienia subobsoleta* OZAWA (1925, Pl. V, fig. 2), which was later referred by HUZIMOTO (1936) to *Pseudofusulina parvula*.

T. obai n. sp. is somewhat similar to *T. victorioensis* DUNBAR and SKINNER from Texas in some features, but they are easily separable by the following differences: *T. victorioensis* is more slender in form and has more numerous volutions at maturity. It has also much more massive and distinct chomata throughout the growth of the shell.

The name of this species is dedicated to Mr. Seiu OBA of Akiyoshi, Shuho-cho, who kindly helped me during my field work.

Occurrence.—Triticites obai TORIYAMA, n. sp. is one of the characteristic species in the Plα subzone, but ranges upward into the overlying subzone although its occurrence becomes rather rare. The following localities are known: Nos. 4 and 5 limestones of Section III (Loc. 540A and Loc. 540, respectively), No. 3 limestone of Section XII (Loc. 607), No. 2 limestone of Section XX (Loc. 343), No. 3 limestone of Section XXII (Loc. 331), No. 3 limestone of Section XXIV (Loc. 550A), No. 5 limestone of Section XXVII (Loc. 791), and Loc. 368.

Triticites kawanoboriensis HUZIMOTO

Pl. 11, figs. 8–13

1937. *Triticites kawanoboriensis* HUZIMOTO. Japan. Jour. Geol. Geogr., Vol. XVII, pp. 118, 119, Pl. VII, figs. 1–7.

HUZIMOTO (1937) established *Triticites kawanoboriensis* for forms which had long been misidentified by MÖLLER and later workers to *Alveolina montipara* EHRENBERG. The latter is, as discussed in some detail by DUNBAR and SKINNER (1936), not a species of *Triticites* but belongs to the genus *Schwagerina*.

Although HUZIMOTO's original specimens are insufficient for the precise comparison and not well oriented, I have obtained a considerable number of forms which are referred to *T. kawanoboriensis* HUZIMOTO. The following description is entirely based on my collection from the Akiyoshi limestone group.

The shell of *Triticites kawanoboriensis* HUZIMOTO is of medium size for the genus and is inflated fusiform in shape, with convex to slightly irregular lateral slopes, nearly straight axis of coiling, and narrowly rounded poles. Mature shells of five to six volutions are 4.2 to 5.2 mm long and 1.8 to 2.4 mm wide, giving form ratios of 1.8 to 2.4. The shell gradually increases in relative length from the first volution of subspherical to ellipsoidal shape to the last one of inflated fusiform. Average ratios of the half length to the radius vector of the first to sixth volution in seven specimens are 1.5, 1.7, 1.7, 1.8, 2.0, and 1.8, respectively.

The proloculus is of medium size for the sell of this size, with outside diameters of 104 to 220 microns, averaging 156 microns for fifteen specimens. The rate of the growth is slow in the first two volutions but becomes rapid from the third volution and slightly decreases again in the last volution of some specimens. Average radius vectors of the first to sixth volution for eighteen specimens are 131, 224, 374, 593, 766, and 1,070 microns, respectively. The chambers are nearly the same in height almost throughout the length of the inner volutions and in the central half of the outer ones but gradually increase in height towards the palar ends in the outer volutions.

The spirotheca is typical for the genus, consisting of a tectum and a coarsely alveolar keriotheca. In the inner one or two volutions, however, minute structure of the spirotheca cannot be seen as well as in the proloculus wall which seems to be structureless. Average thickness of the spirotheca of the first to sixth volution in fifteen specimens is 17, 30, 54, 57, 74, and 83 microns, respectively. The proloculus wall is 12 to 20 microns in thickness, averaging 17 microns in six specimens.

The septa are relatively thin and moderately spaced. Average septal counts of the first to fifth volution of six specimens are 8, 14, 17, 21, and 23, respectively. The pycnotheca is hardly discernible in the inner volutions but distinctly developed in the outer ones. The septa are nearly plane or slightly fluted in the equatorial zone of the shell where the fluting is restricted to the lower margins of the septa. They are, however, fluted throughout most of their height in the polar regions.

The tunnel is narrow in the inner three to four volutions and becomes more or less broad in the outer ones. Its path is almost straight throughout the shell. Averages of the tunnel angles in the second to fifth volution of four specimens are 27, 36, 34, and 33 degrees, respectively. The chomata are well developed throughout most of the shell except in the ultimate volution of some specimens. They are highly asymmetrical in inner two volutions but become less asymmetrical in the outer volutions where they are about half as high as the chambers.

Remarks.—Although HUZIMOTO proposed a new specific name *Triticites kawanoboriensis* for the forms referred to "*Fusulina montipara*" by MÖLLER and the subsequent authors, and for his form collected from Kawanobori-mura*, Kyushu,

* Combined with the adjoining villages, Kawanobori-mura was raised to Notsu-machi, Onogun by the law stated in the foot-notes of page 12.

Table 40. Table of Measurements (in Millimeters) of *Triticites kawanoboriensis* HUZIMOTO

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1	570	1202	5.2+	2.19	2.4	.12?	.130	.191	.290	.501	.840	
2	103	101	5.7±	2.25	2.5	.160	.111	.200	.302	.471	.700	1.001
3	473	736	4.2+	2.23	1.9+	.192	.190	.306	.480	.791	1.11+	
4	570	1206	×	1.80	×	.149	.121	.175	.290	.480	.775	
5	570	1207	×	2.07	×	.146	.139	.280	.461	.719	1.130	
6	570	1207	×	1.84	×	.192	.180	.289	.510	.830		
				Max.		.220	.190	.307	.543	.830	1.130	1.260
				Min.		.104	.070	.142	.228	.380	.564	.920
				Aver.		.156	.131	.224	.374	.593	.766	1.070
						15	18	18	18	18	15	9

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6
1	—	—	1.6	1.8	2.0		—	—	—	.025	.040	.052	.092
2	—	—	1.9	2.0	2.1		.019	—	.028	.038	.052	.066	.085
3	—	1.4	1.8	1.8	1.9		—	.018	.030	.054	.089		
4							.012	—	.018	.033	.051	.082	
5							—	.019	.033	.046	.047	.101	
6							.020	.018	.025	.057	.075		
Max.	1.6	2.2	2.0	2.0	2.2	1.9	.020	.019	.041	.057	.075	·101	.106
Min.	1.5	1.4	1.5	1.5	1.8	1.7	.012	.014	.018	.025	.040	.050	.067
Aver.	1.5	1.7	1.7	1.8	2.0	1.8	.017	.017	.030	.054	.057	.074	.083
	2	5	7	7	6	2	6	8	14	15	15	12	8

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5	Pl.	fig.
1	—	—	37	34	35						11	8
2	—	—	36	35	35						11	9
3	28	30	45	34							11	10
4						7	13	13	17	18	11	11
5						7	15	19	24	29	11	12
6						—	14	20	23		11	13
Max.	—	30	45	35	35	9	15	20	24	29		
Min.	—	24	24	34	30	7	12	13	17	18		
Aver.	28	27	36	34	33	8	14	17	21	23		
	1	2	4	3	3	5	6	6	5	3		

his specimens seemingly are neither conspecific with *Fusulina montipara* MÖLLER nor with *Schellwienia montipara* OZAWA. It seems, therefore, better to restrict the name "*kawanoboriensis*" to only the form collected from Kawanobori-mura.

The Akiyoshi specimens of *kawanoboriensis* well agree with those of Kawanobori-mura in all the essential characters.

As HUZIMOTO did not designate the holotype specimen in his original description of the species I here designate Pl. VII, fig. 2 as the lectotype of this species, although it is not a fully grown shell.

Occurrence.—Triticites kawanoboriensis HUZIMOTO is common in the No. 1 limestone of Section XIII (Loc. 570) and Loc. 334 and 453. It also occurs in No. 4 limestone of Section XIV (Loc. 103), although it is very rare. The stratigraphical range of this species is restricted to the Plα and Plβ subzones, and it is more common in the latter.

Triticites arctica (SCHELLWIEN)

Pl. 11, figs. 14–25

1908. *Fusulina arctica* SCHELLWIEN. Palaeontographica Bd. LV, p. 173, Pl. XVI, figs. 3–9.
1910. *Fusulina arctica* STAFF u. WEDEKIND. Upsala Univ. Geol. Inst., Bull. Vol. 10, Nos. 19–20, pp. 115–118, figs. 4–6.
1927. *Schellwienia arctica* LEE. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 1, pp. 52–55, Pl. VIII, figs. 1–7.
1937. *Schwagerina arctica* LEE. Geol. Soc. China, Bull., Vol. XVI, pp. 96, 97 [Not illustrated].
1938. *Triticites arcticus* RAUSER-CERNOUSSOVA. Travaux l'Institut géologique Acad. Sci. U. S. S. R., Tome VII, pp. 115, 116, Pl. IV, figs. 5, 6.

The shell of *Triticites arctica* (SCHELLWIEN) is small and fusiform, with pointed polar ends, convex to slightly irregular lateral slopes at maturity and almost straight axis of coiling. Mature specimens of four and a half to six volutions attain 3.3 to 4.8 mm in length and 1.5 to 2.1 mm in width, giving form ratios of 2.2 to 3.0. The first volution is spherical to subspherical in shape, but in the succeeding ones the axis of coiling becomes rapidly extended. The average ratios of the half length to the radius vectors of the first to fifth volution in five specimens are 1.4, 1.8, 2.2, 2.5, and 2.5, respectively.

The proloculus is small but is medium in relative size for this size of the shell. It is spherical in shape, having outside diameters of 166 to 240 microns and averaging 206 microns in twenty specimens. The shell increases in width slowely in the inner one to one and a half volutions and then becomes rapidly expanded, but reduced again in the last volution. Averages of radius vectors of the first to sixth volution in twenty specimens are 173, 285, 437, 652, 958, and 1,140 microns, respectively. The chambers are uniform in height in central half of the shell but increase in height toward the polar ends of the outer volutions.

The spirotheca is typical for the genus, consisting of a tectum and rather a finely alveolar keriotheca. It increases in thickness moderately throughout the growth of the shell. Averages of the thickness in the first to sixth volution of fourteen specimens are 20, 32, 46, 64, 76, and 84 microns, respectively. The proloculus wall is thin, the minute structure of which is hardly observable. The thickness in six specimens averages approximately 19 microns.

The septa are thin and composed of thin pycnotheca. They are strongly fluted

Table 41. Table of Measurements (in Millimeters) of *Triticites arctica* (SCHELLWIEN)

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1	257	615	4.45	1.70	2.6	.200	.189	.300	.441	.630	1.05?	
2	298	647	4.3+	1.7+	2.5	.205	.152	.241	.370	.560	.851	
3	480	1107	4.82	1.88	2.6	.226	.215	.356	.552	.81?		
4	273	1037	4.1+	1.50	2.7	.250	.191	.310	.519	.720		
5	318	1050	4.70	1.57	3.0	.201	.170	.285	.401	.723		
6	258	618	×	2.28	×	.206	.165	.311	.470	.680	.961	1.290
7	299	650	×	1.9+	×	.218 .240 ×	.210	.369	.550	.810	1.100	
8	258	618	×	1.60	×	.206	.165	.291	.420	.610	.810	
9	273	1041	×	1.97	×	.167	.190	.260	.400	.600	.901	
					Max.	.240	.215	.370	.552	.810	1.100	1.320
					Min.	.166	.125	.200	.310	.410	.701	.810
					Aver.	.206	.173	.285	.437	.652	.958	1.140
						20	20	20	20	20	11	3

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	Thickness of spirotheca 0	1	2	3	4	5	6
1	1.0	1.5	2.4	2.6	2.3	.019	.023	.042	.047	.061		
2	1.7	1.8	2.0	2.3	2.6	.015	.015	.033	.042	.056	.075	
3	—	—	—	2.6	2.8	—	.019	.034	.039		.107	
4	1.4	2.1	2.4	2.8		.020	.023	.028	.066	.056		
5	—	1.9	2.3	1.9		—	.025	.039	.045	.055	.105	
6						—	.014	—	.047	.066	.075	.061
7						.026	.024	.034	.052	.066	.089	
8						.012	.019	.037	.052	.075	.070	
9						—	.014	.028	.040	.047	.061	
Max.	1.7	2.1	2.4	2.8	2.8	.026	.025	.042	.066	.097	.107	.098
Min.	1.0	1.5	1.8	1.9	2.2	.012	.014	.019	.028	.047	.061	.061
Aver.	1.4	1.8	2.2	2.5	2.5	.019	.020	.032	.046	.064	.076	.084
	4	5	5	5	4	6	11	12	14	13	9	3

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5	6	Pl.	fig.
1	22	27	32	30								11	14
2	—	24	20	22	26							11	15
3	26	26	21	22								11	16
4	—	28	40	48								11	17
5	32	32	31									11	18
6						5?	13?	21	22	26	28	11	21
7						8	12	18	24	25		11	22
8						8	13	16	18			11	23
9						7?	12?	19?	19	23		11	25
Max.	32	32	40	48	35	11	17	25	30	26	28		
Min.	22	21	20	22	26	5?	12	16	18	23	28		
Aver.	26	26	28	32	30	8	14	19	23	25	28		
	4	6	6	6	3	7	7	7	7	4	2		

in the extreme polar regions, but toward the center of shell the fluting becomes restricted to the base of the septa and almost plane above the tunnel. Average septal counts of the first to sixth volution in seven specimens are 8, 14, 19, 23, 25, and 28, respectively.

The tunnel is low and narrow in the first one or two volutions and becomes wide in the succeeding ones. Average tunnel angles of the first to fifth volution in four specimens are 26, 26, 28, 32, and 30 degrees, respectively. The chomata are present throughout the growth except for the last volution of some specimens. They are low and highly asymmetrical in the inner volutions, with steep to almost vertical tunnel sides and gentle poleward slopes, but in the outer volutions they are nearly symmetrical, being semi-circular shape in cross section.

Remarks.—In his original description of "*Fusulina arctica,*" SCHELLWIEN distinguished the megalospheric form (Pl. XVI, figs. 3, 4, 5, and 9) and the microspheric form (Pl. XVI, figs. 6, 7, and 8). They seem, however, not to be the representatives in the dimorphism, but are only showing variation among individuals, because, as discussed by DUNBAR, SKINNER and KING (1935), microspheric form of a species of fusulinid has much smaller proloculus of a different order, more numerous volutions in juvenarium, and is very rare in occurrence.

The Akiyoshi specimens considerably well agree with SCHELLWIEN's "microspheric" form, except for having smaller proloculus. Moreover, they mostly well agree with *T. arctica* described by RAUSER-CERNOUSSOVA (1938) from the I_1 horizon (seemingly Lower Permian) of Samara Bend in all the essential characters.

LEE (1927) described this species from the Yaoku and Kushi limestones of Shansi, North China. However, as discussed by him in detail, the Chinese form has thicker shell, stronger septal folding and very heavy axial fillings in the inner volutions and no chomata throughout the shell, and is not conspecific with the Spitzbergen's original form.

LEE intended, therefore, to propose a new specific name "*sinoarctica*" for his Chinese form, although he did not do so because of insufficiency of his materials. The Akiyoshi specimens are seemingly not conspecific with the Chinese form.

Occurrence.—*Triticites arctica* (SCHELLWIEN) is common in the Plα and Plβ subzones, and has been found in the following localities: No. 16 limestone of Section I (Loc. 298), No. 1 limestone of Section VIII (Loc. 318), No. 5 limestone of Section XVIII (Loc. 313), Nos. 1 and 2 limestones of Section XXI (Loc. 257 and 258, respectively), No. 5 limestone of Section XXIII (Loc. 273), and Loc. 299 and 480.

Triticites kuroiwaensis TORIYAMA, n. sp.

Pl. 12, figs. 1–12

Triticites kuroiwaensis TORIYAMA, n. sp. has a small inflated fusiform shell of four to six and a half volutions which is 1.9 to 4.0 mm long and 1.0 to 2.1 mm wide, giving form ratios of 1.5 to 2.1. It has almost straight to uniformly convex lateral slope, straight axis of coiling and the bluntly pointed poles. The general shape of the shell remains closely similar throughout its growth except for the first volution which is subspherical in shape. Average ratios of the half length to the radius vector of the first to sixth volution in eighteen specimens are 1.5, 1.7, 1.8, 1.9, 1.9, and 2.1, respectively.

The proloculus is small, but is medium for the size of the shell. Its outside diameter ranges from 124 to 246 microns, averaging 178 microns for fifty specimens. The shell expands considerably slowly in the first two to two and a half volutions, but rather rapidly in the succeeding outer ones. Average radius vectors of the first to sixth volution for fifty-three specimens are 148, 238, 352, 559, 789, and 1,020 microns, respectively. The chambers are about the same in height across the central two-thirds of the shell and become slightly higher in the polar regions.

The spirotheca is very thin in the early stage of the growth but increases in thickness rapidly toward maturity. It is rather coarsely alveolar, alveoli of which are distinct in the outer volutions but obscure or hardly observable in the inner ones. Averages of the thickness in the first to sixth volution for thirty-six specimens are 18, 23, 42, 58, 71, and 78 microns, respectively. The proloculus wall is also very thin, consisting of a single homogeneous layer. The thickness of the proloculus wall averages 16 microns in twenty-five specimens.

The septa are thin and rather closely spaced. They are fluted almost throughout their length. The fluting extends completely to the tops of the septa in the polar ends and is slightly developed in the middle portion of the shell. Distinct pycnotheca can be observable in the outer volutions. Average septal counts of the first to fifth volution in seventeen specimens are 9, 14, 18, 19, and 23, respectively.

The tunnel is narrow in the inner volutions and becomes very slightly wide in the outer ones. It is about half or slightly less than half as high as the chambers. The tunnel angles in the first to fifth volution of sixteen specimens average 26, 28, 28, 29, and 37 degrees, respectively. The chomata are developed throughout the growth except in the ultimate volution of most specimens. They have steep to almost vertical tunnel sides and much lower poleward slopes. Immediately adjacent to the tunnel of the inner two volutions, the secondary deposits extend up the septa and along the lower surface of the spirotheca so as to leave only small semi-circular lateral openings at the top of the chambers.

Table 42. Table of Measurements (in Millimeters) of *Triticites kuroiwaensis* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1*	262	624	3.95	1.96	2.1	.180	.151	.258	.409	.591	.890	1.070
2	551	1194	4.3?	1.9?	2.3?	.197	.141	.257	.424	.668	.935	
3	273	1037	3.82	1.80	2.1	—	.189	.260	.440	.698	.998	
4	607A	1211	—	1.70	—	.172	.150	.241	.391	.601	.832	
5	570A	803	2.63	1.38	1.9	.140?	—	.231	.320	.550	.771	
6	262	625	2.57	1.31	2.0	.190	.165	.257	.380	.586		
7	456	1088	1.88	1.11	1.6	.180	.147	.245	.362	.506		
8	262	621	×	1.20	×	.160	.151	.241	.360	.560		
9	262	622	×	1.71	×	.160 .150 ×	.122	.191	.295	.481	.742	.930
10	570	1203	×	1.94	×	.134	.130	.219	.359	.550	.850	1.092
11	570	1203	×	1.58	×	.167	.121	.249	.390	.598	.92?	
12	262	630	×	1.35	×	.196	.150	.261	.454	.696		
					Max.	.246	.240	.380	.540	.800	.989	1.210
					Min.	.124	.091	.140	.233	.370	.551	.780
					Aver.	.178	.148	.238	.352	.559	.789	1.020
						50	52	52	53	52	37	12

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6
1*	2.2	1.8	2.0	2.5	2.2		.015	—	—	.030	—	.061	
2	2.3	2.4	2.7	2.4	2.1		—	—	.027	.049	.065	.059	
3	1.2	1.6	1.7	1.9	2.0		—	.024	.037	.065	.075	.094	
4	—	—	—	—	—		.015	.018	.018	.051	.072	.049	
5	1.3	2.2	1.9	1.9	1.7		—	—	.016	.022	.039		
6	1.3	1.4	1.7	1.7			—	.017	.021	.032	.065		
7	1.4	1.4	1.6	1.5			.012	—	—	.042			
8							—	.012	.019	.028	.047		
9							.014	.016	.019	.037	.066	.085	
10							.014	—	.028	.047	.054	.105	
11							.015	.016	.027	—	.064	.065	
12							—	.017	.019	.049	.059		
Max.	2.4	2.4	2.7	2.5	2.2	2.1	.020	.033	.057	.065	.080	.105	.107
Min.	1.0	1.2	1.3	1.5	1.6	2.0	.012	.011	.015	.022	.032	.048	.054
Aver.	1.5	1.7	1.8	1.9	1.9	2.1	.016	.018	.023	.042	.058	.071	.078
	14	17	18	17	12	2	25	26	35	36	34	28	8

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5	6	Pl.	fig.
1*	27	22	23	22								12	1
2	—	25	31	27	29							12	2
3	—	—	31	31	51							12	3
4	—	—	—	—	—							12	4
5	—	—	33	36	48							12	5
6	28	24	34	34								12	6
7	22	—	24	28								12	7
8						10	16	17	19			12	8
9						8	12	15	18	19		12	9
10						—	9	12	17	24		12	10
11						8	13	17	22	23		12	11
12						9	13	15	18			12	12
Max.	28	30	34	36	51	10	19	25	27	25			
Min.	22	20	20	21	29	7	9	12	17	19			
Aver.	26	28	28	29	37	9	14	18	19	23	25		
	7	11	11	16	7	15	17	17	13	6	1		

* Holotype specimen.

Remarks.—The general shell shape, the relative size of the proloculus, and the rate of expansion of *Triticites kuroiwaensis* TORIYAMA, n. sp. resemble those of *T. petschoricus* var. *brevis* RAUSER-CERNOUSSOVA, BELJAEV and REITLINGER from Petschoraland, northern Ural. The former is, however, distinguished from the latter in its more strongly fluted septa and less massive chomata.

Triticites kuroiwaensis n. sp. also resembles *T. obai* TORIYAMA, n. sp. in some respects, but differs from the latter in having more inflated form, smaller proloculus, thicker spirotheca, and more rapid expansion of the shell. However, these two species seem to have close relationship with each other.

Triticites confertus THOMPSON recently described from the Wolfcampian rocks of Colorado, Texas and Kansas is somewhat similar to the species under consideration in the general shell shape and the relative size of the shell, but *T. confertus* has more numerous volutions, relatively thicker spirotheca, less strongly fluted septa and more massive and distinct chomata than those of *T. kuroiwaensis*.

Along with its allied forms, *Triticites kuroiwaensis* n. sp. seemingly is transitional in development between the genera *Triticites* and *Schwagerina* in the stock of the subfamily Schwagerininae.

Occurrence.—*Triticites kuroiwaensis* TORIYAMA, n. sp. is fairly abundant in the basal two subzones, Plα and Plβ of the Permian part of the Akiyoshi limestone group, but more common in the latter. It is found in the following localities: No. 4 limestone of Section XII (Loc. 607A), Nos. 1 and 2 limestones of Section XIII (Loc. 570 and 570A, respectively), No. 3 limestone of Section XVIII (Loc. 315), No. 5 limestone of Section XXI (Loc. 262), Nos. 2 and 5 limestones of Section XXIII (Loc. 270 and 273, respectively), No. 2 limestone of Section XXIV (Loc. 551), and Loc. 251, 442, and 456.

Triticites ellipsoidalis TORIYAMA, n. sp.

Pl. 12, figs. 13–34

The shell of *Triticites ellipsoidalis* TORIYAMA, n. sp. is of medium size and is ellipsoidal to subcylindrical form, with flat or very slightly depressed median portion, convex lateral slopes and almost straight to very slightly arched axis of coiling. The volution numbers 6 or 7 in most specimens but rarely 8 in some. The specimens of five to seven volutions are 2.5 to 4.2 mm long and 1.0 to 1.7 mm wide, giving a form ratio of 2.0 to 3.8. The first volution is ellipsoidal in shape, and beyond the second volution the axis of coiling becomes extended rather slowly, and the chambers also become inflated rather slowly, resulting in that the form ratio is almost uniform during the growth. Average ratios of the half length to the radius vector of the first to seventh volution for twenty-four specimens are 2.1, 2.6, 2.7, 2.7, 2.8, 2.6, and 2.4, respectively.

The proloculus is of medium for the size of the shell. Its outside diameter measures 94 to 214 microns, averaging 140 microns for thirty-three specimens. In some specimens the proloculus is not completely spherical but ellipsoidal in shape. The shell expands slowly and almost uniformly except for the outer two or three volutions where the chambers increase in height considerably rapidly. Average radius vectors of the first to eighth volution for forty-one specimens are 99, 146, 211, 301, 425, 551, 689, and 793 microns, respectively. The chambers are lowest in height in the central portion of the shell, and they increase in height only slightly toward the axial regions of the shell.

The spirotheca is considerably thick in the outer volutions where it is finely alveolar. However, it is too thin to measure accurately in the inner one or two volutions. Average thickness of the spirotheca in the first to seventh volution of thirty-six specimens is 10, 13, 16, 21, 31, 42, and 49 microns, respectively. The proloculus wall of most specimens is also too thin for exact measurements. However, the proloculus wall has an approximate thickness of 6 to 13 microns, averaging 10 microns in twenty specimens.

The septa are moderately thick. The spirotheca seemingly extends downward to form the septa with rapidly diminishing thickness. The septa are almost plane across the middle portion of the shell. They are fluted in the polar regions but

Table 43. Table of Measurements (in Millimeters) of *Triticites ellipsoidalis* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7	8
1*	613	910	12	13	4.23	1.50	2.8	.151	.110	.156	.230	.307	.442	.613	.748	
2	613	920	12	15	3.65	1.18	3.0	.137/.200 ×	.090	.135	.196	.267	.387	.574		
3	613	858	12	16	3.62	1.17	3.1	.163/.205 ×	.109	.163	.229	.321	.460	.611		
4	613	908	12	17	3.81	1.56	2.4	.097/.166 ×	.074	.126	.199	.285	.430	.613	.821	
5	613	870	12	18	3.54	1.01	3.5	.128	.092	.125	.181	.260	.351	.520		
6	613	909	12	19	3.54	1.07?	3.3	.125	.092	.132	.170	.250	.369	.48?		
7	613	897	12	20	4.23	1.17	3.6	—	.086	.141	.209	.289	.410	.610		
8	613	909	12	21	2.47	0.80	3.1	—	—	.113	.172	.249	.335			
9	613	873	12	23	2.90	1.23	2.4	.164	.112	.151	.201	.316	.401	.546	.628	
10	613	906	12	24	×	1.57	×	.105/.129 ×	.095	.144	.211	.294	.418	.589	.791	
11	613	894	12	25	×	1.54	×	.095/.107 ×	.081	.107	.152	.214	.308	.440	.601	.740
12	613	894	12	26	×	1.20	×	.120/.145 ×	.094	.131	.187	.271	.381	.537	.634	
13	613	894	12	27	×	1.34	×	.122/.132 ×	.091	.123	—	.284	.450	.520	.630	
14	613	875	12	28	×	1.18	×	.119	.081	.113	.165	.233	.330	.458	.595	
15	62	1003	12	32	×	1.70	×	.130/.180 ×	.113	.176	.244	.326	.449	.613	.782	
						Max.		.214	.165	.200	.310	.450	.580	.650	.850	.96?
						Min.		.094	.072	.104	.151	.214	.308	.440	.570	.680
						Aver.		.140	.099	.146	.211	.301	.425	.551	.689	.793
								33	38	40	40	41	40	34	20	3

Specimen	Ratio of Hl./Rv.								Thickness of spirotheca								
	1	2	3	4	5	6	7	8	0	1	2	3	4	5	6	7	8
1*	1.4	1.7	1.7	2.1	2.0	2.1	2.6		—	.011	.012	.016	.019	.024	.041	.041	
2	2.8	3.1	3.1	3.3	3.2	2.9			.010	.011	.012	.017	.019	.029	.049		
3	2.0	2.4	2.6	2.6	2.4	2.8			.010	.011	—	.019	.021	.043	.048		
4	2.4	2.4	2.7	2.5	2.3	2.3	2.2		.010	.009	.011	.016	.017	.030	.049	.048	
5	2.4	3.0	2.9	2.9	3.1	2.7	2.9		.010	—	.008	—	.019	.027	.034		
6	2.3	2.9	3.6	3.6	3.3	3.1			.007	.013	.011	.015	.017	.028			
7	—	3.3	3.6	3.6	3.4	3.6			—	—	—	.019	.027	.039	.048		
8	—	—	2.5	2.6	2.9				—	—	.010	.015	.017	.027			
9	1.2	1.5	1.9	1.9	2.1	2.2	2.5		.009	.009	.011	.012	.021	.028	.048		
10									.011	.011	.012	.013	.020	.020	.036	.031	
11									.008	.006	.009	.014	.016	.019	.037	.041	.044
12									.011	—	.013	.016	.019	.030	.043	.029	
13									.006	.012	—	—	.018	.020	.029	.041	
14									.011	.010	.011	—	.016	.027	.034		
15									.013	.011	.014	.016	.016	.035	.069	.071	
Max.	3.0	3.3	3.6	3.7	4.6	3.3	2.9	2.8	.013	.013	.019	.025	.037	.057	.069	.081	
Min.	1.2	1.6	1.7	1.9	1.8	1.9	1.9	2.4	.006	.006	.008	.012	.016	.019	.029	.029	
Aver.	2.1	2.6	2.7	2.7	2.8	2.6	2.4	2.6	.010	.010	.013	.016	.021	.031	.042	.049	
	17	20	24	23	22	19	13	2	20	21	29	31	36	36	29	16	

Specimen	Tunnel angle							Septal count						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1*	24	29	35	40	43	43								
2	24	25	37	37	46	55								
3	—	31	32	33	40	37								
4	—	30	35	32	42	47								
5	—	34	37	39	38	45	44							
6	—	—	35	45	50									
7	—	41	45	44	49									
8	—	31	31	40	47									
9	—	30	38	43	37									
10								7	11	12	14	15	15	16
11								7	11	13	13	15	17	18
12								7	11	13	13	15	18	20
13								6	10	14	16	18	18	20
14								—	11?	14?	14	14	15	20?
15								6	13	14	21	20		
Max.	24	41	45	47	50	55	44	10	13	15	21	20	18	23
Min.	24	25	27	32	35	37	33	6	10	12	13	14	15	16
Aver.	24	32	36	39	43	44	39	7	12	14	16	17	17	20
	2	12	15	16	16	10	2	7	9	10	10	8	6	6

* Holotype specimen.

the closed chamberlets formed by the fluting of the septa do not reach the top of the chamber. Averages of the septal counts of the first to seventh volution of ten specimens are 7, 12, 14, 16, 17, 17, and 20, respectively.

The tunnel is broad. Average tunnel angles of the first to seventh volution of sixteen specimens are 24, 32, 36, 39, 43, 44, and 39 degrees, respectively. The path of the tunnel seemingly is about straight. The chomata are low and narrow, but they are well defined except in the outer one or two volutions. They are about half as high as the chambers in all but the outer volutions. The chomata are semi-circular in cross section, both slopes of which being nearly similar. In some specimens, however, the poleward slope of the chomata is moderately low.

Remarks.—*Triticites ellipsoidalis* TORIYAMA, n. sp. is one of the best index fossil for the Plβ subzone of the Akiyoshi limestone group.

It closely resembles *Triticites langsonensis* described by SAURIN (1950, 1954) from Ky Lua, Langson (Tonkin) in many aspects. However, *T. ellipsoidalis* is smaller in the size of the shell, less slender in the shell length, slower in the rate of the expansion, and thinner in the spirothecal thickness than *T. langsonensis*. Moreover, the former seemingly has slightly stronger septal fluting especially in the polar regions. Although two forms may not be conspecific, they are biologically and stratigraphically closely related with each other.

It also compares closely in ellipsoidal shape of the shell with *Triticites pusilla* (SCHELLWIEN), which was originally described by SCHELLWIEN from the Schwarzekalke of the Uggowitzer Breccie in the Carnic Alps. DUNBAR (1937) and DUNBAR and HENBEST (1942) referred this species to the genus *Schwagerina*. In Eastern Asia *Triticites pusilla* has been reported by LEE (1927) from the Lower Permian Taiyuan series of Honan and Shansi, and by CHEN from the Lower Permian Chuanshan limestone of Chekiang. Comparing with these forms, *Triticites ellipsoidalis* n. sp. is smaller in size and has more numerous volutions, less weakly fluted septa and well defined chomata; and the height of the chambers for the corresponding volution is smaller in the species under consideration.

It is of interest that *Triticites pusilla* and *T. ellipsoidalis* show similar faunal assemblage. They are almost always associated with large forms of *Pseudoschwagerina* or *Paraschwagerina;* namely, *T. pusilla* is associated with *Pseudoschwagerina fusulinoides* (SCHELLWIEN) and *P. princeps* (EHRENBERG) [*P. glomerosa* (SCHWAGER)] both in the Carnic Alps and in South China, while *Triticites ellipsoidalis* n. sp. occurs with *Paraschwagerina* (*Paraschwagerina*) *akiyoshiensis* n. sp. in the Akiyoshi limestone group.

Occurrence.—*Triticites ellipsoidalis* TORIYAMA, n. sp. occurs most abundantly in No. 3 quarry at Isa-machi (Loc. 613); and common in Nos. 1 and 8 limestones of Section XII (Loc. 606 and 611, respectively) and Loc. 497. A doubtful specimen of this species is also known in Loc. 62.

Triticites sp. A

Pl. 12, figs. 35–38

Several specimens of a minute form of *Triticites* were obtained from the limestone of the *Pseudoschwagerina* zone exposed at Isa-machi, which do not seem to be referable to any of the forms hitherto described. Unfortunately, however, I do not have sufficient materials of this form to describe it thoroughly, but for the sake of completeness I illustrate several typical sections and give the following description.

The shell is fusiform and small for the genus. It has pointed poles, convex lateral slopes, and a slightly arched axis of coiling. A typical specimen of four and a half volutions (Pl. 12, fig. 35) is 3.0 mm long and 1.2 mm wide, giving a form ratio of 2.6.

The proloculus is small, and its outside diameter measures 118 to 170 microns, averaging 151 microns for eleven specimens. The shell expands rather slowly in the first one and a half to two volutions, but rapidly in the outer ones. Average radius vectors of the first to fifth volution of eleven specimens are 123, 195, 306, 478, and 696 microns, respectively.

The spirotheca is very thin and difficult to measure its thickness accurately

Table 44. Table of Measurements (in Millimeters) of *Triticites* sp. A

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5
1	570A	798	12	35	3.0+	1.15	2.6	.150	.121	.162	.359	.461	.61+
2	607A	1209	12	36	3.00	1.13	2.6	.151	.107	.171	.251	.410	.628
3	607A	1211	12	37	×	1.30	×	.168	.139	.218	.340	.549	.78+
4	607A	1210	12	38	×	1.48	×	.168	.140	.235	.360	.550	.770
							Max.	.170	.140	.250	.360	.560	.78+
							Min.	.118	.107	.150	.231	.400	.58?
							Aver.	.151	.123	.195	.306	.478	.696
								11	11	11	11	10	6

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	Thickness of spirotheca 0	1	2	3	4	5
1	2.0	2.4	3.7	3.5		.016	.012	.014	.029	.054	
2	0.9	1.4	1.6	2.1	2.2	.014	.013	.019	.035	.037	.055
3						.013	—	.020	.034	.062	.075
4						.011	—	.016	.030	.045	.052
Max.	2.0	2.4	3.7	3.5	2.2	.016	.018	.022	.043	.062	.091
Min.	0.9	1.4	1.6	1.9	2.0	.011	.011	.014	.024	.033	.052
Aver.	1.6	1.9	2.6	2.5	2.1	.014	.014	.018	.031	.048	.068
	5	5	5	4	3	7	6	10	10	8	4

Specimen	Tunnel angle 2	3	4	5	Septal count 1	2	3	4	5
1	—	33	30?	35					
2	28?	29	28	29					
3					7	14	16	19?	22?
4					9	13	14	17	18
Max.	31	42	34	44	9	14	16	19	22
Min.	25	29	28	29	7	12	13	17	18
Aver.	28	33	31	36	8	13	14	18	20
	4	5	3	3	3	3	3	3	2

in the early two volutions. The spirotheca of the outer volutions is typical for the genus and is finely alveolar. Average thickness of the spirotheca of the first to fifth volution of ten specimens is 14, 18, 31, 48, and 68 microns, respectively.

The septa are thin and closely spaced. The septal counts of the first to fifth volution of three specimens average 8, 13, 14, 18, and 20, respectively. The septa are strongly fluted in the polar regions but are weakly or almost plane across the median part of the shell.

The tunnel is almost straight throughout its length. It is narrow in the first two volutions. Average tunnel angles of the second to fifth volution for five specimens are 28, 33, 31, and 36 degrees, respectively. The chomata are low and narrow in the early volutions, but become more or less massive in the outer ones.

Remarks.—Triticites sp. A resembles *T. nitens* DUNBAR and NEWELL from the Wolfcampian of Spillapampa, Bolivia in the minute size of the shell and the character of the septal fluting. However this species has a slightly larger proloculus, more rapid rate of expansion, and more or less slender shape of the shell.

Triticites sp. A also resembles *T. simplex* var. *minuta* (LEE) from the Wolfcampian Yaoku limestone of Kansu and Shansi, but is distinguished from the latter in having slightly larger size and the shape of the shell and the distinct chomata.

Occurrence.—Triticites sp. A is common in No. 4 limestone of Section XII (Loc. 607A), No. 2 limestone of Section XIII (Loc. 570A), No. 2 limestone of Section XX (Loc. 343) and Loc. 15 and 251. The stratigraphical range of this species is the Plα and Plβ.

Genus *Dunbarinella* THOMPSON, 1942

Dunbarinella cervicalis (LEE)

Pl. 13, figs. 1–11

1927. *Schellwienia cervicalis* LEE. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 1, pp. 77, 78, Pl. X, figs. 13–17.

The shell of *Dunbarinella cervicalis* (LEE) is elongate fusiform, with gently convex to almost straight or slightly depressed median portion, straight to convex lateral slopes, and narrowly rounded polar extremities. The number of the volution is usually 5 or 6, rarely 7. Mature specimens of five to six volutions are 4.6 to 6.3 mm in length and 1.9 to 3.0 mm in width, giving form ratios of 2.1 to 2.7. The shell retains nearly the same axial profile throughout all except for the first volution which is subspherical to short fusiform, with bluntly rounded poles. Average ratios of the half length to the radius vector of the first to sixth volution in nine specimens are 2.1, 2.4, 2.8, 2.6, 2.5, and 2.4, respectively.

The proloculus is small and spherical, with outside diameters of 110 to 294 microns, averaging 202 microns for twenty-two specimens. The shell relatively

Table 45. Table of Measurements (in Millimeters) of *Dunbarinella cervicalis* (LEE)

Speci-men	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1	297	1552	13	1	7.6+	2.84	2.7	.176	.138	.254	.395	.632	.954	1.245	1.53?
2	316	1407	13	2	5.00	2.14	2.3	.215	.153	.261	.407	.628	.905	1.226	
3	297	1551	13	3	4.56	2.20	2.1	.219	.166	.251	.386	.586	.855	1.174	
4	297	1552	13	4	—	2.1+	—	.208	.159	.254	.38?	.534	.813	1.120	
5	259	1028	13	5	5.30	2.25	2.4	.16+	.141	.201	.310	.481	.700	1.010	
6	613	867	13	7	×	1.6±	×	.219	.110	.200	.310	.489	.740		
7	296	1404	13	8	×	2.34	×	.211	.188	.269	.409	.589	.810	1.111	
8	316	1408	13	9	×	2.3+	×	.111	.091	.148	.233	.374	.650	.921	1.196
9	316	1407	13	10	×	3.0+	×	.202	.184	.269	.421	.612	.905	1.226	
10	316	1408	13	11	×	3.3+	×	.169	.098	.151	.267	.401	.613	.996	1.300
							Max.	.294	.230	.395	.635	.892	1.226	1.462	1.53?
							Min.	.110	.091	.148	.233	.374	.613	.920	1.196
							Aver.	.202	.162	.268	.426	.658	.952	1.157	1.394
								22	24	24	24	24	20	15	4

Speci-men	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6	7
1	—	—	2.9	3.0	2.5	2.5	—	.015	.021	.029	.049	.051	.058	
2	—	—	—	2.5	2.2	2.1	.018	.018	.022	.036	.067	.069	.072	
3	—	—	2.4	2.1	2.0	1.9	—	.010	.019	.022	.031	.048	.055	
4	—	—	—	—	—	—	—	.018	.019	.027	.035	.043	.054	
5	2.2	—	3.0	2.7	2.8	2.7	—	—	.024	.037	.052	.061	.060	
6							—	—	.030	.043	—	—		
7							—	.021	.028	.038	.056	.061	.085	
8							—	—	—	.030	.040	.069	.084	.070
9							.017	.018	.028	.040	.072	.076	.096	
10							—	—	.019	.030	.040	.054	.081	
Max.	2.2	—	3.2	3.0	2.8	2.7	.018	.023	.030	.054	.067	.086	.096	
Min.	1.9	—	2.3	2.2	2.0	1.9	.013	.010	.018	.022	.031	.027	.054	
Aver.	2.1	2.4	2.8	2.6	2.5	2.4	.015	.018	.024	.034	.049	.059	.069	.070
	2	1	6	9	9	7	7	11	16	18	17	16	11	1

Speci-men	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5	6
1	—	—	38?	44?	38	30						
2	38	39	36	32								
3	37	36	32	—	32							
4	—	—	—	—	—							
5	39	35	40?	42	31							
6							9	17	23	23+		
7							9	13	16	22?	30?	30+
8							9	13	14	18		
9							8	17	16	21	24	
10							—	—	—	23?	28?	
Max.	39	39	40	48?	40?		12	18	27	33?	30?	
Min.	32	30	23?	32	31		8	13	14	18	24	
Aver.	37	35	34	41	35	30	9	16	20	24	27	30
	4	4	6	5	4	1	8	7	7	9	4	1

tightly colis in the first one or two volutions, and becomes more or less rapid in expansion in the following three or four volutions and slightly decreases in the outer one or two volutions. Average radius vectors of the first to seventh volution of twenty-four specimens are 162, 268, 426, 658, 952, 1,157, and 1,394 microns, respectively. The chambers are almost the same in height throughout the length of the shell except for the polar regions.

The spirotheca consists of a tectum and moderately finely keriotheca, increasing in thickness from the first to the last volution. Average thickness of the first to sixth volution for eighteen specimens is 18, 24, 34, 49, 59, and 69 microns, respectively. The proloculus wall is thin and seemingly structureless, averaging 15 microns in thickness for seven specimens.

The septa are rather thick and moderately spaced. In some parts of the outer volutions it is clearly observed that the septa are composed of the downward extension of the keriotheca, whereas in most parts of the inner volutions they are seemingly composed of dense materials. Average septal counts of the first to fifth volution of nine specimens are 9, 16, 20, 24, and 27, respectively. The septa are narrowly fluted throughout their length, but the fluting is much more intense in the polar regions. The closed chamberlets extend slightly above the top of the tunnel in the center of the shell and almost to tops of the chambers in the end regions.

The tunnel is relatively wide with a nearly straight pass and almost half as high as the chambers near its center. Average tunnel angles of the first to fifth volution in six specimens are 37, 35, 34, 41, and 35 degrees, respectively. The chomata are observable only in few inner volutions, where they are very rudimentary in development, forming small and nearly symmetrical low ridges. The heavy axial fillings occur in the polar regions throughout all except the innermost and last-formed volutions of some specimens.

Remarks.—LEE (1927) distinguished two forms in *Schellwienia cervicalis*, the microspheric form having a small proloculus and 8 to 9 volutions and the megalospheric one having a larger proloculus and 6 to 7 volutions. A number of specimens here referred to *Dunbarinella cervicalis* are closely similar to the LEE's megalospheric form in almost all the essential characters of the shell. Only differences between the Chinese and Akiyoshi forms are slightly larger size of the proloculus and the weak development of the chomata in the present species. These differences are considered to be not specific but variation within a species.

Occurrence.—*Dunbarinella cervicalis* (LEE) was originally described from the Shanchiang limestone of Honan and the Fuching limestone of Chihli, both of them were referred by LEE to "the Upper Carboniferous" or "Uralian" (the Sakmarian or Wolfcampian age in the present interpretation). The Akiyoshi specimens are found in the Plα and Plβ subzones, although more common in the latter. The following localities are known: Nos. 14 and 15 limestones of Section I (Loc. 296 and 297, respectively), No. 6 limestone of Section VII (Loc. 437), No. 10 limestone of Section X (Loc. 568A), No. 5 limestone of Section XIV (Loc. 101), No. 2 limestone of Section XVIII (Loc. 316), No. 3 limestone of Section XXI (Loc. 259), and Loc. 613. A doubtful specimen referred to *D. cervicalis* with question is found in the No. 3 limestone of Section V (Loc. 463).

Dunbarinella densa TORIYAMA, n. sp.

Pl. 13, figs. 12–20

A small number of specimens referred to this species have been sectioned from my collection obtained from Loc. 336, the northeast of the top of Kirigadai, Kyowa, Shuho-cho. Although they are not enough in number, they are not referable to any species hitherto described from the Permian rocks of the Tethys region. Therefore, I describe and illustrate this form under a new specific name *Dunbarinella densa*.

The shell of *Dunbarinella densa* is medium and inflated fusiform, with straight axis of coiling, almost straight to convex lateral slopes, and broadly pointed polar extremities. Mature shell of five to seven volutions has a length of 4.9 to 6.0 mm and a width of 2.1 to 3.0 mm, giving a form ratio of 2.1 to 2.7. The first volution is ellipsoidal in shape, with broadly rounded poles, but in the succeeding volutions the shell maintains a nearly similar shape, with a slow rate of increasing in form ratio. Average ratios of the half length to the radius vector of the first to sixth volution in five specimens are 1.7, 1.9, 1.9, 1.9, 2.0, and 2.2, respectively.

The proloculus is very small and spherical, with outside diameters of 144 to 172 microns, averaging 156 microns in three specimens. The proloculus wall is rather thick, attaining an average thickness of 22 microns in three specimens, but its minute structure is hardly discernible, seemingly being composed of a single homogeneous layer. The first two volutions are rather tightly coiled, followed by considerably rapid and uniform expansion of the succeeding volutions. Average radius vectors of the first to seventh volution of seven specimens are 131, 226, 358, 549, 812, 1,053, and 1,330 microns, respectively.

The spirotheca is thin and finely alveolar. Alveoli are hard to be distinguishable in the inner volutions and polar regions of most specimens. The spirotheca changes very slowly in thickness laterally in a given chamber from the tunnel to the poles. Average thickness of the spirotheca above the tunnel in the first to seventh volution of seven specimens are 15, 20, 29, 41, 53, 55, and 50 microns, respectively.

Because no exactly oriented sagittal section is available, the detailed characters of the septa are not fully understood. However it seems that the septa are more or less thick and closely spaced. They are fluted throughout the length of the shell, but the fluting is more intense in the end zones, extending more nearly to

Table 46. Table of Measurements (in Millimeters) of *Dunbarinella densa* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1	336	685	13	12	5.63	2.15	2.7	.152	.121	.193	.341	.528	.775	1.012	
2*	336	684	13	13	6.00	2.95	2.1	.144	.123	.211	.322	.513	.803	1.104	1.338
3	336	686	13	14	4.99	2.14	2.3	.172	.139	.239	.392	.644	.948		
4	336	687	13	15	4.88	2.41	2.0	—	.135	.218	.34?	.522	.727	.984	1.306
5	336	683	13	16	5.38	2.32	2.3	—	.138	.211	.338	.497	.813	1.088	
6	336	685	13	17	×	2.20	×	—	—	.264	.415	.616	.846	1.088	
7	336	686	13	18	×	2.60	×	—	—	.245	.360	.522	.775	1.040	1.350
							Max.	.172	.137	.264	.415	.644	.846	1.104	1.350
							Min.	.144	.121	.193	.322	.497	.727	.984	1.306
							Aver.	.156	.131	.226	.358	.549	.812	1.053	1.330
								3	5	7	7	7	7	6	3

Specimen	Radius vector 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
1	2.1	2.2	1.8	2.1	2.1	2.8		.019	.013	.028	.028	.043	.052	.056	
2*	1.5	1.9	2.3	2.1	2.1	2.1	2.4	.025	—	.018	.029	.050	.062	.063	.056
3	1.6	1.9	1.7	1.8	2.0			.021	.016	.018	.036	.039	.065		
4	—	1.8	1.7	1.3	1.6	1.5	1.9	—	—	.019	.027	.042	.036	.063	.059
5	—	2.0	2.0	2.3	2.1	2.6		—	—	.016	.029	.036	.054	.050	
6								—	—	.021	.037	.047	.059	.050	
7								—	—	—	.020	.028	.044	.046	.036
Max.	2.1	2.2	2.3	2.3	2.1	2.8	2.4	.025	.016	.028	.036	.050	.065	.063	.059
Min.	1.5	1.8	1.7	1.3	1.6	1.5	1.9	.019	.013	.016	.020	.028	.036	.046	.036
Aver.	1.7	1.9	1.9	1.9	2.0	2.2	2.2	.022	.015	.020	.029	.041	.053	.055	.050
	3	5	5	5	5	4	2	3	2	6	7	7	7	6	3

Specimen	Tunnel angle 1	2	3	4	5	6	Septal count 2	3	4	5	6	7
1	20	20	20	19	19							
2*	15	17	21	25	23	17						
3	—	19	15	20	13	20						
4	—	18	22	20	29							
5	—	17	17	20	22	23						
6							19?	24?	25?	32?	37?	
7							—	—	25?	33?	36?	40?
Max.	20	20	22	25	29	23						
Min.	15	17	15	19	13	17						
Aver.	18	18	19	21	21	20	19	24	25	33	37	40
	2	5	5	5	5	3	1	1	2	2	2	1

* Holotype specimen.

the tops of the chambers. An excentric section has 25?, 33?, 36?, and 40? septa in the fourth to seventh volution, respectively.

The tunnel is low and narrow throughout the volutions, with an almost straight to irregular path. Average tunnel angles of the first to sixth volution of five specimens are 18, 18, 19, 21, 21, and 20 degrees, respectively. The chomata are highly asymmetrical in the inner volutions where their poleward slopes extend almost to the poles, but in the outer volutions the chomata are narrow and almost symmetrical. The axial filling is not developed even in the polar regions of inner volutions.

Remarks.—As stated above no species of the Tethysian schwagerinid is specifically comparable with the present one. However *Dunbarinella obesus* (BEEDE) described by WHITE from the Caddo Creek and Harpersville formations of Texas resembles *D. densa* n. sp. in some respects, but the latter is smaller in the shell size, slower in the rate of expansion, and a little stronger in the septal fluting. *D. densa* n. sp. also somewhat resembles *D. eoextensa* THOMPSON from the Waldrip No. 1 limestone of Texas and from the Americus limestone of Kansas but is distinguished by its more intense septal fluting, less massive chomata, and thinner spirotheca.

Dunbarinella densa n. sp. is, along with *D. eoextensa* mentioned above, one of the most inflated form in the genus.

Occurrence.—*Dunbarinella densa* TORIYAMA, n. sp. has been obtained only from one locality, Loc. 336, and is considered to be the Plβ in the stratigraphical age.

Dunbarinella sp. A

Pl. 13, figs. 21, 22

Only two specimens here referable to *Dunbarinella* sp. A are available in the present collection from No. 3 limestone of Section V.

The shell of *Dunbarinella* sp. A is small and short fusiform, with almost straight median portion, straight to convex lateral slopes, and narrowly pointed poles. Only available axial section which is illustrated as Pl. 13, fig. 21 is 3.91 mm long and 2.04 mm wide, giving a form ratio of 1.92. The ratios of the half length to the radius vector of the first to eighth volution of the same specimen are 1.6, 2.6, 2.6, 2.4, 2.3, 2.0, 2.1, and 2.0, respectively. These figures show that the shell is nearly subspherical in form in the first volution, and that the axis becomes extended very rapidly in the second and third volutions but the rate of elongation of the axis decreases gradually from the fourth volution to maturity.

The proloculus is minute and spherical. Its outside diameter is measured 110 microns in the illustrated axial section. The shell expands very slowly. The radius vectors of the first to eighth volution of the same specimen are 86, 123, 172, 242, 356, 514, 700, and 942 microns, respectively. The chambers are nearly the same in height throughout the length of the shell at least in the outer volutions.

The spirotheca is thin and consists of a tectum and a finely alveolar keriotheca. The thickness of the spirotheca of the second to eighth volution of the illustrated axial section is 12, 14, 21, 27, 33, 39, and 45 microns, respectively. Alveoli of the keriotheca are hardly recognizable in the inner three volutions.

The septa are narrowly and highly fluted throughout their length except in the inner volutions. The closed chamberlets nearly reach to the tops of the chambers. The spacing of the septa and the septal counts are unknown due to the absence of well oriented sagittal section.

The tunnel is low but relatively broad and its path is somewhat irregular. The tunnel angles of the third, fifth, seventh, and eighth volutions of the illustrated axial section are 17, 28, 33, and 37 degrees, respectively. The chomata occur at least in the inner volutions but they are very rudimentary in development. Dense secondary deposits fill the axial regions of the chambers throughout all except for the last two volutions.

Remarks.—The rate of expansion and the heavy axial fillings of this form are closely similar to those of the microspheric form of *D. cervicalis* (LEE) illustrated as Pl. X, fig. 14 in LEE's monograph, but more sufficient material is need for the specific determination. *D.* sp. A may be one of the smallest form in the genus.

Occurrence.—As described above *Dunbarinella* sp. A is known only from No. 3 limestone of Section V (Loc. 463) which is referable to the Plβ subzone.

Genus *Schwagerina* MÖLLER, 1877

Schwagerina okafujii TORIYAMA, n. sp.

Pl. 14, figs. 1–16

The shell of *Schwagerina okafujii* TORIYAMA, n. sp. is small and inflated fusiform, with almost straight axis of coiling and narrowly rounded poles. The lateral slopes are straight to convex in the inner volutions but become slightly concave in the outer volutions of some specimens. Typical specimens of four to five volutions are 2.6 to 4.4 mm long and 1.5 to 2.3 mm wide, giving form ratios of 1.6 to 2.3. The general shape of the shell is almost uniform throughout the growth. The only recognizable change in shape is a slightly rapid increase in relative length in the last volution. Average ratios of the half length to the radius vector in the first to fourth volution in eleven specimens are 1.7, 1.8, 1.8, and 1.9, respectively.

The proloculus is spherical and large, with outside diameters of 224 to 410 microns, averaging 302 microns in forty specimens. The first half to one volution is more or less tightly coiled, but the shell expands rapidly and almost uniformly in the succeeding volutions. Average radius vectors of the first to fifth volution in thirty-nine specimens are 261, 429, 693, 947, and 1,254 microns, respectively. The chambers are nearly uniform in height in central two-thirds to three-fourths of the inner volutions, increasing in height only slightly poleward. In the outer volutions where the lateral slopes become irregular or concave the chambers increase in height somewhat rapidly.

The spirotheca is thick for the shell of this size and is typical in structure for the genus. Alveoli of the keriotheca are hard to be discernible in the inner one or two volutions, but become distinct in the outer ones. In most of the specimens the spirotheca is thickest above the tunnel, decreasing its thickness slightly poleward. Average thickness of the spirotheca above the tunnel of the first to fifth volution in twenty-seven specimens are 30, 45, 65, 79, and 77 microns, respectively.

The septa are thin and rather closely spaced. They are composed of the downward deflection of the tectum and the pycnotheca, the latter of which is, however, not observable in the inner volutions. They are fluted throughout their length, but the fluting extends to the tops of the chambers only in the extreme polar regions. It does not reach to the tops of the chambers in the central portion of the shell, being half to three-fourths as high as chambers. Average septal counts of the first to fourth volution in thirteen specimens are 11, 19, 25, and 28, respectively.

The tunnel is low and narrow in the inner volutions and only slightly widens outwards. Average tunnel angles of the first to fourth volution of twelve specimens are 25, 25, 27, and 25 degrees, respectively. The chomata are distinct only in the inner two to three volutions where they are low, narrow, and asymmetrical, with steep to vertical tunnel sides and low lateral slopes. They do not occur in the outer volutions. No axial filling is developed.

Schwagerina okafujii TORIYAMA, n. sp. was named in honour of Mr. Goro OKAFUJI of Ominé High School who helped me in my field work.

Remarks.—*Schwagerina okafujii* TORIYAMA, n. sp. is rather a primitive member of the genus and is intermediate in general structures between the genera *Triticites* and *Schwagerina.*

Schwagerina okafujii n. sp. most closely resembles *Schwagerina* (?) *ominensis* (OZAWA) in many respects, but is distinguished from the latter in having larger size of the shell, larger proloculus, more rapid expansion of the shell, and more numerous septa.

It is also similar to *Schwagerina propinqua* (DEPRAT) from the Akasaka limestone of Central Japan, which was, however, referred to *Pseudofusulina japonica* (GÜMBEL) by OZAWA (1927). Comparison of "*Fusulina propinqua* DEPRAT" (III^{e}

Table 47. Table of Measurements (in Millimeters) of *Schwagerina okafujii* TORIYAMA, n. sp.

Speci-men	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5
1*	613	875	14	1	3.81	2.04	1.9	.236	.181	.310	.512	.870	1.200
2	613	860	14	2	4.4+	2.22	2.0	.299	.249	.410	.688	1.001	
3	613	861	14	3	4.18	1.82	2.3	.315	.240	.401	.660	.969	
4	480	1105	14	4	3.6+	2.1+	1.7	.245	.248	.380	.621	.860	
5	480	1107	14	5	3.65	1.66	2.2	.28?	.19?	.280	.463	.721	
6	480	1104	14	6	3.08	1.72	1.8	.246	.240	.392	.644	.942	
7	613	868	14	12	×	2.18	×	.272 × .322	.279	.498	.745	1.140	
8	480	1108	14	13	×	2.7+	×	.352	.338	.583	.905	1.287	
9	613	870	14	14	×	2.1+	×	.286	.249	.341	.570	.851	
10	613	861	14	15	×	2.3+	×	.317	.279	.479	.809	1.040	
							Max.	.410	.338	.609	1.020	1.287	1.550
							Min.	.224	.181	.280	.463	.721	1.110
							Aver.	.302	.261	.429	.693	.947	1.254
								40	39	39	38	22	6

Speci-men	Ratio of Hl./Rv. 1	2	3	4	5	Thickness of spirotheca 0	1	2	3	4	5
1*	—	2.0	—	1.6	1.7	.027	—	.032	.059	.088	.058
2	1.7	1.7	1.7	1.9		.016	.025	.043	.069	.081	
3	2.0	2.1	2.1	2.3		.027	.032	.040	.092		
4	—	—	1.6	1.9		—	.027	.057	.064	.080	
5	—	1.8	2.0	2.1		.020	.036	.048	.071		
6						—	.038	.039	.077	.101	
7						.021	.021	.046	.073	.071	
8						.026	.054	.080	.107	.118	
9						.024	.020	.022	.035	.057	
10						.025	.029	.045	.107	.045	
Max.	2.2	2.5	2.2	2.3		.027	.054	.080	.107	.120	.090
Min.	1.3	1.5	1.5	1.5		.015	.021	.022	.035	.045?	.058
Aver.	1.7	1.8	1.8	1.9	1.7	.022	.030	.045	.065	.079	.077
	6	10	11	9	2	20	22	27	26	15	3

Speci-men	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4
1*	25	21	23	16?					
2	29	23	27	22?					
3	19	20	26	23					
4	28	26	29	25					
5	28	27	22						
6	32	28	30	28					
7						11	22	28?	35
8						19	16	25	26
9						10?	20?	19?	24?
10						12	18+	28?	
Max.	32	32	32	39		13	22	28?	35
Min.	19	20	21?	16?		9	16	19?	24?
Aver.	25	25	27	25	23	11	19	25	28
	12	11	12	8	1	13	13	10	6

* Holotype specimen.

Memoir, Pl. I, fig. 13) with the inner volutions of a well centered axial section of "*Fusulina japonica*" (fig. 1 of the same plate) shows that the OZAWA's opinion seems to be correct, and if it is so, "*Fusulina propinqua*" is regarded as an immature specimen of "*Fusulina japonica*." Indeed, both *propinqua* and *japonica* were reported by DEPRAT together from the horizon 3 (Permien inférieur) of his division. Whereas, *Schwagerina okafujii* n. sp. occurs abundantly in limestone masses of the following localities in which no specimen of *Pseudofusulina japonica* and its allied forms is associated with. Moreover, *S. okafujii* differs from *S. propinqua* (or the young shell of *Pseudofusulina japonica*) in having slightly slower rate of expansion, less numerous septa and no axial filling.

Occurrence.—*Schwagerina okafujii* TORIYAMA, n. sp. occurs abundantly in No. 1 limestone of Section VIII (Loc. 318) and Loc. 480 and 613. The stratigraphical range of this species is restricted to the Plα and Plβ subzones, but it is more characteristic in the latter.

Schwagerina etoi TORIYAMA, n. sp.

Pl. 14, figs. 17–29

The shell of *Schwagerina etoi* TORIYAMA, n. sp. is inflated fusiform, with almost straight axis of coiling, convex to nearly straight lateral slopes, and bluntly pointed polar ends. The shell is moderate in size. Mature shells of four and a half to five volutions are 4.6 to 6.5 mm long and 2.0 to 3.0 mm wide, giving form ratios of 2.0 to 2.8. The first half to one volution is subelliptical to short fusiform. From the second volution to maturity the shell retains almost the same axial profile, with only slightly slow rate of increasing in the axial length. Average ratios of the half length to the radius vector of the first to fifth volution in twelve specimens are 1.8, 2.0, 1.9, 2.1, and 1.9, respectively.

The proloculus is large for the size of the shell. In most of the specimens it is almost spherical in shape, but is ellipsoidal or somewhat irregular in others. Its outside diameter is considerably variable, ranging from 258 to 508 microns, averaging 381 microns in thirty specimens. The shell expands considerably rapidly and about uniformly throughout the growth of the shell. Average radius vectors of the first to fifth volution of thirty-one specimens are 314, 501, 742, 981, and 1,231 microns, respectively. The heights of the chambers are nearly the same throughout the length of the shell.

The spirotheca is typical in structure for the genus, containing rather coarse alveoli in the keriotheca. It increases in thickness rapidly as the shell grows, but it is nearly the same in thickness throughout the length of the shell except for the polar regions. Average thickness of the spirotheca of the first to fifth volution for twenty-seven specimens is 31, 40, 52, 60, and 73 microns, respectively. The

Table 48. Table of Measurements (in Millimeters) of *Schwagerina etoi* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5
1	553	1640	14	17	5.3+	3.00	1.8	.454	.378	.550	.794	1.001	1.302
2	552	1636	14	18	5.4+	2.09	2.6	.381	.310	.431	.644	.870	
3	496	1124	14	19	5.6+	2.0+	2.8	.516	.399	.607	.932		
4*	553	1640	14	20	6.54	2.9?	2.3	.32+	.291	.433	.595	.828	1.153
5	553	1639	14	21	5.1+	2.41	2.1	.441	.368	.540	.751	1.100	1.36?
6	496	1121	14	22	3.81	2.09	1.8	.380	.276	.543	.788	1.030	
7	552	1635	14	23	3.06	1.55	2.0	.350	.309	.461	.690		
8	553	1640	14	25	—	1.87	—	.380	.320	.548	.749	.837	1.150
9	496	1122	14	26	×	1.88	×	.307 .344 ×	.276	.421	.736	1.021	
10	496	1130	14	27	×	2.25	×	.400	.338	.552	.837	1.177	
11	496	1122	14	28	×	2.04	×	.352 .447 ×	.356	.589	.918		
12	553	1642	14	29	×	2.63	×	.300	.307	.537	.920	1.226	
							Max.	.508	.404	.607	.932	1.226	1.51?
							Min.	.258	.205	.380	.595	.800	.920
							Aver.	.381	.314	.501	.742	.981	1.231
								30	31	31	31	23	12

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	Thickness of spirotheca 0	1	2	3	4	5
1	1.7	2.0	2.0	2.1	2.0	—	.019	.025	.027	.028	
2	2.0	2.6	2.6	2.5		.015	.014	.020	.024	.027	
3	2.2	2.3	2.2			.024	.039	.034	.060		
4*	1.5	1.5	2.0	1.9	2.1	.018	.018	—	.017	.024	.044
5	2.0	2.3	—	2.1		.027	.026	.049	.064	.088	
6	1.9	1.6	1.6	1.7		.028	.035	.039	.059		
7	1.1	1.3	1.3			—	—	.031	.039	.052	
8						—	.030	.033	.046	.062	.091
9						.021	.027	.036	.062		
10						.029	.027	.032	.050		
11						.021	.039	.060	.070		
12						—	.035	.062	.073	.065	
Max.	2.2	2.6	2.7	2.5	2.1	.031	.044	.062	.075	.088	.097
Min.	1.1	1.5	1.3	1.4	1.6	.013	.014	.020	.017	.024	.044
Aver.	1.8	2.0	1.9	2.1	1.9	.023	.031	.040	.052	.060	.073
	9	12	12	12	4	14	23	26	27	16	5

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4
1	—	27	28	21					
2	36?	37	28						
3	30	24	30						
4*	36	25	20	28	33				
5	34	30	29	25?					
6	—	21	—	27					
7	—	16?	19						
8	—	—	—	—	—				
9						11	19	27	35
10						—	26?	28?	
11						—	23?	29?	
12						—	—	22?	29?
Max.	36	37?	33	31		11	26?	29?	35
Min.	27	16	20	25?		10	19	22?	29?
Aver.	31	27	28	28	33	11	22	27	32
	9	12	12	4	1	2	4	4	2

* Holotype specimen.

proloculus wall seems to be composed of a single homegeneous layer, attaining an average thickness of 23 microns in fourteen specimens.

The septa are thin and relatively closely spaced. They are formed of the downward deflection of the tectum and somewhat obscure dark layer. They are narrowly fluted throughout their length. The fluting extends to the tops of the chambers, forming closed chamberlets for at least two-thirds to three-fourths the height of the chambers. Average septal counts of the first to fourth volution in four specimens are 11, 22, 27, and 32, respectively. No phrenotheca is observable.

The tunnel is low and its path is irregular. Average tunnel angles of the first to fourth volution in twelve specimens are 31, 27, 28, and 28 degrees, respectively. The chomata occur in the first one or two volutions, but do not present in the outer ones of most specimens. The dense axial deposits completely fill the chambers in the axial area of the inner volutions where they extend almost to the tunnel.

This species is named in honour of Mr. Ichiro ETO, the pioneer of field geologist in Akiyoshi area.

Remarks.—Schwagerina etoi TORIYAMA, n. sp. closely resembles *Schwagerina stabilis* RAUSER-CERNOUSSOVA from Samara Bend, Russia in many respects, but differs from the latter principally in having larger proloculus and more rapid rate of expansion. It also resembles *Schwagerina krotowi* (SCHELLWIEN) and its allied forms, but is distinguished from most of them by its larger proloculus, larger radius vector for the corresponding volution, relatively thicker spirotheca, and heavier axial fillings.

Because *Schwagerina etoi* has considerably larger proloculus and the small number of the volution for the size of the shell, there may be a question if it is a megalospheric form of some species. Although it may be true, it is almost impossible, or at least very difficult, to find a microspheric form in massive limestones which is, as pointed out by DUNBAR, SKINNER and KING (1935), exceedingly few in number of individuals in comparison with the megalospheric form of the same species.

Occurrence.—Schwagerina etoi TORIYAMA, n. sp. is common in several localities, all of them are referable to the Plβ subzone. It is found in the No. 4 limestone of Section VII (Loc. 435), No. 3 limestone of Section XVIII (Loc. 315), No. 1 limestone of Section XXIV (Loc. 552), Nos. 6 and 7 limestones of Section XXVI (Loc. 755 and 757, respectively), and Loc. 457, 480, 494, 496, 553, and 613.

Schwagerina (?) cf. *kueichihensis* (CHEN)

Pl. 15, figs. 1–7

1934. *Triticites kueichihensis* CHEN. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 2, pp. 42, 43, Pl. V, figs. 16, 17.

The shell of *Schwagerina* (?) cf. *kueichihensis* (CHEN) is large and inflated fusiform, with straight axis of coiling, convex to almost straight axis of coiling, and broadly pointed poles. Mature shells of six to seven volutions are 4.9 to 6.2 mm long and 2.5 to 3.6 mm wide, giving a form ratio of 1.9 to 2.1. Average form ratio of four specimens is 2.0. The first volution is subspherical in shape, having short axis of coiling. Beyond the second volution to maturity the axial ends become extended slowly, resulting in that the shell remains nearly the same axial profiles. Average ratios of the half length to the radius vector of the first to sixth volution in nine specimens are 1.5, 1.6, 1.8, 1.8, 1.9, and 2.0, respectively.

The proloculus is large and spherical, with an outside diameter of 240 to 309 microns, averaging 259 microns in thirteen specimens. The shell expands considerably rapidly and uniformly in all but the innermost volution where it is relatively tightly coiled. Average radius vectors of the first to seventh volution in fourteen specimens are 217, 348, 515, 754, 1,050, 1,404, and 1,728 microns, respectively.

The spirotheca is thick and contains coarsely alveolar keriotheca. It is relatively thin in the inner volutions, but increases in thickness rapidly towards maturity. Average thickness of the spirotheca in the first to seventh volution for twelve specimens is 22, 35, 49, 69, 81, 94, and 108 microns, respectively. The proloculus wall is thin and seems to be composed of a single homogeneous dense layer. Average of the proloculus wall of four specimens is 17 microns.

The septa are thin, composed of the downward deflection of the tectum and pycnotheca, the latter of which is, however, sometimes hard to be distinguished. They are moderately to highly fluted in the polar regions where the fluting extends to the tops of the chambers. In the central part of the shell, however, the septa are almost plane or only slightly fluted. The spacing of the septa is close in the inner volutions but relatively wide in the outer ones. Average septal counts of the first to fifth volution in three specimens are 10, 15, 19, 23, and 25, respectively.

The tunnel is low and relatively narrow in the inner two volutions but rapidly widens in the succeeding outer ones. Its path is not straight in most of specimens. Average tunnel angles of the first to sixth volution in seven specimens are 26, 26, 32, 38, 49, and 37 degrees, respectively. The chomata are relatively well developed throughout the shell except in the last volution. They are highly asymmetrical in the inner two volutions with very steep to almost vertical, sometimes overhanging, tunnel sides and gentle poleward slopes. In the outer volutions the chomata are massive and nearly symmetrical and are about half as high as chambers.

Table 49. Table of Measurements (in Millimeters) of *Schwagerina*(?) cf. *kueichihensis* (CHEN)

Specimen	Loc.	Rg. No.	Pl. fig.		L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1	546	1177	15	1	6.1?	3.2?	1.9	.265	.254	.383	.552	.810	1.058	1.370	1.815
2	546	1176	15	2	6.2+	3.00	2.1	.309	.254	.374	.567	.806	1.082	1.420	
3	546	1178	15	3	5.90	2.95	2.1	.264	.231	.383	.564	.828	1.135	1.462	
4	551	1193	15	4	4.9?	2.52	1.9	.246	.180	.300	.461	.711	1.010	1.290	
5	546	1178	15	5	×	1.83	×	.24+	.224	.338	.522	.705	.935		
6	546	1179	15	6	×	2.5+	×	.276	.193	.316	.460	.653	.935	1.287	
7	546	1178	15	7	×	2.64	×	.255	.211	.392	.574	.858	1.135	1.625	
							Max.	.309	.254	.392	.574	.858	1.135	1.625	1.900
							Min.	.240	.180	.280	.460	.630	.890	1.200	1.470
							Aver.	.259	.217	.348	.515	.754	1.050	1.404	1.728
								13	13	14	14	14	12	9	3

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
1	1.1	1.4	1.6	1.4	1.5	1.6	1.7	—	—	.036	.041	.063	.077	.102	.114
2	1.7	1.7	1.8	2.0	2.2	2.4		.018	.014	.025	.041	.062	.063	.089	
3	1.2	1.4	1.7	1.9	2.2	2.1		—	—	.034	.044	.077	.080	.086	
4	—	—	1.8	1.6	1.8	1.8		—	—	.036	.060	.073	.096	.080	
5								—	—	.048	.064	.070	.085		
6								—	.023	.039	.040	.049	.072		
7								.017	.021	.026	.040	.063	.072	.078	
Max.	2.0	2.1	2.1	2.0	2.2	2.4		.018	.029	.059	.069	.082	.110	.133	.114
Min.	1.1	1.4	1.5	1.5	1.5	1.6		.014	.014	.022	.034	.049	.063	.072	.102
Aver.	1.5	1.6	1.8	1.8	1.9	2.0	1.7	.017	.022	.035	.049	.069	.081	.094	.108
	5	6	7	9	7	6	1	4	3	11	12	12	10	6	2

Specimen	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5	6
1	27	20	25	—	53?							
2	31	30	52	51	74							
3	34	—	—	38	38	38						
4	23	24?	30	29	48							
5							11	16?	19?	22?		
6							9	13	17?	21	24?	
7							—	17?	20?	25?	26?	28?
Max.	34	30	52	51	74	38	11	17	20	25	26	
Min.	21	20	24	29	31?	35	9	13	17	21	24	
Aver.	26	26	32	38	49	37	10	15	19	23	25	28
	7	5	6	4	5	2	2	3	3	3	2	1

Remarks.—The generic reference of this species is somewhat doubtful. The general shell shape, degree of the septal fluting, the spirothecal thickness and the development of the chomata of the Akiyoshi form well agree with those of the Chinese form from the Chihsia limestone, but the former is larger in relative size of the shell and the proloculus. These forms may belong to the same species, or may be closely related if not strictly conspecific.

Although this species is not comparable with any other species except for the above one, it seemingly is rather primitive in the biological development. Relatively weak septal fluting and considerably well development of the chomata of this species suggest that it is gradational between *Triticites* and *Schwagerina* and is one of the most primitive representative if it is really referable to the latter.

Occurrence.—*Schwagerina* (?) cf. *kueichihensis* (CHEN) is fairly common in the Plβ subzone. It is found in the following four localities: No. 12 limestone of Section III (Loc. 546), No. 2 limestone of Section XXIV (Loc. 551) and Loc. 569 and 572.

Schwagerina krotowi (SCHELLWIEN)

Pl. 15, figs. 8–19

1908. *Fusulina krotowi* SCHELLWIEN. Palaeontographica, Vol. LV, pp. 190–192, Pl. XX, figs. 1–10.
1925. *Schellwienia krotowi* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 27, 28, Pl. VII, figs. 5, 6.
1936. *Pseudofusulina krotowi* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 82–84, Pl. XV, figs. 1–5, 9–15.
1938. *Pseudofusulina krotowi* RAUSER-CERNOUSSOVA. Travaux l'Inst. Géol. Acad. Sci. U. S. S. R., Tome VII, pp. 143, 144, Pl. IX, figs. 1, 2.

The shell of *Schwagerina krotowi* (SCHELLWIEN) is small for the genus and ellipsoidal to short fusiform, with straight axis of coiling, essentially convex lateral slopes and broadly rounded poles. The typical form of the species is about 5.0 to 6.6 mm long and 2.4 to 3.8 mm wide. In the present materials there are a considerable number of specimens which have a little smaller shell than that of the typical form. They have a length of 4.1 to 4.7 mm and a width of 2.0 to 3.2 mm. The form ratio is the same in both the forms, being 1.6 to 2.0.

The proloculus is spherical and small. The outside diameter of the typical form is ranging from 190 to 261 microns, averaging 256 microns in eleven specimens. It is a little smaller in another form, being 114 to 234 microns, averaging 178 microns in nineteen specimens. The shell tightly coils in the first two volutions and expands moderately rapidly and nearly uniformly in the outer four to five volutions. Average radius vectors of the first to seventh volution of the typical form in thirteen specimens are 208, 335, 536, 814, 1,161, 1,502, and 1,724 microns, respectively. The radius vector of the corresponding volution of the smaller form is slightly larger than that of the preceding volution of the typical form; namely, average radius vectors of the first to seventh volution of the smaller form of nineteen specimens are 140, 224, 357, 573, 861, 1,120, and 1,283 microns, respectively. The chambers are almost the same in height throughout the length of the shell.

The spirotheca consists of a tectum and a coarsely alveolar keriotheca. In the ultimate volution of an axial section (Pl. 15, fig. 8) 5 alveoli are counted in a space of 100 microns. It is relatively thin in the inner two or three volutions, but becomes gradually thick in the outer ones. Average thickness of the spirotheca in the first to seventh volution is 25, 34, 53, 64, 77, 92, and 98 microns, respectively, in ten specimens of the typical form, and is 15, 23, 34, 55, 83, 84, and 85 microns, respectively, in sixteen specimens of the smaller form. The proloculus wall is thin and averages 24 microns in six specimens of the typical form and 15 microns in seven specimens of the smaller one. The spirotheca is thickest immediately above the tunnel and gradually decreases to the poles.

The septa are thin and considerably closely spaced in the inner volutions, and are more or less thick and rather widely spaced in the outer ones. Average septal counts of the first to sixth volution of the typical form in three specimens are 10, 20, 26, 29, 29, and 35, respectively. Those of the first to seventh volution of the smaller form in six specimens are 9, 14, 17, 20, 22, 24, and 25, respectively. The septa are narrowly fluted throughout the length of the shell. The closed chamberlets are more than half to two-thirds as high as chambers in the central two-thirds of the shell. In some tangential sections referred to the typical form with question cuniculi-like structures are observable, although they are very incomplete.

The tunnel is low and narrow throughout the growth with somewhat irregular path. Average tunnel angles of the first to sixth volution of two specimens of the typical form are 28, 25, 25, 20, 20, and 19 degrees, respectively. Those of the smaller form in the first to seventh volution of eight specimens are 28, 27, 28, 26, 27, 31, and 31 degrees, respectively. The chomata are present in almost all the volutions. They are less symmetrical in the inner volutions, being extended polewardly to some extent. In the outer volutions they are less massive, rudimentary in some specimens, and are nearly symmetrical to overhanging to the tunnel sides.

Remarks.—The above description is entirely based on the material collected from the Akiyoshi limestone group.

As described above, the typical and smaller forms are distinguished in the present materials of *Schwagerina krotowi* (SCHELLWIEN). The differences between them are, however, considered to be not enough to separate the smaller form from the typical one as a variety. They are seemingly within a limit of variation in a species.

Also, in the SCHELLWIEN's original illustration of "*Fusulina krotowi*" these two forms are recognized; namely, figs. 1 and 6 and figs. 5 and 10 of Pl. XX seem to represent the typical and smaller forms, respectively. Besides these, two sagittal sections (figs. 4 and 7) are illustrated in the same plate which are almost twice as large as the smaller form in the radius vectors for the corresponding volution and have much thicker spirotheca. These two specimens seem to be not conspecific with the others.

Table 50A. Table of Measurements (in Millimeters) of the smaller form of *Schwagerina krotowi* (SCHELLWIEN)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7	8
1	448	1082	15	8	4.13	2.52	1.6	.12+	.095	.178	.291	.442	.628	.877	1.165	
2	448	1083	15	9	4.34	2.36	1.8	.15?	.135	.245	.383	.577	.880	1.190		
3	13	1001	15	10	4.7+	2.32	2.0	.22+	.160	.259	.448	.639	.920	1.230		
4	338	1413	15	11	4.4+	2.8+	1.6	.114	.107	.167	.291	.507	.864	1.364		
5	492	1115	15	12	×	2.14	×	.196	.144	.231	.368	.674	1.070			
6	448	1084	15	13	×	2.16	×	.186	.151	.245	.353	.592	.898	1.150		
7	13	1002	15	14	×	2.75	×	.22+	.179	.252	.362	.521	.750	1.010	1.360	
							Max.	.234	.179	.259	.448	.727	1.004	1.364	1.360	
							Min.	.114	.095	.167	.291	.392	.628	.877	1.140	
							Aver.	.178	.140	.224	.357	.573	.861	1.120	1.283	1.650
								19	19	19	19	19	16	11	3	1

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
1	1.3	1.4	1.7	1.7	1.7	1.6	1.6	—	.017	.026	.032	.039	.070	.077	.064
2	2.3	2.6	2.2	2.4	2.2	1.9		—	—	.027	.037	.062	.078	—	
3	—	2.5	2.1	2.2	1.9	1.7		—	—	.035	.049	.062	.085	.107	
4	2.0	2.4	2.4	2.1	1.8			—	.016	—	.029	.063	.086	.107	
5								.017	.014	.021	.039	.062			
6								.016	.019	.025	.032	—	.088	.057	
7								.012	.012	.021	.021	.050	.069	.081	.100
Max.	2.5	2.6	2.6	2.4	2.2	2.0		.018	.019	.035	.049	.070	.089	.107	.100
Min.	1.3	1.4	1.7	1.7	1.7	1.6		.011	.008	.016	.021	.037	.062	.057	.064
Aver.	2.0	2.2	2.2	2.1	1.9	1.8	1.6	.015	.015	.023	.034	.055	.083	.084	.085
	7	8	8	8	7	4	1	7	11	15	16	16	14	9	3

Specimen	Tunnel angle 1	2	3	4	5	6	7	Septal count 1	2	3	4	5	6	7
1	—	24	27	26	—	26	31							
2	—	29	28	27	28	26								
3	—	30	32	26	33	40								
4	—	22	29	29	27	32								
5								9	14	20	21			
6								7	12	17	19	21?	26?	
7								9	11	14	17	18	19	22?
Max.	30	33	32	29	33	40		11	16	20	24	25	27	28
Min.	26	22	22	23	24	26		7	11	14	17	18	19	22
Aver.	28	27	28	26	27	31	31	9	14	17	20	22	24	25
	2	8	8	7	5	5	1	6	6	6	6	4	3	2

Table 50B. Table of Measurements (in Millimeters) of the typical form of *Schwagerina krotowi* (SCHELLWIEN)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7	8
8	493	1118	15	15	5.09	3.22	1.6	.190	.175	.307	.482	.720	1.027	1.410	1.750	
9	493	1117	15	16	5.4+	3.56	1.5+	.236	.205	.338	.580	.923	1.226	1.538	1.980	
10	619	1229	15	17	×	3.2+	×	.24+	.269	.399	.589	.800	1.141	1.492		
11	619	1233	15	18	×	2.42	×	.305/.238 ×	.280	.469	.728	1.039	1.320			
12	368	1067	15	19	×	3.1+	×	.238	.215	.338	.567	.886	1.226	1.603		
							Max.	.261	.280	.469	.728	1.039	1.320	1.860	1.980	
							Min.	.190	.113	.212	.390	.701	.905	1.200	1.51+	
							Aver.	.256	.208	.335	.536	.814	1.161	1.502	1.724	1.992
								11	13	13	13	12	12	9	4	1

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
8	1.6	2.2	1.9	1.6	1.6	1.6		—	—	.025	.039	.066	.074	.107	
9	2.7	2.5	2.0	1.8	1.8	1.9		.026	.028	—	—	.072	.078	.106	.107
10								—	—	.026	.037	.054	.065	.081	
11								.025	.020	.037	.052	.075	.071		
12								.022	—	.040	.077	.082	.096	.104	
Max.	2.7	2.5	2.1	2.0	2.0	2.0		.026	.031	.043	.077	.082	.105	.107	.107
Min.	1.6	2.0	1.9	1.6	1.6	1.6		.021	.020	.024	.036	.046	.049	.074	.080
Aver.	2.2	2.2	2.0	1.8	1.8	1.8	2.0	.024	.025	.034	.053	.064	.077	.092	.098
	2	3	3	3	3	3	1	6	5	9	10	10	9	8	5

Specimen	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5	6
8	25	25	25	—	22	20						
9	31?	25	—	20	19	18						
10							—	—	25	30	31	36
11							10	21	25?	31		
12							—	—	—	25	27?	33?
Max.							10	21	27	31	31	36
Min.							10	19	25	25	27	33
Aver.	28	25	25	20	20	19	10	20	26	29	29	35
	2	2	1	1	2	2	2	2	3	3	2	2

Schwagerina krotowi (SCHELLWIEN), so far has been known, is widespread in the Lower Permian formation in this country, but has hitherto been described and illustrated only from the Akiyoshi limestone and the Kwanto massif by OZAWA and HUZIMOTO, respectively. Of these, the OZAWA's specimen (Pl. VII, fig. 5, section II-14 in his collection) well agrees with the smaller form of my materials in all the essential characters, although it has more numerous volutions than any of the specimens at my hand. Most of the HUZIMOTO's specimens, judging from his illustration, also seem to be referable to the smaller form of the Akiyoshi specimens.

Occurrence.—Schwagerina krotowi (SCHELLWIEN) is one of the characteristic species of the Plβ subzone, although it ranges upward into the Plγ subzone. However its occurrence in the latter subzone is very much limited and the number of individual is very few. The following localities are known: No. 2 limestone of Section VIA (Loc. 448), Nos. 2 and 3 limestones of Section X (Loc. 492 and 493, respectively), No. 4 limestone of Section XX (Loc. 338), No. 6 limestone of Section XXVI (Loc. 755), and Loc. 13, 365, 368, 613, 619, and 714.

Schwagerina tschernyschewi (SCHELLWIEN)
Pl. 16, figs. 1–7

1908. *Fusulina tschernyschewi* SCHELLWIEN. Palaeontographica, Vol. LV, pp. 168–170, Pl. XIV, figs. 1–12.
1934. *Pseudofusulina tschernyschewi* CHEN. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 2, pp. 52–54, Pl. III, fig. 5; Pl. IV, fig. 2; Pl. VII, figs. 13–15; Pl. X, figs. 1–11, 15, 17, 19; Pl. XIV, figs. 5–10.
1936. *Pseudofusulina tschernyschewi* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 84–86, Pl. IX, fig. 7; Pl. XVI, figs. 1–8.
1938. *Pseudofusulina tschernyschewi* RAUSER-CERNOUSSOVA. Travaux l'Inst. géol. Acad. Sci. U. S. S. R., Tome VII, pp. 140–142, Pl. VIII, fig. 8.

The shell of *Schwagerina tschernyschewi* (SCHELLWIEN) is subcylindrical, with straight axis of coiling, flat or somewhat depressed median portion, convex lateral slopes, and rounded poles. The number of volution is 5 to 6, rarely attaining 7. Mature specimens of five to six volutions are 3.9 to 5.5 mm long and 1.6 to 2.4 mm wide, giving a form ratio of 2.0 to 2.6. Fully grown shells of seven volutions are about 6.5 mm long and 3.2 mm wide. The shell remains nearly the same axial profile throughout the growth. Average ratios of the half length to the radius vector of the first to seventh volution in nine specimens are 1.8, 2.0, 2.1, 2.0, 2.0, 1.8, and 1.7, respectively.

The proloculus is small and spherical, with an outside diameter of 180 to 294 microns, averaging 249 microns in seventeen specimens. The shell is relatively tightly coiled in the first two volutions and expands more or less rapidly and almost uniformly in the outer ones. Average radius vectors of the first to sixth volution in twenty-one specimens are 202, 318, 485, 710, 970, and 1,322 microns, respectively. The chambers are almost the same in height throughout the length of the shell.

The spirotheca is typical for the genus, consisting of a tectum and a coarsely alveolar keriotheca. Average thickness of the spirotheca in the first to sixth volution for thirteen specimens is 21, 31, 45, 59, 69, and 67 microns, respectively. The proloculus wall is moderately thick and structureless, with an average thick-

Table 51. Table of Measurements (in Millimeters) of *Schwagerina tschernyschewi* (SCHELLWIEN)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1	496	1123	16	1	5.45	2.25	2.4	.270	.205	.322	.540	.809	1.080		
2	457	1090	16	2	4.8+	2.36	2.0	.261	.196	.294	.436	.677	.972	1.312	
3	459	1094	16	3	4.4+	2.25	2.0	.259	.200	.307	.491	.690	.951		
4	317	1556	16	4	4.29	2.08	2.1	.253	.196	.261	.368	.513	.668	.864	1.055
5	758	1749	16	5	×	1.61	×	.226 .258 ×	.175	.282	.380	.570	.813		
6	714	1234	16	6	4.10	1.82?	2.3	.231	.162	.264	.448	.724	.978		
7	714	1236	16	7	×	2.15	×	.180	.138	.227	.362	.613	.975		
						Max.		.294	.233	.404	.613	.837	1.100	1.450	1.656
						Min.		.180	.138	.227	.362	.513	.668	.864	1.055
						Aver.		.249	.202	.318	.485	.710	.970	1.322	1.435
								17	20	20	21	21	17	7	3

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
1	—	2.5	2.1	2.3	2.1			—	—	.037	.057	.074	.087		
2	1.5	1.8	1.9	1.8	2.0	1.9		.019	.013	.030	.034	.048	.063	.069	
3	1.9	2.4	2.4	2.3	2.3			.025	.025	.041	.061	.066	.070		
4	—	—	1.8	1.8	1.9	1.8	1.8	.015	.014	.013	.019	.036	.036	.051	
5								.020	.021	.029	.035	.055	.060		
6								.014	.018	.030	.046	.072			
7								.017	.025	.035	.035	.072	.089		
Max.	1.9	2.5	2.4	2.4	2.3	1.9	1.8	.026	.026	.041	.064	.092	.089	.081	
Min.	1.5	1.5	1.5	1.5	1.6	1.7	1.6	.014	.014	.013	.019	.036	.036	.051	
Aver.	1.8	2.0	2.1	2.0	2.0	1.8	1.7	.019	.021	.031	.045	.059	.069	.067	.099
	5	8	9	9	7	3	2	7	9	11	12	13	11	3	1

Specimen	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5
1	29?	30	32	32							
2	31	40	47	—	36?						
3	—	—	37	26?							
4	35?	37	38	—	41?	43?					
5							8	12	16	16+	17+
6	18	18	29	27							
7							11	14	16	20	25
Max.	35?	40	47	32	41?		11	17	23	23	31
Min.	18	18	29	26?	31		8	12	16	16	17+
Aver.	28	29	36	28	36	43?	9	15	19	20	25
	4	5	6	4	3	1	3	4	4	4	4

Specimens 6 and 7 are referred to this species with question.

ness of 19 microns in seven specimens.

The septa are relatively widely spaced. In most parts of the shell they are seemingly coated by dense materials, forming club-shaped profiles in the sagittal sections. Average septal counts of the first to fifth volution in four specimens are 9, 15, 19, 20, and 25, respectively. The septa narrowly fluted throughout the length of the shell. The fluting reaches to the tops of the chambers in the polar regions, but it is half to two-thirds as high as the chambers in the central portion of the shell.

The tunnel is low and narrow throughout the growth, with somewhat irregular path. Average tunnel angles of the first to sixth volution of six specimens are 28, 29, 36, 28, 36, and 43? degrees, respectively. The chomata occur throughout all but for the outer one or two volutions. They are however rather rudimentary in development, being low and small, with steep to overhanging tunnel sides and less steep poleward slopes.

Remarks.—The above description is based on the materials obtained from the Akiyoshi limestone group. Although they are not sufficient for detailed comparison, they agree closely in all the measurable details with the types of "*Fusulina tschernyschewi*" from Timan, Russia. Because no exactly oriented axial section is available in my collection, further detailed discussion seems to be not advisable here.

Schwagerina tschernyschewi (SCHELLWIEN) is, like as *S. krotowi* (SCHELLWIEN), rather widespread in the Lower Permian formations of Japan, but has been described and illustrated by HUZIMOTO (1936) only from the Kwanto massif. As well as in the present materials no exactly oriented axial section is available in his specimens, but both the Akiyoshi and Kwanto forms are not recognized to be specifically distinguished from each other.

Occurrence.—*Schwagerina tschernyschewi* (SCHELLWIEN) was originally reported from the C_3^2 (Cora horizont) and C_3^3 (Schwagerinenkalk) of Timan, Russia, but its stratigraphical range in the Akiyoshi limestone group is limited only to the Plβ subzone. The true range of the species may, however, be a slightly longer than Plβ, ranging upward into Plγ or downward into Plα.

It has been obtained from the following localities: No. 1 limestone of Section XVIII (Loc. 317), No. 4 limestone of Section XXIV (Loc. 550), No. 8 limestone of Section XXVI (Loc. 758), and Loc. 457, 459, 475, 496, and 714.

Schwagerina regularis (SCHELLWIEN)

Pl. 16, figs. 8–15

1898. *Fusulina regularis* SCHELLWIEN. Palaeontographica, Vol. XLIV, pp. 250, 251, Pl. XIX, figs. 1–6.

1912. *Fusulina regularis* DEPRAT. Mém. Serv. Géol. l'Indochine. Vol. I, fasc. III, pp. 28, 29, Pl. VII, figs. 14, 15.
1927. *Schellwienia regularis* LEE. Palaeontologia Sinica, Ser. B, Vol. IV, fasc. 1, pp. 50–52, Pl. VII, figs. 8–10.
1936. *Pseudofusulina regularis* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 94, 95, Pl. X, figs. 9–11; Pl. XVIII, fig. 1.

The shell of *Schwagerina regularis* (SCHELLWIEN) is moderate in size and elongate fusiform, with straight to slightly arching axis of coiling, convex to slightly irregular lateral slops, and bluntly pointed poles. A typical specimen of five and a half volutions is 7.6 mm long and 2.7 mm wide, giving a form ratio of 2.8. Mature specimens of five to six volutions are 6.4 to 7.6 mm long and 1.8 to 3.3 mm wide, giving form ratios of 2.7 to 2.9. The first volution is subspherical to short fusiform. The polar ends of the succeeding one to two volutions are sharply pointed. The axis of coiling becomes rapidly extended in the outer volutions where the polar ends become less pointed. Average ratios of the half length to the radius vector of the first to sixth volution in eight specimens are 2.1, 2.4, 2.4, 2.5, 2.8, and 2.5, respectively.

The proloculus is relatively large and spherical, having an outside diameter of 176 to 280 microns and averaging 212 microns for thirty specimens. The shell coils relatively slowly in the first two volutions but expands rapidly and uniformly in the succeeding outer volutions. Average radius vectors above the tunnel in the first to sixth volution in thirty-five specimens are 167, 276, 446, 716, 1,027 and 1,347 microns, respectively. The chambers are about the same in height in the central half of the shell but increase poleward in the end half to third of the outer volutions.

The spirotheca is moderately thick for the size of the shell and distinctly alveolar. Alveoli are, however, not observable in the first one to one and a half volutions. The spirotheca is somewhat irregular in thickness in the outer volutions. Average thickness of the spirotheca above the tunnel in the first to sixth volution in twenty-eight specimens is 18, 30, 50, 72, 90, and 83 microns, respectively. The proloculus wall is considerably thick and apparently structureless, consisting of a single homogeneous layer. Average thickness of the proloculus wall is 19 microns in eleven specimens.

The septa are thin and moderately widely spaced, consisting of the downward deflection of the tectum and the distinct pycnotheca. In the inner volutions, however, the pycnotheca is sometimes hard to be discernible, and the septa are coated by the secondary deposits from the chomata, giving them a thick and pendant-shaped cross section. The lower margins of the septa are fluted throughout the length of the shell, but the upper margins are plane except in the polar extremities. Average septal counts of the first to sixth volution in twelve specimens are 10, 17, 21, 23, 26, and 28, respectively.

Table 52. Table of Measurements (in Millimeters) of *Schwagerina regularis* (SCHELLWIEN)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1	272	1539	16	8	7.60	2.70	2.8	.280	.219	.328	.568	.879	1.289	
2	322	1560	16	9	6.6+	2.25	2.9	.24?	.171	.267	.418	.613	.904	1.184
3	571	1673	16	10	6.43	2.41	2.7	—	—	.252	.430	.671	.980	1.320
4	272	1540	16	11	×	2.82	×	.221	.180	.261	.412	.661	.961	1.330
5	329	1568	16	12	×	1.67	×	.18?	.189	.309	.530	.830		
6	606A	1683	16	13	×	2.63	×	.230	.193	.291	.460	.733	1.043	1.416
7	329	1566	16	14	×	2.14	×	.181/.239 ×	.200	.328	.549	.810	1.110	
8	272	1540	16	15	×	2.20	×	.109	.135	.212	.331	.521	.862	1.201
							Max.	.280	.219	.328	.568	.920	1.289	1.660
							Min.	.176	.123	.187	.330	.521	.810	1.184
							Aver.	.212	.167	.276	.446	.716	1.027	1.347
								30	31	33	34	35	28	17

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of Spirotheca 0	1	2	3	4	5	6
1	2.1	3.3	3.0	2.8	2.8		.028	.024	.047	.080	.100	.122	
2	1.9	2.4	2.8	2.9	3.1	2.9	—	.016	.027	.048	.056	.096	.078
3	—	3.2?	2.6	3.0	3.0	2.7	—	—	—	.064	.080	.115	.067
4							.019	.018	.033	.052	.085	.089	.075
5							—	—	.042?	.056	.080		
6							.017	.020	—	.050	.088	.095	.084
7							.024	.028	.038	.058	.075	.094	
8							.016	.017	.023	.042	.066	.099	.089
Max.	2.8	3.3	3.0	3.0	3.5	2.9	.028	.028	.047	.085	.100	.122	.101
Min.	1.8	1.5	1.7	2.0	1.9	2.1	.013	.011	.016	.028	.047	.063	.062
Aver.	2.1	2.4	2.4	2.5	2.8	2.5	.019	.018	.030	.050	.072	.090	.083
	5	8	8	7	6	4	11	22	25	28	28	22	11

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5	6
1	33	37	34	42	49?						
2	—	—	48	49							
3	—	—	31	39	35						
4						9	16	20	25	29	30
5						12	18	21	25		
6						10?	19?	23?	27	25	32
7						11?	15?	21	27	27?	
8						10	15	17	22	25	26+
Max.			48	49	49?	13	21?	22	29?	29	32
Min.			31	39	35	7	14?	17	20?	23	24
Aver.	33	37	38	43	42	10	17	21	23	26	28
	1	1	4	4	2	11	12	12	11	6	4

The tunnel is wide with a path almost straight. Average tunnel angles of the first to fifth volution in four specimens are 33, 37, 38, 43, and 42 degrees, respectively. The chomata are only developed in the inner one or two volutions where they are low and asymmetrical.

Remarks.—A number of specimens here referred to *Schwagerina regularis* (SCHELLWIEN) are almost identical with the original types from the Carnic Alps.

So far has been reported, *Schwagerina regularis* (SCHELLWIEN) is known in Japan from the C_3 of the Kwanto massif, and the Dai and Serita formations of the western part of the Yamaguchi Prefecture (TORIYAMA, 1954). Of these only the form from the Kwanto massif was described and illustrated by HUZIMOTO (1936). None of his axial sections is exactly well oriented and is adequate to detailed comparison.

Occurrence.—This species has been obtained from the following localities: Nos. 6, 7, 9, and 12 limestones of Section III (Loc. 541, 542, 543A, and 546, respectively), No. 4 limestone of Section VIII (Loc. 322), No. 2 limestone of Section XII (Loc. 606A), No. 3 limestone of Section XIII (Loc. 571), No. 1 limestone of Section XXII (Loc. 329), No. 4 limestone of Section XXIII (Loc. 272), and Loc. 218*. The stratigraphical range of this species is the Plβ to Plγ subzone of the Akiyoshi limestone group, but it is more common in the former.

Schwagerina cf. *alpina* var. *rossica* (SCHELLWIEN)

Pl. 16, figs. 17–19

1908. *Fusulina alpina* var. *rossica* SCHELLWIEN, Palaeontographica, Vol. LV, pp. 171, 172, Pl. XV, figs. 5–13; Pl. XVI, figs. 1, 2.

Only two axial and one sagittal sections of this form have been obtained, which are tentatively referred to *Schwagerina alpina* var. *rossica* (SCHELLWIEN) with question. Although my material is not sufficient to give a full description, I describe and illustrate the species for completeness' sake.

The shell of *Schwagerina* cf. *alpina* var. *rossica* (SCHELLWIEN) is relatively large and elongate fusiform, with nearly straight axis of coiling, convex to somewhat irregular lateral slopes and broadly rounded poles. One of the illustrated axial section (Pl. 16, fig. 17) has a length of 8.6 mm and a width of 3.4 mm, giving a form ratio of 2.6. The first volution is seemingly subspherical or short fusiform, and the axis becomes extended rapidly from the second volution to the last. Ratios of the half length to the radius vector of the first, second, third, fifth, and sixth volution of the same section are 1.8, 2.3, 2.8, 2.9, and 2.4, respectively.

The proloculus is small and spherical, with an outside diameter of 138 to 198

* Loc. 218 belongs to the Dai formation described in Part II of this paper.

microns, averaging 175 microns in three specimens. The shell considerably tightly coils in the first two volutions, but expands rapidly from the third volution to maturity. Averages of the radius vectors of the first to sixth volution of three specimens are 162, 277, 478, 789, 1,137, and 1,850? microns, respectively.

The spirotheca is typical for the genus, consisting of a tectum and a relatively coarse keriotheca. However alveoli cannot be discernible in the inner volutions. The spirotheca raipdly increases in thickness, averaging 17, 33, 51, 79, and 90 microns, respectively, in the first to fifth volution of three specimens. The proloculus wall is also thin and seemingly structureless. It is measured 12 microns in the illustrated axial section.

The septa are thin and moderately spaced. They are formed of the downward deflection of the tectum and clear pycnotheca. The septal counts of the first to fifth volution of the illustrated sagittal section are approximately 8, 16, 21, 22, and 23, respectively. The septa are relatively narrowly and highly fluted throughout their length. The closed chamberlets are nearly half as high as the chambers in the central parts of the shell, and become higher poleward.

The tunnel is low and considerably broad and its path is nearly straight. The tunnel angles of the first to third volution of the illustrated axial section are 30, 36, and 44 degrees, respectively, and those of the second to fifth volution of another

Table 53. Table of Measurements (in Millimeters) of *Schwagerina* cf. *alpina* var. *rossica* (SCHELLWIEN)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector					
									1	2	3	4	5	6
1	608	1217	16	17	8.6+	3.38	2.6	.138	.147	.280	.564	.966	1.230	1.85?
2	273	1039	16	18	6.5?	2.26	2.9	.198	.189	.288	.471	.741	1.15?	
3	273	1041	16	19	×	2.35	×	.189	.151	.262	.401	.660	1.030	
							Aver.	.175	.162	.277	.478	.789	1.137	1.85?

Specimen	Ratio of Hl./Rv.						Thickness of Spirotheca					
	1	2	3	4	5	6	0	1	2	3	4	5
1	1.8	2.3	2.8	—	2.9	2.4	.012	.015	.039	.056	.100	.091
2	1.3	1.7	1·7	1.8	2.6?		—	.019	.027	.052	.080	
3							.019	.018	.033	.045	.056	.089
Aver.	1.6	2.0	2.2	1.8	2.7	2.4	.016	.017	.033	.051	.079	.090

Specimen	Tunnel angle					Septal count				
	1	2	3	4	5	1	2	3	4	5
1	30	36	44							
2	—	32	26	31	40?					
3						8	16?	21?	22?	23?
Aver.	30	34	35	31	40?					

axial section are 32, 26, 31, and 40 degrees, respectively. The chomata occur only in the inner three volutions and are rather rudimentary in development, being small and nearly symmetrical in the axial profile.

Remarks. — The specimens here referred to *Schwagerina alpina* var. *rossica* (SCHELLWIEN) with question are insufficient in number, from which not enough information for detailed specific comparison is available.

LEE (1927) pointed out that SCHELLWIEN's three varieties of "*Fusulina alpina*", *antiqua*, *fragilis* and *communis* are merely different in their stratigraphical occurrence, and that there is no reason to distinguish these varieties from "*F. alpina* s. str." owing the fact that forms approach all these varieties occur side by side in Yatzetsi, Shenhsien, Honan. So far as the Russian specimens are concerned the LEE's opinion seems to be correct, but judging from his illustrations, the majority of the Honan specimens have so much complicated and irregular septal fluting that they seemingly are not conspecific with *Schwagerina alpina* emend. LEE also insisted that one of variety, *rossica* only deserves to be an independent species because of having a stouter shape of shell and much more regularly folded septa. However SCHELLWIEN's illustrations (Pl. XV, figs. 5–13) show that their septa are not so regularly fluted, and *rossica* seemingly is distinguished from *alpina* s. str. in smaller size of the proloculus and slower rate of the expansion.

The Akiyoshi specimens fairly well agree with the Russian form in the size of the proloculus, the rate of expansion, and the intensity and irregularity of the septal fluting, but differ from the latter in having thicker shell and slightly thicker spirotheca in the outer volutions.

Further study of this form will be necessary before the definite specific determination is made.

Occurrence.—*Schwagerina* cf. *alpina* var. *rossica* (SCHELLWIEN) is known only from the following two localities: No. 5 limestone of Section XII (Loc. 608) and No. 5 limestone of Section XXIII (Loc. 273). The stratigraphical range of this species is restricted only to the Plβ subzone in the Akiyoshi limestone group.

Schwagerina cf. *otukai* (HUZIMOTO) (?)

Pl. 16, fig. 20

1936. *Pseudofusulina otukai* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 62, 63, Pl. VI, fig. 11; Pl. VII, figs. 1, 2.

Specimens here referred to *Schwagerina otukai* (HUZIMOTO) with question are very rare, being represented by only two axial sections collected from two localities. However, for completeness' sake, I briefly describe the species and illustrate one of the axial sections.

The shell of *Schwagerina* cf. *otukai* (HUZIMOTO) (?) is large and inflated fusiform, with nearly straight axis of coiling, convex to almost straight lateral slopes, and bluntly pointed poles. The illustrated specimen of six volutions is 8.3 mm long and 4.1? mm wide, giving a form ratio of 2.0. The shell retains almost the same axial profile throughout the growth. The ratios of the half length to the radius vector of the first to sixth volution of the illustrated axial section are 2.4, 2.2, 2.1, 2.5, 2.1, and 2.2, respectively.

The proloculus is relatively small. Its outside diameter is 240 microns in the illustrated axial section. That of another axial section (Rg. No. 1501) is 260 microns. The shell relatively tightly coils in the first three volutions but expands rapidly and nearly uniformly in the outer three volutions. The radius vectors of the first to sixth volution of the illustrated axial section are 192, 307, 442, 705, 1,165, and 1,613 microns, respectively. Those of another axial section are 208, 338, 574, 770, 1,180, and 1,530 microns, respectively. The chambers are almost the same in height throughout their length except for the extreme polar regions.

The spirotheca is typical for the genus. Alveoli of the keriotheca are rather coarse in the outer volutions but hardly discernible in the inner ones. The spirotheca rapidly increases in thickness from the first to the last volution. Thickness of 17, 27, 35, 61, 107, and 127 microns is measured in the first to sixth volution of the illustrated axial section, respectively.

The septa are highly and narrowly fluted throughout the length of the shell. The closed chamberlets almost reach to the tops of the chambers even in the central portion of the shell. The septal counts and other characters of the septa are unknown.

The tunnel is low and narrow with somewhat irregular path. The tunnel angles of the first to sixth volution of the illustrated axial section are 25, 24, 20, 25, 30?, and 27? degrees, respectively. The chomata occur in the inner volutions where they are asymmetrical with steep tunnel sides and gentle poleward slopes. They do not occur in the outer volutions. Dense deposits fill the axial portions of the chambers in the inner three volutions.

Remarks.—As described above the specimens here referred to *Schwagerina otukai* (HUZIMOTO) with question are so insufficient that enough information is not available for the specific comparison.

The Akiyoshi specimens of *S.* cf. *otukai*(?) differ from the type specimen* from Kanô-san, Kwanto massif in having a slightly smaller form ratio, larger proloculus, more rapid expansion of the shell, and thicker spirotheca in the outer volutions.

Occurrence.—The specimens here studied are obtained from No. 6 limestone of

* Since HUZIMOTO did not designate the holotype specimen, fig. 1 of Pl. VII (Rg. No. 472) is designated here as the lectotype of *Schwagerina otukai* (HUZIMOTO).

Section VI (Loc. 452) and Loc. 4, both of them are referable to the Plβ.

Schwagerina cf. *royandersoni* THOMPSON, WHEELER, and DANNER

Pl. 17, figs. 1, 2

1950. *Schwagerina andersoni* THOMPSON, WHEELER, and DANNER. Contrib. Cushman Found. Foram. Res., Vol. I, Pts. 3 & 4, pp. 55, 56, Pl. 4, figs. 1-5; Pl. 8, fig. 13 (?)

1953. *Schwagerina royandersoni* THOMPSON, WHEELER, and DANNER. Footnote of p. 547 in THOMPSON, PITRAT, and SANDERSON, Jour. Palaont., Vol. 27, No. 4.

Specimens here referred to *Schwagerina royandersoni* THOMPSON, WHEELER, and DANNER with question are very rare in my collection gathered from five localities. Since THOMPSON, WHEELER, and DANNER gave the description in detail, there is no need to add further description except for the difference between the

Table 54. Table of Measurements (in Millimeters) of *Schwagerina* cf. *royandersoni* THOMPSON, WHEELER, and DANNER

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector							
									1	2	3	4	5	6	7	8
1	567	2012	17	1	6.3+	4.0+	1.6	.184	—	.307	.430	.665	.965	1.296	1.730	2.004
2	552	1632	17	2	5.09	2.38	2.1	.156	.138	.233	.360	.613	.951	1.23+		
3	567	2015			×	0.77	×	.196	.170	.264	.400					
						Max.		.196	.170	.307	.430	.665	1.160	1.580	1.730	2.004
						Min.		.159	.107	.190	.280	.454	.725	1.058	1.316	1.603
						Aver.		.168	.133	.231	.357	.585	.936	1.244	1.505	1.804
								5	4	8	9	8	7	6	4	2

Specimen	Ratio of Hl./Rv.								Thickness of spirotheca								
	1	2	3	4	5	6	7	8	0	1	2	3	4	5	6	7	8
1	—	—	—	—	—	1.8	1.6	1.6	—	—	.027	—	.052	.062	.097	.097	.107
2	—	1.9	2.2	—	—	2.4			—	—	—	.047	.088	.085			
3									.015	.016	.029	.041					
Max.		1.9	2.9	2.4	2.2	2.4	2.2	1.8		.018	.029	.047	.088	.085	.122	.097	.107
Min.		1.9	1.7	1.7	1.4	1.5	1.6	1.6		.016	.014	.024	.051	.052	.065	.081	.089
Aver.	1.8	1.9	2.2	2.0	1.8	2.0	1.9	1.7	.015	.017	.025	.039	.059	.071	.092	.087	.098
	1	2	6	5	4	5	3	2	1	2	5	6	8	7	5	3	2

Specimen	Tunnel angle							Septal count		
	1	2	3	4	5	6	7	1	2	3
1	—	—	—	24	23	23	23			
2	27?	31	32	28	27					
3								11	15	18
Max.	27?	31	32	31	27	23				
Min.	23	21	26	20?	23	22				
Aver.	25	26	28	26	24	23	23			
	2	2	3	4	3	2	1			

American form from Washington and the Akiyoshi form.

Although the present materials are very insufficient in number and all the available sections are not exactly oriented it seems that the Akiyoshi form is considerably smaller. The holotype of *Schwagerina royandersoni* is 10.0 mm long and 5.2 mm wide, whereas the largest specimen at my disposal is about 6.3 mm long and 4.0 mm wide. They are also somewhat different in the mode of expansion of the shell; namely, the Akiyoshi form is a little faster in the inner five or six volutions in the rate of expansion, but slower in the outer two or three volutions. Another difference between them is the thickness of the spirotheca in the outer volutions. The holotype of *Schwagerina royandersoni* has a thickness of 191, 190, and 220 microns in the seventh to ninth volution, respectively, whereas the maximum thickness of the seventh and eighth volution in the Akiyoshi form is 97 and 107 microns, respectively.

Although the above differences are somewhat clear, all other important features are almost the same in both the forms. Therefore, two forms may represent regional variations of the same species, and the differences between them seemingly are not of enough magnitude to distinguish species.

Occurrence.—In British Columbia *Schwagerina royandersoni* THOMPSON, WHEELER, and DANNER was reported from the zone of *Yabeina*, associating with *Y. cascadensis* (ANDERSON) and *Codonofusiella duffelli*? THOMPSON, WHEELER, and DANNER, whereas the species seemingly has more wide stratigraphical range in the Akiyoshi limestone group; namely, it occurs in the Plβ subzone of Section XXIV and the Pmα and Pmβ subzones of Section X, but is not known in the Pmδ subzone which is considered to be equivalent with the zone of *Yabeina* in British Columbia. The specimens here studied have been obtained from Nos. 8 and 10 limestones of Section X (Loc. 567 and 568A, respectively), No. 5 limestone of Section XIV (Loc. 101), No. 1 limestone of Section XXIV (Loc. 552), and Loc. 784.

Schwagerina (?) *satoi* (OZAWA)

Pl. 17, figs. 3–8

1925. *Schellwienia satoi* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 44, 45, Pl. VIII, figs. 4, 6a, 8; Pl. IX, fig. 3?.

The shell of *Schwagerina* (?) *satoi* (OZAWA) is moderate in size and highly inflated fusiform, with straight axis of coiling, convex to slightly irregular lateral slopes, and bluntly pointed poles. A typical mature shell of six volutions is 6.0 mm long and 3.3 mm wide, giving a form ratio of 1.8. The ratios of the half length to the radius vector of the first to sixth volution in the same specimen are 2.0, 2.5, 2.2, 2.2, 1.8, and 1.8, respectively. These figures show that the shell is somewhat slender in the first two volutions and that the axis becomes extended gradually as the shell grows, retaining almost the same axial profiles in the outer volutions.

The proloculus is spherical and minute, with outside diameters of 100 to 199 microns, averaging 137 microns in seven specimens. The inner two to three volutions, sometimes three and a half volutions, are tightly coiled, but the shell expands rapidly from the third or fourth volution to the last. Average radius vectors of the first to sixth volution in ten specimens are 119, 196, 330, 590, 1,031, and 1,593 microns, respectively. The height of the chambers is nearly the same throughout

Table 55. Table of Measurements (in Millimeters) of *Schwagerina* (?) *satoi* (OZAWA)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1*	OZAWA's type	I-71	17	4	6.70	3.23+	2.1	—	.08?	.153	.276	.555	1.043	1.588
2	337	1056	17	3	5.98	3.32	1.8	.130	.101	.165	.280	.601	1.180	1.730
3	15	602	17	5	×	2.68	×	.199	.144	.22?	.33?	.445	.781	1.33?
4	15	601	17	6	×	3.11	×	.109	.107	.178	.310	.571	1.030	1.571
5	337	1058	17	7	×	2.54	×	.100	.095	.155	.261	.461	.780	1.360
							Max.	.199	.144	.250	.424	.770	1.280	1.850
							Min.	.100	.089	.155	.261	.445	.770	1.33?
							Aver.	.137	.119	.196	.330	.590	1.031	1.593
								7	7	7	9	10	10	8

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6
1*	2.1	1.9	1.9	1.7	1.8	2.3	—	—	.017	.020	.050	.064	.080
2	2.0	2.5	2.2	2.2	1.8	1.8	—	.014	.014	.037	.056	.066	.085
3							.018	.018	.019	—	.036	.071	.073
4							.016	.020	.021	.027	.045	.045	.086
5							—	.017	.017	.028	.049	.051	.069
						Max.	.018	.020	.021	.037	.061	.071	.086
						Min.	.016	.013	.014	.026	.036	.046	.046
						Aver.	.017	.016	.019	.029	.042	.058	.073
							2	6	6	5	7	8	7

Specimen	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5	6
1*	29	29	29	37	36	24?						
2	22	30	34	34	29	23?						
3							—	15?	—	—	—	
4							8	13	16	19	21	
5							9	14	17?	20	27?	26?
Max.	—	—	—	—	—	—	9	15	20	24	27	34?
Min.	—	—	—	—	—	—	8	13	16	19	21	26?
Aver.	22	30	31	33	34	23	9	14	18	21	25	30
	1	1	2	2	2	1	2	4	3	4	4	2

* The statistics of the specimen 1 is excluded from the averages.

the length of the shell except for the extreme polar regions.

The spirotheca is typical in structure for the genus, consisting of a tectum and a finely alveolar keriotheca. It is considerably thin in the earlier part of the shell, but increases in thickness rather rapidly in the inflated outer volutions. Average thickness of the first to sixth volution for eight specimens is 16, 19, 29, 42, 58, and 73 microns, respectively. The proloculus wall seems to be thin, being 16 microns in one of sagittal sections (Pl. 17, fig. 6).

The septa are very thin, being composed of the downward deflection of the tectum and the pycnotheca, the latter of which is, however, not observable in some parts of the shell. They are narrowly spaced in the first two to three volutions and become moderate in spacing in the outer ones. They are fluted almost throughout their length, but the fluting is more intense in the polar regions where the closed chamberlets extend almost to the tops of the chambers. Average septal counts of the first to sixth volution in four specimens are 9, 14, 18, 21, 25, and 30, respectively.

The tunnel is low and narrow in the earlier volutions and only slightly widens in the outer ones. Average tunnel angles of the first to sixth volutions of two specimens are 22, 30, 31, 33, 34, and 23 degrees, respectively. The chomata are low and highly asymmetrical in the inner volutions, extending almost to the polar extremities. In the outer volutions, however, they become more rudimentary and less asymmetrical, and are seemingly discontinuous at least in some parts.

Remarks.—The above description of *Schwagerina* (?) *satoi* (OZAWA) is based on a part of the OZAWA's original specimens and several ones collected by myself, none of which is, however, exactly oriented.

As already pointed out by the original author, this form is gradational in nature between two genera, *Schwagerina* and *Pseudoschwagerina*. So far as the mode of expansion of the shell and the thickness of the septa are concerned, this species is more likely referable to the genus *Pseudoschwagerina*. The OZAWA's axial section (section number I-71, illustrated as Pl. VIII, fig. 8 in his 1925' paper and also as Pl. 17, fig. 4 in this paper), which is only an available section* in his collection, shows that the septa of this form flute not so weakly as are seen in species of *Pseudoschwagerina*, but relatively strongly flute even in the median portion of the shell except in the inner volutions. Such being the case, it seems advisable, at least at present, to refer this species to the genus *Schwagerina* rather than to *Pseudoschwagerina*.

Occurrence.—*Schwagerina*(?) *satoi* (OZAWA) is rare in the Akiyoshi limestone group and is known only from the following localities: No. 8 limestone of Section III

* It is unfortunate to us that the specimen illustrated as Pl. VIII, fig. 6a is missing in his collection.

(Loc. 543), No. 4 limestone of Section XIV (Loc. 103), No. 6 limestone of Section XXI (Loc. 337) and Loc. 15. The stratigraphical range of this species is restricted to the basal subzone of the Permian part of the Akiyoshi limestone group.

It is unfortunate that I have not been able to find the species at Ueyama and Hoso-ono whence OZAWA reported it originally.

Schwagerina sp. A

Pl. 17, figs. 9–11

Several specimens referable to *Schwagerina* sp. A have been sectioned from the limestones of the *Neoschwagerina* and *Yabeina* zones. Although I have not been able to obtain enough well-oriented sectiones of this form to observe the pertinent data concerning its individual variations, I briefly describe and illustrate some of this form for the sake of completeness. The following description is based on about ten thin sections.

The shell is of medium, and elongate fusiform to sub-cylindrical, with nearly flat to slightly depressed median portion, convex lateral slopes, and narrowly pointed poles. Mature specimens of six to seven volutions are 4.3 to 6.1 mm long and 1.8 to 2.7 mm wide, giving a form ratio of about 2.4 to 2.7. The shell seemingly retains nearly the same axial profile throughout the growth except in the earliest stage.

The proloculus is small and spherical, with an outside diameter of 148 to 276 microns, averaging 224 microns for eight specimens. The shell tightly coils in the first two volutions and expands rather rapidly and almost uniformly from the third volution to maturity. Average radius vectors of the first to seventh volution for ten specimens are 171, 242, 366, 549, 787, 1,055, and 1,301 microns, respectively.

The spirotheca is thin and relatively coarsely alveolar. Average thickness of the spirotheca of the first to sixth volution in ten specimens is 16, 23, 40, 54, 63, and 78 microns, respectively. The proloculus wall is also thin and is seemingly structureless. It is measured 11 microns in one specimen and 17 microns in another.

The septa seem to be highly and narrowly fluted throughout their length. The closed chamberlets reach to the tops of the chambers even in the median portion of the shell. The septa are formed by the downward deflection of the tectum and dense structureless materials which are mainly present on the posterior side of the septa. Average septal counts of the first to fifth volution of two specimens are 10, 17, 18, 20, and 23, respectively.

The tunnel is low but relatively broad. Its path is considerably irregular. Because there is no exactly oriented axial section, the tunnel angle cannot be measured. The chomata occur only in the earlier volutions in very rudimentary form. The secondary deposits fill the chambers in the axial area of most of the outer volutions except for the last one or two volutions.

Table 56. Table of Measurements (in Millimeters) of *Schwagerina* sp. A

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1	98	2121	13	9	5.5?	2.20	2.5	.275	.196	.294	.482	.644	.820	1.006	
2	369	2198	13	10	4.34	1.80	2.4	.201	.147	.205	.320	.460	.665	.81?	
3	369	2198	13	11	×	1.76	×	.218	.172	.270	.390	.537	.736	.920	
							Max.	.275	.210?	.294	.482	.644	.920	1.226	1.330
							Min.	.148	.132	.196	.270	.460	.665	.81?	1.272
							Aver.	.224	.171	.242	.366	.549	.787	1.055	1.301
								8	9	10	10	10	9	9	2

Specimen	Thickness of spirotheca 0	1	2	3	4	5	6	7	Ratio of Hl./Rv. 1	2	3	4	5	6
1	—	—	—	.039	.047	.060	.077		—	—	—	2.9	2.7	2.7
2	.011	.018	.024	.030	.041	.046			1.7	2.4	2.7	2.9	2.6	2.9
3	.017	—	.026	.031	.042	.044								
Max.	.017	.020	.034	.062	.075	.094	.099							
Min.	.011	.012	.019	.030	.040	.044	.055							
Aver.	.014	.016	.023	.040	.054	.063	.078	.071						
	2	5	8	10	9	9	6	1						

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5
1	—	41?	30?							
2	36	48	46	41	52?					
3						14	20	23	26	30

Remarks.—*Schwagerina* sp. A resembles *S. tschernyschewi* (SCHELLWIEN) in some respects, but differs from the latter in having slower rate of expansion and thinner spirotheca. Because of the insufficiency of the present material more detailed specific comparison is not advisable here, but this species seemingly is a little more advanced biologically than *S. tschernyschewi*.

Further study of this form will be necessary before a definite specific assignment is done.

Occurrence.—*Schwagerina* sp. A is rare in the occurrence and was obtained from No. 6 limestone of Section X (Loc. 523), No. 2 limestone of Section XIV (Loc. 98), No. 1 limestone of Section XXVII (Loc. 1), and Loc. 369 and 379. It seemingly is wide in the stratigraphical occurrence, ranging from the Pmα to Puα.

Schwagerina sp. B

Pl. 17, figs. 12–15

Samples from Nos. 2 and 7 limestones of Section XII (Loc. 606A and 610, respectively) at Isa-machi and No. 7 limestone of Section IV (Loc. 720) of Akago, Mito-cho, contain scattered specimens of a species of *Schwagerina* that differs considerably from the forms described above. I have not obtained a sufficient number of well-oriented axial sections of this form to give a full description. For the sake of completeness, however, I illustrate some of this form and give the following description.

The exact external form of the shell is unknown, but it seemingly has inflated fusiform. One diagonal (nearly axial) section is 5.1 mm long and 2.6 mm wide.

The proloculus is small and spherical. Its outside diameter is 148 to 224 microns, averaging 185 microns in six specimens. The shell tightly coils in the inner two to two and a half volutions, but expands very rapidly in the outer volutions except in the last one which is slightly more tightly coiled than the penultimate volution. The radius vectors of the first to seventh volution of a typical sagittal section (Pl. 17, fig. 13) are 138, 202, 260(?), 390, 661, 1,040, and 1,470 microns, respectively. Average radius vectors of the first to sixth volution of six specimens are 148, 221, 351, 604, 802, and 1,067 microns, respectively.

The spirotheca consists of a tectum and finely alveolar keriotheca. Alveoli of the latter are, however, not discernible in the inner two or three volutions. Average thickness of the spirotheca of the first to sixth volution for six specimens is 16, 29, 41, 55, 71, and 65 microns, respectively. The proloculus wall is thin, averaging 17 microns in three specimens.

The septa are very thin, composed mainly of the downward deflection of the tectum. In the tightly coiled part of the shell the septa are thickened by coating of the secondary materials. Average septal counts of the first to fifth volution for three specimens are 9, 16, 20, 22, and 26, respectively. The septa seem to be fluted more or less strongly and nearly uniformly throughout the length of the shell. Thin phrenotheca is well developed throughout all but the inner two or three volutions.

The true nature of the tunnel and the chomata is not understood, because well oriented axial section of this species is not available. So far has been observed in the illustrated diagonal section, however, the chomata present in the second volution, although they are very rudimentary in development.

Remarks.—*Schwagerina* sp. B is clearly intermediate between the genera *Schwagerina* and *Paraschwagerina* in the mode of coiling of the shell and of the septal fluting. It somewhat resembles *Schwagerina satoi* (OZAWA), but differs from the latter in being the shell more slowly expanded in the later stage of the growth

Table 57. Table of Measurements (in Millimeters) of *Schwagerina* sp. B

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector						
									1	2	3	4	5	6	7
1	606A	1686	17	12	5.10	2.62	2.0	.179	.169	.245	.374	.705	1.180		
2	606A	1685	17	13	×	2.79	×	.161	.138	.202	.26+	.390	.661	1.040	1.470
3	606A	1684	17	14	×	2.62	×	.178	.138	.208	.316	.537	1.055	1.425	
4	606A	1685	17	15	×	—	×	.158	.104	.153	.236	.356	.736		

Specimen	Ratio of Hl./Rv.					Thickness of spirotheca						
	1	2	3	4	5	0	1	2	3	4	5	6
1	1.3	1.8	2.1	2.2	2.0	—	.014	.021	.032	.062	.082	
2						—	—	—	—	.028	.057	.066
3						.021	.015	.025	.030	.041	.073	.063
4						.014	.015	.020	.021	.039	.045	.054

Specimen	Tunnel angle				Septal count				
	1	2	3	4	1	2	3	4	5
1	—	27?	39	38?					
2					9 ?	—	18	25?	27?
3					—	16?	19?	24?	
4					11	16	18	21	23?

and having more complicated fluting of the septa.

Schwagerina sp. B does not resemble any form of other schwagerinids found in the Akiyoshi limestone group. Although this form may be an undescribed new species, sufficient information to describe the species has not been available from the specimens here referred to *S.* sp. B.

Occurrence.—*Schwagerina* sp. B is relatively common in the Loc. 606A among three localities cited above, all of them are referable to the Plβ subzone.

Schwagerina sp. C
Pl. 17, figs. 16–18

Specimens here referred to *Schwagerina* sp. C were obtained from No. 4 limestone of Section X (Loc. 521) and Loc. 498 and 784. Although they are extremely insufficient to describe the species, they are somewhat similar to *Schwagerina douvillei* (COLANI) from the Lower Permian of Yunnan. The specimens of *S.* sp. C have, however, larger radius vector for the corresponding volutions, considerably larger proloculus, and more numerous septa for the corresponding volutions than those of *S. douvillei* (COLANI). Although none of the present materials is well oriented I am illustrating three of them for completeness' sake.

Table 58. Table of Measurements (in Millimeters) of *Schwagerina* sp. C

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7	8
1	498	2040	17	16	5.70	3.32	1.7	.27+	.205	.330	.482	.671	.860	1.170	1.530	
2	784	1257	17	17	5.84+	5.20	1.1+	—	.132	.221	.383	.644	1.070	1.650	2.115	2.530
3	498	2039	17	18	×	4.02	×	.16?	.153	.227	.421	.770	1.076	1.441	1.840	

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 1	2	3	4	5	6	7
1	—	—	—	1.5	1.7	1.5		—	—	.037	.055	.056	.058	.081
2	1.7	1.8	1.6	1.3	1.1	1.2	1.2	.016	.027	.048	.084	.100	.075	.081
3								—	—	.041	.073	.080	.091	.109

Specimen	Tunnel angle 3	4	5	6	7	Septal count 2	3	4	5	6
1	23	20	26	25	30?					
2	—	25	31	33?	21?					
3						16	24	28	33?	37?

Genus *Paraschwagerina* DUNBAR and SKINNER, 1936

Subgenus *Paraschwagerina* DUNBAR and SKINNER, 1936

Paraschwagerina (*Paraschwagerina*) *akiyoshiensis* TORIYAMA, n. sp.

Pl. 18, figs. 1–14

The shell of *Paraschwagerina* (*Paraschwagerina*) *akiyoshiensis* TORIYAMA, n. sp. is inflated fusiform with almost straight axis of coiling, convex to straight lateral slopes and bluntly pointed poles. The holotype specimen of seven volutions is about 7 mm long and 4 mm wide, giving a form ratio of 1.8. The first three to four volutions are elongate fusiform and very tightly coiled, with sharply pointed poles, but the relative width of the shell increases sharply outward from the fourth or fifth volution. The ratios of the half length to the radius vector of the first to seventh volution of the holotype specimen are 2.5, 2.3, 2.5, 2.4, 1.8, 1.5, and 1.7, respectively.

The proloculus is spherical and minute, with outside diameters of 84 to 133 microns, averaging 109 microns in eight specimens. The first to third volutions are very tightly coiled, followed by the fourth volution which expands a little rapidly. The fifth and sixth volutions are highly inflated, but the ultimate volution is slightly more tightly coiled than the penultimate one. Average radius vectors of the first to seventh volution of thirteen specimens are 87, 144, 228, 510, 1,021, 1,540, and 2,150 microns, respectively. The chambers are nearly the same in height across the central three-fourths of their length.

The spirotheca is thin in the inner three volutions and becomes moderately thick in the outer volutions where it has relatively coarse alveoli. Average thickness of the spirotheca in the first to sixth volution of twelve specimens is 13, 16, 22, 34, 43, and 69 microns, respectively. The thickness of the spirotheca of the seventh volution of the holotype specimen is measured 84 microns. The spirotheca is almost the same in thickness throughout the central half to two-thirds of the shell, thinning slowly poleward. The proloculus wall is also thin and structureless, attaining a thickness of 14 microns in the holotype specimen and averaging 13 microns in four specimens.

The septa are thin and numerous. The exact number of the septa is hardly counted because of the complex fluting, but averages 7, 14, 18, 23, and 29 septa, respectively, in the first to fifth volution of nine specimens. The septa are strongly and rather irregularly fluted throughout the length of the shell, forming many chamberlets of round to irregular shape which extend almost to the tops of the chambers. One septum is brought in contact with the preceding one near the top of the chamber, while it is joining with another one near the base at the same time. Thus, many chamberlets of irregular shape are appeared even in the sagittal sections.

The tunnel is low and narrow in the inner volutions and becomes gradually wide in the outer volutions. The tunnel angles of the first to fifth volution of the holotype specimen is 22, 22, 28, 28, and 33 degrees, respectively. The chomata occur only in the tightly coiled inner volutions where they are more or less asymmetrical in the axial profile, with steep tunnel sides and gentle poleward slopes which extend one-fifth to one-fourth of the distance to the pole. The phrenotheca develops in the outer loosely coiled volutions. No secondary deposit is observed.

Remarks.—Paraschwagerina (Paraschwagerina) akiyoshiensis TORIYAMA, n. sp. is considered to be an intermediate form from *Paraschwagerina (Paraschwagerina)* to *Paraschwagerina (Acervoschwagerina)*.

As pointed out by THOMPSON (1948), *Paraschwagerina (Paraschwagerina)* includes rather two distinct groups; the extreme of one group is represented by the genotype of the genus, *Paraschwagerina gigantea* (WHITE), which has rather elongate shell with sharply pointed poles, relatively thick spirotheca and closely and highly fluted septa throughout the length of the shell; the typical representative of the other group is *P. yabei* (STAFF) which has subglobular shell with rounded polar areas, considerably thin spirotheca and rather weakly fluted septa of the outer volutions. Seemingly *Acervoschwagerina* is a derivative from the latter group.

So far as the irregularity of the septal fluting is concerned, *Paraschwagerina (Paraschwagerina) akiyoshiensis* TORIYAMA, n. sp. is intermediate between the second group of *Paraschwagerina* and *Acervoschwagerina*, but it is more likely

Table 59. Table of Measurements (in Millimeters) of *Paraschwagerina* (*Paraschwagerina*) *akiyoshiensis* TORIYAMA, n. sp.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1*	613	881	18	1	7.02	3.97	1.8	.112	.080	.123	.182	.281	.700	1.501	2.150
2	613	923	18	2	4.07+	2.47	1.7	.102	.092	.126	.184	.338	.766	1.313	
3	606A	1688	18	3	4.40	2.68	1.7	—	—	.162	.260	.460	.919	1.470	
4	613	911	18	4	×	2.20+	×	.133	.107	.175	.226	.858	1.290		
5	613	902	18	5	×	2.25	×	.128	.095	.172	.297	.613	1.052		
6	613	888	18	6	×	2.73	×	.087	.067	.102	.151	.321	.922	1.450	
7	613	819	18	7	×	2.31	×	.113	.095	.150	.230	.516	1.132		
8	613	860	18	8	×	2.79	×	—	—	—	.205	.427	.852	1.32?	
9	613	900	18	9	×	2.95	×	.116	.091	.148	.254	.60?	1.262		
10	475	1446	18	10	×	3.24	×	.085	.080	.128	.260	.528	1.180	1.69?	
						Max.		.133	.107	.175	.297	.858	1.290	2.040	
						Min.		.084	.067	.102	.151	.281	.700	1.313	
						Aver.		.109	.087	.144	.228	.510	1.021	1.540	2.150
								8	11	12	13	13	13	7	1

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6	7
1*	2.5	2.3	2.5	2.4	1.8	1.5	1.7	.014	.012	.013	.018	.032	.050	.075	.084
2	1.4	1.4	1.4	1.8	1.4	1.6		—	.014	.013	.018	.025	.030	.059	
3	—	2.1	2.3	2.5	1.8	1.5		—	—	—	.026	.050	.056	.073	
4								.011	.014	.019?	.030	.058	.052		
5								.016	.012	.016	.025	.035			
6								—	—	—	.013	.021	.028		
7								—	—	.015	.017	.028	.043		
8								—	—	—	—	.027	.035	.050	
9								—	.012?	.017	.026	.044	.063		
10								.009	—	.016	.025	.040	.048		
Max.	2.5	2.3	2.5	2.5	1.8	1.6		.016	.014	.019	.030	.058	.063	.088	
Min.	1.4	1.4	1.4	1.8	1.4	1.5		.009	.012	.013	.013	.019	.028	.050	
Aver.	1.8	1.9	2.1	2.2	1.7	1.5		.013	.013	.016	.022	.034	.043	.069	
	2	3	3	3	3	3		4	5	8	11	12	10	5	

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5
1*	22	22	28	28	33					
2	—	24	32	33	35					
3	—	35	48							
4						8	16	18	22?	
5						8	13	18	20	27
6						7 ?	12?	16?	19?	31?
7						—	12?	18?		
8						—	—	19?	28?	
9						—	—	—	—	
10						—	—	18?	25?	29?
Max.		35	48	33	35	8	16	19?	28?	31?
Min.		24	28	28	33	7	12	16?	19?	27
Aver.	22	27	36	31	34	7	14	18	23	29
	1	3	3	2	2	5	7	9	8	5

* Holotype specimen

referable to the former in general aspects. *P.* (*P.*) *akiyoshiensis* n. sp. somewhat resembles *Schwagerina tinvenkiangi* LEE from Yatzetsi, Honan, China, but is distinguished from the latter by its shell form and more highly and irregularly fluted septa.

Occurrence.—*Paraschwagerina* (*Paraschwagerina*) *akiyoshiensis* TORIYAMA, n. sp. has been collected from the No. 15 limestone of Section I (Loc. 297), No. 5 limestone of Section VII (Loc. 436), No. 2 limestone of Section XII (Loc. 606A), No. 1 limestone of Section XIII (Loc. 570), and Loc. 475 and 613. The stratigraphical distribution of the species seemingly is narrow, being restricted within the Plβ subzone in the Akiyoshi limestone group.

Genus *Pseudoschwagerina* DUNBAR and SKINNER, 1936

Subgenus *Pseudoschwagerina* DUNBAR and SKINNER, 1936

Pseudoschwagerina (*Pseudoschwagerina*) *muongthensis* (DEPRAT)

Pl. 18, figs. 15–18; Pl. 19, figs. 1–9

1915. *Fusulina muongthensis* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. IV, fasc. 1, pp. 5, 6, Pl. II, figs. 1–6.

1925. *Schellwienia muongthensis* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 47, 48, Pl. VIII, figs. 1, 2.

1927. *Schwagerina muongthensis* LEE. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 1, p. 120, Pl. XXIII, figs. 3, 4, 2?.

1938. *Schwagerina muongthensis* RAUSER-CERNOUSSOVA. Travaux l'Institut géol. Acad. Sci. U. S. S. R., Tome VII, pp. 131, 132, Pl. VII, fig. 4.

The shell of *Pseudoschwagerina* (*Pseudoschwagerina*) *muongthensis* (DEPRAT) is moderate in size and robustly fusiform in shape, with almost straight axis of coiling, convex lateral slopes, and broadly rounded poles. Mature specimens of six to seven volutions are 3.9 to 7.3 mm long and 2.4 to 4.9 mm wide, giving form ratios of 1.3 to 1.7. The first volution seems to be subspherical in shape. The following two, rarely three, volutions are fusiform to elliptical in axial profile with more or less sharply pointed poles. Beyond the fourth or fifth volution the shell retains robustly fusiform. Average ratios of the half length to the radius vectors of the first to seventh volution of seven specimens are 2.0, 2.0, 2.0, 1.8, 1.5, 1.4, and 1.5, respectively.

The proloculus seemingly is minute. Its outside diameter is approximately 100 microns in an axial section. The shell expands slowly during the first three volutions, but beyond them the chambers increase in height rapidly. The last volution of some specimens is slightly more tightly coiled than the penultimate one. Average radius vectors of the first to seventh volution in twelve specimens are 98, 192, 327, 618, 1,101, 1,615, and 2,001 microns, respectively.

The spirotheca is relatively thin and gradually increases in thickness. Average thickness of the spirotheca in the first to seventh volution in twelve specimens is 13, 21, 30, 43, 59, 83, and 117 microns, respectively. Alveoli of the spirotheca are relatively coarse. About 6 alveoli are observed in a space of 100 microns in the outer volution of an axial section. However, they are not recognized in the inner volutions of most specimens.

The septa are also thin, and relatively widely spaced in the outer volutions. The exact septal counts in the inner volutions are unknown, but the approximate averages of the septal count of the second to sixth volution in five specimens are 13, 17, 18, 23, and 25, respectively. Although the detailed structure of the septa in the inner volution is not clear, the septa seemingly consist only of the downward deflection of the tectum of the spirotheca in the outer volutions, except in the last one or two volutions where they are slightly coated with the secondary deposits. The tips of the septa are thickened in most of specimens. The septa are broadly or slightly irregularly fluted throughout their height and length in the outer three to four volutions but are almost plane in the inner three volutions. The fluting in the outer volutions is slightly more intense in the polar regions than in the middle part of the shell.

The tunnel is narrow in the inner three volutions, increasing in width gradually beyond the fourth volution, but slightly decreasing in the last one or two volutions. Average tunnel angles of the first to sixth volution in four specimens are 23, 26, 31, 43, 47, and 35 degrees, respectively. The tunnel path is not straight. The chomata are highly asymmetrical in the inner three to four volutions, extending one-third to half of the distance to the poles. They are, however, very rudimentary or absent in the outer volutions, being almost symmetrical in cross section.

Remarks.—The above description is based entirely upon the Akiyoshi specimens, although they are not sufficient in number and I have not been able to obtain enough number of exactly oriented section. However, all the essential characters of the Akiyoshi form so well agree with those of the Tonkin form that it is almost impossible to find any difference between them.

As cited in the synonymy this species was already reported by OZAWA from the Tombstone Region and Serita in the Akiyoshi area. His specimens are also indistinguishable from the DEPRAT's original form. Besides this, *Pseudoschwagerina* aff. *muongthensis* (DEPRAT) was reported from the lower subzone of the *Pseudoschwagerina* zone of the Tobiishi group in the Southern Kyushu (KANMERA, 1952), but has not been described yet.

LEE (1927) and RAUSER-CERNOUSSOVA (1938) respectively described and illustrated this species from the Wuhutsui coalfield, South Manchuria and Samara Bend. Their specimens are, however, not sufficient, and, therefore, the detailed specific

Table 60. Table of Measurements (in Millimeters) of *Pseudoschwagerina* (*Pseudoschwagerina*) *muongthensis* (DEPRAT)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1	269	1444	18	15	5.8+	3.75	1.4	—	.116	.187	.307	.442	.803	1.275	1.715
2	269	1440	18	16	3.93	3.45	1.1	.100?	.090?	.182	.301	.569	1.260	1.92?	
3	269	1445	18	17	3.86	2.38	1.6	—	.112	.172	.270	.443	.740	1.284	
4	568B	1197	18	18	6.1+	4.82	1.3	—	—	—	.270	.588	.99?	1.55?	2.12
5	258	617	19	1	×	3.00	×	—	.111	.198	.368	.789	1.310	1.850	
6	269	1442	19	2	×	2.79	×	—	—	—	.33+	.520	1.070	1.480	
7	269	1445	19	3	×	2.90	×	—	—	.184	.285	.457	.951	1.517	
8	717	1453	19	4	×	4.90	×	—	.08?	.151	.365	.813	1.293	1.970	
9	568B	1197	19	5	×	4.56	×	—	—	—	—	.52?	1.290	1.870	2.480
10	717	1454	19	6	—	3.86	—	—	.083	.132	.215	.386	.663	1.064	1.573
						Max.		—	.116	.198	.368	.813	1.360	1.970	2.480
						Min.		—	.083	.132	.215	.386	.663	1.064	1.573
						Aver.		—	.098	.192	.327	.618	1.101	1.615	2.001
								—	6	8	10	12	12	11	5

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 1	2	3	4	5	6	7
1	1.7	1.6	1.8	2.3	2.1	1.9	1.8	.012	.016	.019	.037	.047	.101	
2	—	—	1.8	1.6	1.1	1.1		—	—	.047	.066	.085	.113	
3	2.3	2.4	2.3	2.3	2.1	1.6		—	.021	.026	.036	.055	.064	
4	—	—	—	1.6	1.5	1.3	1.3	—	—	.020	.021	.041	.065	.107
5								.014	.028	.037	.042	.061	.080	
6								—	—	—	.052	.066	.094	
7								—	—	.025	.042	.060	.070	
8								—	.018	.041	.070	.087		
9								—	—	—	.032	.047	.101	.118
10								—	—	.026	.030	.030	.037	—
Max.	2.3	2.4	2.3	2.3	2.1	1.9	1.8	.014	.028	.047	.070	.087	.113	.127
Min.	1.7	1.6	1.8	1·6	1.1	1.1	1.3	.012	.016	.019	.021	.034	.037	.107
Aver.	2.0	2.0	2.0	1.8	1.5	1.4	1.5	.013	.021	.030	.043	.059	.083	.117
	2	2	3	6	7	7	4	2	4	8	11	12	11	3

Specimen	Tunnel angle 1	2	3	4	5	6	7	Septal count 2	3	4	5	6
1	26	27	23	33	47	36	38?					
2	—	27	37	47	40							
3	19	23	34	50	53							
4	—	—	—	—	46	34						
5								12?	17?	17?	21?	
6								—	20?	21?	24?	
7								14?	15?	15?	21?	
8								—	—	17?	28?	26?
9								—	—	—	20?	23?
10								—	—	—	—	—
Max.	26	27	37	50	53	36		14?	20?	21?	28?	26?
Min.	19	23	23	33	40	34		12?	15?	15?	20?	23?
Aver.	23	26	31	43	47	35	38	13	17	18	23	25
	2	3	3	3	4	2	1	2	3	4	5	2

comparison between these forms and the Akiyoshi one is not advisable here.

Occurrence.—Pseudoschwagerina (Pseudoschwagerina) muongthensis (DEPRAT) was obtained from No. 4 limestone of Section IV (Loc. 717), No. 11 limestone of Section X (Loc. 568B), No. 2 limestone of Section XXI (Loc. 258), No. 1 limestone of Section XXIII (Loc. 269), and Loc. 548. This species is characteristic of the Lower Permian in the Tethys region, and seemingly is restricted to the Plα and Plβ subzones in the Akiyoshi limestone group, although more common in the former.

Pseudoschwagerina (Pseudoschwagerina) sp.

Pl. 19, figs. 10, 11

A single specimen of *Pseudoschwagerina (Pseudoschwagerina)* sp. has been found in No. 9 limestone of Section XVI (Loc. 746). A sagittal section illustrated by OZAWA as *Schwagerina muoungthensis* (DEPRAT) [Pl. VIII, fig. 2 in his monograph (1925)] seemingly is conspecific with this species. The following description is based on these two specimens.

The shell of *Pseudoschwagerina* sp. is large and ventricose, with broadly rounded poles and convex lateral slopes. The illustrated axial section of four volutions is approximately 7.2 mm in length and 4.2 mm in width with a form ratio of 1.7. The shell assumes nearly the same axial profile throughout the growth, excepting the first volution which takes a fusiform with more or less pointed poles. The ratios of the half length to the radius vector of the first to fourth volution of the axial section are 1.6, 1.5, 1.6, and 1.6, respectively.

The proloculus is spherical with an outside diameter of 430 microns in the axial section and 393 microns in the OZAWA's sagittal section. The shell considerably tightly coils in the first volution, but from the second volution it expands very rapidly and slightly declines in height in the last volution. The radius vectors of the first to fourth volution of the axial section are 360, 1,055, 1,787, and 2,440 microns, respectively. Those of the first to fifth volution of the sagittal section are 300, 528, 1,031, 1,711, and 2,245 microns, respectively. The chambers are nearly the same in height throughout the length of the shell, although they are lowest in the middle of the shell, increasing in height very slightly towards the poles.

The spirotheca is typical in structure for the genus and is finely alveolar and moderate in thickness. The thickness of the spirotheca is 26, 39, 73, and 73 microns, respectively, in the first to fourth volution of the axial section, and is 30, 54, 79, 94, and 102 microns, respectively, in the first to fifth volution of the sagittal section. The proloculus wall is rather thick, attaining a thickness of 25 and 28 microns, respectively, in the axial and sagittal sections.

The septa are thin and closely spaced throughout the shell. They are almost plane in the middle portion of the shell, and are weakly but rather irregularly fluted in the axial regions where the septal loops of irregular shape appear. The septal counts of the first to fifth volution of the figured sagittal section are 18?, 20?, 23, 25, and 33?, respectively.

The tunnel is low and narrow throughout the shell, with more or less irregular path. The chomata are distinct only in the first volution but become rudimentary or disappear in the outer volutions. The tunnel angles of the first to fourth volution of the axial section are 24, 40, 22, and 25? degrees, respectively.

Remarks.—Available specimens of *Pseudoschwagerina* sp. are extremely insufficient for the description of the species and for the comparison to the allied forms. *Pseudoschwagerina* sp. most closely resembles *P. muoungthensis* (DEPRAT) from which it differs in having larger proloculus, more rapid expansion of the shell, and thicker spirotheca for the corresponding volution. The present species somewhat resembles some American species of *Pseudoschwagerina*, such as *P. uddeni* (BEEDE and KNIKER), but is distinguished from the latter in having more closely spaced and more irregularly fluted septa, and slightly less globular form of the shell.

Further study of this species will be necessary before the definite specific assignment can be made.

Occurrence.—The illustrated axial section was obtained from No. 9 limestone of Section XVI (Loc. 746). The sagittal section in the OZAWA's collection (section number I-64) is labelled "the back of Akiyoshi marble quarry, Akiyoshi-dai." The stratigraphical range of this species is the Plα subzone.

Genus *Nagatoella* THOMPSON, 1936

Nagatoella kobayashii THOMPSON

Pl. 20, figs. 6–9

1925. *Schellwienia ellipsoidalis* var. *orientis* OZAWA [part]. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 22, 23, Pl. VI, fig. 1a; Pl. VIII, fig. 5. [non Pl. VIII, fig. 3]
1926. *Nagatoella kobayashii* THOMPSON. Transact. Proc. Pal. Soc. Japan, No. 2, pp. 20–22, Pl. II, figs. 4–6.

A few specimens here referred to *Nagatoella kobayashii* THOMPSON were obtained from scattered localities on the Akiyoshi and Ofuku plateaux. Although the present materials are extremely insufficient for the detailed paleontological study, and none of the specimens is well-oriented, all the important characters and statistics observed and measured from the present specimens are well in accord with *Nagatoella kobayashii* which was restudied and redescribed in detail by THOMPSON (1926). Accordingly, I feel there is no need to add further description to the THOMPSON's designation and redescription of this species.

Table 61. Table of Measurements (in Millimeters) of *Nagatoella kobayashii* THOMPSON

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.
1	819	2051	20	6	8.09	3.91	2.1	—
2	195	1401	20	7	6.7+	4.5+	1.5	—
3	300	1858	20	8	—	2.47	—	—
4	OZAWA'S specimen	II-55	20	9	×	3.70+	×	.072 .091 ×

Speci-men	Radius vector															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	—	.113	.162	.215	.288	.387	.503	.660	.840	1.031	1.263	1.514				
2	—	—	—	.17?	.26?	.36	.46	.58	.75	.95	1.15	1.47	1.79	2.07	2.26	2.57
3	—	—	—	—	—	—	—	.53	.71	.92	1.17					
4	.062	.089	.129	.189	.247	.321	.463	.586	.775	.993	1.208	1.524	1.763			

Specimen	Thickness of spirotheca														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	—	—	—	.019	—	—	.025	.043	.046	.049	.094				
2	—	—	—	.010	.012	.021	.019	.022	.030	.050	.054	.093	.100	.110	.091
3	—	—	—	—	—	—	—	.029	.035	.041	.051				
4	.006	.009	.009	.012	.013	.014	.014	.017	.022	.033	.036	.082	.078		

Specimen	Ratio of Hl./Rv.												
	4	5	6	7	8	9	10	11	12	13	14	15	16
1	3.5	3.3	2.9	2.9	2.6	—	2.7	2.6	2.5				
2	—	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.4	1.3

Specimen	Tunnel angle							
	3	4	5	6	7	8	9	10
1	25?	22?	—	—	29	35	27	22
2	—	—	—	—	—	—	19?	

Specimen	Septal count												
	1	2	3	4	5	6	7	8	9	10	11	12	13
4	9 ?	11	11	12	13	15	20	20	27	24	27	32	33

Occurrence.—Nagatoella kobayashii THOMPSON occurs in the following localities: No. 12A limestone of Section I (Loc. 819), No. 8 limestone of Section X (Loc. 567), No. 2 limestone of Section XIX (Loc. 375), No. 6 limestone of Section XXV (Loc. 300), and Loc. 194, 195, and 572. This species seemingly has comparatively long stratigraphical duration, ranging from the Plβ to Pmβ subzone.

Nagatoella sp.

Pl. 20, figs. 10, 11

Specimens here referred to *Nagatoella* sp. is very rare in the present collection, represented by only two sagittal and one oblique sections. As they are too insufficient in number to describe the species, I only point out the followings: The rate of expansion of *N.* sp. is slowest among the species of *Nagatoella* hitherto described. The illustrated sagittal section has radius vectors of 96, 128, 173, 230, 307, 380, 510, 674, 849, and 1,043 microns in the first to tenth volution, respectively. The above figures show that *N.* sp. is closely similar to *N. orientis* (OZAWA) so far as the rate of expansion is concerned. None of the well oriented axial section has been obtained.

Table 62. Table of Measurements (in Millimeters) of *Nagatoella* sp. A

Specimen	Loc.	Rg.No.	Pl.	fig.	W.	Prol.	Radius vector									
							1	2	3	4	5	6	7	8	9	10
1	496	1130	20	10	1.95	.128/.157 ×	.096	.128	.173	.230	.307	.380	.510	.674	.849	1.043
2	101	1511	20	11	1.1+	.120	.104	.141	.200	.285	.368	.537				

Specimen	Thickness of spirotheca							Septal count						
	3	4	5	6	7	8	9	1	2	3	4	5	6	7
1	.010	.010	.014	.019	.026	.033	.036	8?	12?	15?	16?	18?	20?	26?
2	.014	—	.015	.031				6?	11	13	14?	16		

Occurrence.—*Nagatoella* sp. has been collected only from two localities, Loc. 496 and No. 5 limestone of Section XIV (Loc. 101). The stratigraphical range of *Nagatoella* sp. is assumed to be the Plβ to Pmα subzone.

Genus *Pseudofusulina* DUNBAR and SKINNER, 1936

Pseudofusulina vulgaris (SCHELLWIEN)

Pl. 20, figs. 12–18; Pl. 21, figs. 1–15

1909. *Fusulina vulgaris* SCHELLWIEN. Palaeontographica, Vol. LVI, p. 163, Pl. XIV, figs. 1, 2.
1925. *Schellwienia vulgaris* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 23, 24, Pl. VII, fig. 3.
1927. *Schellwienia vulgaris* LEE. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 1, pp. 59–64, Pl. VIII, figs. 6–9, 11, 12; Pl. IX, fig. 9.
1934. *Pseudofusulina vulgaris* CHEN. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 2, pp. 67, 68, Pl. VI, fig. 10.
1936. *Pseudofusulina vulgaris* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 75–77, Pl. XI, figs. 1–7.
1955. *Pseudofusulina vulgaris* MORIKAWA. Sci. Repts. Saitama Univ., Ser. B, Vol. II, No. 1, pp. 89, 90, Pl. IX, figs. 1–6.

The shell of *Pseudofusulina vulgaris* (SCHELLWIEN) is moderate in size and robustly fusiform in shape, with almost straight axis of coiling, convex to straight lateral slopes, and bluntly pointed poles. Mature shell attains four to five, rarely six, volutions, being 4.8 to 6.5 mm in length and 2.7 to 5.7 mm in width and giving form ratios of 1.5 to 1.9. The shell retains almost the same axial profile throughout all except the first half volution where it is subspherical in shape. Average ratios of the half length to the radius vector of the first to fifth volution for sixteen specimens are 1.7, 1.7, 1.6, 1.7, and 1.6, respectively.

The proloculus is moderate for the size of the shell. Its outside diameter varies with a considerable degree, ranging from 220 to 404 microns and averaging 290 microns in forty-seven specimens. The shell is relatively tightly coiled in the first volution, but beyond the second volution it expands very rapidly and almost uniformly. Average radius vectors of the first to sixth volution for fifty-one specimens are 260, 468, 815, 1,211, 1,658, and 2,151 microns, respectively. The chambers are almost the same in height throughout the length of the shell.

The spirotheca is relatively thin in the first volution, but increases in thickness towards maturity. It consists of a tectum and a coarsely alveolar keriotheca. However, alveoli are hard to be observable in the first few chambers of most specimens. Average thickness of the spirotheca of the first to sixth volution for thirty-nine specimens is 28, 47, 69, 94, 115, and 115 microns, respectively. The proloculus wall is considerably thick, averaging 20 microns for eighteen specimens.

The septa are considerably thick, consisting of the downward deflection of the tectum and the thick pycnotheca. They are narrowly spaced in the inner volutions, but the spacing becomes a little wide towards maturity. Average septal counts of the first to sixth volution of twenty-two specimens are 10, 18, 24, 27, 33, and 41, respectively. The septa are highly and narrowly fluted throughout their length, forming closed chamberlets for about two-thirds to three-fourths of the height of the chambers. In the end zones of the outer volutions of most specimens, the closed chamberlets extend almost to the top of the chambers.

The tunnel is rather narrow and its path is somewhat irregular. Average tunnel angles of the first to fifth volution in twelve specimens are 25, 25, 25, 25, and 28 degrees, respectively. The chomata occur only in the first one or two volutions and are hardly discernible in the outer volutions, being very rudimentary in development if present. The thin phrenotheca develops throughout the growth in most specimens, except in the inner one or two volutions and in the last several chambers of the ultimate volution. It usually cuts the chambers nearly parallel to the floor of the chamber, but obliquely or irregularly in some parts. No axial filling is present.

Remarks.—The above description is entirely based upon the materials collected

Table 63. Table of Measurements (in Millimeters) of *Pseudofusulina vulgaris* (SCHELLWIEN)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1	463	1602	20	12	6.38	4.0?	1.6	.307	.254	.482	.760	1.073	1.520	—
2	297	1548	20	13	6.05?	4.00	1.5	.277	.270	.461	.742	1.290	2.0?	
3	297	1547	20	14	6.5?	3.40	1.9	.294	.308	.548	.879	1.360	1.820	
4	610	1700	20	15	5.20	3.11	1.7	.260	.276	.528	.981	1.337	1.771	
5	463	1605	20	16	4.78	2.68	1.8	.305	.276	.494	.905	1.303		
6	297	1554	21	3	×	5.73	×	.298	.280	.639	1.158	1.882	2.450	2.900
7	463	1602	21	4	×	3.05	×	.247+	.227	.436	.775	1.135	1.665	
8	463	1607	21	5	×	3.27	×	.300+	.230	.347	.705	1.081	1.412	1.701
9	568	1646	21	6	×	3.81	×	.237	.271	.466	.682	1.092	1.66?	2.270
10	297	1555	21	7	×	4.18	×	.246	.206	.381	.757	1.287	1.840	2.360
11	572	1894	21	8	×	3.7?	×	.221	.202	.371	.674	1.052	1.592	2.08?
12	463	1612	21	10	×	3.38	×	.287/.267 ×	.211	.350	.595	.981	1.388	1.740
							Max.	.404	.359	.779	1.318	1.882	2.450	2.900
							Min.	.220	.193	.282	.512	.790	1.250	1.701
							Aver.	.290	.260	.468	.815	1.211	1.658	2.151
								47	50	51	49	36	25	9

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	Thickness of spirotheca 0	1	2	3	4	5	6
1	1.7	1.8	1.6	1.6	1.5	.017	.021	.046	.064	.065	.107	—
2	1.1	2.0	1.9	2.0	1.6	—	.033	.061	.085	.122	.108	
3	1.4	1.5	1.4	1.6	1.7	.028	.037	.056	.091	.131	.117	
4	2.3	2.1	1.8	1.9		—	.030	.051	.078	—		
5	1.2	1.5	1.5	1.5		—	.032	.047	.069	.092		
6						.019	.029	.059	.082	.127	.107	.084
7						—	.022	.043	.066	.097	.120	
8						—	.027	.030	.058	.088	.101	
9						—	—	—	.059	.116	.134	.156
10						—	.022	—	.067	.096	.121	—
11						—	—	.037	.067	.089	.120	
12						.019	.025	.036	.065	.092	.110	.132
Max.	2.3	2.1	2.1	2.0	1.0	.028	.049	.076	.091	.127	.140	.156
Min.	1.1	1.3	1.4	1.3	1.5	.016	.014	.025	.031	.043	.093	.084
Aver.	1.7	1.7	1.6	1.7	1.6	.020	.028	.047	.069	.094	.115	.115
	15	16	16	14	6	18	33	38	39	25	15	5

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5	6
1	23	28	23	23	18						
2	—	—	32	37							
3	25	25	22	33	38						
4	23?	30	30								
5	28	26	22								
6						12	23	30	35	34	46
7						10	16	22	32	32?	
8						10	20	22	32	37	
9						9	17	23?	24?	31	34
10						10	15	23	26	30	
11						7?	14?	23?	27?	31?	
12						7	15	20	30	36	39?
Max.	30	30	32	37	38	16?	24	31	35	37	46
Min.	17	19	19	18	18	7	15	19	24	30	34
Aver.	25	25	25	25	28	10	18	24	27	33	41
	12	11	12	7	2	22	21	19	13	9	4

from the Akiyoshi limestone group.

Pseudofusulina vulgaris (SCHELLWIEN) is one of the most common and widespread species in the Lower Permian formations in Japan and has been reported from more than ten areas in the islands of Honshu, Shikoku and Kyushu. However, only OZAWA (1925) and HUZIMOTO (1936) described and illustrated this species from the Akiyoshi limestone and Kwanto massif, respectively. MORIKAWA (1955) described this species also from the Kwanto-massif very recently.

In the original description of this species, SCHELLWIEN illustrated only two specimens, each one of axial and sagittal sections, the latter of which (fig. 2 of Pl. XIV) seems to be not conspecific with the former (fig. 1 of Pl. XIV). Although they are the same in number of volution, they are considerably different in the diameter of the shell and the thickness of the spirotheca; namely, the spirothecal thickness measured at the thickest part of the outer volutions is nearly 150 microns or less in the axial section (fig. 1) of 6.2 mm in the approximate width, but it exceeds 260 microns in the sagittal section (fig. 2) of 8.9 mm in diameter. If the axial and sagittal sections illustrated in the original description of a species could not be regarded as being conspecific, the species must be based on the axial section. Therefore, the axial section (fig. 2 of Pl. XIV) automatically becomes the type specimen of *Pseudofusulina vulgaris* (SCHELLWIEN) and is here designated as the lectotype of the species.

LEE (1927) distinguished the large and small types in this species which were considered by him to be representing the megalospheric and microspheric forms of the dimorphism, respectively. He also regarded the axial and sagittal sections illustrated by SCHELLWIEN as the microspheric and megalospheric forms of the species, respectively. However, as recognized by DUNBAR, SKINNER and KING (1935), the microspheric shell of a species possesses much larger shell and more numerous volutions, and is, so far has been known, much less in number of individuals than the megalospheric shell. They also clarified that the proloculi of both the forms are of a different order of size, and the proloculus of the megalospheric shells has about ten times the diameter of the corresponding microspheric proloculus. Such being the case, it may be improbable in Chinese and Darwas specimens to regard the larger shells with larger proloculus and thicker spirotheca as the megalospheric form of the dimorphism.

The Akiyoshi specimens collected by myself from many localities well agrees in all the essential characteristics with the SCHELLWIEN's Darwas specimen, if his figure 2 of Plate XIV is chosen as the type specimen as discussed above. No further discussion seems to be necessary.

Occurrence.—SCHELLWIEN, OZAWA, LEE, and HUZIMOTO stressed the associate occurrence of *Pseudofusulina vulgaris* with its many varieties. In the Akiyoshi limestone group it is often, if not always, found associating with many variants.

Pseudofusulina vulgaris (SCHELLWIEN) occurs most widely in the Plβ subzone, although it is ranging upward into the Plγ subzone. The following localities are known: Nos. 13 and 15 limestones of Section I (Loc. 295 and 297, respectively), Nos. 2 and 3 limestones of Section V (Loc. 462 and 463, respectively), No. 4 limestone of Section VII (Loc. 435), Nos. 9, 10, and 12 limestones of Section X (Loc. 568, 568A, and 568C, respectively), Nos. 1, 7, and 8 limestones of Section XII (Loc. 606, 610, and 611, respectively), No. 5 limestone of Section XIV (Loc. 101), No. 5 limestone of Section XXIII (Loc. 273), No. 10 limestone of Section XXVI (Loc. 760), and Loc. 62, 490, 553, 572, 613, 623, and 626.

Pseudofusulina vulgaris var. *globosa* (SCHELLWIEN)

Pl. 21, figs. 16–18; Pl. 22, figs. 1–7

1909. *Fusulina vulgaris* var. *globosa* SCHELLWIEN. DYHRENFURTH. Palaeontographica, Vol. LVI. pp. 164, 165, Pl. XIV, figs. 3–7.
1925. *Schellwienia vulgaris* var. *globosa* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 24, 25, Pl. VII, figs. 1, 2.
1927. *Schellwienia vulgaris* var. *globosa* LEE. Palaeontologia Sinica, Ser, B, Vol. IV, Fasc. 1, p. 67, Pl. IX, fig. 12.
1936. *Pseudofusulina vulgaris* var. *globosa* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 77, 78, Pl. XII, figs. 1–7; Pl. XIV, figs. 1, 2.

More than a score of specimens which are almost identical with *Pseudofusulina vulgaris* var. *globosa* (SCHELLWIEN) have been obtained in my collection. They are almost the same in all the important characters and statistical measurements with those of the type form of *Pseudofusulina vulgaris* s. str. except for the form ratio; namely, this form is more globular in shape than the type form of the species, attaining form ratios of 1.25 to 1.48. Average ratios of the half length to the radius vector of the first to sixth volution in six specimens are 1.7, 1.6, 1.5, 1.5, 1.4, and 1.4, respectively.

I do not describe other characteristics in detail, but, for completeness' sake, I am giving the statistical data of this form in the Table 64.

Remarks.—The same remarks as those in *Pseudofusulina vulgaris* (SCHELLWIEN) s. str. are also given to this form; namely, the axial section in the original illustration (fig. 3 of Pl. XIV) seems to be not conspecific with the sagittal section (fig. 7 of Pl. XIV), which has a larger shell, larger proloculus and thicker spirotheca and was referred by SCHELLWIEN as the typical megalospheric form of the species. Such being the case *Pseudofusulina vulgaris* var. *globosa* should be based on figs. 3 and 5 of Plate XIV, and the axial section (fig. 3) is, therefore, designated as the lectotype of this species. The Akiyoshi specimens so well agree with *Pseudofusulina vulgaris* var. *globosa* as thus defined that no further discussion seems to be necessary.

Table 64. Table of Measurements (in Millimeters) of *Pseudofusulina vulgaris* var. *globosa* (SCHELLWIEN)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1	437	1591	21	16	4.8+	3.43	1.4	.307	.307	.482	.840	1.312	1.840	
2	437	1588	21	17	5.09	4.07	1.3	.367	.316	.628	.987	1.542	1.988	
3	719	1706	22	1	5.63	3.81	1.5	.240+	.231	.432	.701	1.181	1.53+	1.88+
4	436	1583	22	2	5.7+	4.05	1.4	.322	.240	.392	.653	1.120	1.540	2.050
5	568B	1199	22	3	×	3.36	×	.252	.211	.383	.741	1.191	1.712	
6	719	1706	22	4	×	3.68	×	.306	.261	.466	.805	1.293	1.815	
7	719	1705	22	5	×	4.8+	×	.289	.276	.520	.858	1.312	1.80?	
8	720A	1711	22	6	×	4.00	×	.253	.245	.442	.683	1.064	1.474	1.940
							Max.	.380	.316	.745	1.310	1.937	1.988	2.050
							Min.	.240	.192	.292	.530	.837	1.212	1.606
							Aver.	.277	.268	.489	.822	1.271	1.625	1.846
								20	21	21	21	19	14	6

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6
1	—	1.5	1.5	1.6	1.5		.021	.027	.034	.067	.121	.088	
2	1.9	1.5	1.4	1.4	1.4		—	.027	.064	.094	.108		
3	1.2	1.4	1.5	1.2	1.5	1.5	—	.021	.043	.067	.088	.086	
4	—	1.5	1.5	1.5	1.5	1.3	.019	.025	.039	.054	.096	.110	.107
5							.018	.025	.034	.074	.102	.107	
6							.011	.022	.032	.069	.096	.126	
7							.018	.024	.046	.078	.117		
8							—	.022	.045	.072	.081	.107	.114
Max.	1.9	1.8	1.7	1.6	1.5	1.5	.021	.044	.080	.133	.134	.124	.114
Min.	1.2	1.4	1.4	1.2	1.4	1.3	.011	.020	.032	.051	.070	.086	.103
Aver.	1.7	1.6	1.5	1.5	1.4	1.4	.017	.027	.049	.073	.101	.105	.108
	4	6	6	6	4	2	12	19	19	18	18	19	3

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5	6
1	19	21	22	22							
2	32	32	—	22?							
3	33	22	24?	19	20						
4	—	—	—	—	—						
5						11?	20	22	32	32?	
6						11	18	23	34	32	
7						12	21	30	32	36?	
8						11	19	23	28	31	35
Max.	38	33	33	24		12	21	31	35	37	39
Min.	19	21	24?	19		9	17	21	27	31	35
Aver.	30	27	28	22	20	11	19	25	32	34	37
	4	4	3	4	1	9	8	8	7	5	2

Occurrence.—*Pseudofusulina vulgaris* var. *globosa* (SCHELLWIEN) is the same in the stratigraphical occurrence as the type species, but it occurs not necessarily associated with the latter. The following localities are known: Nos. 6 and 8 limestones of Section IV (Loc. 719 and 720A, respectively), Nos. 5 and 6 limestones of Section VII (Loc. 436 and 437, respectively), and No. 11 limestone of Section X (Loc. 568B).

Pseudofusulina vulgaris (SCHELLWIEN) var. *megaspherica* TORIYAMA, n. var.

Pl. 22, figs. 8–17; Pl. 23, figs. 1–3

The shell of *Pseudofusulina vulgaris* (SCHELLWIEN) var. *megaspherica* TORIYAMA, n. var. is considerably large and thickly fusiform, with almost straight axis of coiling and bluntly pointed poles. The lateral slopes are straight to convex in the inner volutions, but become somewhat irregular or concave in some parts of the outer volutions. Mature specimens of five to seven volutions are 4.0 to 6.9 mm in length and 3.1 to 5.2 mm in width, giving form ratios of 1.4 to 2.0. The shell is subspherical in shape in the first volution, but becomes thickly fusiform in the second volution and later retains almost the same axial profile to maturity. Average ratios of the half length to the radius vector in the first to fifth volution for nine specimens are 1.4, 1.6, 1.5, 1.6, and 1.5, respectively.

The proloculus is large, and is almost spherical in most of the specimens, but short ellipsoidal or somewhat irregular in some specimens. Its outside diameter measures 332 to 575 microns, averaging 435 microns in thirty-one specimens. The shell expands relatively tightly in the first volution but rapidly and somewhat uniformly from the second to the last volution. Average radius vectors of the first to seventh volution of thirty-three specimens are 378, 621, 942, 1,332, 1,713, 2,036, and 2,380 microns, respectively. The chambers are of nearly the same height throughout their length in the inner three or four volutions and become distinctly higher in the polar ends of the outer volutions.

The spirotheca is thick and coarsely alveolar, increasing in thickness nearly uniformly with the growth of the individual. Average thickness of the spirotheca in the first to sixth volution of twenty-five specimens is 39, 57, 79, 103, 114, and 120 microns, respectively. The alveoli of the keriotheca are discernible in all but the innermost volution of most specimens. About 4 alveoli are counted in a distance of 100 microns of the spirotheca in the outer volution of one sagittal section. The proloculus wall is relatively thick and seemingly structureless, averaging 23 microns in thickness for fifteen specimens.

The septa are thick and highly fluted throughout the length of the shell. The fluting extends almost completely to the tops of the chambers. The septa are

Table 65. Table of Measurements (in Millimeters) of *Pseudofusulina vulgaris* (SCHELLWIEN) var. *megasphaerica* TORIYAMA, n. var.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1*	568C	1666	22	8	6.86	4.50	1.5	.500	.436	.612	.835	1.061	1.381	1.900	2.362
2	463	1604	22	9	6.00	3.91	1.5	.485	.431	.918	1.309	1.83?			
3	463	1607	22	10	5.62	3.97	1.4	.449	.386	.813	1.273	1.780	2.059		
4	606	1678	22	11	5.52	3.1+	1.8	.34+	.312	.602	1.001	1.39?			
5	572	1893	22	12	—	3.05	—	.450	.335	.537	.733	1.031	1.303	1.600	
6	572	1893	22	13	4.02	2.00	2.0	.478	.365	.501	.652	.951	1.141		
7	101	1507	22	15	×	3.27	×	.399	.404	.662	.965	1.340	1.758		
8	606	1676	23	1	×	4.50	×	.437	.380	.688	1.070	1.570	2.128	2.669	
9	606	1675	23	2	×	3.55?	×	.383	.356	.550	1.064	1.603			
10	568C	1667	23	3	×	5.0?	×	.36+	.374	.613	.935	1.373	1.869	2.390	
						Max.		.575	.522	.918	1.309	1.83?	2.209	2.669	2.88+
						Min.		.332	.241	.401	.652	.951	1.141	1.483	1.900
						Aver.		.435	.378	.621	.942	1.332	1.713	2.036	2.380
								31	31	33	33	28	16	7	3

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6	7
1*	1.2	1.2	1.4	1.5	1.7	1.8	.023	.035	.062	.079	.085	.140	.169	.158
2	1.3	—	1.4	1.3			—	.045	.092	.105	.144			
3	1.5	1.3	1.3	1.4	1.4		.021	.036	.072	—	—	—		
4	—	2.3	1.9	2.1			.019	.028	.042	.088	.099	.118		
5	—	—	—	—	—		.018	.030	.050	.061	.062	.092		
6	—	1.8	1.8	1.7			.018	.022	.043	.052	.094	.079		
7							.025?	.057	.073	.086	.108	.121		
8							.024	.035	—	.096	.102	.119	.100	
9							.017	—	.047?	.092	.107			
10							—	—	.055	.064	.121	.141	.112	
Max.	1.5	2.3	2.0	2.1	1.7		.028	.057	.092	.111	.144	.165	.169	
Min.	1.2	1.2	1.2	1.3	1.4		.016	.022	.041	.052	.062	.075	.100	
Aver.	1.4	1.6	1.5	1.6	1.5	1.8	.023	.039	.057	.079	.103	.114	.120	.158
	5	7.	8	9	3	1	15	22	25	25	21	15	6	1

Specimen	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5	6
1*	25	26	20	21	27	24						
2	30	22	21	21								
3	37	41	28?	28	—							
4	25	29?	19?	—								
5	—	—	—	—	—							
6	29	22	26	21	26							
7							8	16	23?	32	34	
8							—	—	35?	40?	41?	
9							11	24	27	34		
10							—	23?	26?	40?	44?	50?
Max.	37	41	28?	23	27		11	24	35?	40?	44?	50?
Min.	16	19	19	16	26		8	16	20	26	33?	37
Aver.	26	26	22	20	27	24	10	21	26	33	38	44
	8	8	9	8	2	1	8	10	11	10	5	2

* Holotype specimen

very numerous, averaging 10, 21, 26, 33, 38, and 44, respectively, in the first to sixth volution of eleven specimens. In sagittal sections it can clearly be seen that the septa are formed of the downward deflection of the tectum and dense structureless pycnotheca, the latter of which is mainly deposited on the distal side of the former.

The tunnel is well developed, with somewhat irregular path. Average tunnel angles of the first to fifth volution of nine specimens are 26, 26, 22, 20, and 27 degrees, respectively. The chomata do not occur in all but the innermost volution. The phrenotheca occurs in some part of some specimens, but it is not so distinct as in the type form of the species.

Remarks.—Pseudofusulina vulgaris (SCHELLWIEN) var. *megaspherica* TORIYAMA, n. var. is closely allied to *Pseudofusulina vulgaris* (SCHELLWIEN) and its varieties in the general shell characters, but is distinguished from them by its larger shell, larger proloculus, more rapid rate of expansion, thicker spirotheca, and a little numerous number of the septa. If only one of these characters is taken into account, it may not be enough to separate this form from the type species as a variety. However, as the differences of shell characters as a whole are rather distinct, I have divided this form as a variety. From the phylogenetical point of view *P. vulgaris* var. *megaspherica* seemingly is more highly developed along the evolutionary trend than the type species and its varieties previously described.

Some forms referred by earlier workers either to *Pseudofusulina vulgaris* s. str. or to *P. vulgaris* var. *globosa* may be referable to this variety, because it is highly probable that they might have been identified with the megalospheric form of the SCHELLWIEN's original illustrations which were, as already discussed, considered to be neither conspecific with *P. vulgaris* s. str. nor with *P. vulgaris* var. *globosa*. SCHELLWIEN's figs. 2, 4, and 7(?) of Pl. XIV (1909), OZAWA's fig. 1 of Pl. VII (1925), and HUZIMOTO's fig. 11 of Pl. X, figs. 1, 2, and 4 of Pl. XI, and figs. 1, 2, 3, 4, 5. and 7(?) of Pl. XII (1936) seemingly are referable to this variety.

Occurrence.—Pseudofusulina vulgaris (SCHELLWIEN) var. *megaspherica* TORIYAMA, n. var. shows rather wide stratigraphical occurrence, ranging from the Plβ to Pmβ subzone. It was found in the following localities: No. 9 limestone of Section I (Loc. 289), No. 3 limestone of Section V (Loc. 463), Nos. 9, 10, and 12 limestones of Section X (Loc. 568, 568A, and 568C, respectively), No. 1 limestone of Section XII (Loc. 606), No. 5 limestone of Section XIV (Loc. 101), No. 5 limestone of Section XXIII (Loc. 273), and Loc. 494, 553, and 572.

Pseudofusulina vulgaris var. *watanabei* (OZAWA em. LEE)
Pl. 23, figs. 4–6

1923. *Fusulina* (*Schellwienia*) *watanabei* OZAWA. Japan. Jour. Geol. Geogr., Vol. II, p. 38, Pl. V, figs. 1a, b.
1927. *Schellwienia vulgaris* var. *watanabei* LEE. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 1, pp. 64–66, Pl. IX, figs. 4, 8.
1955. *Pseudofusulina watanabei* MORIKAWA. Sci. Repts. Saitama Univ., Ser. B, Vol. II, No. 1, pp. 91, 92, Pl. VII, fig. 18.

The shell of *Pseudofusulina vulgaris* var. *watanabei* (OZAWA em. LEE) is moderately large and thickly fusiform, with almost straight axis of coiling and bluntly pointed poles. It has nearly straight to convex lateral slopes in the inner four or five volutions, and straight to slightly concave in the outer two volutions. The largest specimen of seven volutions at my disposal has an approximate length of 8.6 mm and a width of 4.6 mm, giving a form ratio of 1.9. The first volution seemingly is subspherical or short ellipsoidal. From the second volution to maturity the shell is almost the same in the axial profile. The ratios of the half length to the radius vector of the fourth to seventh volution in the illustrated axial section are 1.6, 1.7, 1.8, and 1.8, respectively.

The proloculus is relatively large and spherical to subspherical in shape, with outside diameters of 300 to 477 microns, averaging 367 microns for eleven specimens. The shell is loosely coiled in all but the first volution which is slightly tightly coiled. The ultimate volution of some specimens is slighly more tightly coiled than the penultimate one. Average radius vectors of the first to seventh volution for ten specimens are 312, 518, 819, 1,187, 1,527, 1,985, and 2,523 microns, respectively. The chambers are nearly the same in height throughout the length of the shell except in the extreme polar regions.

The spirotheca is considerably thick and coarsely alveolar. It shows, however, some irregularity in thickness even in the same volution. In sagittal sections it increases in thickness sharply immediately adjacent to the septa. Average thickness of the spirotheca measured above the tunnel in the first to seventh volution in nine specimens is 45, 59, 82, 99, 119, 126, and 126 microns, respectively. The proloculus wall is moderately thick, averaging 22 microns in three specimens.

The septa are relatively thick, consisting of clear downward deflection of the tectum and the pycnotheca. They are fluted throughout the length of the shell. The closed chamberlets are formed for less than half the height of the chambers in the central portion of the shell, and for half to two-thirds in the polar third of the shell. Average septal counts of the first to sixth volution in three specimens are 8, 20, 21, 25, 29, and 31(?), respectively.

The tunnel is low but relatively wide with almost straight path. The tunnel angles of the second to fifth volution of the illustrated axial section (Pl. 23, fig.

4) are 28, 28, 28, and 24 degrees, respectively. The chomata occur only in the inner three to four volutions where they are narrow and almost symmetrical in cross section, being half to less than half as high as the chambers. The phrenotheca is not distinct, occurring only in limited parts of the outer volutions. The weak axial fillings present in the inner volutions.

Table 66. Table of Measurements (in Millimeters) of *Pseudofusulina vulgaris* (SCHELLWIEN) var. *watanabei* (OZAWA em. LEE)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector						
									1	2	3	4	5	6	7
1	OZAWA's type	IV-72*			5.67	3.22	1.8	.260	.267	.517	.833	1.230	1.680		
2	451	1594	23	4	8.6?	4.61	1.9	.367	.338	.528	.808	1.104	1.440	1.94+	2.40+
3	451	1593	23	5	×	4.77	×	.477	.404	.656	.945	1.337	1.708	2.080	2.41?
4	451	1595	23	6	×	4.93	×	.345/.385 ×	.338	.561	.852	1.226	1.641	2.180	2.760
						Max.		.477	.404	.656	1.070	1.370	1.708	2.180	2.760
						Min.		.300	.210	.390	.610	.981	1.320	1.740	2.410
						Aver.		.367	.312	.518	.819	1.187	1.527	1.985	2.523
								11	8	10	10	10	7	4	3

Specimen	Thickness of spirotheca								Ratio of Hl./Rv.						
	0	1	3	3	4	5	6	7	1	2	3	4	5	6	7
1	—	.041	.067	.067	.108	.095			1.6	1.6	1.4	1.6	1.6		
2	—	·048	.050	.096	.092	.125	.139	.099	—	—	—	1.6	1.7	1.9	1.8
3	.020	.051	.072	.093	.107	.128									
4	—	.051	.059	.076	.129	.138	.155	.153							
Max.	.025	.051	.072	.121	.129	.138	.155	.153							
Min.	.020	.030	.050	.062	.076	.095	.085	.099							
Aver.	.022	.045	.059	.082	.099	.119	.126	.126							
	3	5	5	9	8	6	3	2							

Specimen	Tunnel angle					Septal count					
	1	2	3	4	5	1	2	3	4	5	6
1	30	21	25	23	26						
2	—	28?	28	28	24						
3						8	20	20	26	32	
4						—	—	—	24?	25?	31?

* The type specimen was collected from Huo-shih-kou, Shetsun, Kung-hsien, Honan, China. (河南省, 有鞏県, 涉村, 火石溝). The statistics of this specimen is excluded from the averages.

Remarks.—The above description is based entirely on the materials collected from the Akiyoshi limestone group.

When OZAWA (1923) established "*Fusulina* (*Schellwienia*) *watanabei*" based on the Honan specimens collected by Mr. WATANABE, he stated that *F. watanabei* is undoubtedly related to the group of "*Fusulina vulgaris* SCHELLWIEN"; nevertheless he distinguished this form as an independent species. Later LEE (1927) discussed the close similarity between both the forms and emended to regard *F.* (*Schellwienia*) *watanabei* as a variety of *Schellwienia vulgaris* s. str.

I am of the opinion that the LEE's emendation is correct. In reality the Akiyoshi specimens also show close resemblance to *Pseudofusulina vulgaris* (SCHELLWIEN) s. str., and I cannot find any reason for distinguishing the present form from *P. vulgaris* as an independent species. Only difference observed in the Akiyoshi form is its slightly less numerous septa for the corresponding volution, weaker occurrence of the phrenotheca in the outer volutions and the presence of weak axial fillings in the inner volutions.

MORIKAWA recently reported this species from the Shomaru pass of the Kwanto massif, but his description and illustration are too insufficient to make detailed comparison. Seemingly his only illustrated specimen is immature and may not be conspecific with this species.

Occurrence.—*Pseudofusulina vulgaris* (SCHELLWIEN) var. *watanabei* (OZAWA em. LEE) was originally reported from the Lower Permian rocks of Honan, China. The Akiyoshi specimens were found in the limestones referable to the Plβ and Plγ subzones. Three localities are known: No. 5 limestone of Section VI (Loc. 451), No. 4 limestone of Section X (Loc. 521), and Loc. 569. The specimens from the second locality are doubtful and tentatively referred to this species with question.

Pseudofusulina globosa (DEPRAT) var. *exilis* TORIYAMA, n. var.

Pl. 23, figs. 7-16 ; Pl. 24

Compare :

1912. *Fusulina globosa* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. I, fasc. 3, pp. 22-24, Pl. VI, figs. 5-10, Pl. VII. fig. 1.

1913. *Fusulina globosa* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. II, fasc. 1, pp. 10, 11.

The shell of *Pseudofusulina globosa* (DEPRAT) var. *exilis* TORIYAMA, n. var. is moderately large and thickly fusiform, with almost straight axis of coiling, nearly straight to convex lateral slopes and bluntly pointed to rounded poles. Mature specimens of four to five volutions have a length of 5.4 to 7.2 mm and a width of 3.1 to 5.1 mm, giving form ratios of 1.4 to 2.1. The first half to one volution is subspherical or short ellipsoidal, but the shell soon assumes the closely similar axial profiles to those of the mature shells. Thus, the ratios of the half length to the radius vector are nearly the same throughout the growth. Average ratios of the first to fourth volution of twenty-three specimens are 1.8, 1.8, 1.7, and 1.6, respectively.

The proloculus is large and spherical in most specimens, but ellipsoidal to slightly irregular in some specimens. The outside diameter is ranging from 282 to 534 microns, averaging 380 microns in sixty-eight specimens. The shell expands rapidly and about uniformly throughout all except the ultimate volution which is more slightly tightly coiled than the penultimate one. Average radius vectors of the first to fifth volution for sixty-eight specimens are 353, 697, 1,175, 1,691, and 2,230 microns, respectively. The heights of the chambers are nearly the same throughout their length except in the very extreme polar regions.

The spirotheca is rather thick in the absolute thickness, but comparatively thin for the size of the shell. It increases in thickness almost uniformly as the growth of the shell. Average thickness of the spirotheca of the first to fifth volution of fifty specimens is 35, 60, 86, 100, and 125 microns, respectively. The keriotheca of the spirotheca is coarsely alveolar. 5 to 5½, rarely 6, alveoli are counted in a space of 100 microns of the spirotheca in the outer volutions. The spirotheca is thickest in the equatorial region of most specimens, decreasing in thickness gradually towards the poles.

The septa are thin and narrowly and highly fluted throughout their length. The fluting extends completely to the tops of the chambers. The septa are wavy as they extend to the tops of the spirotheca, and are somewhat irregular along the folds developed by the fluting, resulting in that many septal loops of round to irregular shapes appear not only in axial sections but also even in sagittal sections. Average septal counts of the first to fifth volution of twenty-one specimens are 11, 21, 29, 34, and 41, respectively.

The tunnel is low and narrow and the complicated folding of the septa makes the tunnel sides difficult to determine. Average tunnel angles of the first to fourth volution for eighteen specimens are 34, 31, 28, and 25 degrees, respectively. The chomata do not occur throughout all except the first one or two volutions where they form nearly symmetrical small ridges. The thin phrenotheca occurs in central part of most specimens, running nearly parallel to the surface of the spirotheca. No axial filling is present.

Remarks.—The high and narrow septal fluting of *Pseudofusulina globosa* var. *exilis* TORIYAMA, n. var. suggests a relationship to the genera *Paraschwagerina* and *Schwagerina*. However other characters of this form show that it seems better to refer it to the genus *Pseudofusulina*.

Among the short gibbous species of *Pseudofusulina*, *P. globosa* (DEPRAT) is most closely allied to this form. As the differences of the shell size, the prolocular size, the rate of expansion, and the thickness of the spirotheca between both forms are not so distinct as to distinguish the species, I have described the present form as a variety of *P. globosa* (DEPRAT).

This variety also resembles rather closely *Pseudofusulina nelsoni opima* THOMPSON from the upper Hueco limestone of Texas. Although it is not easy to make definite distinction between both forms, *P. globosa* var. *exilis*, n. var. differs

Table 67. Table of Measurements (in Millimeters) of *Pseudofusulina globosa* (DEPRAT) var. *exilis* TORIYAMA, n. var.

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.		Prol.	Radius vector 1	2	3	4	5
1*	463	1601	23	7	5.41	4.02	1.4		.423	.421	.772	1.318	2.020	
2	463	1600	23	8	7.2?	4.8?	1.5		.351	.353	.772	1.514	2.101	2.57?
3	568A	1661	23	9	5.84	3.48	1.7		.410	.374	.800	1.373	1.900	
4	720	1707	23	10	6.00	2.84	2.1		.300+	.282	.613	1.116	—	
5	568A	1654	24	17	4.4?	2.57	1.7		.403	.356	.797	1.456		
6	463	1612	24	3	×	3.3+	×		.417 .477 ×	.448	.843	1.489	2.00?	
7	568A	1651	24	4	×	4.35	×		.432	.431	1.052	1.858	2.298	
8	568A	1652	24	5	×	5.10	×		.295 .374 ×	.347	.671	1.257	1.962	2.420
9	568A	1657	24	6	×	4.07	×		.300+	.312	.511	.923	1.630	2.201
10	568A	1656	24	7	×	3.75	×		.368	.338	.626	1.104	1.594	2.050
11	568A	1654	24	8	×	3.37	×		.343	.311	.592	1.001	1.591	
12	720	1708	24	11	×	2.9+	×		.325	.285	.491	.852	1.401	
								Max.	.534	.528	1.058	1.858	2.298	2.57?
								Min.	.282	.245	.475	.752	1.196	1.770
								Aver.	.380	.353	.697	1.175	1.691	2.230
									68	68	68	60	33	9

Specimen	Ratio of Hl./Rv. 1	2	3	4	Thickness of spirotheca 0	1	2	3	4	5
1*	1.3	1.7	1.6	1.4	.021	.032	.044	.096	.112	
2	2.0	1.8	1.4	1.3	.022	.036	.086	.116	.193	
3	2.1	1.8	1.7	1.6	.019	.048	.074	.124	.070	
4	2.1	1.5	—		—	.030	.050	.101	—	
5	2.6	—	1.6		.019	.032	.054	.059		
6					.016	.044	.070	.110	—	
7					.024	.034	.055	.118	—	
8					.025	.027	.070	.093	.096	.115
9					—	—	—	.092	.103	.104
10					.019	—	.054	.081	.086	.104
11					—	.030	.052	.074	.094	
12					.022	—	.039	.094	.102	
Max.	2.6	2.6	2.4	1.8	.030	.049	.086	.131	.193	.178
Min.	1.1	1.4	1.4	1.3	.015	.018	.039	.048	.050	.104
Aver.	1.8	1.8	1.7	1.6	.022	.035	.060	.086	.100	.125
	23	23	20	8	39	43	50	41	20	4

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5
1*	33	23	25							
2	30	40?	25?	27?						
3	31	27	32?							
4	45	31	36							
5	43	35	20							
6						9	23	36	—	
7						10	20?	32?	—	
8						10	19	26	36	42
9						11	21	23	31	40
10						10	21	26	36	
11						10	22	29	40?	
12						10	20	28	30	
Max.	45	40	36	32		12	25	36	40	42
Min.	24	23	20	20		9	17	23	28	40
Aver.	34	31	28	25	24	11	21	29	34	41
	18	16	16	7	1	21	21	16	10	3

* Holotype specimen

from *P. nelsoni opima* in having more vaulted shell, slightly more rapid and uniform expansion especially in the inner one or two volutions, and a little numerous septa for the corresponding volutions. At any rate both forms seem to be biologically closely related if not conspecific.

Pseudofusulina globosa var. *exilis* TORIYAMA, n. var. somewhat resembles *P. santyuensis* HUZIMOTO from the Lower Permian of the Kwanto massif, but is distinguished from the latter by its more gibbous shell, thinner spirotheca and thinner and more complicated septa.

Occurrence.—*Pseudofusulina globosa* var. *exilis* TORIYAMA, n. var. is very abundant in the Plβ subzone, but is ranging upward into the Plγ subzone. It has been obtained from the following localities: No. 15 limestone of Section I (Loc. 297), No. 9 limestone of Section IV (Loc. 720), No. 3 limestone of Section V (Loc. 463), No. 4 limestone of Section VII (Loc. 435), No. 10 limestone of Section X (Loc. 568A), Nos. 2 and 7 limestones of Section XII (Loc. 606A and 610, respectively), No. 7 limestone of Section XXVI (Loc. 757), and Loc. 613.

Pseudofusulina kraffti (SCHELLWIEN) var. *magna* TORIYAMA, n. var.

Pls. 25, 26

Compare:

1909. *Fusulina kraffti* SCHELLWIEN. Palaeontographica, Vol. LVI, p. 169, Pl. XVI, figs. 1–9.
1925. *Fusulina* (*Schellwienia*) *kraffti* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 25, 26, Pl. VII, fig. 4; Pl. VI, fig. 7.
1927. *Schellwienia kraffti* OZAWA. Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. II, Vol. II, pt. 3, p. 147, text-figs. 5a, b, c.
1936. *Pseudofusulina kraffti* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 80, 81, Pl. XIV, figs. 3–8.
1955. *Pseudofusulina kraffti* MORIKAWA. Sci. Repts. Saitama Univ., Ser. B, Vol. II, No. 1, pp. 94, 95, Pl. VII, figs. 15–17.

The shell of *Pseudofusulina kraffti* (SCHELLWIEN) var. *magna* TORIYAMA, n. var. is fairly large and short, thick fusiform, with straight axis of coiling, almost even to somewhat depressed median portion, convex lateral slopes, and broadly rounded polar ends. Mature specimens of five to seven volutions are 4.3 to 8.1 mm in length and 2.9 to 5.4 mm in width, giving form ratios of 1.3 to 1.9. The typical specimen, one of the largest specimen among the present materials, is 8.1 mm long and 5.4 mm wide, attaining a form ratio of 1.5. The inner three to four volutions are subspherical to short ellipsoidal with rounded poles and the axis becomes extended poleward only slightly in the outer volutions, resulting in that the shell retains nearly the same axial profiles throughout the growth. Average ratios of the half length to the radius vectors of the first to seventh volution of twenty specimens are 1.5, 1.6, 1.5, 1.6, 1.6, 1.5, and 1.6, respectively.

The proloculus is large and spherical to ellipsoidal in most specimens, but somewhat irregular in others. Two specimens which have double proloculi of nearly the same size have been found in this form. The outside diameter is 332 to 778 microns, averaging 491 microns in fifty-nine specimens. The shell expands rapidly and almost uniformly throughout all but the first volution which is very slightly tightly coiled. Average radius vectors of the first to seventh volution for fifty-nine specimens are 410, 654, 956, 1,269, 1,689, 2,027, and 2,552 microns, respectively. The chambers are nearly the same in height throughout the length of the shell in all the volutions. The proloculus wall is moderate in thickness, ranging 16 to 36 microns, and averaging 25 microns in thirty-one specimens.

The spirotheca consists of a tectum and a coarsely alveolar keriotheca. About 4 alveoli are discernible in a distance of 100 microns of the spirotheca of the outer volutions. The alveoli are also clearly observable even at the beginning of the first volution in well preserved specimens. Average thickness of the spirotheca of the first to sixth volution for forty-six specimens is 42, 57, 76, 99, 114, and 118 microns, respectively. The spirotheca is thickest immediately above the tunnel in most specimens, but it is somewhat irregular in thickness even in the same volution of some specimens. It is also thickened immediately after the septa.

The septa are rather thick and relatively closely spaced. Average septal counts of the first to sixth volution of ten specimens are 9, 20, 24, 30, 35, and 37, respectively. They are highly and narrowly fluted throughout their length. The fluting extends to the tops of the chambers, forming closed chamberlets which are of nearly the same height as the chambers in the polar third of the shell and half to two-thirds in the central region. The phrenotheca does not occur in most of the specimens but is rarely observable in the outer volutions of some specimens.

The tunnel is low and considerably wide in the earliest volution but becomes narrow in the outer volutions, and its path is considerably irregular. The intense fluting of the septa makes the tunnel sides difficult to identify in all parts of most specimens. Average tunnel angles of the first to sixth volution of seventeen specimens are 33, 27, 24, 24, 24, and 20 degrees, respectively. The chomata do not occur in most specimen, but present in the earliest stage of the growth in few specimens although they are very rudimentary in development. The massive axial fillings completely fill the chambers of the axial zone of the inner three to five volutions. They do not occur in the outer two or three volutions or become much less dense if present.

Remarks.—SCHELLWIEN and DYHRENFURTH distinguished two forms in "*Fusulina kraffti*", the typical and short thick forms. Both the forms, however, considerably differ from each other in the form ratio of the shell, the prolocular size, and the rate of expansion, and may be at least subdivisible into varieties if not different species.

Table 68. Table of Measurements (in Millimeters) of *Pseudofusulina krafft* (SCHELLWIEN) var. *magna* TORIYAMA, n. var.

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7
1*	382	1582	25	1	8.10+	5.35	1.5	.522	.383	.635	.920	1.226	1.597	2.080	2.481
2	382	1581	25	2	7.61	5.09	1.5	.431 × .618	.386	.644	.932	1.257	1.686	2.120	2.610
3	450	1867	25	3	8.2?	4.77	1.7	.700	.64?	.920	1.230	1.589	1.998	2.391	2.79?
4**	522	1626	25	5	7.34	4.82	1.5	.613 × .588	.510	.939	1.333	1.751	2.146		
5	381	1574	25	7	6.00	3.65?	1.6	.478	.353	.583	.873	1.180	1.540		
6	381	1574	25	9	5.7?	3.3?	1.7	.443	.392	.592	.871	1.152	1.5?	2.0?	
7	381	1577	26	2	5.4?	3.27	1.7	.474	.401	.653	.989	1.355	1.680		
8	567	2026	26	5	×	3.65	×	.450 × .576	.463	.751	1.071	1.564	1.962		
9	450	1868	26	6	×	4.13	×	.411 × .478	.377	.613	.877	1.140	1.462	1.876	2.284
10	382	1580	26	7	×	4.88	×	.340+	.352	.613	.996	1.370	1.769	2.180	
11	375	1421	26	8	×	2.84	×	.530	.440	.659	.900	1.169	1.480		
						Max.		.778	.64?	.951	1.380	1.840	2.03?	2.391	2.79?
						Min.		.332	.260	.411	.620	.861	1.230	1.793	2.284
						Aver.		.491	.410	.654	.956	1.269	1.689	2.027	2.552
								59	57	59	58	56	39	14	6

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	Thickness of spirotheca 0	1	2	3	4	5	6
1*	—	—	—	—	1.4	1.5		.026	.064	—	.064	.120	.123	—
2	—	—	1.5	1.5	1.5	1.4		.017	.043	.055	.082	.097	.116	.128
3	1.0	1.0	1.0	1.0	1.1	1.3		.019	.039	.048	.057	.094	.114	.120
4**	1.2	1.3	1.3	1.3	1.5			—	.028	.067	.074	.092	.087	
5	—	1.8	1.7	1.9	1.8			.030	.035	.059	.082	.096	.104	
6	1.1	—	1.4	1.4	1.5			.034	.057	.075	—	—	.093	
7	—	—	—	1.7				.025	.056	—	.099	.137	.153	
8								.025	.071	.096	.107	.167	.096	
9								.022	.039	.048	.064	.074	.091	.113
10								—	.034	.048	.089	.096	.126	—
11								.024	.042	.060	.089	.094	.062	
Max.	2.0	2.2	2.1	2.0	2.2	2.2	1.8	.036	.071	.096	.118	.167	.164	.169
Min.	1.0	1.0	1.0	1.0	1.1	1.3	1.5	.016	.024	.035	.041	.044	.062	.082
Aver.	1.5	1.6	1.5	1.6	1.6	1.5	1.6	.025	.042	.057	.076	.099	.114	.118
	9	12	16	20	16	6	2	31	46	45	45	45	29	9

Specimen	Tunnel angle 1	2	3	4	5	6	Septal count 1	2	3	4	5	6
1*	27	21	19	19	18	—						
2	28	26?	24	15?	18?	17?						
3	30	26	20	19	—	—						
4**	32	27	20?	20	22							
5	30	28	23	27	24							
6	29	27	28	32								
7	—	33	27	33	25							
8							6	20	26	27	33	
9							10	23?	29?	35?	37?	42?
10							9	19	21	29	36?	36?
11							—	21?	25?	28?	—	
Max.	48	34	30	33	30	23	10	24	30	35	37	42
Min.	27	20	19	15	18	17	6	17	21	27	30	36
Aver.	33	27	24	24	24	20	9	20	24	30	35	37
	13	16	17	16	10	2	8	10	10	8	6	3

* Holotype specimen

** Specimen which has double-proloculi.

The Akiyoshi specimens, including the OZAWA's ones, well agree with the short, thick form of "*Fusulina krafti*" in all the essential characters and statistics except for that the latter has slightly thicker spirotheca in the outer volutions.

Pseudofusulina krafti (SCHELLWIEN) is one of the most common species in the upper part of the Lower Permian and the lower part of the Middle Permian formations of Japan, and has been reported from more than ten localities throughout this country, though only OZAWA (1925) and HUZIMOTO (1936) described and illustrated this species from Akiyoshi and Akasaka limestones and the Kwanto massif, respectively. Besides, MORIKAWA (1955) also described and illustrated the same species very recently from the Shomaru pass of the Kwanto massif. However, unfortunately to say, their illustrations are neither sufficient in number nor exactly well oriented except few, and therefore, the detailed comparison seems to be not advisable here, but some of them, i. e., the upper left figure of fig. 7 of OZAWA's Pl. VI and most of the HUZIMOTO's specimens, seemingly are at least referable to this variety.

Occurrence.—*Pseudofusulina krafti* (SCHELLWIEN) var. *magna* TORIYAMA, n. var. is considerably wide in the stratigraphical occurrence, ranging from the Plβ to Pmβ subzone, although it is more abundant in the lower two subzones (Plβ and Plγ) than in the upper ones (Pmα and Pmβ). The Akiyoshi specimens were collected from the following localities: No. 4 limestone of Section VI (Loc. 450), Nos. 5 and 8 limestones of Section X (Loc. 522 and 567, respectively), No. 6 limestone of Section XVI (Loc. 188), No. 2 limestone of Section XIX (Loc. 375), No. 1 limestone of Section XX (Loc. 265), No. 6 limestone of Section XXV (Loc. 300), No. 8 limestone of Section XXVI (Loc. 758), and Loc. 194, 195, 380, 381, 382, 497, 553, and 572 (OZAWA's specimens were collected from Kunigyo, Isa-machi, Miné-shi).

Pseudofusulina cf. *yobarensis* (OZAWA)

Pl. 27, figs. 1–13

1925. *Schellwienia yobarensis* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XIV, Art. 6, p. 27, Pl. VII, figs. 7, 8.

The shell of *Pseudofusulina* cf. *yobarensis* (OZAWA) is subglobular to very short fusiform and small in size for the genus, with almost straight axis of coiling, broadly rounded poles, and convex lateral slopes. Mature specimens of four to four and a half, rarely five, volutions are 3.6 to 4.7 mm in length and 2.1 to 3.2 mm in width, giving form ratios of 1.3 to 1.5. The shell is almost the same in axial profile throughout the growth. Average ratios of the half length to the radius vector of the first to fourth volution in nine specimens are 1.3, 1.4, 1.4, and 1.4, respectively.

The proloculus is large for the size of the shell, and considerably varies in outside diameter, ranging from 246 to 660 microns and averaging 447 microns in thirty-six specimens. The shell expands relatively rapidly and almost uniformly throughout the growth. Average radius vectors of the first to fifth volution of thirty-eight specimens are 381, 648, 988, 1,246, and 1,564 microns, respectively. The chambers are nearly the same in height throughout the length of the shell, except in the very extreme polar regions.

The spirotheca is thick for this size of the shell, increasing in thickness rapidly. Average thickness of the spirotheca of the first to fifth volution of thirty-two specimens are 39, 70, 90, 99, and 121 microns, respectively. They are composed of the tectum and coarsely alveolar keriotheca, the latter of which is not observable in the first half to one volution of most specimens. In the outer volutions 5, rarely 6, alveoli are counted in a distance of 100 microns of the spirotheca. The spirotheca is thickest immediately above the tunnel and decreases toward the poles in most of the specimens. The proloculus wall is considerably thick, averaging 24 microns in twenty-two specimens.

The septa are thin and moderately widely spaced. Average septal counts of the first to fifth volution of fourteen specimens are 10, 20, 24, 27, and 30, respectively. They are rather highly fluted throughout the length of the shell. The closed chamberlets extend almost to the top of the chambers in the end third of the shell, but are nearly half to two-thirds as high as the chambers in the central region of the shell.

The tunnel is narrow, with a path somewhat irregular. Average tunnel angles of the first to fourth volution of nine specimens are 29, 25, 21, and 24 degrees, respectively. The chomata occur in all except the outer one to two volutions. They are low and asymmetrical in the first one to two volutions, having steep tunnel sides and gentle poleward slopes. In the outer volutions they are nearly symmetrical and about half as high as the chambers. The phrenotheca does not occur in most specimens including the OZAWA's type material, but is observable in some specimens although it occurs in a limited part of the outer volutions.

Remarks.—One may question if *Pseudofusulina yobarensis* (OZAWA) may represent a megalospheric form of some form of *P. vulgaris* (SCHELLWIEN) and its allies. In the remarks of his original description of this species, however, OZAWA (1925) stated that it may be regarded as a small form which does not attain the size of *Schellwienia vulgaris* and its allies, and not as younger stage of the latters.

The present specimens are considerably larger than the OZAWA's type specimen*, although outer part of the latter is clearly broken out after the fossilization,

* OZAWA illustrated only four specimens and did not designate the holotype. Because the right figure of the fig. 7 of Pl. VII being only the axial section, it automatically becomes the holotype specimen of *Pseudofusulina yobarensis*.

Table 69. Table of Measurements (in Millimeters) of *Pseudofusulina* cf. *yobarensis* (OZAWA)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5
1*	OZAWA'S specimen	II-24	27	12	2.36	1.61	1.5	$\genfrac{}{}{0pt}{}{.301}{.377}\times$	.275	.473	.737		
2*	OZAWA'S specimen	II-24	27	13	×	1.81	×	$\genfrac{}{}{0pt}{}{.294}{.307}\times$	.270	.505	.794		
3	495	1119	27	1	4.5?	3.1?	1.5	.451	.344	.613	.951	1.226	
4	552	1637	27	2	3.8+	3.0+	1.3	$\genfrac{}{}{0pt}{}{.405}{.528}\times$	.353	.613	.960	1.343	
5	497	1621	27	3	4.29	2.95	1.5	.581	.442	.759	1.226		
6	452	1879	27	4	3.59	2.55	1.4	.437	.477	.612	.832	1.151	1.410
7	475	1446	27	6	×	2.4+	×	.332	.307	.552	.980		
8	567	2024	27	7	×	3.07	×	.313	.31?	.61?	.95?	1.34?	
9	552	1634	27	8	×	3.0+	×	.490	.375	.567	.861	1.200	
10	552	1638	27	9	×	2.90	×	.40?	.308	.591	.895	1.214	1.470
						Max.		.660	.552	.951	1.30?	1.441	1.820
						Min.		.246	.230	.445	.700	1.060	1.410
						Aver.		.447	.381	.648	.988	1.246	1.564
								36	37	38	38	19	7

Specimen	Ratio of Hl./Rv. 1	2	3	4	Thickness of spirotheca 0	1	2	3	4	5
1*	1.3	1.3	1.4		.022	.036	.073	.071		
2*					.025	.048	.067	.071		
3	1.6	1.4	1.4	1.6	.025	.047	.089	.105	.091	
4	1.6	1.5	1.5	1.3	.028	.034	.096	.107	.153	
5	1.5	1.5	1.5		.020	.034	—	.120		
6	1.6	1.6	1.5	1.4	.019	.028	.055	.062	.075	
7					.025	.037	.070			
8					—	—	.071	.096	.081	
9					.026	.033	.055	.059	—	
10					—	.041	.062	.072	.075	.118
Max.	1.6	1.7	1.6	1.7	.043	.074	.127	.166	.153	.134
Min.	1.0	1.1	1.2	1.1	.011	.025	.043	.059	.075	.103
Aver.	1.3	1.4	1.4	1.4	.024	.039	.070	.090	.099	.121
	7	9	9	7	22	32	31	29	15	5

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5
1*	33	22	22							
2*						9	19	22		
3	31	20	17	16						
4	30	30	21	23						
5	25	29	31							
6	37	27	—	23?						
7						11	19	22?		
8						—	—	24	26	31
9						9	17	20	26	
10						—	19	24	28	
Max.	37	30	31	33		13	23	29	30	31
Min.	22	20	17	16		7	17	20	24	30
Aver.	29	25	21	24	15	10	20	24	27	30
	9	9	7	7	1	12	14	11	7	2

* The statistics of the specimens 1 and 2 is excluded from the averages.

and I am referring them to *Pseudofusulina yobarensis* (OZAWA) with some question.

The present species is closely similar to *P. vulgaris* var. *megaspherica* n. var., but differs from the latter in having smaller and more gibbous shell, less numerous volutions and slightly less numerous septa for the corresponding volution. They may be biologically closely related with each other.

Occurrence.—*Pseudofusulina* cf. *yobarensis* (OZAWA) occurs most abundantly in the Plγ subzone, but is ranging both upward to the Pmα and downward to the Plβ subzone. It was obtained from No. 13 limestone of Section I (Loc. 295), No. 6 limestone of Section VI (Loc. 452), Nos. 7 and 8 limestones of Section X (Loc. 566 and 567, respectively), No. 1 limestone of Section XXIV (Loc. 552), Nos. 5 and 9 limestones of Section XXVI (Loc. 754 and 759, respectively), and Loc. 475, 495, and 497.

Pseudofusulina (?) *isaensis* TORIYAMA, n. sp.

Pl. 27, figs. 14–21

The shell of *Pseudofusulina* (?) *isaensis* TORIYAMA, n. sp. is of relatively large size and thickly fusiform, with almost straight axis of coiling, much inflated central region, and tapering and bluntly pointed poles. The lateral slopes of the inner three volutions are convex to nearly straight, but those of the outer two volutions are considerably concave. Mature shells of five to six volutions are 6.7 to 7.9 mm in length and 2.8 to 4.9 mm in width, giving form ratios of 1.5 to 2.2. The first two to three volutions have short axis of coiling and subspherical to short fusiform. Beyond the third or fourth volution the axial ends become rather rapidly extended and the lateral slopes become concave. Average ratios of the half length to the radius vector of the first to sixth volution in four specimens are 1.5, 1.4, 1.5, 1.8, 1.8, and 1.9, respectively.

The proloculus is large and almost spherical, with an outside diameter of 446 to 600 microns, averaging 555 microns in nine specimens. The shell expands rapidly and almost uniformly throughout all but the last volution which seemingly is slightly tightly coiled than the penultimate one. Average radius vectors of the first to fifth volution for nine specimens are 473, 750, 1,057, 1,421, and 1,688 microns, respectively. The chambers are nearly the same in height throughout the length in the inner three volutions but rapidly increase in height polewardly in the outer two to three volutions.

The spirotheca is thick, consisting of the dense tectum and distinct alveolar keriotheca. About 5 alveoli are counted in a space of 100 microns of the spirotheca of the outer volutions. They can not be observed in the earliest stage of the growth. The spirotheca increases in thickness rapidly throughout the growth, except that it decreases in the ultimate volution of some specimens. Average thickness of the spirotheca in the first to fifth volution of eight specimens is 51, 72, 103, 124, and 109 microns, respectively. The proloculus wall, which seemingly consists of a single structureless layer, is moderately thick, averaging 22 microns in five specimens.

The septa are moderately thick and highly fluted throughout the length of

Table 70. Table of Measurements (in Millimeters) of *Pseudofusulina*(?) *isaensis* TORIYAMA, n. sp.

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector					
									1	2	3	4	5	6
1*	522	1627	27	14	6.70	3.11	2.2	.467	.415	.686	1.064	1.453		
2	522	1628	27	16	7.5+	4.93	1.5	.545	.500	.828	1.241	1.656	1.915	
3	572	1896	27	17	5.0?	2.75	1.8?	.490	.392	.613	.806	1.107	1.440	
4	572	1895			7.93	3.54	2.2	.594	.471	.686	.91+	1.210	1.530	1.870
5	522	1627	27	18	×	3.91	×	.559	.491	.766	1.088	1.470	1.740	
6	522	1630	27	19	×	4.07	×	.60+	.513	.889	1.337	1.778		
7	553	1643	27	21	×	3.22	×	.496	.424	.625	.941	1.287	1.748	
						Max.		.600	.550	.889	1.337	1.778	1.915	
						Min.		.446	.392	.613	.806	1.107	1.440	
						Aver.		.555	.473	.750	1.057	1.421	1.688	
								9	9	9	8	8	7	

Specimen	Ratio of Hl./Rv.						Thickness of spirotheca						
	1	2	3	4	5	6	0	1	2	3	4	5	6
1*	1.2	1.4	1.4	1.9	—		.018	.041	.041	.122	.118		
2	1.2	1.0	1.0	1.3	1.7		—	.057	.129	.142	.166	—	
3	2.0	1.5	1.7	2.1	1.8		—	—	.031	.050	.081	.060	
4	1.7	1.6	2.0	—	1.8	1.9	.025	.025	.040	.048	.088	.100	.084
5							.027	.055	.096	.103	.139	—	
6							—	.057	.092	.153	.150		
7							.021	.057	.062	.102	.123	.168	
						Max.	.027	.064	.129	.153	.166	.168	
						Min.	.018	.025	.040	.048	.081	.060	
						Aver.	.022	.051	.072	.103	.124	.109	
							5	7	8	7	7	3	

Specimen	Tunnel angle						Septal count			
	1	2	3	4	5	6	1	2	3	4
1*	29	24	19	15						
2	27	24	17	18	26					
3	28	23	15	21?						
4	24	24	21	20?	14?	16?				
6							10	26	32?	36+
7							9	21	27	27+

* Holotype specimen

the shell in all the volutions. The closed chamberlets extend almost completely to the tops of the chambers. Due to the insufficiency of material the septal counts of this form are not exactly known, but 10, 26, 32?, and 36+ septa are counted in the first to fourth volution of one sagittal section. Cuniculi formed by the intense fluting of septa are observed, although they are not so distinct as in typical form of *Parafusulina*.

The tunnel is narrow with somewhat irregular path. Average tunnel angles of the first to fifth volution of four specimens are 27, 24, 18, 19, and 20 degrees, respectively. The chomata occur only in the inner two or three volutions where they are low and asymmetrical. In the outer volutions they are, if present, not recognized as distinct ridges, being rather heavy, irregular deposits on the septa and the spirotheca. The thin phrenotheca is observable in some part of the outer volutions but they are not so distinct as in *Pseudofusulina vulgaris* (SCHELLWIEN) and its varieties. No axial filling exists.

Remarks.—Pseudofusulina(?) *isaensis* TORIYAMA, n. sp. is rather unique in the shell form and is not comparable with any species of *Pseudofusulina* hitherto described in this country. It somewhat resembles *Pseudofusulina hawkinsi* (DUNBAR and SKINNER) from the Glass Mountain, Texas, but differs from the latter in having more vaulted shell with the subspherical inner volutions, slightly larger proloculus and more or less thinner spirotheca.

The intense fluting of the septa and the existence of cuniculi in this species, though not so distinct as in the typical form of *Parafusulina*, suggest its approach to the latter genus, but it is still referable to the genus *Pseudofusulina* with question by its much vaulted form of the shell, large proloculus and rather thick septa and spirotheca.

Occurrence.—Pseudofusulina(?) *isaensis* TORIYAMA, n. sp. occurs only in three localities, No. 5 limestone of Section X (Loc. 522) and Loc. 553 and 572. Its stratigraphical age is of the Plβ subzone, but it is perhaps ranging upward into the Plγ subzone.

Pseudofusulina ambigua (DEPRAT)

Pl. 28; Pl. 29, figs. 1–9

1913. *Fusulina ambigua* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. II, fasc. 1, pp. 14, 15, Pl. III, figs. 4–7.
1914. *Fusulina ambigua* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. III, fasc. 1, p. 16, Pl. II, figs. 1–4.
1925. *Schellwienia ambigua* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, p. 31, Pl. IV, fig. 8.
1927. *Schellwienia ambigua* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Sec. II, Vol. II, Pt. 3, p. 144, Pl. XXXV, fig. 7; Pl. XXXVII, figs. 2, 4; Pl. XXXVIII, fig. 1a; Pl. XXXIX, fig. 10; Pl. XLV, figs. 7, 8.
1936. *Pseudofusulina ambigua* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1,

No. 2, pp. 69, 70, Pl. IX, figs. 5, 6; Pl. X, figs. 1–3.

The shell of *Pseudofusulina ambigua* (DEPRAT) is considerably large and elongate fusiform, with almost straight axis of coiling and bluntly pointed poles. The lateral slopes are convex to straight in the inner volutions, but are straight to somewhat concave in the outer ones. Mature specimens of four and a half to five, very rarely five and a half, volutions are 7.6 to 9.0 mm long and 2.2 to 3.5 mm wide, giving form ratios of 2.5 to 3.0. Most typical specimen in the present collection has a length of 7.90 mm and a width of 2.63 mm, giving a form ratio of 3.0. The shell is subspherical to ellipsoidal in shape in the first volution, but beyond the second volution the axis extends with considerable rapid rate. The ratios of the half length to the radius vector of the first to fifth volution in twelve specimens are 1.9, 2.2, 2.4, 2.6, and 2.8, respectively.

The proloculus is relatively large for the size of the shell. It is usually spherical to ellipsoidal, but is somewhat irregular in some specimens. Its outside diameter is ranging from 244 to 414 microns, averaging 308 microns in fifty-seven specimens. The largest diameter of the ellipsoidal proloculus attains 440 microns. The shell relatively rapidly expands throughout the growth except in the first volution which is slightly tightly coiled. The radius vectors average 255, 428, 685, 1,023, 1,377, and 1,676 microns in the first to sixth volution, respectively, in sixty-two specimens. The chambers are lowest immediately above the tunnel, and they increase in height slowly and uniformly poleward from the tunnel.

The spirotheca is moderately thick, consisting of a tectum and a coarsely alveolar keriotheca. Alveoli are hard to be observable in the inner volutions of some specimens. Average thickness of the spirotheca in the first to fifth volution for fifty-one specimens is 29, 43, 68, 89, and 98 microns, respectively. The proloculus wall is seemingly structureless, being 25 microns of average thickness in thirty-two specimens. The spirotheca is thickest immediately above the tunnel, changing in thickness slightly toward the poles.

The septa are thin and moderately spaced. They are formed of the downward deflection of the tectum and distinct pycnotheca. Average septal counts of the first to fifth volution of eighteen specimens are 11, 19, 24, 29, and 31, respectively. The septa are narrowly and highly fluted completely to the tops of the chambers in the polar regions and slightly less highly fluted across the center of the shell. The closed chamberlets extend slightly above the top of the tunnel.

The tunnel widens considerably rapidly as the shell expands. Its path is nearly straight in some specimens but irregular in others. Average tunnel angles of the first to fifth volution in fifteen specimens are 26, 28, 33, 40, and 44 degrees, respectively. The chomata are distinct in the inner two to three volutions of most specimens where they are low and asymmetrical, with steep tunnel sides and gentle poleward slopes. In the outer volutions they are not present or very

Table 71. Table of Measurements (in Millimeters) of *Pseudofusulina ambigua* (DEPRAT)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector					
									1	2	3	4	5	6
1	271	1521	28	1	7.90	2.63	3.0	.360	.261	.452	.741	1.110	1.48+	
2	474	1617	28	2	9.00	3.00	3.0	.345/.385 ×	.280	.439	.683	1.043	1.450	
3	544	1168	28	3	8.15	3.23	2.5	.294	.245	.368	.595	.920	1.350	1.665
4	329	1563	28	5	6.60	2.70	2.4	.360/.440 ×	.299	.508	.819	1.170		
5	544	1170	28	10	8.0+	2.89	2.8	.338	.322	.516	.806	1.226	1.533	
6	543A	1159	29	1	7.60	2.80	2.7	.378	.307	.470	.696	1.049	1.508	
7	329	1562	28	11	×	2.38	×	.281/.310 ×	.290	.479	.780	1.150		
8	544	1172	28	12	×	2.12	×	.245	.215	.335	.613	.920		
9	271	1522	28	13	×	2.68	×	.254/.340 ×	.251	.441	.720	1.000	1.330	
10	544	1169	29	4	×	2.63	×	.280	.236	.395	.662	1.024	1.395	
11	492	1114	29	7	×	2.23	×	.301	.242	.421	.635	1.003		
12	271	1524	29	9	×	2.66	×	.270	.260	.400	.661	1.030	1.401	
						Max.		.414	.348	.587	.959	1.290	1.533	1.810
						Min.		.244	.192	.333	.531	.834	1.180	1.580
						Aver.		.308	.255	.428	.685	1.023	1.377	1.676
								57	60	62	60	56	34	5

Specimen	Ratio of Hl./Rv.						Thickness of spirotheca						
	1	2	3	4	5	6	0	1	2	3	4	5	6
1	2.3	2.0	3.0	2.9	2.8		.024	.020	.066	.089	.100		
2	1.0	1.5	2.0	2.6	2.9		.029	.034	.043	.097	.119	.134	
3	1.4	2.1	2.3	2.6	2.7	2.7	—	—	.039	.070	.096	.168	.074
4	2.5	2.4	2.6	2.8			.028	.042	.052	.062	.083		
5	1.7	2.0	2.5	—	—		—	.031	.054	.080	.092	.101	
6	2.3	2.9	3.2	3.3	2.9		.026	.029	.036	.076	.107	.117	
7							.028	.037	.047	.070	.085		
8							.019	.021	.024	.073	.072		
9							.024	.039	.047	.061	.070	.085	
10							—	.026	.037	.061	.070	.064	
11							.030	.030	.037	.054	.089		
12							.024	—	.042	.070	.117	.141	
Max.	2.5	2.9	3.2	3.3	2.9	2.9	.033	.045	.077	.103	.119	.141	.091
Min.	1.0	1.5	1.7	1.9	2.6	2.7	.015	.020	.024	.055	.061	.061	.073
Aver.	1.9	2.2	2.4	2.6	2.8	2.8	.025	.029	.043	.068	.089	.098	.079
	12	12	12	12	6	2	32	42	51	49	46	31	3

Specimen	Tunnel angle					Septal count				
	1	2	3	4	5	1	2	3	4	5
1	—	28	35	44						
2	—	22	33	34	43					
3	20	24	27	31	42					
4	17	23	26	38	43					
5	32	26	42	57						
6	24	23	34	35						
7						8	20	25	33	
8						12	20	24	26	
9						11	18	25	33	28
10						13	23	26	36	30
11						10	18	21	29	
12						11	20	27	27	34
Max.	33	36	42	57	50	13	24	28	36	36
Min.	17	22	25	28	42	8	15	21	24	28
Aver.	26	28	33	40	44	11	19	24	29	31
	11	15	15	12	5	16	17	18	15	8

rudimentary in development. If present, they occur as irregular deposits on the septa and the spirotheca. The phrenotheca seemingly does not occur in most specimens.

Remarks.—All the important characters of the Akiyoshi specimens—the shell form, the prolocular size, the rate of expansion, the spirothecal thickness, and the mode and intensity of the septal fluting—considerably well agree with those of the Cammon specimens originally described by DEPRAT. Only the difference is that the number of the septa is slightly less numerous in the Akiyoshi form, which is of course regarded as being within the limit of specific variation.

Since DEPRAT (1913) established this species, it has been described and illustrated from Akasaka by DEPRAT (1914) and OZAWA (1927), from Yobara of Akiyoshi by OZAWA (1925), and from Asamido, Fukazawa and other localities of the Kwanto massif by HUZIMOTO (1936). However, their materials, excepting DEPRAT's ones from Akasaka, are represented by not well oriented axial sections or immature specimens, and are not available for the detailed comparison.

In the remark of *Schellwienia ambigua* in his study of the Akasaka limestone, OZAWA (1927) suggested that some species described by DEPRAT from Eastern Asia —"*Fusulina subcylindrica*, *F. parumvoluta*, *F. laosensis* and *F. complicata* (not SCHELLWIEN's)—are not distinct from "*Fusulina ambigua* DEPRAT" but are of the synonymy with the latter. However, under the precise knowledge of the recent micropaleontology, these species cannot be regarded as being conspecific, but are easily distinguished from one another.

Occurrence.—*Pseudofusulina ambigua* (DEPRAT) was originally collected from the Permien supérieur of Cammon with "*Fusulina subcylindrica* DEPRAT". Later DEPRAT also recorded this species from "the Permien supérieur" of the Akasaka limestone of Japan with "*Fusulina exilis* SCHWAGER, *F. margheritii* DEPRAT and *Neoschwagerina globosa* YABE". OZAWA doubted its occurrence in such a higher horizon, and, indeed, he found it in the lower part of the Nn zone and the upper part of the Benijima limestone which are possibly correlated with the Plγ subzone and a part of the Pmα subzone.

In the Akiyoshi limestone group, *Pseudofusulina ambigua* (DEPRAT) is considerably abundant in the Plβ and Plγ subzones, although more common in the latter. Several doubtful specimens tentatively referred to this species with question have been obtained from the higher Pmα subzone. The following localities are known: Nos. 8, 9, 10, and 11 limestones of Secton III (Loc. 543, 543A, 544, and 545, respectively), Nos. 2 and 11 limestones of Section X (Loc. 492 and 568B, respectively), Nos. 2 and 6 limestones of Section XII (Loc. 606A and 609, respectively), No. 4 limestone of Section XIII (Loc. 571A), No. 3 limestone of Section XX (Loc. 342), No. 1 limestone of Section XXII (Loc. 329), Nos. 2 and 3 limestones of Section

XXIII (Loc. 270 and 271, respectively) and Loc. 474 and 508.

Pseudofusulina (?) *kyowaensis* TORIYAMA, n. sp.

Pl. 29, figs. 10–18

The shell of *Pseudofusulina* (?) *kyowaensis* TORIYAMA, n. sp. is large and elongate fusiform, with almost straight to slightly arched axis of coiling and narrowly rounded polar ends. The lateral slopes are almost straight to convex in the inner volutions but straight to concave in the outer ones. Mature specimens of five to five and a half volutions, including the holotype specimen, are 5.9 to 9.7 mm long and 2.8 to 3.5 mm in width, giving form ratios of 2.2 to 2.8. The shell is short fusiform with rounded polar ends in the first volution, and beyond the second volution the axis becomes extended more or less rapidly. Average ratios of the half length to the radius vector of the first to sixth volution in ten specimens are 2.1, 2.1, 2.2, 2.3, 2.4, and 2.4, respectively.

The proloculus is large and nearly spherical to somewhat irregular in shape. Its outside diameter is ranging from 332 to 520 microns, averaging 405 microns in thirty specimens. The shell expands rapidly and almost uniformly from the first volution to maturity. Average radius vectors of the first to fifth volution in twenty-nine specimens are 354, 580, 865, 1,237, ane 1,573 microns, respectively. The chambers are almost the same in height in the central two-thirds of the shell but increase poleward in the outer volutons.

The spirotheca is moderately thick and coarsely alveolar. It increases in thickness nearly uniformly with the growth of the shell. Average thickness of the spirotheca in the first to fifth volution of twenty-five specimens are 37, 56, 73, 92, and 94 microns, respectively. The proloculus wall is thick, consisting of a single dense homogeneous layer and averaging 27 microns in thickness for twenty specimens.

The septa are thin and narrowly and highly fluted throughout the length of the shell. The fluting extends almost completely to the tops of the chambers. The pycnotheca is well defined in all but the inner one to two volutions. Average septal counts of the first to fifth volution in eleven specimens are 12, 24, 27, 30, and 34, respectively.

The tunnel is low and narrow with an irregular path. The tunnel angles are nearly uniform during the growth, averaging 29, 29, 27, 33, and 26 degrees in the first to fifth volution, respectively, in four specimens. These measurements of the tunnel angles are not precise because it is rather difficult to define tunnel exactly. The chomata are very weakly developed in most specimens, and occur as small rudimentary ridges in the inner volutions of some specimens.

Remarks.—The generic reference of this form is somewhat doubtful. The cuniculi

Table 72. Table of Measurements (in Millimeters) of *Pseudofusulina*(?) *kyowaensis* TORIYAMA, n. sp.

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1*	258	617	29	10	8.25	3.50	2.4	.441	.412	.663	.961	1.260	1.551	1.730
2	494	1884	29	11	9.70	3.50?	2.8	.42+	.362	.513	.742	1.073	1.44?	
3	494	1884	29	12	7.18	3.22	2.2	.369	.307	.491	.770	1.135	1.559	
4	494	1882	29	13	7.40	3.1+	2.4	.367	.307	.454	.750	1.111	1.38+	
5	547	790	29	16	×	3.10	×	.39+	.291	.538	.860	1.258	1.809	
6	547	791	29	17	×	2.50	×	.368 .442 ×	.485	.797	1.257			
7	329	1562	29	18	×	2.87	×	.421 .520 ×	.418	.737	1.197	1.658		
							Max.	.520	.485	.797	1.257	1.658	1.809	
							Min.	.332	.245	.440	.650	.882	1.380	
							Aver.	.405	.354	.580	.865	1.237	1.573	1.730
								30	29	29	29	22	12	1

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5
1*	1.9	2.0	2.2	2.2	2.2	2.4	.024	.042	.052	.070	.075	.070
2	1.9	2.4	—	2.9	3.4		.030	.029	.045	.084	.099	.118
3	—	2.1	2.2	2.2	2.2		.027	.031	.062	.071	.099	.118
4	1.8	1.8	1.9	2.1	2.5		.021	.042	.048	.054	.090	.075
5							.021	.028	.061	.096	.108	.086
6							.035	.041	.067	.064		
7							.038	.042	.061	.094	.080	
Max.	2.6	2.4	2.7	2.9	3.4		.043	.052	.094	.107	.141	.118
Min.	1.8	1.8	1.9	2.0	1.9		.018	.027	.037	.048	.062	.070
Aver.	2.1	2.1	2.2	2.3	2.4		.027	.037	.056	.073	.092	.094
	9	10	9	6	5		20	23	25	25	17	9

Specimen	Tunnel angle 1	2	3	4	5	Septal count 1	2	3	4	5
1*	—	29	22	29						
2	—	—	24	38	28					
3	28	—	—	32	25					
4	—	—	31	—	—					
5						10	16	22	25	35?
6						13	23	25?		
7						14	31	33	31	
Max.	33	32	32	38	28	16	31	33	35	35?
Min.	28	25	22	29	25	10	16	22	25	32
Aver.	29	29	27	33	26	12	24	27	30	34
	3	3	4	3	2	10	11	9	5	2

* Holotype specimen

of this form seemingly develop at least in the outer volutions, but it is not certain that whether do they occur also in the inner volutions of the shell.

Pseudofusulina(?) *kyowaensis* TORIYAMA, n. sp. is closely similar to *P. ambigua* (DEPRAT) in the size and shape of the shell and the rate of expansion, but is distinguished from the latter in having slightly thicker form, larger proloculus, and more highly and narrowly fluted septa.

Pseudofusulina (?) *kyowaensis* n. sp. also resembles some American forms of *Schwagerina* and *Parafusulina*. Among them, *Schwagerina caurus* THOMPSON, WHEELER and DANNER from South Twin Lakes limestone, Washington, has some resemblance to the present species in the shape of the shell, the rate of expansion and the intensity of the septal fluting, but the former is distinguished from the latter by thicker spirotheca, slightly larger proloculus and heavier axial fillings.

Parafusulina diabloensis DUNBAR and SKINNER from the Bone Spring formation, Texas, is somewhat similar to the present form in some respects, but differs from the latter in having larger and more stout shell, much thicker spirotheca and more intense septal fluting.

At any rate, this form may be referable to *Parafusulina* or *Schwagerina*, and indeed, it is transitional in biological characters from *Schwagerina* to *Pseudofusulina* or to *Parafusulina*. For the present I have placed it in the genus *Pseudofusulina* with question.

Occurrence.—*Pseudofusulina*(?) *kyowaensis* TORIYAMA, n. sp. has been found in the Nos. 8, 10, and 11 limestones of Section III (Loc. 543, 544, and 545, respectively), No. 2 limestone of Section X (Loc. 492), Nos. 1 and 2 limestones of Section XXI (Loc. 257 and 258, respectively), No. 1 limestone of Section XXII (Loc. 329) and Loc. 494, 547 and 548. It is most common in the Loc. 494. The stratigraphical range of this species is fairly wide, ranging from the Plα to Pmα, of which the Plβ and Plγ seemingly are of the acme of this species.

Genus *Parafusulina* DUNBAR and SKINNER, 1931

Parafusulina lutugini (SCHELLWIEN)

Pl. 30, figs. 1–5

1908. *Fusulina lutugini* SCHELLWIEN. Palaeontographica, Vol. LV, pp. 177, 178, Pl. XVII, figs. 2, 3, 7, 8, 12–14.
1925. *Schellwienia lutugini* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 28, 29, Pl. VI, fig. 4.
1927. *Schellwienia* cf. *lutugini* LEE. Palaeontologia Sinica, Ser. B, Vol. IV, Fasc. 1, pp. 76, 77, Pl. X, figs. 5, 6.
1947. *Schwagerina* cf. *lutugini* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XX, Nos. 2–4, pp. 68, 69, Pl. 16, fig. 2.

I have obtained only two sections of *Parafusulina* from the limestone of Loc. 494. One is axial, though not exactly axial, and the other is sagittal. Although they are not sufficient for the detailed study, they are perhaps referable to *Parafusulina lutugini* (SCHELLWIEN). The following description is based on these two specimens.

The shell is relatively large and elongate fusiform, with slightly arcuate axis, straight to gently convex lateral slopes and bluntly pointed poles. The axial section is estimated to have an axial length of 11 mm (half length is 5.5 mm) and a width of 3.0 mm. These figures give a form ratio of 3.7. The first volution seemingly is ellipsoidal and the axis extends rapidly as the shell grows. The polar end of each volution is difficult to be determined due to the heavy secondary deposits.

The proloculus is moderate in size, and is probably spherical in the axial section, having an outside diameter of at least 260 microns, while in the sagittal section it is ellipsoidal with a maximum outside diameter of 460 microns and a minimum one of 332 microns. The shell expands more or less rapidly and almost uniformly. The radius vectors of the first to sixth volution of the axial section are 320, 470, 714, 980, 1,287, and 1,644 microns, respectively, and those of the first to fifth volution in the sagittal section are 307, 480, 680, 980?, and 1,220? microns, respectively. The chambers are lowest immediately above the tunnel only slightly increasing in height polewards.

The spirotheca is rather thin for the size of the shell. The thickness of the spirotheca of the second, fourth, fifth, and sixth volution of the axial section is 45, 75, 78, and 57(?) microns, respectively, and that of the first to fifth volution of the sagittal section is 26, 43, 49, 69, and 70 microns, respectively. The spirotheca consists of a tectum and a keriotheca. The alveoli are clearly observable throughout all but the first volution. About 8 alveoli are counted in a space of 100 microns of the spirotheca of the fifth volution.

The septa are highly and narrowly fluted throughout the length of the shell. Although the fluting extends to the tops of the septa, the closed chamberlets extend about two-thirds of the height of the chambers in the median part of the shell.

The tunnel is considerably wide with nearly the straight pass. The tunnel angles of the second to fifth volution are 54, 53, 52, and 37 degrees, respectively. The chomata do not occur even in the earliest stage of the growth. The heavy secondary deposits occur in a narrow zone along the axis.

Remarks.—*Parafusulina lutugini* (SCHELLWIEN) is one of the most slender fusuline found in the Akiyoshi limestone group. It resembles rather closely *P. guatemalaensis* DUNBAR from Purula, Guatemala, but differs from that species in having thinner spirotheca and less dense axial deposits. The proloculus of the latter seemingly is larger than that of the former.

Parafusulina lutugini (SCHELLWIEN) displays rather wide geographic distribution in the Tethys area, and has often been designated as the zone fossil by previous workers. So far has been reported, the OZAWA's CPg, "*Fusulina lutugini*" subzone in the Akiyoshi limestone, RAUSER-CERNOUSSOVA's "*Pseudofusulina lutugini*" zone in the Ishimbaio oil-field of the western Ural, and RUZENCEV's "*Schwagerina lutugini*' zone in the Orenburg region are these examples, all of which were regarded as the Middle or Lower Artinskian in age.

I have examined the OZAWA's collection now kept in the University of Tokyo and found that "*Fusulina (Schellwienia) lutugini*" is represented by only three sections (II–70 to II–72), all of them were collected from the Kaerimizu doline. Nevertheless, it is rather funny that OZAWA selected this species as the zone fossil.

Occurrence.—This species is rarely found in the Plβ subzone. Loc. 494 is only locality in the Akiyoshi limestone group.

Parafusulina kaerimizensis (OZAWA)

Pl. 30, figs. 6–12; Pls. 31, 32.

1925. *Schellwienia kaerimizensis* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 31, 32, Pl. IV, figs. 6, 7; Pl. VI, fig. 5. [non Pl. IV, fig. 5]

1936. *Pseudofusulina kaerimizensis* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 65–67, Pl. VII, figs. 6–8; Pl. VIII, figs. 1–4.

1955. *Parafusulina kaerimizensis* MORIKAWA. Sci. Repts. Saitama Univ., Ser. B, Vol. II, No. 1, pp. 107, 108, Pl. XV, figs. 11–13.

The shell of *Parafusulina kaerimizensis* (OZAWA) is moderately large and elongate fusiform to subcylindrical, with straight to slightly arcuate axis of coiling, straight to somewhat depressed median portion, gently convex lateral slopes, and bluntly pointed poles. The number of volution is 5 to 7 in most specimens, but is 8 or even 9 in some specimens. Mature shells of 5 to 7 volutions are 10.3 to 14.3 mm in length and 2.3 to 3.6 mm in width giving form ratios of 3.2 to 5.1. The first volution is subspherical to short fusiform, but the axis becomes extended very rapidly as the shell grows. Average ratios of the half length to the radius vector of the first to eighth volution of seventeen specimens are 2.7, 3.0, 3.3, 3.5, 3.6, 3.6, 4.0, and 3.6, respectively.

The proloculus is spherical to subspherical and moderate in size. The outside diameters range from 215 to 466 microns, averaging 312 microns for forty-five specimens. The inner two to three volutions relatively tightly coil and from the the third or fourth volution the shell expands considerably rapidly and almost uniformly. Average radius vectors of the first to eighth volution in forty-nine specimens are 231, 345, 501, 700, 940, 1,210, 1,510, and 1,709 microns, respectively. The chambers are nearly the same in height in central one-third of the shell, increasing in height gradually and slowly toward the ends in the polar third.

The spirotheca is rather thin and moderately coarsely alveolar. Average thickness of the spirotheca of the first to eighth volution of forty-one specimens is 22, 27, 36, 46, 61, 74, 87, and 83 microns, respectively. The alveoli of the keriotheca are distinct in all but the earliest volution. 5 to 6 of alveoli are observed in a space of 100 microns of the spirotheca of the outer volutions. The spirotheca is thickest immediately above the tunnel, only slightly decreasing in thickness polewardly. The proloculus wall is also thin, averaging 18 microns for twenty-three specimens.

The septa are relatively thin and highly and narrowly fluted throughout their length. The closed chamberlets formed by the strong fluting of the septa are completely, or almost completely at least, reaching to the tops of the chambers throughout the length of the shell. The cuniculi are clearly observable in the tangential sections. The septa are formed of the downward deflection of the tectum and seemingly structureless pycnotheca. The spacing of the septa is considerably narrow, and average septal counts of the first to seventh volution of fifteen specimens are 10, 21, 25, 30, 33, 32, and 35, respectively.

The tunnel is relatively wide although it is rather difficult to determine the tunnel sides exactly due to the high fluting of the septa. The tunnel path is more or less irregular. Average tunnel angles of the first to seventh volution for fifteen specimens are 28, 33, 31, 32, 30, 33, and 36 degrees, respectively. The chomata seemingly do not occur throughout the growth except in the earliest volution of some specimens, where they form small, nearly symmetrical ridges. The heavy secondary deposits occur in the axial zones of the inner four to five volutions of most specimens. In the outer one to two volutions they become less dense, filling the chambers only partially. No phrenotheca is present.

Remarks.—Parafusulina kaerimizensis (OZAWA) is one of the most common species of schwagerinids found in the Middle Permian rocks of Japan. Although in his original description of this species OZAWA illustrated two axial sections, one [fig. 7 of Pl. IV (the enlarged figure of fig. 5 of Pl. VI)] from Kaerimizu and the other (fig. 5 of Pl. IV) from Tomuro, they seem to be not conspecific with each other. Since OZAWA did not designate the holotype, one of the above two must be chosen for the lectotype. It is natural that if a specific name is derived from the locality name, the type specimen must be chosen from the specimens collected from that locality; and, therefore, *Parafusulina kaerimizensis* (OZAWA) should be based on the specimen (section No. II-81 in the OZAWA's collection) illustrated as fig. 7 of Pl. IV (or fig. 5 of Pl. VI) which is designated here as the lectotype of the species.

I have examined and measured scores of specimens collected from Kaerimizu, and found that *P. kaerimizensis* as thus defined has some variations within the species in the rate of expansion, the spirothecal thickness and the intensity of axial fillings, and that the lectotype specimen represents one extremity of the limit of variation; namely, it shows the slowest rate of expansion and has thinner, if not the thinnest, spirotheca.

Table 73. Table of Measurements (in Millimeters) of *Parafusulina kaerimizensis* (OZAWA)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7	8	9	Ratio of Hl./Rv. 1	2	3	4	5	6	7	8
1*	OZAWA's specimen	II-81	32	7	12.3?	3.6+	3.4	.264	.190	.254	.368	.513	.705	.975	1.226	1.594	1.870	—	—	3.1	3.6	3.7	3.5	3.6	—
2*	OZAWA's specimen	II-80	32	8	×	3.06	×	.248	.190	.300	.454	.616	.816	1.088	1.367										
3	817	1920	30	6	12.8+	3.27	3.9	.303/.418×	.218	.347	.516	.650	.873	1.147	1.413			3.1	3.1	3.0	3.6	3.7	3.6	3.8	
4	817	1917	30	8	10.25	2.31	4.4	.246/.307×	.187	.288	.451	.724	.984	1.26?	1.53?			3.6	3.5	3.3	2.9	3.4	3.6	3.4	
5	817	1917	31	2	11.0+	2.45	4.5	.40+	.288	.408	.546	.791	.984	1.27?				2.2	2.5	2.8	3.0	4.0	4.1		
6	765A	2261	31	3	12.36	3.00	4.1	.342/.466×	.245	.332	.440	.577	.750	.981	1.238	1.600		1.8	2.4	2.8	3.1	3.2	3.4	3.3	3.4
7	288A	1838	31	4	10.5+	2.7+	3.9	.280+	.261	.432	.634	.862	1.160					2.4	2.6	2.9	3.2	3.5			
8	287B	2184	31	5	14.30	2.8+	5.1	.226	.153	.236	.338	.472	.674	.890	1.107			—	—	3.1	3.7	3.3	3.7	4.5	
9	291	2192	32	2	10.01	3.16	3.2	.276/.344×	.298	.440	.590	.850	1.070	1.380	1.660			3.3	—	3.8	3.6	3.7	3.7	3.7	
10	817	1933	30	9	×	2.48	×	.276	.227	.368	.546	.785	1.076	1.35+											
11	817	1918	30	11	×	2.34	×	.290	.221	.329	.475	.677	.940	1.211											
12	817	1919	30	12	×	3.32	×	.298/.393×	.233	.350	.494	.742	1.015	1.340	1.732										
13	288A	1840	32	5	×	3.36	×	.307/.351×	.218	.320	.424	.647	.920	1.257	1.616										
14	287	2172	32	6	×	2.96	×	.188/.226×	.153	.245	.372	.551	.82?	1.180	1.580										
							Max.	.466	.307	.460	.613	.834	1.160	1.410	1.840	1.880		3.6	3.5	4.5	4.8	5.6	4.2	4.5	3.8
							Min.	.215	.153	.236	.338	.472	.674	.890	1.107	1.600		1.3	1.9	1.8	2.3	2.5	2.8	2.9	3.3
							Aver.	.312	.231	.345	.501	.700	.940	1.210	1.510	1.709		2.7	3.0	3.3	3.5	3.6	3.6	4.0	3.6
								45	45	49	49	49	39	26	17	4		12	12	17	17	17	13	8	5

Specimen	Thickness of spirotheca 0	1	2	3	4	5	6	7	8	9	Tunnel angle 1	2	3	4	5	6	7	Septal count 1	2	3	4	5	6	7
1*	—	.016	.027	.027	.030	.040	.057	.058	.088	.070	22	23	27	26	29	29	30							
2*	—	.024	.027	.030	.048	.049	.074	.095										10	21	26	28	36	34	34
3	.019	.023	.028	.033	.041	.067	.069	.080			—	29	27	30	29	34	43							
4	.016	.017	.025	.030	.067	.078	.078	.067			23	24	—	—	28	34								
5	.021	.020	.022	.035	.055	.064	.097				25	19	—	23	35	37								
6	.021	.018	.026	.028	.028	.033	.046	.081	.070		—	21	19	20	21	28	31							
7	—	—	.026	.044	.055	.088					—	32	28	31	28									
8	—	.023	.024	.028	.037	.042	.061	.090			—	40	—	—	—									
9	.012	.024	.025	.035	.044	.060	.080	.070			—	—	—	—	24									
10	—	.021	.020	.032	.045	.059	.066											10	23	28	33	31		
11	.026	.021	.030	.043	.057	.085	.078											—	20	22	24	28		
12	.020	.021	.028	.043	.049	.058	.086	.091										12?	22	26	28	33	30	33
13	—	.020	.021	.029	.043	.072	.096	.107										10	21	26	31	34	31	36
14	.020	.028	.037	.052	.062	—	.108											8	16	17?	22	27?	36?	
Max.	.026	.034	.037	.052	.067	.088	.108	.107	.095		33	51	43	48	47	38	43	12	24	28	37	41	36	36
Min.	.012	.015	.018	.025	.028	.033	.046	.067	.070		23	19	19	20	21	28	31	8	16	17?	22	28	30	33
Aver.	.018	.022	.027	.036	.046	.061	.074	.087	.083		28	33	31	32	30	33	36	10	21	25	30	33	32	35
	23	31	38	40	41	31	21	13	2		11	13	13	13	15	9	3	12	15	14	12	8	3	2

* The statistics of the specimens 1 and 2 is excluded from the averages.

Besides the OZAWA's original report, only HUZIMOTO (1936) described and illustrated this species from the Kwanto massif. Although he remarked that his specimens are fairly variable in the external size, the number of the septa and the form of the proloculus, the statistics of most of the Tsuchisaka-toge specimens are outside of the limit of variation observed in the Akiyoshi specimens; namely, most of the Tsuchisaka-toge specimens have larger radius vector and thicker spirotheca, especially in the outer volutions than those of any specimen found at Kaerimizu and other localities in the Akiyoshi limestone group.

Very recently MORIKAWA (1955) also described this species from the Shomaru pass, eastern part of the Kwanto massif, but his materials are very insufficient and his measurements seemingly do not coincide with his illustrations. Judging from his microphotographs, only fig. 12 of Pl. XV seems to be referable to this species.

Occurrence.—*Parafusulina kaerimizensis* (OZAWA) occurs most abundantly in the Pmα subzone and seemingly is ranging upward into the Pmβ subzone. It has been found in the Nos. 5, 7, 9, 9A, 10, and 11 limestones of Section I (Loc. 287, 288A, 290, 817, 291, and 292, respectively), Nos. 1 and 2 limestones of Section XV (Loc. 765A and 183, respectively), and Nos. 3 and 5 limestones of Section XVI (Loc. 191 and 189, respectively), and Loc. 572.

Parafusulina edoensis (OZAWA)

Pls. 33–35; Pl. 36, fig. 1

1925. *Schellwienia edoensis* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 30, 31, Pl. VI, figs. 1b, 2, 3.

The shell of *Parafusulina edoensis* (OZAWA) is large and elongate fusiform, with more or less arcuate axis of coiling, nearly horizontal to slightly convex median portion, straight to weakly convex lateral slopes, and bluntly pointed poles. The volution numbers 5 to 7 in most specimens but rarely attains 8 in some specimens. The OZAWA's type specimen of six volutions is approximately 14.3 mm in length and 4.1 mm in width, giving a form ratio of 3.5. The first volution is ellipsoidal to short fusiform with rounded poles, and from the second volution to maturity the axis becomes extended rapidly towards the poles as the shell grows. Due to the arching of the axis of coiling and the heavy axial fillings it is rather difficult to measure the true length of the axis exactly. Average ratios of the half length to the radius vector of the first to seventh volution of sixteen specimens are approximately 1.9, 2.2, 2.2, 2.3, 2.5, 2.5, and 2.6, respectively.

The proloculus is large and spherical to short ellipsoidal, with an outside diameter of 290 to 760 microns, averaging 471 microns for sixty-seven specimens. The shell expands slightly slowly in the first one to two volutions, but rapidly and almost uniformly from the third volution to maturity. Average radius vectors of the first to seventh volution in seventy specimens are 354, 526, 765, 1,043, 1,360, 1,692, and 2,083 microns, respectively. The chambers are lowest immediately above the tunnel, increasing in height gradually towards the poles.

The spirotheca is moderately thick and distinctly coarsely alveolar. About 5 alveoli occupy a distance of 100 microns in the spirotheca of the outer volutions. In the well preserved specimens alveolar structure is observable throughout the growth except in the spirotheca of the earliest few chambers. The spirotheca gradually increases in thickness as the shell grows. Average thickness of the spirotheca of the first to seventh volution in fifty-five specimens is 35, 45, 57, 72, 92, 114, and 112 microns, respectively. The proloculus wall is seemingly structureless, with a thickness of 18 to 37 microns, averaging 25 microns in thirty-eight specimens.

The septa are thin and highly and narrowly fluted throughout the length of the shell. The fluting extends almost completely to the tops of the chambers. The closed chamberlets formed by the strong fluting completely reach to the tops of the chambers or at least more than two-thirds as high as the chambers even in the central portion of the shell. The septa are considerably narrowly spaced. Average septal counts of the first to sixth volution of fourteen specimens are 9, 21, 26, 30, 32, and 34, respectively.

The tunnel is narrow and its path is somewhat irregular. The strong fluting of the septa makes the tunnel sides difficult to determine with certainty. Average tunnel angles of the first to seventh volution of twenty-six specimens are 32, 29, 27, 26, 26, 23, and 23 degrees, respectively. The occurrence of the chomata is restricted only in the first one to two volutions of some specimens. If present, the chomata are very rudimentary in development, being small, more or less asymmetrical ridges on the spirotheca. The dense secondary deposits almost completely fill the chambers of the axial regions throughout all but a part of the first and ultimate volutions.

Remarks.—Although *Parafusulina edoensis* was named by OZAWA after Edo, he was incorrect in nomenclature that he mixed up the locality name and the personal name to whom he intended to devote the specific name of this form. This has been clarified by the personal communication from Dr. OZAWA to Mr. ETO (not Edo*) of Akiyoshi, Shuho-cho, saying that "I have found several new species and wish to name one of them in honour of you, ..." Therefore, this species was ought to be named "*Schellwienia etoi* OZAWA". At any rate, it should be noted that *P. edoensis* does not occur at Edo, Akago, Mito-cho.

* The Chinese characters of Eto (恵藤) can also be pronounced "*edo*". OZAWA seemed to misread Mr. ETO's name, and moreover, to mix up the misread personal name "Edo" and the locality name "Edo (絵堂)"

Table 74. Table of Measurements (in Millimeters) of *Parafusulina edoensis* (OZAWA)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector								Ratio of Hl./Rv.						
									1	2	3	4	5	6	7	8	1	2	3	4	5	6	7
1*	OZAWA's specimen	II-50	34	5	14.3+	4.1+	3.5	$\frac{.431}{.508}\times$	.360	.522	.858	1.245	1.717	2.055			1.9	2.2	2.2	2.4	2.7	3.3	
2*	OZAWA's specimen	II-47	34	6	13.94	4.18	3.3	$\frac{.480}{.500}\times$	.411	.644	.920	1.401	1.824	2.146			2.2	2.2	2.4	2.4	2.5	2.9	
3	814	1950	33	1	13.35	4.45	3.0	—	.371	.555	.775	1.092	1.340	1.606	1.956		1.3	1.7	1.7	2.0	2.4	3.2	3.5
4	814	1957	33	2	11.80	3.96	3.0	$\frac{.503}{.590}\times$	.418	.587	.806	1.034	1.364	1.594	1.882		1.9	2.2	2.1	2.0	2.0	2.3	2.8
5	814	1939	33	3	13.1+	4.45	2.9	.35+	.513	.748	.960	1.300	1.644	2.060	2.41+		1.9	2.1	2.3	2.3	2.4	2.7	2.7
6	814	1942	33	4	10.5+	3.91	2.7	$\frac{.388}{.760}\times$	.350	.564	.766	1.047	1.370	1.708	2.072		1.9	1.8	1.9	1.9	2.4	2.6	2.5
7	814	1943	34	1	13.4+	4.56	2.9	$\frac{.520}{.601}\times$	.457	.677	.920	1.226	1.625	2.032	2.31+		0.8	1.3	1.4	1.7	1.7	1.8	2.2
8	286	2163	35	8	11.2?	4.0?	2.8	$\frac{.405}{.540}\times$	.330	.520	.772	1.031	1.331	1.660	1.96?		2.2	1.5	1.6	1.9	2.1	2.1	2.5
9	814	1948	33	6	×	3.59	×	$\frac{.485}{.700}\times$	.360	.561	.781	1.073	1.456	1.748									
10	814	1955	33	7	×	3.48	×	$\frac{.492}{.581}\times$	.457	.677	.895	1.193	1.533										
11	814	1941	34	2	×	4.23	×	$\frac{.326}{.533}\times$	.440	.714	1.034	1.296	1.637	1.93+									
12	814	1953	34	3	×	3.65	×	$\frac{.597}{.674}\times$	.469	.650	.883	1.165	1.465										
13	814	1941	34	4	×	4.61	×	$\frac{.566}{.661}\times$	.463	.613	.788	1.070	1.376	1.717	2.035	2.403							
							Max.	.760	.513	.748	1.034	1.320	1.740	2.060	2.420		2.7	2.8	3.4	3.3	3.4	3.2	3.5
							Min.	.290	.250	.377	.543	.835	1.064	1.364	1.711		0.8	1.3	1.4	1.7	1.7	1.8	2.2
							Aver.	.471	.354	.526	.765	1.043	1.360	1.692	2.083		1.9	2.2	2.2	2.3	2.5	2.5	2.6
								67	68	70	70	68	59	33	22		12	15	16	16	12	9	7

Specimen	Thickness of spirotheca								Tunnel angle							Septal count						
	0	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1*	.028	.040	.040	.090	.104	.142	.077?		53	31	33	29	27									
2*	.032	.040	.058	.075	.101	.102	.106		31	27	20	24	27	18								
3	—	.029	.044	.050	.076	.076	.104		—	32	21	21	19	23								
4	.028	.032	.040	.058	.067	.097	.103		33	23	22	18	25	23	18							
5	.031	.031	.059	.066	.086	.116	.120		23	25	26	23	24									
6	.025	.045	.042	.046	.065	.090	.091	.104	26	28	34?	19	25	29								
7	.020	.048	.059	.062	.102	.082			32	26	29	20	24	—								
8	.023	.042	.047	.048	.066	.080	.085		—	—	34	28	19	21								
9	.022	.027	.033	.046	.071	.090	.090									12	22	34	33	32		
10	.022	.044	.049	.066	.076	.100										8?	21	29	31	34		
11	.031	.043	.044	.064	.075	.126										9?	23?	26	27	34	37?	
12	.026	.047	.050	.066	.073	.075?										10	21	29	28	33?		
13	.022	.035	.036	.059	.067	.085	.124	.107								8	22?	25?	24	27	33	33+
Max.	.037	.057	.070	.100	.147	.129	.177	.174	39	37	34	41?	39	32	26	12	25?	30	31	38	27?	
Min.	.018	.020	.027	.037	.054	.067	.080	.080	23	23	21	18	19	16	22	6	15?	22?	24	27	30?	
Aver.	.025	.035	.045	.057	.072	.092	.114	.112	32	29	27	26	26	23	23	9	21	26	30	32	34	
	38	50	55	54	54	44	20	9	18	23	25	28	22	11	5	13	14	14	13	8	3	

* The statistics of the specimens 1 and 2 is excluded from the averages.

This species somewhat resembles *P. kaerimizensis* (OZAWA), but is distinguished from the latter by its larger proloculus, more rapid expansion and thicker spirotheca for the corresponding volution. It also resembles *Pseudofusulina japonica* (GÜMBEL), but, as OZAWA (1925) already stated, differs from the latter in having more slender shell, thicker spirotheca, and much heavier axial fillings. MORIKAWA regarded them as being conspecific with each other without giving any reason, but these two species are rather easily distinguished by the facts mentioned above.

Parafusulina edoensis also bears some resemblance to *P. splendens* DUNBAR and SKINNER from the Glass Mountain, Texas, from which it differs in slightly less numerous volutions, larger proloculus, thicker spirotheca and septa and less crowded septal loops in the axial areas. Moreover, the secondary deposits seemingly differ in their occurrence in two forms; namely, in most specimens of *P. edoensis* they occur along the axial zone from the second volution outwardly and do not exist in the equatorial portion of the shell, while in *P. splendens* they almost completely fill the chambers of the inner few volutions but not present in the outer ones.

In the OZAWA's collection kept in the University of Tokyo, there are five sections (II–46 to II–50) which are labeled "*Schellwienia edoensis*", of which II–50 (fig. 2 of Plate VI in the original illustration, illustrated as fig. 5 of Pl. 34 in this paper) is most typical, and, is, therefore, designated here as the lectotype of *Parafusulina edoensis* (OZAWA).

Occurrence.—According to OZAWA his specimens were collected from Kaerimizu, Yobara and Ofuku plateau (in the lenticular limestone in shale), and he labeled the locality as follows: II–46, Kaerimizu (in the ponor); II–47, limestone in shale, northen margin of the Ofuku-dai; II–48, Ofuku-dai; II–49, Serita, Kyowa-mura; and II–50, Ofuku-dai. Unfortunately to me their exact localities are not known. My specimens of *P. edoensis* have been obtained from Nos. 1, 4, 7, 8, 8A, and 11 limestones of Section I (Loc. 285A, 286, 288A, 289, 814, 290, and 292, respectively), No. 7 limestone of Section XII (Loc. 610), No. 2 limestone of Section XV (Loc. 184), Nos. 4 and 7 limestones of Section XVI (Loc. 190 and 744, respectively), No. 1 limestone of Section XVII (Loc. 317), and Loc. 195, 379, and 569. The stratigraphical range of this species is of the Pmα and Pmβ subzones.

Parafusulina gigantea (DEPRAT) (?)

Pl. 36, figs. 2–11

1913. *Fusulina gigantea* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. II, fasc. 1, pp. 29, 30, Pl. I, figs. 1–6.
1925. *Schellwienia gigantea* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 32, 33, Pl. IV, fig. 9.
1935. *Pseudofusulina gigantea* GUBLER. Mém. Soc. Géol. France, No. 26, pp. 91, 92, Pl. II, figs. 4, 5, 8, 9; Pl. III, fig. 4.

The shell of *Parafusulina gigantea* (DEPRAT) (?) is large and thickly fusiform, with nearly straight axis of coiling, convex lateral slopes, and bluntly pointed poles. Mature shell of five to six volutions exceeds 7.6 mm in length and 3.2 mm in width, giving form ratios of 2.0 to 2.8. The shell is subellipsoidal to short fusiform in the first volution, and retains nearly the same axial profile from the second volution to maturity. Average ratios of the half length to the radius vector of the first to fifth volution in ten specimens are 1.5, 1.7, 1.8, 2.0, and 2.1, respectively.

The proloculus is exceedingly large and spherical, ellipsoidal, or somewhat irregular in shape. The outside diameter varies from 410 to 754 microns, averaging 561 microns in twenty specimens. The shell expands rapidly and almost uniformly throughout all but the ultimate volution which is more slightly tightly coiled than the penultimate one. Average radius vectors of the first to sixth volution of twenty-four specimens are 461, 706, 1,045, 1,462, 1,912, and 2,240 microns, respectively. The chambers are lowest immediately above the tunnel, only slightly increasing in height polewards.

The spirotheca is thick and coarsely alveolar. It increases in thickness very rapidly as the shell grows. In some specimens the spirotheca of the second or third volution exceeds 120 microns in thickness. Average thickness of the spirotheca in the first to fifth volution of twenty-one specimens is 52, 72, 102, 128, and 131 microns, respectively. Alveoli of the keriotheca is not observable in the first few chambers, but soon become very distinct. About 6 alveoli are recognized in a space of 100 microns of the spirotheca of the outer volutions. The spirotheca is thickest in the central portion of most volutions, but the thickness seemingly changes somewhat irregularly towards the poles. The proloculus wall is apparently structureless and moderately thick, averaging 25 microns for fifteen specimens.

The septa are numerous except for the first volution of some specimens where they are exceptionally widely spaced. Average septal counts of the first to fifth volution of seven specimens are 9, 23, 31, 39, and 38, respectively. They are formed of the downward extention of the tectum and the pycnotheca, but in the posterior side of the septa of some specimens the alveolar structure is still observable. The septa are highly and narrowly fluted throughout their length. The closed chamberlets reach to the tops of the chambers even in the median portion of the shell.

The tunnel is difficult to be determined due to highly fluted septa. Approximate tunnel angles average 27, 27, 32, and 28 degrees, respectively, in the first to fourth volution of seven specimens. The chomata do not occur even in the earliest stage of the shell. The secondary deposits occur only in a part of the inner volutions.

Table 75. Table of Measurements (in Millimeters) of *Parafusulina gigantea* (DEPRAT)(?)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6
1	287	2177	36	2	7.6+	3.80	2.0	.695/.754 ×	.520	.739	1.072	1.511	1.920	
2	452	1877	36	3	6.48	2.3+	2.8	.500/.614 ×	.401	.611	.870	1.100		
3	100	2128	36	4	6.6+	2.92	2.3	.582/.660 ×	.528	.837	1.147	1.480		
4	100	2122	36	5	5.90	2.73	2.2	.615	.520	.778	1.148	1.527		
5	194	1830	36	7	×	3.8+	×	.605/.681 ×	.441	.632	.952	1.331	1.850	
6	100	2127	36	8	×	3.88	×	.473/.552 ×	.482	.745	1.153	1.660	1.960	
7	100	2124	36	10	×	4.65	×	.638	.548	.915	1.151	1.810	2.250	
8	100	2127	36	11	×	2.89	×	.515/.594 ×	.445	.703	1.070	1.482		
							Max.	.754	.548	.915	1.153	1.810	2.250	2.400
							Min.	.410	.315	.513	.795	1.100	1.610	2.100
							Aver.	.561	.461	.706	1.045	1.462	1.912	2.240
								20	24	24	24	21	13	3

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	Thickness of spirotheca 0	1	2	3	4	5	6
1	—	1.5	1.7	1.8	2.0		.032	.047	.061	.103	.134		
2	—	1.6	2.0	2.2			—	.036	.048	.075			
3	1.9	1.9	2.1	2.2			.024	.061	.127	.127			
4	1.1	1.5	1.8	2.0			.025	.061	.085	.108	.115		
5							.021	.045	.056	.085	.094	.141	
6							—	.056	.075	.103	.141		
7							.019	.054	.074	.120	.169	.132	
8							.028	.052	.052	.136	.164		
Max.	1.9	2.1	2.1	2.2	2.2		.033	.070	.127	.136	.169	.153	
Min.	1.1	1.2	1.3	1.8	2.0		.019	.028	.048	.070	.094	.117	
Aver.	1.5	1.7	1.8	2.0	2.1	1.9	.025	.052	.072	.102	.128	.131	.141
	5	9	10	6	4	1	15	19	19	21	13	7	1

Specimen	Tunnel angle 1	2	3	4	Septal count 1	2	3	4	5
1	22	21	28	29					
2	22	24	—						
3	28	37?	—						
4	—	32	31						
5					6	23	32	36	
6					11	25	35	45	
7					9	28	31	—	—
8					8	19	29	33	
Max.	33	37	46	36	11	28	35	45	
Min.	22	21	17	20	8	19	28	33	
Aver.	27	27	32	28	9	23	31	39	38
	7	7	5	4	7	7	6	4	1

Remarks.—Although *Parafusulina gigantea* (DEPRAT) is rather easily distingnishable from other species of the genus *Parafusulina* by its large and thickly fusiform shell, extremely large proloculus, the rapid rate of expansion and the thick spirotheca, the present Akiyoshi specimens, on which the above dscription is based, are insufficient in number, and enough information for the specific comparison is not available from them.

Since DEPRAT (1913) first described *P. gigantea* from Indochina, OZAWA (1925) and GUBLER (1935) identified the same species from Akiyoshi and Laos and Cochinchina, respectively. However, the OZAWA's materials are very insufficient (section number II-57 to II-59 in his collection) in which no exactly oriented axial section is available ; while the GUBLER's specimens contain forms seemingly somewhat different from the DEPRAT's type specimen*; namely, the GUBLER's specimens illustrated as figs. 5 and 9 of his Pl. II have less complicated fluting of the septa and rather heavy axial fillings.

The present Akiyoshi specimens, though no axial section of the mature individual is contained, are almost identical with the GUBLER's figs. 5 and 9, and are referred to this species with question. Further study on more sufficient materials of this form will be necessary before the definite specific assignment and the limit of specific variation are determined.

Occurrence.—Although *Parafusulina gigantea* (DEPRAT) was originally reported from the "Upper" Permian of Laos with *Schwagerina crassa* (DEPRAT), *Yabeina globosa* (YABE), *Pseudodoliolina pseudolepida* (DEPRAT) and *Sumatrina annae* VOLZ, its stratigraphical range seemingly is more wide, extending downward at least into the Pmα subzone, and it is possible that it ranges more downward into the Plγ and even into the upper part of the Plβ subzone.

In the Akiyoshi limestone group it has been found in the No. 5 limestone of Section I (Loc. 287), No. 3 limestone of Section XIV (Loc. 100), No. 6 limestone of Section XXVI (Loc. 755), and Loc. 194. Few doubtful specimens have also been obtained in the No. 6 limestone of Section VI (Loc. 452).

Parafusulina sp. A

Pl. 36, fig. 12

The shell of *Parafusulina* sp. A is relatively large and short cylindrical fusiform with nearly straight axis of coiling, straight to depressed median portion, and broadly rounded poles. The figured axial section is 10.5 mm in length and 4.2 mm in width, giving a form ratio of 2.5. The shell is ellipsoidal in the first volution and the axis becomes extended gradually and nearly uniformly from there to

* DEPRAT's fig. 2 of Pl. I is here designated the lectotype of *Parafusulina gigantea* (DEPRAT).

maturity. Average ratios of the half length to the radius vector of the first to seventh volution of four specimens are 1.4, 2.1, 2.0, 2.2, 2.3, 2.4, and 2.5, respectively.

The proloculus is relatively large and spherical. Because no exactly centered section is available in my collection the exact outside diameter has not been measured. So far as observed five specimens average at least 300 microns in outside diameter. The shell expands relatively rapidly and uniformly throughout the growth. Average radius vectors of the first to sixth volution for seven specimens are 310, 537, 784, 1,087, 1,444, and 1,720 microns, respectively. The chambers are lowest immediately above the tunnel and increase in height rapidly in the polar third of the outer volutions, resulting in that the shell assumes its characteristic axial profile in maturity.

The spirotheca is relatively thick and moderately coarsely alveolar. It increases in thickness rapidly as the shell grows and seems to decrease slightly in the ultimate volution. Average thickness of the spirotheca of the first to sixth volution of seven specimens is 40, 46, 65, 91, 100, and 118 microns, respectively. The sixth and seventh volutions of the illustrated axial section is 132 and 117 microns, respectively, in the spirothecal thickness. The alveoli of the keriotheca are seen almost throughout the growth. At least 6 of them are measured in a space of 100 microns of the spirotheca in the outer volutions.

The septa are highly fluted throughout the length of the shell. The closed chamberlets formed by the strong fluting are completely, or at least nearly completely, reaching to the tops of the chambers even in the central portion of the shell. The cuniculi are clearly observable. The septal count of this form is not exactly known due to the insufficiency of the material.

The tunnel is relatively narrow and its path is somewhat irregular. The tunnel angles of the second to sixth volution in four specimens are 44, 23–33?, 23–36, 25–32, and 24–33 degrees respectively. The chomata do not occur. The heavy secondary deposits almost completely fill the chambers of all the volutions along the axial zones.

Remarks.—Although the sufficient information for the specific comparison is not available from my materials, *Parafusulina* sp. A somewhat resembles the slender form (typical form for the species) of *Pseudofusulina kraffti* (SCHELLWIEN & DYHRENFURTH), but it differs from the latter in having larger size of the shell, more rapid rate of expansion, thicker septa and heavier axial fillings. No other species is comparable with the present one, though it needs more sufficient materials to determine the true nature of this species.

Occurrence.—*Parafusulina* sp. A has been obtained from the No. 11 limestone of Section I (Loc. 292), No. 8 limestone of Section XXVI (Loc. 758) and Loc. 194. Its stratigraphical range is of the Plγ to Pmβ subzones.

Table 76. Table of Measurements (in Millimeters) of *Parafusulina* sp. A

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector						
									1	2	3	4	5	6	7
1	194	1828	36	12	10.5?	4.2?	2.5	.320+	.301	.482	.703	1.001	1.333	1.700	2.20?
2	194	1829			8.95	3.22	2.7	—	.369	.658	1.067	1.439	1.777		
3	292	1852			8.04	2.36+	3.4-	—	.368	.669	.920	1.29?			
4	758	1250			8.0+	3.27	2.5	.260+	.212	.361	.550	.762	1.023	1.270	
5	758	1250			×	3.23	×	.280+	.238	.420	.630	.920	1.281	1.66?	
6	292	1852			×	2.47	×	.320+	.300	.431	.620	.892			
7	194	1829			×	4.18	×	.340+	.378	.736	1.000	1.402	1.806	2.147	

Specimen	Ratio of Hl./Rv.							Thickness of spirotheca							
	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
1	1.4	1.7	1.4	1.6	1.8	2.1	2.5	.033	.042	.066	.080	.094	.141	.132	.117
2	—	2.3	2.3	2.4	2.5			—	—	—	.089	.164	.071		
3	—	2.3	2.3	2.3				—	—	.032	.053	.054			
4	—	—	—	2.6	2.6	2.7		—	.043	.045	.051	.075	.086	.103	
5								.030	.031	.036	.049	·063	.084		
6								—	.024	.037	.038	.054			
7								—	.061	.061	.094	.132	.117		

Specimen	Tunnel angle						Septal count			
	1	2	3	4	5	6	1	2	3	4
1	—	44	33?	24?	25					
2	—	—	28	36	32	33?				
3	—	—	23	—						
4	—	—	—	23	30	24				
5							—	15?	19?	30?
6							—	—	—	—
7							—	—	—	—

Subfamily VERBEEKININAE STAFF and WEDEKIND, 1910

Genus *Verbeekina* STAFF, 1909

Verbeekina verbeeki (GEINITZ)

Pls. 37, 38

1876. *Fusulina verbeeki* GEINITZ. Palaeontographica, Vol. XXII, pp. 399, 400.
1925. *Verbeekina verbeeki* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 48–51, Pl. X, figs. 6, 7.
1936. *Verbeekina verbeeki* THOMPSON. Jour. Paleont., Vol. 10, No. 3, pp. 197–200, Pl. 24, figs. 1–8.
1956. *Verbeekina verbeeki* CHEN. Palaeontologia Sinica, New Ser. B, No. 6, pp. 47, 48, Pl. IX, figs. 5, 6; Pl. XIII, figs. 1, 2.

THOMPSON (1936) studied the materials from the Padany Highland, Boekit

Besi, Sumatra and redescribed *Verbeekina verbeeki* (GEINITZ) in very much detail. The specimens obtained from the Akiyoshi limestone group agree so closely with those described and illustrated by THOMPSON that further description and discussion seem unnecessary here except for giving the statistical data of the Akiyoshi specimens.

Table 77. Table of Measurements (in Millimeters) of *Verbeekina verbeeki* (GEINITZ)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.
1	285	2001	37	2	4.55	4.12	1.1	.053
2	286A	2004	37	4	6.95	7.5?	0.9	.040?
3	765A	2257	37	1	7.72	7.88	1.0	—
4		6A*-1	37	3	5.36	5.5+	1.0	.033
5	HASHIMOTO's collection	6A*-3	38	1	6.00	5.84	1.0	.042
6		6A*-2	38	2	5.57	5.57	1.0	—
7	765A	2258	38	3	×	7.47	×	—
8		6A*-8			×	5.25	×	.040?
9	HASHIMOTO's collection	6A*-6	38	5	×	6.70	×	.047
10		6A*-5	38	4	×	5.31	×	.048
11		6A*-7			×	5.31	×	—
							Max.	.054
							Min.	.033
							Aver.	.043 / 7

Specimen	Radius vector 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	.057	.096	.136	.184	.264	.418	.628	.901	1.177	1.453	1.726	2.075				
2	.051	.092	.141	.188	.310	.471	.720	.990	1.292	1.581	1.880	2.210	2.511	2.840	3.210	
3	—	—	.141	.221	.415	.702	1.104	1.564	1.983	2.367	2.748	3.070	3.420	3.730	3.990	
4	.050	.087	.140	.223	.344	.564	.733	1.015	1.226	1.462	1.745	1.995	2.278	2.587		
5	.056	.096	.141	.214	.380	.555	.717	.901	1.104	1.333	1.588	1.840	2.130	2.34+	2.73+	2.98+
6	.077	.116	.184	.264	.380	.577	.820	1.070	1.337	1.588	1.833	2.090	2.342	2.556		
7	—	—	.138	.202	.307	.46+	.781	1.076	1.352	1.659	1.934	2.226	2.513	2.793	3.070	3.380
8	.04?	.090	.142	.204	.313	.503	.716	.981	1.296	1.603	1.925	2.250	2.610	2.880		
9	.052	.094	.143	.230	.42+	.61+	.915	1.263	1.606	1.920	2.300	2.655	2.985	3.282		
10	.062	.092	.161	.267	.435	.680	.911	1.196	1.486	1.740	2.042	2.385	2.64+			
11	—	.090	.132	.218	.380	.528	.830	1.162	1.462	1.790	2.106	2.406	2.676			
Max.	.077	.116	.184	.298	.475	.702	1.104	1.564	1.983	2.367	2.748	3.070	3.420	3.730	3.990	
Min.	.040	.087	.132	.184	.240	.380	.628	.901	1.104	1.333	1.588	1.840	2.130	2.34+	2.73+	
Aver.	.056	.096	.150	.222	.369	.568	.834	1.143	1.439	1.738	2.038	2.340	2.591	2.902	3.276	
	9	11	13	15	16	16	16	15	15	16	14	15	12	10	5	

* 6A in the HASHIMOTO's collection is the same locality as Loc. 286A.

Speci-men	Thickness of spirotheca																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	—	—	—	—	.008	.012	.023	.023	.025	.037	.041	.045					
2	—	—	.009	.012	.022	.022	.028	.033	.032	.047	.047	.037	.034	.051	.049	.041	
3	—	—	—	.011	.012	.015	.016	.016	.016	.034	.055	.060	.057	.062	.062	.059	
4	.008	.008	.008	.010	.012	.016	.026	.023	.032	.040	.036	.043	.043	.043	.039		
5	.007	.007	.009	.010	.014	.017	.017	.023	.027	.030	.034	.051	.045	.044	.046	.045	
6	—	—	—	.008	.012	.011	.016	.021	.023	.028	.030	.040	.045	.044	.037		
7	—	—	—	.015	.016	.016	.017	.023	.023	.032	.040	.043	.056	.056	.033	.045	.060
8	—	—	.009	.011	.010	.011	.014	.016	.017	.026	.035	.046	.055	.045	.056		
9	.008	.008	.009	.010	.011	.012	.015	.022	.031	.041	.047	.072	.059	.061	.043		
10	.007	.008	.009	.011	.022	.017	.018	.025	.037	.044	.040	.063	.048	.043	.059		
11	—	—	.009	.010	.011	.011	.014	.015	.021	.027	.049	.055	.046	.042			
Max.	.008	.008	.009	.015	.022	.022	.028	.033	.037	.059	.074	.072	.064	.062	.062	.059	
Min.	.007	.007	.007	.008	.008	.011	.014	.015	.016	.026	.030	.037	.034	.042	.033	.041	
Aver.	.008	.008	.009	.010	.014	.015	.018	.022	.027	.038	.046	.052	.049	.050	.048	.048	.060
	4	4	8	11	13	15	15	15	15	15	15	14	13	11	10	4	1

Speci-men	Ratio of Hl./Rv.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0.6	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9			
2	0.6	0.7	0.7	0.9	1.1	1.2	1.1	—	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	—	—	1.5	1.7	1.5	1.4	1.3	1.2	1.1	1.1	1.1	1.1	1.0	1.0	
4	0.7	0.9	0.8	0.6	1.0	0.9	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
5	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6	—	0.7	0.7	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Max.	0.7	0.9	1.5	1.7	1.5	1.4	1.3	1.2	1.1	1.1	1.1	1.1	1.0	1.0	1.0
Min.	0.6	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9
Aver.	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9
	4	6	7	8	8	8	8	7	8	8	8	8	6	6	2

Speci-men	Septal count														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7	—	—	—	—	—	—	14+	19+	28+	33+	34+	38+	37+	45+	48+
8	—	—	11	11	11	10	13	13	11	20	26	30+			
9	6?	9?	11	11	8	8	8	11	17	23	24	31			
10	7	9	10	9	11	11	13	15	17	26	24				
11	—	8	11	11	10	13	11	14	18	17?	18?	24?			
Max.	7	9	11	11	11	13	14	19	28	33	37	38			
Min.	6	8	10	9	8	8	8	11	11	17?	18?	24?			
Aver.	7	9	11	11	10	10	12	15	18	24	27	31	37	45	48
	2	3	4	4	4	5	6	6	6	6	6	5	1	1	1

Occurrence.—Verbeekina verbeeki (GEINITZ), the leading species of the *Verbeekina verbeeki* subzone, is exceedingly abundant in Nos. 2 and 3 limestones of Section I (Loc. 285 and 286A, respectively) at Kaerimizu. It is associated with no species of fusilinid in the former, and only with *Schwagerina* sp. in the latter. It is also known from the limestone of Loc. 769A and in huge limestone boulder of the limestone conglomerate (No. 1 limestone) of Section XV (Loc. 765).

The stratigraphical range of this species is the Pmγ to Puα subzone in the Akiyoshi limestone group.

Genus *Misellina* SCHENCK and THOMPSON, 1940

Misellina claudiae (DEPRAT)

Pl. 38, figs. 1–19

1912. *Doliolina claudiae* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. I, fasc. 3, pp. 44, 45, Pl. IV, figs. 5–9.
1925. *Verbeekina claudiae* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 52, 53, Pl. XI, figs. 9–11.
1925. *Verbeekina claudiae* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 4, Pl. II, figs. 1, 2.
1934. *Doliolina claudiae* CHEN. Palaeontologia Sinica, Ser. B, Vol. IV, fasc. 2, pp. 99, 100, Pl. XVI, figs. 13–20.
1936. *Doliolina claudiae* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 104, 105, Pl. XXI, figs. 4–9.

The shell of *Misellina claudiae* (DEPRAT) is small and short ellipsoidal, with straight axis of coiling, exclusively convex lateral slopes, and broadly rounded to somewhat umbilicated poles. Mature shells of seven to eight, very rarely nine, volutions are 2.15 to 2.68 mm long and 1.57 to 2.20 mm wide. The form ratio varies from 1.1 to 1.3. The first one to two volutions are nearly spherical with rounded poles to more or less umbilicate with an axis of coiling at considerably high angles to that of the outer volutions. Beyond the second or third volution the axis becomes extended gradually outwards. The polar regions of the outer volutions of some specimens are also somewhat depressed. Average ratios of the half length to the radius vector of the first to eighth volution in nine specimens are 1.0, 1.1, 1.2, 1.3, 1.3, 1.2, 1.2, 1.1, and 1.1, respectively.

The proloculus is small and spherical to short ellipsoidal, with an outside diameter of 107 to 230 microns, averaging 155 microns in twelve specimens. The proloculus wall seemingly structureless, consisting of a thin homogeneous dense layer and attaining an average thickness of 10 microns in eleven specimens. The shell expands rather slowly in the inner three to four volutions and slightly more rapidly but almost uniformly in the outer ones. Average radius vectors of the first to eighth volution for thirteen specimens are 135, 200, 274, 373, 506, 654, 810, and 952 microns, respectively.

The spirotheca is thin, and consists of an upper thin dense layer of the tectum and a lower thick layer of the keriotheca, in the latter of which 13 to 15 alveoli are observed in a distance of 100 microns of the outer volutions. The true thickness of the spirotheca is sometimes difficult to be measured, because it apparently seems very thick if the section is cut near the septum. Average thickness of the spirotheca of the first to eighth volution in thirteen specimens is 11, 13, 15, 19, 24, 26, 29, and 33 microns, respectively.

The septa are composed of the downward deflection of the tectum, on both sides of which the keriotheca also extends more than half as long as the length of the septa. The septa are wedge-shaped in cross section, thinning rapidly from the base downward to the tip. They are completely unfluted throughout the growth, and most of their tips anteriorly bend rather sharply. In the outer volutions the tips of some, if not all, of septa are solidified. Average septal counts of the first to seventh volution of four specimens are 6, 12, 13, 15, 18, 20, and 23, respectively.

The parachomata are well developed in all but the first half to one volution where they do not occur or are very primitive in developmenf if present. They are low and broad, being semi-circular to isosceles-triangular with obtuse apex in cross section. The height of the parachomata is about one-third to half as that of the chambers.

The elliptical foramen occurs at the base of the septa throughout the shell. Their number seemingly varies in individuals, and 20 and 23 foramina are observed in the fifth and eighth volution of one specimen.

Remarks.—After the DEPRAT's first report (1912) of this species from Tou-Tchéou-Chann of Yunnan, OZAWA (1925), CHEN (1935), and HUZIMOTO (1936) respectively reported the same species from the Akiyoshi limestone, the Swine limestone and other localities in South China, and the Kwanto massif. Of which CHEN's specimens seemingly are almost identical with the Yunnan form in every respect. The Kwanto specimens illustrated by HUZIMOTO are not sufficient for the detailed specific comparison, but they may be conspecific with the DEPRAT's type* although their spirotheca seemingly is considerably thicker than that of the latter.

The Akiyoshi specimens, including the OZAWA's collection**, have larger proloculus, more rapid rate of expansion and slightly less massive parachomata than those of the DEPRAT's type specimen although individual variation within the formers is rather large.

Thus, *Misellina claudiae* (DEPRAT) is considerably wide in the specific variation at least in the prolocular size, the rate of expansion and the development of the parachomata.

Occurrence.—*Misellina claudiae* (DEPRAT) is found only in the No. 12A limestone of Section I (Loc. 819) whence OZAWA might have collected his specimens. OZAWA (1925)

* Pl. IV, fig. 5 in the DEPRAT's illustration (1912) is here designated the lectotype specimen of *Misellina claudiae*.

** In the OZAWA's collection Section II-46, II-47, and II-48 are labeled as *Doliolina claudiae*, but the specimen illustrated as Pl. XI, fig. 9 cannot be found in any of them.

Table 78. Table of Measurements (in Millimeters) of *Misellina claudiae* (DEPRAT)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector									
									1	2	3	4	5	6	7	8	9	10
1*	819	2053	39	2	2.47	1.83	1.3	.059	.050	.074	.116	.166	.234	.320	.445	.574	.720	.864
2	819	2064	39	1	2.36	1.76	1.3	.156	.126	.181	.261	.344	.433	.555	.714	.873		
3	819	2064	39	3	2.47	2.20	1.1	.157 .166 ×	.135	.196	.267	.371	.510	.683	.864	1.060		
4	819	2062	39	4	2.31	1.93	1.2	—	—	—	.236	.320	.440	.604	.763	.969		
5	819	2043	39	5	2.15	1.70+	1.3	.143	.141	.199	.291	.386	.522	.686	.870			
6	819	2041	39	6	2.68?	2.20	1.2	.150	.119	.175	.248	.319	.442	.583	.733	.889	1.076	
7	819	2055	39	7	2.31+	1.82	1.3	.188	.150	.221	.313	.415	.586	.745	.935			
8	819	2047	39	12	×	1.97	×	.121	.113	.181	.254	.359	.485	.644	.803	.960		
9	819	2063	39	13	×	1.82	×	.128 .149 ×	.138	.211	.297	.401	.540	.705	.901			
10	819	2052	39	14	×	1.75	×	.139 .163 ×	.147	.215	.300	.392	.528	.665	.84+			
11	819	2044	39	16	×	1.85	×	.107	.098	.159	.233	.329	.451	.601	.781	.960		
							Max.	.230	.187	.264	.368	.475	.613	.785	.901	1.060		
							Min.	.107	.098	.159	.233	.319	.433	.555	.714	.873		
							Aver.	.155	.135	.200	.274	.373	.506	.654	.810	.952		
								12	12	12	13	13	13	13	12	6		

Specimen	Thickness of spirotheca											Ratio of Hl./Rv.									
	0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
1*	.006	.006	.009	.009	.009	.013	.016	.021	.019	.021	.027	1.1	1.2	1.0	1.1	1.2	1.2	1.4	1.3	1.3	1.4
2	.010	.011	.011	.012	.017	.025	.031	.025	.033			1.0	1.2	1.3	1.4	1.5	1.5	1.4	1.2		
3	.011	.011?	.014	.013	.018	.027	.027	.031	.039?			0.7	1.0	1.3	1.3	1.3	1.3	1.2	1.1		
4	—	—	.010	.015	.017	—	.021	.029	.029			—	—	1.3	1.4	1.4	1.3	1.5	1.2		
5	.009	.009	.013?	.016	.018	.027	.025	.027				0.7	0.8	1.0	1.0	1.1	1.1	1.1			
6	.012	.011	.011	.015	.017	.021	.022	.031	.046	.029		1.1	1.2	1.2	1.4	1.3	1.2	1.2	1.2	1.1	
7	.010	.012	.013	.017	.025	.033	.031	.033				1.0	1.1	1.2	1.3	1.2	1.2	1.1			
8	.009	.011	.012	.014	.021	.021	.029?	—	.027												
9	.011	.011	.012	.014	.019	.022	.025	.027													
10	.010	.012	.015	.015	.021	.025	.033	.028													
11	.010?	.010	.011	.013	.013	.018	.022	.029	.025												
Max.	.012	.012	.016	.021	.025	.033	.033	.033	.046			1.2	1.2	1.4	1.4	1.5	1.5	1.5	1.2		
Min.	.009	.009	.010	.012	.013	.018	.020	.025	.025			0.7	0.8	1.0	1.0	1.1	1.1	1.1	1.1		
Aver.	.010	.011	.013	.015	.019	.024	.026	.029	.033			1.0	1.1	1.2	1.3	1.3	1.2	1.2	1.1	1.1	
	11	11	12	12	13	11	13	10	6			8	8	9	9	9	9	8	4	1	

* Microspheric form (?). The statistics of this specimen is excluded from the averages.

Specimen	Septal count							
	1	2	3	4	5	6	7	8
8	5	10	11+	11+	15+	19	20?	24?
9	6?	12	14	15	18	19	27	
10	7	13	15	16	20	21	23	
11	—	11	12	16	20?			
Aver.	6/3	12/4	13/4	15/4	18/4	20/3	23/3	24/1

emphasized the faunal association of this species with *Nagatoella orientis* (OZAWA), and, indeed, the present specimens occur together with *N. kobayashii* THOMPSON in No. 12A limestone of Section I (Loc. 819) although the latter is very rare in number. The stratigraphical age of *M. claudiae* is seemingly narrow, being restricted to the Plγ subzone at least in the Section I.

Genus *Pseudodoliolina* YABE and HANZAWA, 1932

Pseudodoliolina pseudolepida (DEPRAT)

Pl. 39, figs. 20–25

1912. *Doliolina pseudolepida* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. I, fasc. 3, p. 46, Pl. V, figs. 6–9, Pl. VI, fig. 4.
1913. *Doliolina lepida* mut. *pseudolepida* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. II, fasc. 1, p. 50.
1927. (?) *Doliolina lepida* OZAWA. Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. II, Vol. II, Pt. 3, pp. 152, 153, Pl. XLV, fig. 1.
1937. *Pseudodoliolina pseudolepida* THOMPSON and FOSTER. Jour. Paleont., Vol. 11, pp, 141, 142, Pl. 25, figs. 2–4.

As indicated in the synonymy above, this form was referred by the earlier workers to *Doliolina* SCHELLWIEN, and later by THOMPSON and FOSTER (1937) to *Pseudodoliolina* YABE and HANZAWA. THOMPSON and FOSTER discussed the systematic status of the said genus in some detail and gave detailed description of this form based on the specimens from Mt. Omei region of China, although they did not give the statistical data for the spirothecal thickness.

The Akiyoshi specimens at my disposal agree so closely with the DEPRAT's type specimen (fig. 6 of Pl. V is here designated the lectotype), and also with those described and illustrated by THOMPSON and FOSTER (1937) that there is no need to add further discussion except for giving the statistical data of the Akiyoshi specimens.

Occurrence.—*Pseudodoliolina pseudolepida* (DEPRAT) is common in the Pmβ subzone and its stratigraphical range is seemingly limited to that subzone so far as known in the Akiyoshi limestone group. It has been obtained in the No. 5 limestone of Section I (Loc. 287), No. 8 limestone of Section X (Loc. 567) and Loc. 498.

Table 79. Table of Measurements (in Millimeters) of *Pseudodoliolina pseudolepida* (DEPRAT)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.
1	567	2017	39	20	5.4?	2.60	2.1
2	567	2017	39	21	5.20	2.60	2.0
3	287	2175	39	22	3.65?	2.15	1.7
4	HASHIMOTO's collection	6B*-1	39	23	5.36	2.84	1.9
5	498	2039	39	24	×	3.59	×
6	498	2014	39	25	×	3.24	×

Specimen	Prol.	Radius vector													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	.290	.184	.236	.285	.344	.404	.482	.571	.660	.772	.905	1.052	1.196	1.345	
2	.236	—	.221	.273	.341	.400	.482	.592	.696	.837	1.003	1.135	—		
3	—	—	.190	.250	.331	.459	.567	.680	.790	.970					
4	.297×.264	.191	.261	.310	.377	.457	.543	.617	.720	.822	.920	1.052	1.196	1.385	
5	.332	.230	.291	.353	.421	.491	.598	.720	.846	.981	1.153	1.312	1.470	1.634	1.793
6	.18+	.132	.200	.291	.380	.472	.583	.696	.828	.980	1.135	1.296	1.456		
Max.	.332	.230	.291	.353	.421	.491	.598	.720	.846	.981	1.234	1.312	1.470	1.634	
Min.	.148	.132	.191	.248	.307	.383	.482	.571	.660	.772	.905	1.052	1.196	1.345	
Aver.	.233	.169	.222	.282	.357	.437	.535	.636	.752	.894	1.042	1.169	1.330	1.451	
	7	6	10	10	10	10	10	9	9	9	9	8	7	4	

Specimen	Thickness of spirotheca														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	—	—	—	.0078	.0077	.010	.010	.010	.013	.015	.015	.016	.024		
2	—	—	—	—	.0075	—	.009	—	.013	.013	.017				
3	—	—	—	.007	.007	.010	.012	.012	.014	.018					
4	.008	.011	.009	.010	.010	.011	.011	.012	.013	.017	.017	.020	.020	.021	
5	—	—	—	—	—	—	—	—	.014	.016	.020	.024	.029	.030	.036
6	.010?	.0065	.0065	.0075	.010	.011	.011	.012	.012	.014	.015	.017	.022	.020	.022
Max.	.010	.011	.009	.010	.010	.011	.012	.012	.014	.018	.020	.024	.029	.030	.036
Min.	.008	.0065	.0065	.007	.007	.010	.009	.010	.012	.013	.015	.016	.019	.020	.022
Aver.	.009	.009	.008	.008	.009	.010	.011	.011	.013	.017	.017	.019	.023	.023	.024
	2	2	2	4	5	5	6	5	7	7	6	5	5	4	2

Specimen	Ratio of Hl./Rv.												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.3	1.7	1.9	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.0	2.0
2	—	1.5	1.7	1.9	2.2	2.2	2.1	2.1	2.0	1.9			
3	—	—	—	—	—	1.9	1.9	1.9	1.8				
4	1.2	1.3	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2.0	2.0	2.0	1.9
Max.	1.3	1.7	1.9	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.0	2.0
Min.	1.2	1.3	1.6	1.7	1.7	1.8	1.8	1.9	1.8	1.9	2.0	2.0	1.9
Aver.	1.3	1.5	1.7	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.1	2.0	1.9
	2	3	3	3	3	4	4	4	4	3	2	2	2

Specimen	Septal count												
	1	2	3	4	5	6	7	8	9	10	11	12	13
6	5	12	14	16	20	19	24	21	21	25	27	28	29?

* 6B in the HASHIMOTO's collection is almost the same locality as Loc. 287.

Pseudodoliolina ozawai YABE and HANZAWA

Pl. 39, figs. 26–32

1914. *Doliolina lepida* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. III, fasc. 1, p. 22, Pl. III, figs. 12–14.
1932. *Pseudodoliolina ozawai* YABE and HANZAWA. Proc. Imp. Acad. Japan, Vol. VIII, No. 2, pp. 40–42.
1935. *Pseudodoliolina ozawai* CHEN. Palaeontologia Sinica, Ser. B, Vol. IV, fasc. 2, pp. 100, 101, Pl. XVI, figs. 3, 4.
1936. *Pseudodoliolina ozawai* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 108–110, Pl. XXI, figs. 13–18.
1948. *Pseudodoliolina ozawai* THOMPSON. Univ. Kansas, Palaeont. Contrib., Protozoa, Art. 1, Pl. 17, figs. 11, 12.
1956. *Pseudodoliolina ozawai* CHEN. Palaeontologia Sinica, New Ser. B, No. 6, pp. 53, 54, Pl. IV, figs. 12–14.

The shell of *Pseudodoliolina ozawai* YABE and HANZAWA is small and elongate ellipsoidal, with broadly rounded poles, broadly convex lateral slopes, and straight axis of coiling. Mature specimens contain at least ten to twelve volutions. Mature shell of ten volutions measures approximately 3.3? to 4.2 mm in length and 1.3 to 1.6 mm in width, giving a form ratio of 2.5? to 2.7. The first volution is short fusiform with somewhat pointed ends and the shell is almost the same in axial profile from the second volution to maturity. The ratios of the half length to the radius vector of the first to tenth volution average 1.4, 2.0, 2.3, 2.4, 2.6, 2.6, 2.6, 2.7, 2.6, and 2.5, respectively, in five specimens.

The proloculus is relatively large for the size of the shell, with outside diameters of 168 to 228 microns, averaging 185 microns for seven specimens. The shell very gradually increases in height of volution in the inner five to six volutions and expands almost uniformly in the outer ones. Average radius vectors of the first to eleventh volution in nine specimens are 123, 161, 210, 277, 338, 420, 508, 606, 728, 823, and 904 microns, respectively. The chambers are almost the same in height throughout their length except in the extreme polar regions where they become slightly higher.

The spirotheca is very thin and does not exceed 20 microns in thickness even in the thickest part. The thickness of the spirotheca averages 7.3, 6.5, 7.2, 7.3, 9, 10, 10, 11, 12, and 14 microns, respectively, in the first to tenth volution of six specimens. The spirotheca consists only of a single homogeneous layer in the inner four to five volutions. In most parts of the outer volutions it seems to be composed of a thin tectum and an inner lighter layer, in the latter of which fine alveolar structure is not recognizable even under high magnification of the microscope. However, in some part of the eighth and ninth volutions three layers—a tectum, a lighter central layer and a thin inner layer—have been observed. Very faint alveolar structure has been recognized in the central layer.

The septa are thin and composed of the downward deflection of the tectum

Table 80. Table of Measurements (in Millimeters) of *Pseudodoliolina ozawai* YABE and HANZAWA

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7	8	9	10	11	12
1	567	2027	39	26	4.23	1.61?	2.6	.168	.132	.151	.202	.275	.349	.445	.529	.650	.780	.87+		
2	567	2013	39	27	4.18	1.55	2.7	.177	.126	.162	.205	.258	.316	.371	.445	.531	.632	.748		
3	567	2012	39	28	3.37	1.07+	3.1-	.195	.129	.166	.211	.276	.332	.43?	.53?					
4	567	2012	39	29	×	2.02	×	·228	.144	.190	.242	.307	.368	.445	.535	.660	.742	.883	1.000	
5	567	2012	39	30	×	1.59	×	.170	.123	.175	.233	.329	.392	.513	.613	.724	.850			
6	567	2012	39	31	×	1.66	×	—	.110	.153	.211	.276	.347	.436	.516	.613	.828	.94?		
Max.								.228	.132	.190	.242	.329	.392	.513	.613	.660	.850	.94?	1.000	
Min.								.168	.080?	.113	.156	.211	.273	.356	.432	.522	.613	.742	.855	
Aver.								.185	.123	.161	.210	:277	.338	.420	.508	.606	.728	.823	.904	.990
								7	9	9	9	9	9	8	8	7	7	6	3	1

Specimen	Thickness of spirotheca 0	1	2	3	4	5	6	7	8	9	10
1	.0075	—	—	.005	.005	.009	.009	.010	.010	.011	
2	—	—	.0048	.005	.005	.009	.009	.009	.012	.013	.016
3	—	—	—	—	.0075	.009	.009	.009			
4	.0048	.0073	.0076	.009	.009	.010	.011	.012	.012	.012	.012
5	.0104	.0073	.0056	.0085	.0085	.009	.009	.009	.011	.012	
6	—	—	.008	.0085	.095	.010	.011	.012	.011	.014	
Max.	.0104		.008	.009	.0095	.010	.011	.012	.012	.014	.016
Min.	.0048		.0048	.005	.005	.009	.009	.009	.010	.011	.012
Aver.	.0076	.0073	.0065	.0072	.0073	.009	.010	.010	.011	.012	.014
	3	2	4	5	6	6	6	6	5	5	2

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	8	9	10	11
1	1.2	2.0	2.5	2.7	2.9	2.8	2.8	2.7	2.5	2.3	
2	1.0	1.3	1.8	2.0	2.3	2.5	2.5	2.5	2.5	2.5	
3	1.6	2.1	2.5	2.4	2.4	2.3	2.4				
4											
5											
6											
Max.	1.6	2.6	2.5	2.7	2.9	2.9	2.8	2.8	2.7	2.7	
Min.	1.0	1.3	1.8	2.0	2.3	2.3	2.4	2.5	2.5	2.3	
Aver.	1.4	2.0	2.3	2.4	2.6	2.6	2.6	2.7	2.6	2.5	2.7
	5	5	4	5	5	4	4	3	3	3	1

Specimen	Septal count 1	2	3	4	5	6	7	8	9
4	5 +	12?	15	16	18	19	19?	23?	31?
5	7 ?	13	14	17	18	20	21	23	
6	—	—	17?	20?	18?	22	22	25	29
Max.	7 ?	13	17?	20?	18	22	22	25	31
Min.	5 +	12?	14	16	18	19	19	23	29?
Aver.	6	13	15	18	18	20	21	24	30
	2	2	3	3	3	3	3	3	2

and the dense materials coated on either side of the tectum, which, in most part of the shell, seem to be continuous with the parachomata. The septa are rather widely spaced, with average septal counts of 6, 13, 15, 18, 18, 20, 21, 24 and 30? in the first to ninth volution of three specimens. The septa are essentially unfluted throughout the length of the shell.

The parachomata are well developed, being nearly half as high as the chambers in the inner volutions and a little more than half to about two-thirds in the outer volutions. The foramina are small and nearly circular in cross section in the inner volutions and elliptical in the outer ones. There are about 21–26 foramina in the fourth, 29–31 in the fifth, and 38(?) in the seventh volution.

Remarks.—The above description is based entirely on the Akiyoshi specimens. In discussing the generic status of the genus *Pseudodoliolina* YABE and HANZAWA, THOMPSON and FOSTER (1937) regarded the DEPRAT's specimens (figs. 12–14 of Pl. III in his third Mémoir) as being typical of *P. ozawai* YABE and HANZAWA and designated the specimen illustrated by DEPRAT as fig. 12 of Pl. III as the holotype of that species.

Although any of the earlier workers who described and illustrated this species did not give the statistical data of the spirothecal thickness of their specimens, and it is almost impossible to measure the true spirothecal thickness of each volution from their illustrations, it is perhaps true that all the specimens so far referred to *P. ozawai* have very thin spirotheca and that their thickness of the spirotheca may not exceed 20 microns even at the thickest part in the outer volutions.

The Akiyoshi specimens, though not necessarily sufficient in number, well agree with the type specimen (DEPRAT's fig. 12 of Pl. III) and the topotype specimens from Akasaka illustrated by THOMPSON (1948) in all the essential characters of the shell.

Occurrence.—*Pseudodoliolina ozawai* YABE and HANZAWA is one of the most characteristic and widely distributed species among the Middle Permian fusulinids of Japan, and has been reported from more than a dozen of locality of the Western Japan. In the Akiyoshi limestone group it occurs only in No. 8 limestone of Section X (Loc. 567) which is referred to the Pmβ subzone.

Subfamily NEOSCHWAGERININAE DUNBAR and CONDRA, 1928, emend. KANMERA, 1957

Genus *Neoschwagerina* YABE, 1903

Neoschwagerina craticulifera (SCHWAGER)

Pl. 40; Pl. 41, figs. 1–5

1883. *Schwagerina craticulifera* SCHWAGER. in RICHTHOFEN's China, Vol. IV, p. 140, Pl. XVIII,

figs. 15–25.
1906. *Neoschwagerina craticulifera* YABE. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XXI, Art. 5, p. 3, Pl. I, fig. 3 (non. fig. 4)
1914. *Neoschwagerina craticulifera* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. III, fasc. 1, pp. 24–26, Pl. VII, figs. 4–8.
1925. *Neoschwagerina craticulifera* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 54, 55, Pl. II, fig. 8c; Pl. XI, fig. 4.
1927. *Neoschwagerina craticulifera* OZAWA. Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. II, Vol. II, Pt. 3, pp. 154–156, Pl. XL, figs. 1–7, 10, 11a.
1933. *Neoschwagerina craticulifera* LEE. Mem. Nat. Res. Inst, Geol., Vol. XIV, Pl. V, fig. 1.
1935. *Neoschwagerina craticulifera* GUBLER. Mém. Soc. Géol. France, No. 26, pp. 103–106.
1936. *Neoschwagerina craticulifera* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 112, 113, Pl. XXII, figs. 6–9; Pl. XXIII, figs. 6, 7.
1942. *Neoschwagerina craticulifera* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XVIII, No. 4, pp. 244, 245, Pl. XXIV, fig. 13.
1944. *Neoschwagerina craticulifera* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XIX, Nos. 1–4, pp. 81, 82, Pl. VI, fig. 26.
1947. *Neoschwagerina craticulifera* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XX, Nos. 2–4, pp. 76, 77, Pl. XVII, figs. 4–7.
1956. *Neoschwagerina craticulifera* CHEN. Palaeontologia Sinica, New Ser. B. No. 6, pp. 56, 57, Pl. XII, figs. 10–12.

Neoschwagerina craticulifera (SCHWAGER) is one of the most well-known species among the neoschwagerinids and is very common in the Middle Permian formations of Eastern Asia including Japan. Nevertheless, this species has never been described in detail by the earlier workers except GUBLER (1935), and it seems necessary to describe the species in detail under the light of the modern knowledge of this group of foraminifera. The following description is, however, based entirely on the materials collected from the Akiyoshi limestone group.

The shell of *Neoschwagerina craticulifera* (SCHWAGER) is rather small and inflated fusiform, with straight axis of coiling, convex lateral slopes and bluntly rounded poles. Mature specimens in the present collection have 14 to 16 volutions, with an axial length of 4.5 to 5.8 mm and a median width of 2.7 to 3.9 mm. The form ratio varies 1.3 to 1.7. The first volution is coiled perpendicular to or at high angles to the direction of coiling of the outer volutions. The second and third volutions are ellipsoidal in shape with broadly rounded poles. Beyond the fourth volution the axis becomes extended slowly as the shell grows. The shell retains almost the same axial profile from the sixth volution to maturity as shown below. Average ratios of the half length to the radius vector of the first to fifteenth volution for fifteen specimens are 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.6, 1.6, 1.6, 1.6, 1.6, 1.6, 1.6, 1.6, and 1.6, respectively.

The proloculus is very minute, with an outside diameter of 40 to 132 microns, averaging 84 microns in thirty-one specimens. The first three volutions are very tightly coiled. In the following two volutions the shell becomes slightly more rapidly expanded. Beyond the sixth volution to maturity the rate of expansion of the shell is almost uniform. Average radius vectors of the first to sixteenth volution for forty-two specimens are 68, 106, 147, 208, 282, 375, 482, 607, 733, 865, 1,014, 1,120, 1,311, 1,477, 1,651, and 1,842 microns, respectively. The chambers are almost the same in height throughout the length of the shell, except in the very extremities where they are very slightly higher.

The spirotheca is thin and distinctly alveolar. Due to the insertion of the septula, it is rather difficult to measure the thickness of the spirotheca with certainty. It is, of course, thinnest in the midst of two contiguous septula or of septum and adjacent septulus. So far has been measured, the thickness of the spirotheca in the first to fifteenth volution of twenty-one specimens averages 7, 7, 9, 10, 11, 12, 12, 13, 14, 16, 17, 19, 22, 23, and 25 microns, respectively.

The septa are rather thick, consisting of the downward deflection of the tectum, along either side of which the keriotheca also extends down for a considerable distance. The septa are generally perpendicular to the surface of the spirotheca, but some of them are extending anteriorly at a small angle. The presence of the axial septula makes difficult to determine the septal counts exactly. Average septal counts of the first to fourteenth volution of six specimens are 7, 10, 12, 13, 15, 17, 20, 23, 25, 30, 29, 29, 32, and 32, respectively.

The axial septula do not occur in the first three to four volutions. In the fourth or fifth volution they begin to appear in a limited part of the volution although they are very short and primitive in development. Beyond the seventh volution at least one, two at the maximum, axial septulus is inserted between the adjacent axial septa. The primary spiral septula occur throughout all but the first volution. They extend to the tops of the parachomata across the chambers. The secondary spiral septula do not present in the inner six to seven volutions. Although they begin to appear in the seventh or eighth volution, they do not necessarily occur in every space of two adjacent primary spiral septula, but are restricted in development only in a very limited part. If present they are very primitive, being only a low swelling or a short downward extension of the keriotheca.

The foramina are small and generally elliptical in cross section, with the maximum diameter perpendicular to the surface of the spirotheca. They seemingly are not recognizable in the earlier two to three volutions, and are about half to nearly the same as high as the chambers in the outer volutions. Although it is rather difficult to count foramina, there are about 13, 18, 25, 28, 35, 39, 42, 47?, 56?, and 64? foramina in the third to twelfth volution of a typical specimen.

Remarks.—*Neoschwagerina craticulifera* (SCHWAGER) is, as stated above, very common in the Middle Permian rocks of Japan, and has so far been reported from more than ten localities in the western half of this country.

In the original description of this species, SCHWAGER (1883) illustrated each one of axial and sagittal sections, the former of which is automatically the holotype specimen of this species. However, these two specimens differ considerably from each other in the radius vector for the corresponding volutions; namely, the axial section (fig. 17 of Pl. XVIII) of sixteen volutions has the radius vector of 0.19 mm at the fifth and 0.51 mm at the tenth volution, while the sagittal section (fig. 18) of twelve volutions has that of 0.37 mm and 0.89 mm for the corresponding volutions.

Table 81. Table of Measurements (in Millimeters) of *Neoschwagerina craticulifera* (SCHWAGER)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.
1	289	2190	40	1	3.60	2.68	1.3
2	289	2190	40	2	4.60	2.95	1.6
3	289	2186	40	3	4.45	2.94	1.5
4	289	2187	40	4	4.7+	2.70	1.7
5	HASHIMOTO's collection	6C*-14	40	19	3.32	2.14	1.6
6	HASHIMOTO's collection	6B*-13	40	20	4.29	3.11	1.4
7	HASHIMOTO's collection	6B*-15	40	22	5.84	3.59	1.6
8	287B	2185	40	11	×	3.85	×
9	289	2186	40	12	×	3.0+	×
10	289	2191	40	13	×	2.8+	×
11	289	2189	40	14	×	3.35	×
12	HASHIMOTO's collection	6C*-15	41	2	×	3.43	×
13	HASHIMOTO's collection	6C*-16	41	3	×	2.95	×
14	HASHIMOTO's collection	6B*-20	41	4	×	3.38	×

Specimen	Prol.	Radius vector															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	.050	.051	.085	.121	.152	.212	.301	.390	.500	.602	.773	.940	1.071	1.222	1.360		
2	—	—	—	.126	.175	.240	.336	.421	.528	.647	.772	.920	1.052	1.187	1.338	1.47?	
3	—	—	—	.129	.188	.258	.327	.440	.548	.660	.809	.960	1.101	1.250	1.400		
4	.060+	.055	.093	.135	.190	.270	.360	.466	.591	.710	.880	1.042	1.180				
5	.101	.092	.123	.169	.230	.303	.402	.528	.650	.800	.920	1.055	1.187				
6	.045	.055	.092	.135	.190	.264	.341	.448	.567	.677	.825	1.000	1.153	1.321	1.533		
7	.119	.101	.141	.184	.248	.338	.439	.552	.668	.785	.905	1.070	1.257	1.450	1.653	1.800	
8	.069	.061	.101	.151	.222	.311	.420	.539	.676	.818	.960	1.110	1.290	1.479	1.690	1.850	
9	.059	.059	.096	.138	.190	.250	.322	.401	.502	.613	.772	.871	1.018	1.160	1.284	1.435	1.600
10	.060	.059	.100	.131	.180	.260	.330	.431	.550	.690	.830	.962	1.147	1.330			
11	.063	.052	.085	.124	.187	.260	.350	.455	.590	.741	.922	1.108	1.290	1.478	1.663		
12	.082	.066	.100	.147	.211	.282	.368	.463	.580	.668	.797	.960	1.126	1.315	1.493	1.717	1.934
13	.101	.086	.119	.159	.224	.303	.380	.491	.613	.730	.870	1.040	1.184	1.346	1.471		
14	.132	.104	.144	.196	.261	.335	.424	.522	.635	.742	.870	1.015	1.190	1.352	1.573	1.740	
Max.	.132	.104	.144	.196	.267	.359	.482	.630	.770	.920	1.065	1.220	1.360	1.479	1.690	1.850	1.991
Min.	.040	.043	.080	.116	.152	.212	.301	.383	.500	.613	.727	.860	1.030	1.180	1.333	1.435	1.600
Aver.	.084	.068	.106	.147	.208	.282	.375	.482	.607	.733	.865	1.014	1.120	1.311	1.477	1.651	1.842
	31	31	38	41	42	42	42	41	37	36	33	30	26	22	18	11	3

* 6B and 6C in the HASHIMOTO's collection are the same localities as Loc. 287 and Loc. 287A, respectively.

Specimen	Thickness of spirotheca 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	.006	.007	.006	.010	.011	.012	.014	.012	.014	.018	.024	.018	.024			
2	—	.007	.007	.009	.012	.013	.013	.015	.016	.014	.017	.019	.019	.024	.027	
3	—	—	—	.010	.011	.011	.012	.011	.012	.013	.013	.016	.021	.027	.031	
4	—	—	.007	.009	.010	.011	.012	.013	.014	.015	.021	.025	.031			
5	.008	.009	.008	.009	.011	.010	.009	.010	.013	.012	.016	.021				
6	.007	.007	.008	.009	.011	.011	.012	.011	.012	.013	.017	.019	.019	.024		
7	.008	.009	.008	.009	.012	.012	.012	.012	.013	.014	.014	.017	.018	.027	.027	.029
8	—	—	—	—	.011	.011	.013	.015	.015	.014	.015	.014	.020	.021	.020	.017
9	—	.006	.008	.010	.010	.010	.010	.011	.011	.013	.012	.014	.017	.021	.022	.027
10	—	.006	.008	.009	.011	.012	.013	.012	.013	.013	.014	.016	.021	.023		
11	.006	.007	.007	.010	.010	.010	.010	.012	.012	.014	.020	.019	.019	.034	.028	
12	.009	.008	.009	.008	.010	.011	.011	.011	.013	.011	.014	.013	.014	.015	.021	.029
13	.008	.007	.008	.009	.011	.010	.011	.011	.011	.013	.015	.022	.021	.024		
14	.007	.006	.006	.007	.008	.009	.010	.010	.012	.015	.014	.015	.017	.017	.018	
Max.	.009	.009	.009	.010	.012	.013	.014	.015	.016	.018	.024	.025	.031	.034	.031	.029
Min.	.006	.006	.006	.007	.008	.009	.009	.010	.011	.010	.012	.012	.014	.015	.016	.017
Aver.	.007	.007	.007	.009	.010	.011	.012	.012	.013	.014	.016	.017	.019	.022	.023	.025
	10	13	15	17	19	20	21	21	21	21	20	20	18	16	10	6

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1.4	1.2	1.3	1.6	1.6	1.6	1.9	1.8	1.8	1.7	1.5	1.5	1.5		
2	—	—	1.0	1.2	1.3	1.5	1.7	1.7	1.7	1.6	1.6	1.7	1.7	1.6	1.6
3	—	—	1.2	1.3	1.3	1.4	1.4	1.6	1.7	1.7	1.7	1.7	1.6		
4	1.0	1.0	1.2	1.4	1.5	1.6	1.7	1.7	1.8	1.8	1.8	1.9			
5	1.1	1.6	1.6	1.8	2.1	2.1	2.0	2.1	2.1	1.9					
6	1.2	1.2	1.5	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
7	1.0	1.4	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6
Max.	1.4	1.6	1.7	1.8	2.1	2.1	2.0	2.1	2.1	1.9	1.8	1.9	1.8	1.8	
Min.	1.0	1.0	0.9	1.1	1.3	1.4	1.3	1.3	1.3	1.4	1.3	1.5	1.5	1.5	
Aver.	1.1	1.2	1.3	1.4	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
	9	11	13	14	14	15	15	15	15	14	13	10	8	4	2

Specimen	Septal count 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9	—	—	12?	13?	14	14?	24?	22?	22	27	28?	27?	25?	28?	33?
10	—	9	13	14	14	20	21	22	24	30	30				
11	—	—	11	11	16	16	15	19?	20	22	26	27	26?		
12	—	—	11	11	14	16?	18	22	25	26?	27?	28?	36?	35?	
13	6	9	12	12	14	15?	19?	25	27?	28?	30?	32?	35?		
14	7	11	13	15	18	19	23	28	32	34?	32?	32?	34?	34?	
Max.	7	11	13	15	18	20	24?	28	32	34?	32?	32?	36?	35?	
Min.	6	9	11	11	14	14?	15	19?	20	22	26	27	25?	28?	
Aver.	7	10	12	13	15	17	20	23	25	30	29	29	32	32	
	2	3	6	6	6	6	6	6	6	6	6	6	5	3	

In 1914 DEPRAT illustrated very beautiful specimens (figs. 4–8 of Pl. VII in his third Mémoir) from Akasaka, the type locality of the species, of which fig. 4 is one of the most exactly oriented axial section ever illustrated in this species and was reproduced by OZAWA (1927) as fig. 1 of Pl. XL. This figure has, if the magnification is correct, much larger radius vectors than those of the SCHWAGER's axial section—0.36 mm at the fifth, 1.04 mm at the tenth and 1.95 mm at the fifteenth volution. These figures show that the DEPRAT's specimen is almost twice as large as the SCHWAGER's type specimen in the shell size and the radius vectors for the corresponding volutions except the last few ones. Nevertheless many forms seemingly have been referred by later workers to the DEPRAT's form as being typical rather than to the SCHWAGER's type.

Such being the case, *Neoschwagerina craticulifera* (SCHWAGER) is rather variable in the size of the shell and the rate of expansion. Unfortunately, the SCHWAGER's holotype specimen is not typical for the species but represents one extremity of the specific variation. However, I am decidedly not clear from a doubt that if both the SCHWAGER's and DEPRAT's figures have correct magnification to the true dimension of their specimens.

The statistics obtained from the Akiyoshi specimens now I am studying show that they are nearly average for the species in the measurable characters and are rather close to the DEPRAT's specimen discussed above.

Occurrence.—Neoschwagerina craticulifera (SCHWAGER), the zone fossil of the Pmβ subzone, is abundant in the Akiyoshi limestone group and is often crowded in a limestone mass. The following localities are known; Nos. 5, 6, 8, and 10 limestones of Section I (Loc. 287, 287A, 289, and 291, respectively), No. 4 limestone of Section X (Loc. 521), and Nos. 2 and 3 limestones of Section XIV (Loc. 98 and 100, respectively).

The species is, of course, characteristic to the Pmβ subzone, but it is also found in the Pmα subzone and may be ranging upward into the Pmγ subzone.

Neoschwagerina craticulifera haydeni DOUTKEVITCH and KHABAKOV

Pl. 41, figs. 6–8

1909. *Neoschwagerina craticulifera* HAYDEN. Geol. Survey India, Records, Vol. 38, pp. 248, 249, Pl. 24, fig. 1–7.

1934. *Neoschwagerina craticulifera* var. *haydeni* DOUTKEVITCH and KHABAKOV. Acad. Sci. U. S. S. R., Geol. Pamir, Vol. 8, pp. 94–99, Pl. 2, figs. 6–8; Pl. 3, figs. 1, 2.

1946. *Neoschwagerina craticulifera haydeni* THOMPSON. Jour. Paleont., Vol. 20, No. 2, pp. 155, 156, Pl. 23, figs. 12, 13.

Based on a single specimen collected from the Bamian limestone of northern Afghanistan, THOMPSON illustrated and described *Neoschwagerina craticulifera haydeni* DOUTKEVITCH and KHABAKOV in some detail. The specimens here referred to *N. craticulifera haydeni* are also not sufficient to draw up a complete specific description. However, for the sake of completeness, I give the following description based on my collection from the Akiyoshi limestone group.

The shell of *Neoschwagerina craticulifera haydeni* DOUTKEVITCH and KHABAKOV is medium in size and inflated ellipsoidal in shape, with straight axis of coiling, nearly straight to broadly convex lateral slopes and rounded poles. A typical specimen of thirteen volutions is 4.8 mm long and 3.5 mm wide, giving a form ratio of 1.4. The first volution seemingly coils at high angles to the direction of coiling of the outer volutions. The second volution is ellipsoidal. Beyond the third volution the shell retains almost the same axial profile but it becomes slightly more inflated in the last few volutions. Average ratios of the half lengh to the radius vector of the first to thirteenth volution of five specimens are 1.2, 1.3, 1.4, 1.4, 1.5, 1.5, 1.5, 1.5, 1.4, 1.4, 1.3, 1.3, and 1.3, respectively.

The proloculus is minute, with an outside diameter varying from 35 to 86 microns and averaging 51 microns in nine specimens. In the inner four to five volutions the rate of expansion of the shell is very slow, which becomes slightly rapid in the following two volutions. From the sixth or seventh volution the shell expands almost uniformly. Average radius vectors of the first to seventeenth volution for fifteen specimens are 57, 92, 138, 190, 268, 355, 467, 600, 752, 903, 1,080, 1,251, 1,435, 1,604, 1,751, 1,935 and 2,120 microns, respectively. The height of the chamber is almost the same from pole to pole.

The spirotheca is rather thin and distinctly alveolar. Although the presence of the septula makes difficult to measure the true thickness of the spirotheca, approximate thickness of the first to sixteenth volution of three specimens measured at the thinnest point between septula averages 8, 10, 11, 13, 13, 14, 15, 15, 16, 17, 19, 19, 20, 20, 20, and 22 microns, respectively. Although the alveoli of the spirotheca are very fine, they are recognizable in all parts of the spirotheca.

The septa are composed of the tectum and the downward extension of the keriotheca on the posterior and anterior sides of the tectum. The exact number of the septa is not known because no exactly oriented sagittal section is available. For the same reason the true nature of the axial septula is not sufficiently observed. However, the axial septula seemingly do not present at least in the inner few volutions. Beyond the fifth or sixth volution one axial septulum begins to appear between adjacent septa. The primary spiral septula present in most if not all parts of the shell. Most of them extend to the tops of the parachomata across the chambers, but some are short and their lower surfaces are not in contact with the tops of the parachomata. A rudimentary suggestion of the secondary spiral septula is only seen in the very limited part of the outer volution of one specimen.

Small round to elliptical foramina seemingly appear beyond the fifth volution, but their exact number is not known because of the insufficiency of the material.

At least 30 foramina are present in the thirteenth volution of one specimen.

Table 82. Table of Measurements (in Millimeters) of *Neoschwagerina craticulifera haydeni* DOUTKEVITCH and KHABAKOV

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.
1	287A	2180	41	6	4.80	3.50	1.4	—
2	523	112	41	7	3.22	2.63	1.2	.086
3	100	2123	41	8	—	3.8+	—	.045
							Max.	.086
							Min.	.035
							Aver.	.051
								9

Specimen	Radius vector 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	.060	.101	.152	.210	.290	.378	.521	.660	.832	1.002	1.180	1.381	1.580				
2	.082	.121	.172	.242	.322	.424	.552	.674	.820	.951	1.110	1.270					
3	.058	.082	.128	.182	.270	.353	.466	.583	.690	.820	.981	1.130	1.296	1.490	1.674	1.840	
Max.	.082	.121	.172	.242	.326	.440	.580	.730	.915	1.080	1.280	1.410	1.630	1.810	1.885	2.045	2.120
Min.	.032	.067	.107	.121	.218	.303	.392	.494	.592	.714	.880	1.130	1.296	1.474	1.674	1.840	2.120
Aver.	.057	.092	.138	.190	.268	.355	.467	.600	.752	.903	1.080	1.251	1.435	1.604	1.751	1.935	2.120
	11	11	13	14	15	15	15	15	14	12	12	9	8	7	5	4	2

Specimen	Thickness of spirotheca 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	—	.009	.011	.011	.014	.014	.016	.016	.016	.019	.019	.019	.020	.021			
2	.008	.008	.010	.012	.014	.016	.016	.017	.018	.016	.016	.019					
3	—	.008	.009	.011	.012	.010	.011	.012	.012	.014	.015	.018	.018	.018	.020	.020	.022
Aver.	.008	.008	.010	.011	.013	.013	.014	.015	.015	.016	.017	.019	.019	.020	.020	.020	.022
	1	3	3	3	3	3	3	3	3	3	3	3	2	2	1	1	1

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.7	1.5	1.6	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.4	1.4	1.4	
2	1.1	1.2	1.3	1.3	1.4	1.5	1.4	1.5	1.4	1.5	1.4			
Max.	1.7	1.6	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.4	1.4	1.4	
Min.	0.9	1.2	1.3	1.2	1.2	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	
Aver.	1.2	1.3	1.4	1.4	1.5	1.5	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.2
	4	5	5	5	5	5	5	4	4	3	3	2	2	1

Remarks.—*Neoschwagerina craticulifera haydeni* DOUTKEVITCH and KHABAKOV resembles *N. multicircumvoluta* DEPRAT in many respects. Although OZAWA (1927) regarded the latter species as the microspheric form of *N. craticulifera*, the difference of the prolocular size between these two species is not so distinct as being observable in other dimorphic species, and the latter species expands much slower, especially so in the outer volutions. Hence it seems better to distinguish both forms as distinct species.

This subspecies is distinguished from *N. multicircumvoluta* by its slightly numerous volutions of mature shell, more rapid rate of expansion of the outer volutions and more primitive development of the axial septula in the outer volutions.

The Akiyoshi specimens, though not sufficient in number, well agree with HAYDEN's and THOMPSON's specimens from Afghanistan and DOUTKEVITCH and KHABAKOV's specimens from Pamir.

Occurrence.—*Neoschwagerina craticulifera haydeni* DOUTKEVITCH and KHABAKOV is also characteristic to the Pmβ subzone, and it often, if not always, associates with *N. craticulifera* s. str.

It has been obtained from the No. 6 limestone of Section I (Loc. 287A), No. 6 limestone of Section X (Loc. 523), No. 3 limestone of Section XIV (Loc. 100), No. 2 limestone of Section XV (Loc. 184), No. 2 limestone of Section XVI (Loc. 742), and No. 1 limestone of Section XXVI (Loc. 751).

Neoschwagerina douvillei OZAWA

Pl. 41, figs. 9–13; Pl. 42, figs. 1–6.

1906. *Neoschwagerina globosa* DOUVILLE. Bull. Soc. Géol. France, Pl. XVII, Pl. XVIII, figs. 1, 2.
1912. *Neoschwagerina globosa* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. I, fasc. 3, p. 51, Pl. IV, figs. 1–4.
1925. *Neoschwagerina douvillei* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 4, Pl. III, fig. 6; Art. 6, pp. 55–57, Pl. XI, figs. 5, 6 (non fig. 7).
1935. *Neoschwagerina douvillei* GUBLER. Mém. Soc. Géol. France, No. 26, pp. 111–113, Pl. VI, fig. 2; Pl. VIII. fig. 6, 10 (non Pl. VII, figs. 7, 8, 10, 11)
1936. *Neoschwagerina douvillei* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 114, 115, Pl. XXIII, figs. 1–5.
1947. *Neoschwagerina douvillei* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XX, Nos. 2–4, pp. 78, 79, Pl. XVII, fig. 8.
1956. *Neoschwrgerina douvillei* CHEN. Palaeontologia Sinica, New Ser. B, No. 6, pp. 58, 59, Pl. XIII, figs. 3–7; Pl. XIV, fig. 7.

The shell of *Neoschwagerina douvillei* OZAWA is moderately large in size and inflated fusiform, with almost straight axis of coiling, completely convex lateral slopes and broadly rounded poles. A mature shell of fourteen volutions is 7.5 mm in length and 4.3 mm in width, with a form ratio of 1.8. The first one to two volutions seemingly are subspherical to ellipsoidal, with almost rounded poles. Beyond the third volution the shell assumes its mature shape. Average ratios of the half length to the radius vector of the first to fourteenth volution in six specimens are 1.4, 1.5, 1.5, 1.5, 1.6, 1.6, 1.6, 1.6, 1.6, 1.7, 1.7, 1.6, 1.6, and 1.8, respectively.

The proloculus is of moderate size, and spherical to somewhat irregular in shape, with an outside diameter of 177 to 459 microns, averaging 283 microns for ten specimens. The shell considerably tightly coils in the inner four to five volutions and expands slightly more rapidly but almost uniformly in the outer ones. Average radius vectors of the first to fourteenth volution for ten specimens are 196, 276, 359, 464, 568, 697, 840, 987, 1,159, 1,329, 1,513, 1,689, 1,902, and 2,055 microns, respectively. The chambers are almost the same in height throughout the length of the shell except the very extreme polar ends.

The spirotheca is thin and consists of a tectum and a keriotheca. Fine alveoli are clearly seen even in the first volution. Average thickness of the spirotheca at its thinnest point between adjacent septula in the first to fourteenth volution of six specimens is 9.2, 11, 12, 13, 14, 15, 17, 17, 17, 18, 19, 21, 21, and 32 microns, respectively.

The septa are composed of the downward deflection of the tectum and the keriotheca. The latter extends down either side of the former for a short distance. The tips of most septa are solidified and bend anteriorly at a high angle. The axial septula develop throughout the shell. One to two axial septula occur in the inner five volutions and two to four in the outer ones. They are not equal in length and shape in cross section even in a chamber; some are considerably long with solidified tip but others are very rudimentary in their development, only being primitive salience of the lower surface of the spirotheca. The primary spiral septula occur throughout the shell, with their lower surfaces in contact with the tops of the parachomata across the chambers. The secondary spiral septula do

Table 83. Table of Measurements (in Millimeters) of *Neoschwagerina douvillei* OZAWA

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.
1*	DOUVILLE's specimen	Pl. XVIII, fig. 1	42	5	4.3+	2.02	2.1	.38 .44 ×
2*	DOUVILLE's specimen	Pl. XVIII, fig. 2	42	6	×	3.67	×	.20 .22 ×
3*	OZAWA's specimen	I-23	41	12	5.84	3.68	1.6	.282
4	751	2233	41	9	6.50	4.06	1.6	.275
5	127F		41	11	7.2+	4.6+	1.6	.231
6	765E	2302	42	1	5.84	3.32	1.8	.215
7	765E	2301	42	2	4.45	2.79	1.6	.211
8	765E	2300	42	4	5.8+	4.29	1.4	.177
9	765D	2289	41	13	×	3.8+	×	.369 .459 ×
							Max.	.459
							Min.	.177
							Aver.	.283 / 10

* The statistics of the specimens 1, 2, and 3 is excluded from the averages.

not occur in most parts of the shell. However, a rudimentary suggestion of the secondary spiral septula is prensent in the very limited part of the outer volutions. The exact number of the septa is hardly counted, because no exactly oriented

Specimen	Radius vector														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1*	.25	.37	.49	.60	.75	.90	1.06	1.25	1.40	1.58	1.75				
2*	.16	.23	.35	.46	.60	.76	.92	1.11	1.30	1.50	1.69	1.86			
3*	.227	.302	.378	.484	.586	.718	.851	1.021	1.200	1.380	1.570	1.760			
4	.200	.276	.370	.505	.628	.760	.895	1.05+	1.23+	1.38+	1.560	1.75+	1.93+		
5	.156	.254	.365	.470	.592	.736	.880	1.040	1.180	1.358	1.540	1.726	1.915	2.054	
6	.175	.257	.337	.418	.534	.662	.831	.990	1.193	1.373	1.561				
7	.175	.233	.294	.377	.451	.549	.668	.788	.960	1.130	1.306	1.518			
8	.126	.196	.267	.365	.488	.613	.77+	.932	1.120	1.318	1.530	1.736	1.931	2.17+	
9	.245	.320	.401	.520	.613	.733	.846	1.000	1.138	1.293	1.471	1.610	1.763	1.940	2.084
Max.	.254	.350	.450	.550	.653	.790	.950	1.116	1.29+	1.45	1.62+	1.80+	1.97+	2.17+	
Min.	.126	.196	.267	.365	.451	.549	.668	.788	.960	1.130	1.306	1.518	1.763	1.940	
Aver.	.196	.276	.359	.464	.568	.697	.840	.987	1.159	1.329	1.513	1.689	1.902	2.055	2.084
	10	10	10	10	10	9	9	8	7	7	7	6	5	3	1

Specimen	Thickness of spirotheca														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
3*	.0064	.009	.012	.013	.015	.014	.014	.018	.017	.017	.022	.021	.019		
4	.009	.011	.012	.011	.013	.014	.014	.018	.018	.019	.018	.020	.024		
5	—	.011	—	.012	.014	.013	.016	.016	.017	.017	.018	.022	.023	.027	.032
6	.0067	.0067	.010	.012	.013	.014	.015	.020	.021	.019	.019	.022			
7	.009	.0065	.012	.013	.012	.014	.013	.016	.017	.017	.017	.018			
8	.0075	.010	.011	.014	.013	.017	.017	—	.017	.017	.020	.018	.021	.021	
9	.009	.010	.011	.011	.010	.012	.015	.014	.014	.014	.015	.015	.015	.015	
Max.	.009	.011	.012	.014	.014	.017	.017	.020	.021	.019	.020	.022	.024	.027	
Min.	.0067	.0065	.010	.011	.010	.012	.013	.014	.014	.014	.015	.015	.015	.015	
Aver.	.0082	.0092	.011	.012	.013	.014	.015	.017	.017	.017	.018	.019	.021	.021	.032
	5	6	5	6	6	6	6	5	6	6	6	6	4	3	1

Specimen	Ratio of Hl./Rv.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1*	1.2	1.4	1.6	1.8	1.8	2.0	2.0	2.1	2.2	2.2	—			
3*	1.3	1.4	1.6	1.6	1.5	1.6	1.7	1.7	1.7	1.6	1.6	1.6		
4	1.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.7			
5	2.2	1.9	1.9	1.8	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8
6	1.2	1.2	1.5	1.6	1.7	1.7	1.7	1.7	1.8	1.7	1.8			
7	1.0	1.2	1.4	1.4	1.6	1.4	1.5	1.6	1.6	1.6	1.6	1.6		
8	1.2	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
Max.	2.2	1.9	1.9	1.8	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	
Min.	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
Aver.	1.4	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.6	1.6	1.8
	6	6	6	6	6	6	5	5	5	5	5	3	2	1

sagittal section is available in the present collection.

The foramina first appear in the fourth volution. They are nearly circular to ellipsoidal in cross section, with the greatest diameter parallel to the axis of coiling of the shell. The number of foramina is not known exactly, but approximately 11 foramina are observed in the seventh volution and 19 in the eleventh in one axial section.

Remarks.—Because DOUVILLE's and DEPRAT's specimens described as "*Neoschwagerina globosa*" are not identical to "*N. globosa* YABE" in the appearance of the septa and the presence of "false transverse septa" (secondary spiral septula) alternating with "true transverse ones" (primary spiral septula), OZAWA (1925) established *Neoschwagerina douvillei* for the specimens just cited in order to avoid confusion. Hence, this species should be based on the DOUVILLE's specimens illustrated in Pl. XVII and Pl. XVIII of his paper cited above, of which the axial section in the upper-left corner of fig. 1 of Pl. XVIII is here designated as the lectotype of the species.

As thus defined, *N. douvillei* is of moderate in the evolutionary development and is clearly more advanced than *N. craticulifera* from which this species seemingly is derived.

As shown in the synonymy OZAWA referred the following specimens to this species as those described as *N. globosa* (YABE) by DOUVILLE (1906) and DEPRAT (1912) and those from the Akiyoshi limestone collected by himself. Of which OZAWA's fig. 7 of Pl. XI was considered by him to be a megalospheric type of the species. But, as I repeatedly mentioned, this may not be true and that specimen (OZAWA's section I-25) seemingly is referable to *N. megaspherica* DEPRAT.

Besides the above, GUBLER (1935) described and illustrated beautiful specimens of *N. douvillei* from Battambang of Indochina. Although he distinguished two types, slender and globose, his specimens illustrated as figs. 7 and 8 (and probably 10, 11) of Pl. VII seemingly are not referable to this species, being more advanced in the development of the septa and the septula.

In this country this species was thereafter reported by HUZIMOTO (1936) and TORIYAMA (1947) from the Kwanto massif and Shikoku, respectively, from which, however, enough information is not available for the critical comparison.

The Akiyoshi specimens now I am studying are, though not necessarily sufficient in number, almost identical with the lectotype specimen and especially with the DEPRAT's specimens from Yunnan.

Occurrence.—*Neoschwagerina douvillei* OZAWA is rather rare in the Akiyoshi limestone group, being found only in the Nos. 2 and 4 limestones of Section XXVI (Loc. 751 and 753, respectively) and No. 1 limestone of Section XV (Loc. 765). At the last locality it occurs in huge cobbles of the limestone conglomerate. This species is also known in pebbles of the limestone conglomerate of the Shiraiwa formation of the Tsunemori group, which is exposed at Hinaga, Higashi-shibukura, Ominé, Miné-shi (Loc. 127). The stratigraphical range of this species seemingly is narrow, restricted only to the Pmδ subzone, but it may be probable that it is ranging downward into lower subzones.

Neoschwagerina megaspherica DEPRAT

Pl. 42, figs. 7–14; Pl. 43, figs. 1–5

1913. *Neoschwagerina megaspherica* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. II, fasc. 1, pp. 57, 58, Pl. VII, fig. 26; Pl. IX, figs. 4–8.
1924. *Neoschwagerina megaspherica* COLANI. Mém. Serv. Géol. l'Indochine, Vol. XI, fasc. 1, pp. 126, 127 et 158, Pl. XXII, figs. 1–23.
1925. *Neoschwagerina megaspherica* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, p. 58, Pl. XI, fig. 8.
1956. *Neoschwagerina megaspherica* CHEN. Palaeontologia Sinica, New Ser. B, No. 6, pp. 63, 64, Pl. X, figs. 4–8.

The shell of *Neoschwagerina megaspherica* DEPRAT is moderate in size and short inflated fusiform, with straight axis of coiling, convex lateral slopes and rounded polar extremities. The number of volution is rather few for the genus, attaining 11 volutions in the largest specimen, which is 6.5 mm long and 4.9 mm wide, giving a form ratio of 1.3. Because the proloculus is extremely large and somewhat irregular in shape, the shell is more or less irregular in axial profile in the inner two to three volutions. Beyond the third or fourth volution the shell assumes short inflated fusiform. Average ratios of the half length to the radius vector of the first to tenth volution in six specimens are 1.2, 1.2, 1.3, 1.3, 1.4, 1.5, 1.5, 1.5, 1.7, and 1.7, respectively.

The proloculus is exceptionally large and irregular in shape, with the maximum outside diameter ranging from 480 to 1,154 microns, averaging 683 microns for thirteen specimens. The shell expands rapidly and nearly uniformly. Average radius vectors of the first to tenth volution are 454, 591, 735, 896, 1,060, 1,221, 1,398, 1,509, 1,704, and 1,916 microns, respectively, in thirteen specimens. The chambers are almost the same in height throughout the length of the shell.

The spirotheca is thin and very finely alveolar. Most of alveoli seem to extend from the tops of the spirotheca to the base of the keriotheca or to the lower surface of the septula. The true thickness of the spirotheca is hard to be measured because of the presence of numerous septula. Average thickness of the spirotheca at its thinnest point between adjacent septula or between septum and septulus in the first to eleventh volution of nine specimens is 12, 14, 14, 14, 14, 14, 15, 15, 15, 19, and 23 microns, respectively. The proloculus wall is also thin and seemingly structureless, attaining an average thickness of 9 microns in eight specimens.

The septa are composed of the tectum and the downward extension of the keriotheca. The tips of most of the septa are solidified, bending anteriorly with a considerable high angles. Although the exact number of the septa is difficult to be counted, about 6, 11, 12?, 14?, 14?, 15?, 13?, 15? and 18 septa, respectively, are observed in the first to ninth volution of one specimen. The axial septula present throughout the shell. Although the axial septula vary in number even in one volution, two to three axial septula present in the inner four to five volutions and three to four, five at the maximum, in the outer volutions. They are not the same in length and shape even in one chamber. The primary spiral septula occur throughout the shell, the lower surfaces of which are in contact with the tops of the parachomata. The secondary spiral septula do not occur in the first two to three volutions. Although the primitive suggestion of the secondary spiral septula first appears in the third or fourth volution they are not necessarily present in all parts of the outer volutions. If present they are only small low swelling of the lower surface of the keriotheca.

Table 84. Table of Measurements (in Millimeters) of *Neoschwagerina megaspherica* DEPRAT

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.
1	753	2256	42	7	6.54	4.93	1.3
2	751	2235	42	8	7.6+	4.2+	1.8
3	753	2255	42	9	4.93	2.6+	1.9
4	751	2234	42	10	5.9+	4.2?	1.4
5	753	2247	42	11	4.98	3.05	1.6
6	752	2242	42	12	—	3.75	—
7	751	2235	43	1	×	3.22	×
8	751	2231	43	2	×	4.40	×
9	752	2236	43	3	×	3.38	×

Specimen	Prol.	Radius vector										
		1	2	3	4	5	6	7	8	9	10	11
1	.688	.469	.613	.772	.951	1.110	1.278	1.48+	1.66+	1.855	2.050	2.290
2	.48+	.40+	.57+	.737	.907	1.080	1.240	1.436	1.625	1.770	1.985	
3	.615/.765 ×	.445	.543	.660	.813	.960	1.150	1.350				
4	.614	.400	.506	.613	.736	.873	1.034	1.200	1.358	—	—	—
5	.688/.760 ×	.522	.665	.850	1.010	1.196	1.343	1.520				
6	1.116/1.154 ×	.742	.932	1.092	1.270	1.470	1.656	1.84+				
7	.511/.624 ×	.360	.491	.643	.83+	1.000	1.180	1.340	1.510	1.68+		
8	.652	.416	.58?	.72?	.870	1.030	1.131	1.272	1.440	1.625	1.820	
9	.541/.600 ×	.356	.470	.613	.770	.942	1.095	1.273	1.480	1.650		
Max.	1.154	.742	.932	1.092	1.270	1.470	1.656	1.84+	1.66+	1.855	2.050	
Min.	.48+	.356	.470	.613	.736	.873	1.018	1.200	1.350	1.530	1.705	
Aver.	.683/13	.454/13	.591/13	.735/13	.896/13	1.060/13	1.221/13	1.398/13	1.509/9	1.704/7	1.916/5	2.290/1

Small elliptical foramina present throughout all but the first volution. The number of the foramina is difficult to count with certainty. In one of the illustrated specimen 18 foramina are observed in the fourth volution and 31 in the tenth.

Remarks.—*Neoschwagerina megaspherica* DEPRAT originally described from Langnac (Tonkin) of Indochina is one of the most evolved species among the species of *Neoschwagerina*. So far as the extremely large proloculus and the rate of expansion are concerned this species is closely allied with *Yabeina hayasakai* OZAWA, but, as OZAWA (1925) remarked, they are easily distinguished by their septal development.

OZAWA described and illustrated *N. megaspherica*, which is represented by only

Specimen	Thickness of spirotheca											
	0	1	2	3	4	5	6	7	8	9	10	11
1	.006	.013	.016	.015	.016	.017	.015	.016	.016	.016	.026	.028
2	—	.015	.016	.016	.017	.017	.017	.016	.016	.016	—	
3	.009	.011	.012	.011	.011	.014	.016	.013				
4	.009	.010	.012	.012	.012	.014	.012	.013	.014	.013	.014	.017
5	.009	.010	.012	.012	.014	.018	.016	.019				
6	.010	.012	.016	.016	.016	.013	.014	.018				
7	·010	.012	.013	.013	.013	.011	.012	.011	.011	.012		
8	.012	.012	.013	.014	.014	.013	.015	.015	.016	.017	.018	
9	.010	.012	.010	.012	.013	.012	.013	.014	.015	.016		
Max.	.012	.015	.016	.016	.017	.018	.017	.019	.016	.017	.026	.028
Min.	.006	.010	.010	.011	.011	.011	.012	.011	.011	.012	.014	.017
Aver.	.009	.012	.014	.014	.014	.014	.014	.015	.015	.015	.019	.023
	8	9	9	9	9	9	9	9	6	6	3	2

Specimen	Ratiio of Hl./Rv.									
	1	2	3	4	5	6	7	8	9	10
1	1.3	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1·7
2	1.5	1.3	1.4	1.4	1.5	1.6	1.6	1.6	1.7	1.6
3	1.0	1.1	1.2	1.3	1.5	1.6	1.5			
4	1.0	1.2	1.3	1.3	1.3	1.4	1.4	1.4	—	—
5	1.1	1.2	1.3	1.3	1.3	1.4	1.6	1.6		
Max.	1.5	1.4	1.4	1.4	1.5	1.6	1.6	1.6		
Min.	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.4		
Aver.	1.2	1.2	1.3	1.3	1.4	1.5	1.5	1.5	1.7	1.7
	6	6	6	6	6	6	6	4	2	2

Specimen	Septal count								
	1	2	3	4	5	6	7	8	9
7	7	13?	14?	16?	—	—	—	—	—
9	6	11	12?	14?	14?	15?	13?	15?	18

a single axial section, in his paper on the Nagato fauna, but his specimen was not collected from the Akiyoshi limestone but from the Zomeki limestone which is located about 30 km northeast of the former (section No. I–21 in the OZAWA's collection, labeled Kiwada, Ikumo-mura, Abu-gun, Yamaguchi Prefecture). His specimen, though somewhat deformed, seemingly is identical with the DEPRAT's type specimen (DEPRAT's fig. 4 of Pl. IX is here designated as the lectotype of the species). However OZAWA considered that this species might probably be a megalospheric form of *N. douvillei* or *N. margaritae*. But, as I already pointed out elsewhere, this may not be true.

Besides DEPRAT and OZAWA, GUBLER (1935) and COLANI (1924) described and illustrated beautiful specimens of this species from Indochina. However, as KANMERA (1954) discussed in some detail, GUBLER's specimens are not conspecific with the DEPRAT's original one, and hence KANMERA proposed a new species, *Yabeina gubleri* KANMERA, based on his specimens collected from the Upper Permian Kuma formation of Southern Kyushu, which are almost identical to the GUBLER's form in almost all the essential characters.

The Akiyoshi specimens at my disposal are almost identical with the DEPRAT's type specimen in all the important characteristics, except only in having slightly smaller radius vectors for the corresponding volutions. However, there is no fully grown individual in my collection, and more sufficient materials seem to be necessary for the critical discussion for the Akiyoshi form.

Occurrence.—*Neoschwagerina megaspherica* (DEPRAT) occurs only in the Nos. 2, 3 and 4 limestones of Section XXVI (Loc. 751, 752, and 753, respectively), all of which are referred to the Pmδ subzone.

Neoschwagerina sp. A

Pl. 43, figs. 6–14

The shell of *Neoschwagerina* sp. A is inflated ellipsoidal in shape, with nearly straight axis of coiling, straight to convex lateral slopes, and bluntly rounded poles. Mature shells of thirteen to seventeen volutions are 4.93 to 6.05 mm long and 2.95 to 4.45 mm wide, giving a form ratio of 1.6 to 1.8. The first two or three volutions seem to be ellipsoidal and the shell retains nearly the same axial profile from the fourth volution to maturity. The ratios of the half length to the radius vector of the first to fourteenth volution of three specimens average 1.4, 1.4, 1.6, 1.6, 1.7, 1.7, 1.7, 1.7, 1.7, 1.8, 1.8, 1.8, 1.8, and 1.8, respectively.

The proloculus is moderate in size and nearly spherical, with an outside diameter of 166 to 261 microns, averaging 214 microns in eight specimens. The expansion of the shell is slow in the inner three volutions, and becomes gradual but only slightly rapid in the following two volutions. From the sixth volution the shell expands slightly more rapidly and almost uniformly. Average radius vectors of the first to sixteenth volution of six specimens are 157, 221, 283, 364, 451, 545, 647, 762, 889, 1,018, 1,147, 1,282, 1,421, 1,558, 1,748, and 1,914 microns, respectively.

The spirotheca is very thin and composed of a tectum and a finely alveolar keriotheca. Average thickness of the spirotheca of the first to sixteenth volution of eight specimens are 11, 11, 12, 13, 12, 13, 14, 14, 14, 15, 15, 16, 16, 17, 18, and 20 microns, respectively. The fine alveoli apparently extend from the base of the keriotheca to the tops of the spirotheca.

The septa are composed of the downward deflection of the tectum and the keriotheca. The anterior and posterior extension of the keriotheca extends downward along the septa for a little less than a half length of the septum. The lower half of most, if not all, of the septa are solidified and thickened. Average septal counts of the first to fifteenth volution of three specimens are 8, 11, 14, 15, 16, 17, 20, 19, 21, 22, 24, 23, 26, 26, and 26, respectively.

The axial septula first appear in the second volution, where they are very rudimentary in development, being only small low ridges on the lower surface of the keriotheca. In the inner five volutions one to two axial septula occur between adjacent septa and two to three present in the outer volutions. A rudimentary suggestion of a fourth axial septula is seen in some of outer few chambers. As a whole the axial septula of this form are very primitive in development even in the outer volutions; namely, in a chamber having three axial septula only one, rarely two, of them becomes fairly long and others are only low ridges on the lower surface of the keriotheca.

The primary spiral septula occur throughout the shell. They are apparently formed by the downward extension of the keriotheca and contain clear alveoli. The secondary spiral septula do not occur in most parts of the shell, except in the last two or three volutions, where they are only low downward swelling of the keriotheca.

The foramina are small and elliptical in cross section. However their exact number cannot be measured because available axial sections are not exactly oriented.

Remarks.—*Neoschwagerina* sp. A rather closely resembles *Yabeina kaizensis* HUZIMOTO from the Kwanto massif. Although HUZIMOTO's description and illustration are not sufficient for the detailed specific comparison, that species seemingly is rather referable to the genus *Neoschwagerina* than to *Yabeina*. *N.* sp. A and *Y. kaizensis* are almost the same in the structure and the development of septa and septula, especially in the thinness and the wide spacing of septa and septula, but the former is distinguished from the latter by its less numerous volutions, larger proloculus, and more rapid rate of expansion.

These two species are quite similar in the evolutionary development of the shell, and the presence of the secondary spiral septula, though rudimentary in development, in the outer volutions suggests that they are advanced form for the genus *Neoschwagerina.*

Table 85. Table of Measurements (in Millimeters) of *Neoschwagerina* sp. A

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.
1	765D	2289	43	6	4.93	2.95	1.7	—
2	765D	2294	43	7	4.72	2.89	1.6	.175
3	765D	2292	43	8	6.06	3.27	1.8	.166 .202 ×
4	765D	2296	43	9	×	4.45	×	.201 .208 ×
5	765D	2295	43	10	×	3.97	×	.261
6	765D	2290	43	11	×	3.02	×	.254
7	765E	2304	43	14	×	3.80	×	.181
							Max.	.261
							Min.	.166
							Aver.	.214
								8

Speci-men	Radius vector																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	.113	.160	.221	.307	.386	.491	.600	.720	.852	.996	1.129	1.303	1.450				
2	.138	.230	.285	.350	.424	.497	.595	.696	.820	.960	1.062	1.193	1.310	1.435			
3	.141	.202	.267	.350	.440	.533	.61+	.705	.820	.938	1.064	1.196	1.352	1.486	1.610	1.757	
4	.153	.211	.282	.380	.482	.598	.705	.840	.957	1.070	1.200	1.333	1.500	1.637	1.818	1.977	2.158
5	.169	.239	.300	.383	.475	.564	.665	.778	.892	1.024	1.162	1.306	1.455	1.585	1.742	1.906	
6	.184	.236	.291	.347	.415	.513	.613	.727	.850	.972	1.085	1.226	1.380	1.550			
7	.144	.211	.276	.377	.475	.589	.693	.840	.978	1.092	1.226	1.361	1.502	1.653	1.824	2.014	
Max.	.184	.251	.319	.393	.497	.598	.705	.840	.978	1.092	1.226	1.361	1.502	1.653	1.824	2.014	
Min.	.113	.160	.221	.307	.386	.491	.595	.696	.820	.938	1.062	1.193	1.310	1.435	1.610	1.757	
Aver.	.157	.221	.283	.364	.451	.545	.647	.762	.889	1.018	1.147	1.282	1.421	1.558	1.748	1.914	2.158
	9	9	9	9	9	9	9	9	9	9	9	8	7	6	4	4	1

Speci-men	Thickness of spirotheca																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1			.010	.009	.012	.011	.013	.017	.017	.015	.015	.017	.017	.017			
2	.010	.014?	.014	.013	.012	.011	.013	.012	.013	.013	.015	.014	.014	.016	.015	.019	.012
3	.008	.010	.010	.013	.013	.013	.012	.015	.014	.015	.014	.013	.015	.015	.015	.015	.015
4	.005	.012	.010	.011	.013	.011	.011	.015	.015	.014	.014	.016	.016	.015	.015		
5	.009	.011	.013	.013	.014	.013	.014	.015	.015	.016	.018	.017	.019	.020	.021	.022	.024
6	—	.011	.011	.012	.011	.013	.013	.013	.013	.013	.012	.012	.017	.015	.017		
7	.010?	.019	.013	.012	.014	.013	.013	.013	.014	.014	.014	.013	.014	.017	.019	.016	.018
Max.	.010?	.014?	.014	.013	.014	.013	.014	.017	.017	.016	.019	.017	.019	.020	.021	.022	.024
Min.	.005	.009	.010	.009	.011	.011	.011	.012	.012	.013	.012	.012	.014	.015	.015	.015	.015
Aver.	.008	.011	.011	.012	.013	.012	.013	.014	.014	.014	.015	.015	.016	.016	.017	.018	.020
	5	7	8	8	8	8	8	8	8	7	8	8	7	7	6	4	4

Specimen	Ratio of Hl./Rv.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1.4	1.5	1.5	1.7	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7		
2	1.5	1.3	1.4	1.4	1.5	1.6	1.5	1.6	1.5	1.5	1.6	1.6	1.7		
3	1.4	1.5	1.8	1.8	1.8	1.8	1.8	1.8	1.9	2.0	2.0	2.0	1.9	1.8	1.8
Aver.	1.4	1.4	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.8

Specimen	Septal count														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	10?	11?	15	15	15	15	18?	20	20	23?	25				
6	7	12	13	14	15	15	19	17	22	22	23	23	26	25?	
7	7	10	13	17	19	20	22	20	21	21	25	23	25	27	26
Aver.	8	11	14	15	16	17	20	19	21	22	24	23	26	26	26

Further study of these forms on more sufficient materials will be necessary before the definite characteristics can be understood.

Occurrence.—Neoschwagerina sp. A has been obtained only in No. 1 limestone of Section XV (Loc. 765) which consists of limestone conglomerate containing huge limestone boulders and cobbles. Because the present species is found in one of the limestone boulders, its stratigraphical range is not known exactly.

Genus *Yabeina* DEPRAT, 1914

Yabeina cf. *tobleri* (LANGE) (?)

Pl. 43, figs. 15–18

1925. *Neoschwagerina tobleri* LANGE. Geol. Mijnbouwkundig Genootshap voor Nederland en Kolonien Verh., Geol. Ser. Deel 7, pp. 265, 266, Pl. IV, figs. 69a–d.

The specimens here referred to *Yabeina* cf. *tobleri* (LANGE)(?) are not sufficient for giving the precise description of the species. However, for the sake of completeness, I am giving the following description based entirely on the materials collected from the Akiyoshi limestone group.

The shell of *Yabeina* cf. *tobleri* (LANGE) is of moderate in size for the genus, and is inflated fusiform with nearly straight axis of coiling, straight to convex lateral slopes, and broadly rounded poles. A mature specimen of ten volutions is 4.9 mm in length and 3.1 mm in width, giving a form ratio of 1.6. The inner two to three volutions are subspherical to ellipsoidal, with exclusively rounded poles. Beyond the third or fourth volution the axis extends slightly rapidly, and the shell assumes the inflated fusiform. Average ratios of the half length to the radius vector of the first to tenth volution of four specimens are 1.1, 1.2, 1.3, 1.4, 1.4, 1.5, 1.6, 1.6, 1.6, and 1.6, respectively.

The proloculus is large and spherical to ellipsoidal, rarely somewhat irregular in some specimens. The outside diameter varies from 368 to 490 microns, averaging 468 microns in twenty-one specimens. In a proloculus of irregular shape the maximum and minimum diameters are measured 683 and 347 microns, respectively. The shell expands considerably rapidly for the genus and almost uniformly throughout the growth. Average radius vectors of the first to eleventh volution of twenty-one specimens are 318, 435, 564, 696, 836, 974, 1,128, 1,288, 1,460, 1,657, and 1,781 microns, respectively.

The spirotheca is thin and distinctly alveolar. The fine alveoli can be seen even in the earliest volution. The true thickness of the spirotheca is rather difficult to be measured due to the presence of numerous septula. Average thickness of the spirotheca at its thinnest point between adjacent septula in the first to tenth volution of four specimens is 12, 13, 13, 13, 13, 15, 15, 18, 18, and 16 microns, respectively.

The septa are thin and formed of the downward deflection of the tectum and short downward extension of the keriotheca on either side of the tectum. Most of the septa are almost perpendicular to the surface of the spirotheca and some are bending anteriorly at a very small angle. The tips of some septa bend forward at a sharp angle. The septal count is not determined with certainty, but approximately 11, 15, 19, 18, 18, 20, 19, and 18 septa are counted respectively in the first to eighth volution of one specimen.

The axial septula present throughout all the volutions. One or two axial septula are intercalated between adjacent septa in the inner four to five volutions. Although the total number of the axial septula seems to vary from chamber to chamber, there are two to three, four at the maximum, in the outer volutions. They are not equal in length even in one chamber. Shorter axial septulus is represented by only small low swelling of the keriotheca, while longer one is nearly half to two-thirds as high as the chambers, and the lower margin of which is mostly solidified. The primary spiral septula occur throughout the growth of the shell. Although their upper part clearly retains the keriothecal structure, their lower margin is almost completely solidified and combined with the parachomata. The secondary spiral septula are only recognizable in some chambers of the eighth or ninth volution. They are very short and primitive in development, only being a low pendant ridge of the spirotheca.

The foramina are small and nearly circular to short elliptical in cross section. There are about 24, 24 and 28 foramina respectively in the fifth, sixth and eighth volutions of one specimen.

Remarks.—So far as the shell form, the size of the proloculus, the radius vectors for the corresponding volutions, the thickness of the spirotheca, and the number and character of the axial septula are concerned, the present specimens closely

Table 86. Table of Measurements (in Millimeters) of *Yabeina* cf. *tobleri* (LANGE) (?)

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.
1	753	2246	43	15	4.89	3.15	1.6
2	752	2238	43	16	5.8+	3.8+	1.5
3	752	2237	43	17	×	3.16	×
4	752	2236	43	18	×	2.25+	×

Specimen	Prol.	Radius vector										
		1	2	3	4	5	6	7	8	9	10	11
1	.547/.581 ×	.360	.448	.564	.674	.822	.951	1.073	1.226	1.402	1.490	
2	.380	.245	.344	.470	.605	.750	.920	1.088	1.266	1.440	1.670	
3	.466	.338	.448	.604	.750	.905	1.037	1.174	1.340	1.493		
4	.347/.683 ×	.326	.440	.549	.662	.810	.942	1.113	1.278			
Max.	.490	.380	.540	.680	.800	.957	1.120	1.300	1.425	1.660	1.840	1.962
Min.	.368	.245	.344	.460	.567	.680	.813	.980	1.135	1.296	1.462	1.600
Aver.	.468	.318	.435	.564	.696	.836	.974	1.128	1.288	1.460	1.657	1.781
	21	21	21	21	21	21	18	18	16	12	8	2

Specimen	Thickness of spirotheca										
	0	1	2	3	4	5	6	7	8	9	10
1	.010	.011	.012	.013	.014	.014	.013	.013	.015	.015	.015
2	.010	.010	.013	.013	.012	.012	.018?	.017	.022	.018	.017
3	.010	.014	.014	.014	.015	.014	.014	.015	.017	.015	
4	.009	.011	.012	.011	.011	.012	.013	.015	—		
Max.	.010	.014	.014	.014	.015	.014	.018?	.017	.022	.018	.017
Min.	.009	.010	.012	.011	.011	.012	.013	.013	.015	.015	.015
Aver.	.010	.012	.013	.013	.013	.013	.015	.015	.018	.018	.016
	4	4	4	4	4	4	4	4	3	3	2

Specimen	Ratio of Hl./Rv.									
	1	2	3	4	5	6	7	8	9	10
1	—	1.2	1.4	1.6	1.6	1.6	1.7	1.7	1.7	
2	1.3	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.7	1.7

Specimen	Septal count							
	1	2	3	4	5	6	7	8
3	11	15?	19?	18	18	20	19	18

stand to *Yabeina tobleri* (LANGE) described from the Middle Permian rocks of Guguk Bulat of Sumatra. Although the LANGE's original illustrations (1925) are not sufficient for the critical specific comparison, his specimens are seemingly referable to the genus *Yabeina*. The LANGE's axial sections (69b and c) show that the secondary spiral septula occur even in some chambers of the second or third volution. While in the Akiyoshi specimens the secondary spiral septula are only recognizable in some chambers of the eighth or ninth volution, and they are very primitive in development if present. The present species also closely resembles *Neoschwagerina megaspherica* DEPRAT described above in many respects. However, the former differs from the latter in having smaller proloculus, less rapid rate of expansion for the corresponding volutions, and slightly more primitive characteristics in the development of septa and septula.

To determine more definite characteristics of this form further study on more sufficient materials seems to be necessary.

Occurrence.—*Yabeina* cf. *tobleri* (LANGE)(?) was collected only from the Nos. 3 and 4 limestones of Section XXVI (Loc. 752 and 753, respectively) which are referred to the Pmδ subzone.

Yabeina shiraiwensis OZAWA

Pl. 44; Pl. 45, figs. 1–11

1925. *Yabeina shiraiwensis* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 63, 64, Pl. X, figs. 1, 2; Pl. II, fig. 2b, 5c, 7b.
1925. *Neoschwagerina (Yabeina) shiraiwensis* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 4, Pl. III, fig. 8; Pl. IV, figs. 1, 3, 4.
1936. *Yabeina shiraiwensis* HUZIMOTO. Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2, pp. 122, 123, Pl. XXVI, figs. 1–7.
1942. *Yabeina shiraiwensis* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XVIII, No. 4, pp. 245, Pl. XXIV, figs. 14, 15; Pl. XXV, figs. 1–6.
1956. *Yabeina shiraiwensis* CHEN. Palaeontologia Sinica, New Ser. B, No. 6, pp. 64, 65, Pl. XIV, figs. 8–10.

Yabeina shiraiwensis OZAWA is one of the most common species of the neoschwagerinid found in the Upper Permian rocks of Japan. Fairly abundant and well-oriented sections have been obtained in the Akiyoshi limestone group on which the following description is based.

The shell of *Yabeina shiraiwensis* OZAWA is moderately large in size and inflated fusiform, with nearly straight axis of coiling and bluntly pointed poles. The lateral slopes are exclusively convex in the inner four to five volutions but become almost straight to even concave in the outer volutions. The largest specimen of the present collection is 8.2 mm in length and 5.5 mm in width, with a form ratio of 1.5. The OZAWA's type specimen (axial section of Pl. 45, fig. 6 in this paper is here designated the lectotype) is 6.2 mm long and 3.8 mm wide, with a form ratio of 1.6. The first one to two volutions are nearly spherical to subspherical, followed by one to two volutions of short ellipsoidal shape. Beyond the fourth or fifth volution the shell assumes its mature shape. The ratios of the half length to the radius vector of the first to fourteenth volution for twenty specimens are 1.2, 1.4, 1.4, 1.5, 1.6, 1.6, 1.6, 1.6, 1.6, 1.6, 1.6, 1.6, 1.6, and 1.7, respectively.

The proloculus is moderate in size, and spherical to short ellipsoidal. The outside diameter of the spherical proloculus is ranging from 214 to 340 microns, while that of the ellipsoidal or irregular shape is 190 to 356 microns in the shortest diameter and 214 to 396 microns in the longest one. Average of all of them is 301 microns for forty-six specimens. The proloculus of the lectotype specimen has a maximum diameter of 401 microns and a minimum diameter of 338 microns. The shell comparatively tightly coils in the inner four to five volutions, and slightly more rapidly but nearly uniformly expands in the outer ones. The radius vectors of the first to fourteenth volution of the lectotype specimen are 267, 344, 440, 550, 665, 790, 910, 1,034, 1,170, 1,281, 1,413, 1,564, 1,720, and 1,880 microns, respectively. Average radius vectors of the first to sixteenth volution for fifty specimens are 220, 297, 393, 502, 622, 754, 891, 1,044, 1,212, 1,366, 1,545, 1,736, 1,843, 1,986, 2,229, and 2,390 microns, respectively. The chambers are almost the same in height in the central two-thirds to three-fourths of the shell and become slightly higher in the polar regions where the lateral slopes change from nearly straight to concave.

The spirotheca is very thin, consisting of a tectum and a very finely alveolar keriotheca. The alveoli are, however, too fine to be distinguished in most parts of shell, especially in the outer volutions. The true thickness of the spirotheca is difficult to be measured due to the presence of numerous septula. The thickness of the spirotheca measured at the thinnest part between adjacent septula is 9, 9, 10, 10, 10, 11, 11, 11, 11, 12, 11, 13, and 10 microns respectively in the first to thirteenth volution of the lectotype specimen. In the present collection it averages 10, 9, 10, 10, 10, 10, 10, 10, 10, 10, 11, 11, 11, 11, and 12 microns respectively in the first to fifteenth volution of fourteen specimens. The proloculus wall is seemingly structureless, with a thickness of 9 to 11 microns, averaging 10 microns for thirteen specimens.

The septa are thin and composed of the tectum and the downward extension of the keriotheca on both sides of the tectum. The latter is very short, being along the septa only for half to one-third of the length of the septa. The basal half of most of the septa is solidified, consisting of dark dense materials. The base of the septa is thickened and sharply bends anteriorly with a high angle. The septal counts of the first to fourteenth volution of one of the OZAWA's specimen (Pl. X, fig. 2) are 7, 15?, 19?, 17?, 17, 19, 20, 21, 25, 22, 24, 25, 26, and 27, respectively. Average septal counts of the first to eleventh volution of three specimens are 7, 10, 13, 13, 13, 14, 15, 18, 20, 26, and 25, respectively. The axial septula develop throughout the shell. One to two axial septula occur in the first and second volutions, two to four in the third to fifth, three to six in the sixth to ninth, and five to eight, even to nine, in the outer volutions. Although they are not equal in length, most of them assume club-shaped axial profile. The primary spiral septula present throughout the length of the shell. The secondary spiral septula first appear in the third or fourth volution, although they are very

Table 87. Table of Measurements (in Millimeters) of *Yabeina shiraiwensis* OZAWA

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.
1*	OZAWA's specimen	I-14	45	6	6.20	3.80	1.6	.338 .401 ×
2*	OZAWA's specimen	I-15	45	7	×	4.56	×	.239
3	12	2113	44	1	6.86	4.34	1.6	.30+
4	750	2223	44	2	5.31	3.48	1.5	.282
5	765C	2272	44	3	7.6+	4.9+	1.5	.322 .342 ×
6	750	2224	44	4	5.31	3.06	1.7	.307 .355 ×
7	769A	2323	44	5	6.54	4.4+	1.5	.30+
8	370	2199	44	7	4.82	3.11	1.6	.328
9	370	2199	44	9	4·0+	2.65	1.5	.251 .282 ×
10	765C	2277	45	4	8.20	5.52	1.5	.211
11	765C	2272	44	13	×	3.14	×	.303 .332 ×
12	370	2199	44	14	×	1.89	×	.191 .214 ×
13	12	2114	44	15	×	2.33	×	.206
14	750	2225	45	2	×	3.4+	×	.294 .318 ×
15	1	2102	45	3	×	3.7+	×	.276
							Max.	.396
							Min.	.190
							Aver.	.301 / 46

Specimen	Radius vector 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1*	.267	.344	.440	.550	.665	.790	.910	1.034	1.170	1.281	1.413	1.564	1.720	1.880			
2*	.196	.344	.451	.571	.702	.816	.975	1.135	1.296	1.493	1.692	1.867	2.063	2.266	2.443		
3	.27+	.378	.517	.627	.759	.886	1.049	1.200	1.339	1.508	1.691	1.900	2.120				
4	.221	.297	.390	.520	.656	.766	.873	1.010	1.155	1.318	1.470	1.640	1.81?				
5	.245	.307	.390	.495	.587	.693	.816	.920	1.092	1.278	1.442	1.650	1.830	2.060	2.284		
6	.200	.276	.368	.470	.613	.736	.873	1.018	1.177	1.350	1.530	1.720					
7	.261	.340	.472	.581	.720	.867	1.037	1.221	1.425	1.615	1.810	2.020					
8	.236	.332	.445	.567	.727	.890	1.052	1.226	1.410								
9	.221	.303	.415	.528	.660	.791	.920	1.085	1.226								
10	.175	.221	.294	.380	.482	.610	.720	.870	1.058	1.226	1.416	1.625	1.821	2.054	2.290	2.480	2.720
11	.218	.307	.405	.522	.653	.796	.920	1.080	1.245	1.410	1.552						
12	.185	.257	.338	.430	.543	.647	.766	.890									
13	.184	.233	.350	.445	.613	.760	.910	1.050									
14	.190	.288	.368	.466	.57+	.670	.806	.920	1.073	1.220	1.381	1.532	1.690	1.84+			
15	.205	.285	.380	.494	.610	.736	.890	1.037	1.202	1.378	1.550	1.750					
Max.	.270	.378	.517	.627	.759	.890	1.108	1.226	1.425	1.815	2.027	2.246	2.120	2.150	2.370	2.480	
Min.	.175	.221	.294	.380	.482	.610	.720	.870	1.027	1.140	1.260	1.410	1.620	1.780	2.050	2.300	
Aver.	.220	.297	.393	.502	.622	.754	.891	1.044	1.212	1.366	1.545	1.736	1.843	1.986	2.229	2.390	
	46	49	50	50	50	49	48	45	41	33	32	29	15	8	5	2	

* The statistics of the specimens 1 and 2 is excluded from the averages.

short and primitive in development. In the outer volutions, however, one to two secondary spiral septula occur between adjacent primary ones.

Speci-men	Thickness of spirotheca																	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1*	—	.009	.009	.010	.010	.010	.011	.011	.011	.011	.012	.011	.013	.010				
2*	—	.009	.010	.010	.011	.012	.012	.010	.011	.010	.011	.011	.012	.012	.012	.011	—	
3	.011	.011	.009	.011	.010	.011	.009	.009	.010	.010	.010	.012	.011	.012	—			
4	.009	.010	.010	.010	.009	.009	.010	.009	.010	.010	.010	.010	.012	—				
5	.009	.010	.011	.011	.010	.010	.010	.009	.010	.010	.009	.011	.009	.010	.010	.012		
6	.010	—	.008	.009	.010	.011	.009	.009	.009	.010	.009	—						
7	—	.011	.010	.010	.010	.009	.010	.010	.010	.012	.012	.011	.011	.010				
8	.011	.009	.010	.010	.012	.012	.011	.012	.012	—								
9	.011	.010	.010	.009	.011	.010	.010	.009	.010	.011								
10	.010	.008	.008	.008	.009	.010	.011	.010	.010	.010	.010	.010	.012	.012	.011	.012	.013	.012
11	.009	.010	.009	.008	.010	.009	.009	.010	.011	.010	.011	—						
12	.010	.010	.010	.009	.010	.011	.012	.010	.011	.010								
13	—	—	.009	.009	.010	.011	.010	.010	.010	.009								
14	.010	.009	.009	.009	.011	.010	.011	.011	.010	.011	.010	.012	.013	—				
15	.010	.009	.010	.009	.009	.009	.011	.011	.010	.010	.011	.013	.010					
Max.	.011	.011	.011	.011	.012	.011	.012	.012	.013	.012	.011	.013	.013	.012	.011			
Min.	.009	.008	.008	.008	.009	.009	.009	.009	.009	.009	.009	.010	.009	.010	.010			
Aver.	.010	.010	.009	.010	.010	.010	.010	.010	.010	.010	.010	.011	.011	.011	.011	.012		
	13	11	14	14	14	14	13	14	14	13	10	8	8	4	2	2		

Speci-men	Ratio of Hl./Rv.																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1*	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5			
3	1.4	1.5	1.4	1.6	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.7				
4	1.2	1.4	1.5	1.5	1.5	1.5	1.5	1.4	1.5	1.4	1.4	1.4	1.4				
5	1.1	1.2	1.5	1.5	1.6	1.7	1.8	1.9	1.9	1.9	1.9	1.8	1.8	1.7	1.7		
6	—	—	—	1.6	1.7	1.7	1.8	1.8	1.7								
7	1.2	1.4	1.3	1.5	1.5	1.5	1.4	1.6	1.5	1.5	1.5	1.5					
8	1.1	1.3	1.4	1.5	1.5	1.6	1.6	1.6	1.6								
9	1.0	1.3	1.2	1.4	1.4	1.5	1.5	1.5	1.4								
10	1.1	1.2	1.3	1.5	1.6	1.5	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4
Max.	1.6	1.6	1.6	1.7	1.7	1.8	1.8	1.9	1.9	1.9	1.9	1.8	1.8	1.7			
Min.	1.0	1.2	1.2	1.3	1.4	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4			
Aver.	1.2	1.4	1.4	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.7			
	15	17	16	18	18	20	18	17	15	12	10	9	6	3			

Speci-men	Septal count														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2*	—	—	—	14?	18	18	16	18	25	24	22	26	25	27	—
11	7	11	12	13?	14?	15	16?	21?	22?	26?	26				
12	7	10	13	14?	14?	15	15?	14	—						
15	6	10?	—	12?	12?	13?	14?	18?	17?	—	23?	—			
Aver.	7	10	13	13	13	14	15	18	20	26	25				

The foramina are very small and spherical to elliptical, with the greatest diameter parallel to the axis of coiling. It seems, however, that the number of the foramina is not a consistent feature in a given species of neoschwagerinid, and it varies considerably in numer for the corresponding volution of different specimens. There are approximately 14 to 29 foramina in the fifth volution and 29 to 42 in the tenth volution of three specimens including the lectotype specimen.

Remarks.—In establishing *Yabeina shiraiwensis* OZAWA based on the specimens collected from Shiraiwa and Yobara, OZAWA (1925) considered that the size of the proloculus is very important specific character. He emphasized this point in the remarks as follows: "The size of the initial chamber is the most important point. I have not only examined more than twenty oriented sections, and in one case I have also carefully polished a beautiful sample, measuring the diameter of the initial chamber as well as I could. The largest value obtained on this occasion did not surpass 0.32 mm. And so far as I am aware, no example offers a value of more than 0.35 mm." Nevertheless, and as KANMERA (1954) already pointed out, KANMERA and I recently reexamined the OZAWA's original specimen (section number I-14, illustrated as fig. 2 of Pl. X and illustrated as Pl. 45, fig. 6 in this paper) now kept in the University of Tokyo, and found that this specimen has a maximum diameter of 401 microns. In 1942 I described a new species, *Y. yasubaensis*, based mainly on the difference of the prolocular size without noticing OZAWA's error. Therefore, the specific validity of that species has naturally comes into question which will be discussed later.

I have examined more than sixty specimens collected from the Akiyoshi limestone group, which are referable either to *Yabeina shiraiwensis* or to *Y. yasubaensis* if the size of the proloculus and the rate of expansion are left out of consideration. However, by the difference of these two measurable characters, they are divided into two groups, one having relatively larger proloculus and more rapid rate of expansion and the other having relatively smaller proloculus and slower rate of expansion.

Thus, most of specimens here referred to the latter, *Y. shiraiwensis*, have a proloculus of less than 400 microns in the outside diameter, excepting for the lectotype specimen which has the proloculus of ellipsoidal shape with the maximum diameter of 401 microns and the minimum one of 338 microns. It should be noted that the lectotype specimen is typical for the species in the rate of expansion.

These facts suggest that if we rectify the OZAWA's figures, 0.35 mm to 0.41 mm, his statement will be valid for the specific designation of *Y. shiraiwensis*.

In looking over the COLANI's monograph (1924), OZAWA (1925) stated in the supplement that *Y. shiraiwensis* OZAWA and *Y. hayasakai* OZAWA are the synonyms of *Neoschwagerina multiseptata* (DEPRAT) em. COLANI. However, the type specimen of the last named species clearly differs from the former twos, being much more advanced in the spirothecal structure and the septal development. Therefore, OZAWA's emendation is not accepted here.

Yabeina shiraiwensis OZAWA is one of the most important species among the Upper Permian fauna of Japan and has been reported from many localities throughout this country. Besides the OZAWA's original description, however, only HUZIMOTO (1936) and TORIYAMA (1942) described and illustrated this species from the Kwanto massif and Shikoku, respectively. To our regret most of the HUZIMOTO's specimens are more or less deformed and somewhat indistinctly illustrated from which enough information is not available for the critical discussion of minute specific characters.

From the paleontological and stratigraphical points of view KANMERA (1954) discussed very much in detail the faunal assemblage of the *Lepidolina* zone in southern Kyushu and the equivalent formations of Japan, British Columbia and East Asia. I (1954) also pointed out some problems concerning the matter. Although it seems unnecessary here to add further discussion, forms which were referred to *Y. shiraiwensis* OZAWA should be studied in detail under the modern light of micropaleontology, and, at the same time, careful observation must be paid on their field occurrences.

Occurrence.—The stratigraphical range of this species is restricted to the Puα, *Yabeina shiraiwensis* zone, in the Akiyoshi limestone group. It has been obtained from the following localities, all of them are located in the Ofuku plateau: No. 1 limestone of Section XIV (Loc. 97), No. 1 limestone of Section XV (Loc. 765), Nos. 1 and 2 limestones of Section XVI (Loc. 370 and 742, respectively), No. 1 limestone of Section XXVI (Loc. 750), Nos. 1 and 3 limestones of Section XXVII (Loc. 1 and 785, respectively), and Loc. 2, 12, 233, 369, 768, and 769A.

Yabeina yasubaensis TORIYAMA

Pl. 45, figs. 12–14; Pl. 46

1941. *Yabeina yasubaensis* TORIYAMA. Japan. Jour. Geol. Geogr., Vol. XVIII, No. 4, pp. 246, 247, Pl, XXV, figs. 8–13.
1954. *Yabeina yasubaensis* KANMERA. Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol. Vol. IV, No. 1, pp. 18, 19, Pl. 2, figs. 10–13; Pl. 5, figs. 14–19.

Along with *Yabeina shiraiwensis* OZAWA, *Y. yasubaensis* TORIYAMA is one of the most common neoschwagerinid in the Upper Permian formations of Japan. The Akiyoshi specimens agree so closely either with the original type from the Yasuba conglomerate in Shikoku or with those described and illustrated by KANMERA (1954) from the Upper Permian Kuma formation in southern Kyushu that there is no need to add further description. It seems necessary, however, to give further discussion on the specific validity of this species, because some confusion has been arisen on the specific distinction between *Yabeina shiraiwensis* and *Y. yasubaensis*.

As discussed at some length in the foregoing species, *Yabeina shiraiwensis* and *Y. yasubaensis* are closely allied with each other in many important characteristics, but the latter species is distinguished from the former by its generally

Table 88. Table of Measurements (in Millimeters) of *Yabeina yasubaensis* TORIYAMA

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.
1*	Yasuba specimen	No. 39	46	13	8.20	4.77	1.7	.466 .513 ×
2*		No. 3	46	14	8.16	4.50	1.8	.363 .470 ×
3*		No. 4	46	15	×	4.64	×	.433
4*		No. 3	46	16	×	3.05	×	.415 .470 ×
5	370	2202	45	12	2.73	1.85	1.5	.320 .404 ×
6	742	2215	46	2	6.3?	3.7+	1.7	.448
7	768	2312	46	1	—	5.5?	—	.410 .42+ ×
8	765C	2278	45	13	×	3.37	×	.349 .384 ×
9	765C	2273	45	14	×	4.8?	×	.321 .380 ×
10	765C	2276	46	4	×	4.02	×	.338 .378 ×
11	768	2313	46	7	×	3.70	×	.392 .436 ×
12	1	2101	46	8	×	4.02	×	.405 .448 ×
13	370	2202	46	9	×	2.65	×	.404
							Max.	.534
							Min.	.362
							Aver.	.413 22

Specimen	Radius vector 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1*	.338	.439	.537	.647	.788	.935	1.082	1.223	1.373	1.545	1.723	1.912	2.081			
2*	.300	.396	.500	.613	.745	.880	1.052	1.190	1.373	1.533	1.755	1.943	2.145			
3*	.298	.405	.525	.656	.780	.920	1.073	1.214	1.400	1.555	1.757	1.950	2.12+	2.292		
4*	.326	.440	.571	.698	.834	.981	1.145	1.306	1.486	1.640	1.79+					
5	.276	.377	.460	.590	.714	.864	1.000									
6	.307	.392	.506	.612	.690	.816	.963	1.120	1.275	1.432	1.594	1.73+				
7	.308	.392	.490	.613	.765	.920	1.080	1.250	1.422	1.573	1.726	1.910	2.105	2.342	2.540	2.760
8	.254	.353	.466	.586	.720	.895	1.088	1.287								
9	.297	.392	.546	.686	.830	.993	1.165	1.35+	1.533	1.731	1.962	2.177	2.361			
10	.254	.347	.470	.571	.733	.873	1.043	1.217	1.410	1.597	1.815	2.036				
11	.33+	.442	.552	.677	.812	.963	1.120	1.272	1.440	1.600	1.815					
12	.330	.435	.558	.717	.886	1.055	1.235	1.450	1.628	1.835	2.050					
13	.307	.392	.510	.632	.776	.920	1.082	1.278								
Max.	.344	.497	.613	.757	.960	1.153	1.360	1.59?	1.628	1.835	2.050	2.177	2.361			
Min.	.254	.347	.430	.528	.653	.800	.960	1.126	1.263	1.41+	1.585	1.73+	1.946			
Aver.	.303 22	.400 22	.514 22	.636 21	.764 22	.912 20	1.068 19	1.247 16	1.397 10	1.586 9	1.783 9	1.908 6	2.137 3	2.238 2		

* The statistics of the Yasuba specimens is excluded from the averages.

larger proloculus and more rapid rate of expansion. Besides, the axial septula for the corresponding volutions are more numerous in this species than in *Y. shiraiwensis*; namely, 1–3 axial septula occur in the first to second volutions of this species while 1–2 in those of *Y. shiraiwensis*, and 2–5 in the third to fifth volutions of the former, while 2–4 in those of the latter. Moreover, the spirotheca seemingly

Specimen	Thickness of spirotheca														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1*	—	.010	.011	.011	.011	.011	.011	.011	.011	.012	.012	.011	.012	.012	—
2*	.009	.009	.010	.010	.009	.010	.009	.010	.010	.011	.011	.010	.010		
3*	—	.009	.009	.010	.010	.010	.009	.010	.010	.011	.010	.010	.012	.012	.012
4*	.008	.010	.009	.010	.009	.010	.011	.011	.011	.011	.011				
5	.009	.009	.010	.010	.011	.011	.011	.010							
6	.008	.010	.010	.010	.011	.010	.009	.010	.013	.014					
7	—	.010	.009	—	.009	.011	.009	.010	—	.012	.010	.010	.012	.012	.012
8	—	.010	.010	.010	.010	.010	.010	.011	.012						
9	.012	.011	.009	.009	.010	.010	.009	.011	.011	.011	.012	.012	.012	.013	—
10	.011	.008	.009	.010	.009	.010	.011	.011	.010	.011	.010	.010	.010	.010	
11	—	.011	.011	.010	.010	.010	.009	.010	.011	.012	.012	.011			
12	.011	.010	.009	.011	.009	.012	.011	.010	.011	.012	.011	.011	—		
13	.010	0009	.008	.008	.008	.009	.009	.008	.009						
Max.	.012	.011	.011	.011	.011	.012	.011	.011	.013	.014	.012	.012	.012	.013	
Min.	.008	.008	.008	.008	.008	.009	.009	.008	.009	.011	.010	.010	.010	.010	
Aver.	.010	.010	.009	.010	.010	.010	.010	.010	.011	.012	.011	.011	.011	.012	.012
	6	9	9	8	9	9	9	9	7	6	5	5	3	3	1

Specimen	Ratio of Hl./Rv.												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1*	1.4	1.4	1.5	1.6	1.6	1.6	1.7	1.7	1.8	1.7	1.7	1.7	1.7
2*	1.2	1.4	1.6	1.6	1.6	1.6	1.7	1.8	1.8	1.8	1.8	1.7	1.7
5	1.0	1.4	1.5	1.6	1.7	1.7							
6	1.0	1.3	1.4	1.4	1.7	1.8	1.8	1.8	1.9	1.9	1.9	1.9	
Aver.	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.0	1.9	1.9	
	4	4	4	4	4	4	2	2	2	2	2	1	

Specimen	Septal count										
	1	2	3	4	5	6	7	8	9	10	11
4*	9 ?	13?	12?	16	17?	19?	19?	22?	—		
9	8	14	17?	16?	16?	18?	19?	19?	23?	24?	29?
10	8	14	14	14	17	18	18	17?	20?	23?	25?
11	8	11?	12	15?	16	19?	20?	23?	21?	23?	
13	6	11	13	14	14	16	20	18			
Max.	8	14	17?	16?	17	19?	20	23?	23?	24?	
Min.	6	11	12	14	14	16	18	17?	20?	23?	
Aver.	7	13	15	15	16	18	19	19	21	23	27
	6	6	5	4	4	5	4	4	3	3	2

is slightly thinner in this species than in the corresponding volutions of *Y. shiraiwensis.*

This species is also closely related to *Y. pinguis* TORIYAMA, n. sp. described below. The comparison and the phylogenetical relation between these forms are given in the remarks of the last named species.

With *Y. shiraiwensis*, *Y. yasubaensis* is very characteristic to the Upper Permian fusulinid zone, such as the *Lepidolina* zone in southern Kyushu, the *Yabeina shiraiwensis* zone in the Akiyoshi limestone group and the Yasuba conglomerate in Shikoku, and the same attention is also given here for its faunal association and field occurrence as in *Y. shiraiwensis* mentioned already.

Occurrence.—So far has been observed *Y. yasubaensis* TORIYAMA was obtained from the following localities, almost always associated with *Y. shiraiwensis* OZAWA: No. 1 limestone of Section XV (Loc. 765), Nos. 1 and 2 limestones of Section XVI (Loc. 370 and 742, respectively), No. 1 limestone of Section XXVI (Loc. 750), No. 1 limestone of Section XXVII (Loc. 1), and Loc. 233 and 768.

Yabeina pinguis TORIYAMA, n. sp.

Pl. 47, figs. 1-9

The shell of *Yabeina pinguis* TORIYAMA, n. sp. is farily large and globose fusiform, with nearly straight to somewhat arching axis of coiling, straight to convex lateral slopes, and broadly rounded poles. The holotype specimen of fifteen volutions is approximately 5.6 mm in length and 4.7 mm in width, with a form ratio of 1.2. The first volution is nearly spherical. Beyond the second or third volution the shell assumes its mature shape. Average ratios of the half length to the radius vector of the first to sixteenth volution are 1.0, 1.1, 1.2, 1.3, 1.3, 1.3, 1.3, 1.2, 1.3, 1.3, 1.3, 1.2, 1.2, 1.2, 1.2, and 1.2, respectively, in three specimens including the holotype.

The proloculus is rather small and almost spherical to nearly rectangular. The outside diameter of the spherical proloculus is 230 to 362 microns, averaging 277 microns for eight specimens. The maximum and minimum diameters of a typical rectangular proloculus are 444 and 175 microns, respectively. The shell slightly more tightly coils in the inner four to five volutions than in the outer ones where it expands nearly uniformly. Average radius vectors of the first to sixteenth volution of eight specimens are 200, 277, 365, 472, 586, 720, 860, 1,027, 1,194, 1,342, 1,494, 1,683, 1,882, 2,078, 2,287, and 2,410 microns, respectively. The chambers are almost the same in height throughout the length of the shell.

The spirotheca is very thin and very finely alveolar. The alveoli are discernible in the outermost volution. The thickness of the spirotheca at the thinnest point between adjacent septula averages 10, 10, 11, 11, 12, 12, 12, 13, 13, 13, 14, 14, 14, 15, and 15 microns, respectively, in the first to fifteenth volution of eight specimens.

The septa are thin and numerous, although their exact number is hard to be counted. Average septal counts of the first to fifteenth volution of three specimens are 7, 11, 13, 13, 14, 15, 17, 18, 18, 20, 21, 23, 25, 25, and 23, respectively.

Table 89. Table of Measurements (in Millimeters) of *Yabeina pinguis* TORIYAMA, n. sp.

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.
1*	765C	2279	47	1	5.60	4.70	1.2	.264/.362 ×
2	233	2144	47	2	6.0+	4.3+	1.4	.280
3	2	2108	47	3	7.0+	5.5+	1.3	.175/.410 ×
4	2	2108	47	5	×	2.9+	×	.230
5	233	2145	47	7	×	4.5+	×	.232
6	765B	2265	47	8	×	4.46	×	.244
							Max.	.444
							Min.	.175
							Aver.	.277 / 8

Specimen	Radius vector 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1*	.220	.297	.386	.482	.592	.727	.867	1.027	1.165	1.327	1.505	1.723	1.931	2.115	2.324			
2	.200	.261	.338	.445	.540	.662	.791	.942	1.082	1.226	1.373	1.533	1.726	1.930	2.146	2.310		
3	.261	.338	.417	.52?	.635	.750	.868	1.069	1.220	1.380	1.533	1.717	1.900	2.080	2.270	2.510	2.760	3.000
4	.190	.251	.330	.433	.571	.720	.877	1.064	1.250	1.440								
5	.178	.254	.350	.439	.537	.674	.813	.966	1.140	1.320	1.500	1.700	1.902	2.120	2.356			
6	.202	.279	.371	.470	.574	.705	.858	1.020	1.202	1.380	1.550	1.748	1.962	2.146	2.340			
Max.	.220	.338	.417	.543	.683	.826	.975	1.150	1.360	1.440	1.533	1.748	1.962	2.146	2.356			
Min.	.153	.230	.330	.433	.537	.662	.791	.942	1.082	1.226	1.373	1.533	1.726	1.930	2.146			
Aver.	.200	.277	.365	.472	.586	.720	.860	1.027	1.194	1.342	1.494	1.683	1.882	2.078	2.287	2.410		
	8	8	8	8	8	8	8	8	8	7	6	6	6	5	5	2		

Specimen	Thickness of spirotheca 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1*	—	.010	.011	.011	.012	.013	.013	.013	.013	.014	.015	.014	.013	.013	.016			
2	—	.011	.011	.012	.013	.013	.013	.013	.013	.014	.014	.014	.013	.015	.017	.015		
3	—	.010	.009	.010	.012	.012	.010	.011	.012	.011	.012	.014	.013	.013	.015	.014	.013	.014
4	.010	.010	.010	.011	.010	.012	.012	.013	.013	.013	.015	.015						
5	.011	.009	.009	.010	.010	.012	.013	.013	.013	.013	.012	.013	.014	.015	.014	—		
6	.010	.009	.010	.011	.011	.011	.012	.011	.011	.013	.013	.014	.014	.013	.014	—		
Max.	.011	.011	.011	.012	.013	.013	.014	.014	.013	.014	.015	.015	.015	.015	.017			
Min.	.010	.009	.009	.009	.010	.011	.010	.011	.011	.011	.012	.013	.013	.013	.014			
Aver.	.010	.010	.010	.011	.011	.012	.012	.012	.013	.013	.013	.014	.014	.014	.015	.015		
	4	8	8	8	8	8	8	8	8	8	8	8	6	6	5	2		

* Holotype specimen

Specimen	Ratio of Hl./Rv.															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1*	1.1	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.3	1.3	1.3		
2	1.1	1.2	1.4	1.4	1.4	1.4	1.4	1.3	1.4	1.3	1.3	1.2	1.2	1.2	1.2	1.3
3	0.7	0.8	1.0	1.1	1.1	1.2	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1
Aver.	1.0	1.1	1.2	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2

Specimen	Septal count														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	8	11	13	12	13?	14?	15	17	18	18?					
5	6	11	13?	15?	15?	17?	20?	20?	19?	20?	20?	22?	23?	22?	23?
6	7	11	12	13	13?	14?	16?	18?	18?	21?	22	23?	26?	28?	—
Aver.	7	11	13	13	14	15	17	18	18	20	21	23	25	25	23

* Holotype specimen

The upper half of the septa are composed of the tectum and the downward extension of the keriotheca, while the basal half of most of the septa is composed of dense materials and sharply bends anteriorly with a high angle. The axial septula are numerous and present throughout the shell. There are one to two axial septula between adjacent septa in the inner four to five volutions, three to six in the fifth to tenth, and four to seven in the outer volutions. They are not the same in length and profile, and are thinning at the tops and the bases, but thickenning at the middle, resulting in that most of them are pendant club-shaped in profile. The primary spiral septula occur throughout the shell. The secondary spiral septula first appear in the second to fourth volution, although they are very short and primitive. In the outer volutions one to two secondary spiral septula intercalate between the primary ones. In some of the primary and secondary spiral septula the fine alveoli are clearly seen, arranged in fan-shape.

The foramina are small and nearly circular to elliptical in cross section. Although their exact number is hard to be measured, about 18 and 37 foramina respectively are observed in the sixth and tenth volutions of the holotype specimen.

Remarks.—*Yabeina pinguis* TORIYAMA n. sp. is closely allied to *Y. shiraiwensis* OZAWA in many respects, especially in the shell size, the rate of expansion, the spirothecal structure and the septal arrangements. However, strictly speaking, some differences are found between these two species; namely, (1) the shell of *Y. pinguis* n. sp. is more globose, (2) the proloculus is slightly smaller, (3) the spirotheca is slightly thicker, and (4) the septula seemingly are a little primitive in development—the maximum number of the axial septula is 2 in the inner four volutions of this form, while it is 4 in those of *Y. shiraiwensis*, and 7 in the outer five to eight volutions of the former, while 8, rarely 9, in the outer five to six volutions of the latter. So far as this character is concerned, *Y. pinguis* and *Y.*

yasubaensis are reverse in the direction of the evolutionary development with *Y. shiraiwensis* between them; in another words, these three species seemingly are in a series of the evolutionary development and they are biologically closely related with one another.

The table 90 shows the comparison of *Y. pinguis*, *Y. shiraiwensis* and *Y. yasubaensis*.

Table 90. Showing the comparison of *Yabeina pinguis*, *Y. shiraiwensis*, and *Y. yasubaensis*

		Y. pinguis	*Y. shiraiwensis*	*Y. yasubaensis*
Length in mm		6.0—7.0	5.3—6.9	6.5—8.2
Width in mm		4.3—5.5 (?)	3.1—4.6	3.2—4.8
Form ratio		1.2—1.4	1.5—1.7	1.6—2.2
Number of volution		13 (?)—18	12—16	11—16
Proloculus	Min.—Max.	175—444	190—396	362—534
	Aver.	277	301	413
Average radius vector at the	5th vol.	586	622	764
	10th vol.	1.342	1.366	1.586
Spirothecal thickness at the (Holotype)	5th vol.	13	10	11
	10th vol.	15	12	12
Maximum number of axial septula in the	1-2 vols.	2	2	3
	3-5 vols.	3	4	5
	6-10 vols.	6	6	6
	11-last vols.	7	8 (9)	8 (9)

Occurrence.—Yabeina pinguis TORIYAMA, n. sp. is restricted to the Puα subzone in the stratigraphical occurrence, and is found only in the No. 1 limestone of Section XV (Loc. 765) and Loc. 2 and 233.

Yabeina sp. A

Pl. 47, figs. 9–14

Several specimens of this form have been obtained from the limestones referable to the *Yabeina shiraiwensis* zone of the Akiyoshi limestone group. Although they are not sufficient for the detailed description of this form, I give the following description and illustrate some of them for the sake of completeness.

The shell of *Yabeina* sp. A is moderate in size and highly inflated, with almost straight axis of coiling, exclusively convex lateral slopes and broadly rounded polar extremities. The largest specimen of sixteen volutions is approximately 7.0 mm long and 5.4 mm wide, giving a form ratio of 1.3. The first one to two volutions are short ellipsoidal. Beyond the second or third volution to maturity the shell retains almost the same axial profile. Average ratios of the half length to the radius vector of the first to sixteenth volution for four specimens are 1.2, 1.3, 1.4, 1.4, 1.4, 1.4 1.4, 1.4, 1.4, 1.4, 1.3, 1.3, 1.3, 1.4, 1.3, and 1.2, respectively.

The proloculus is rather small for the size of the shell and is spherical in shape, with an outside diameter of 172 to 305 microns, averaging 218 microns for nine specimens. The shell expands slowly in the inner five to six volutions and slightly more rapidly and almost uniformly from there to maturity. Average radius vectors of the first to sixteenth volution in nine specimens are 166, 232, 314, 397, 500, 617, 743, 886, 1,035, 1,186, 1,359, 1,563, 1,767, 1,930, 2,199, and 2,513 microns, respectively.

The spirotheca is thin and finely alveolar. The alveoli of the keriotheca are clearly observable throughout the length of the shell. The thickness of the spirotheca measured at its thinnest point between adjacent septula in the first to fifteenth volution of five specimens averages 8, 9, 10, 10, 11, 11, 12, 12, 11, 12, 12, 13, 13, 13, and 14 microns, respectively.

The septa are composed of the downward deflection of the tectum in the middle and downward extension of the keriotheca on either side of the tectum. The septal count is not known exactly due to the presence of numerous axial septula. There are approximately 6, 12, 13, 12, 14, 16, 19, 19, 19, 20, 23, 21, 25, 23, 23, and 24 septa, respectively, in the first to sixteenth volution of one of the illustrated sagittal section. The axial septula occur throughout the shell. One to three axial septula are present between adjacent septa in the inner six or seven volutions and three to five, rarely six, in the outer volutions. The axial septula vary considerably in length and shape even in one chamber. Some of them are considerably long with solidified tips, while others are very short, being only low pendant ridge from the lower surface of the keriotheca. The primary spiral septula occur throughout the shell. Most of their lower surfaces are in contact with the tops of the parachomata. The secondary spiral septula first appear in the sixth or seventh volution, and in the outer volutions usually one, very rarely two, secondary spiral septula occur between the adjacent primary ones.

The foramina are small and elliptical in cross section. Their exact number is, however, difficult to be counted, because exactly oriented axial section is not available in the present collection.

Remarks.—*Yabeina* sp. A is almost identical with *Y. columbiana* (DAWSON) in many important characteristics and is perhaps conspecific with that species, although sufficient information is not available from the present materials for the detailed comparison.

KANMERA (1954) recently described in very detail and illustrated beautiful specimens of *Y. columbiana* from the Upper Permian Kuma formation which, as pointed out by him, slightly differ from the British Columbian form. The Akiyoshi

Table 91. Table of Measurements (in Millimeters) of *Yabeina* sp. A

Specimen	Loc.	Rg.No.	Pl.	fig.	L.	W.	R.	Prol.
1	765C	2275	47	9	6.97	5.36	1.3	.232
2	2	2110	47	10	5.8+	4.1+	1.4	.219
3	765B	2264	47	11	3.35	2.88	1.2	.180
4	765C	2274	47	13	×	5.04	×	.256
5	2	2106	47	14	×	3.20	×	.305
							Max.	.305
							Min.	.172
							Aver.	.218 / 9

Specimen	Radius vector															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	.200	.276	.359	.470	.599	.751	.908	1.088	1.281	1.474	1.674	1.840	2.008	—	2.382	2.585
2	.175	.245	.341	.440	.546	.650	.742	.880	1.024	1.165	1.333	1.533	1.720	1.880	2.020	
3	.144	.205	.291	.368	.463	.574	.705	.864	1.000	1.184	1.361					
4	.190	.251	.332	.427	.531	.638	.760	.892	1.067	1.226	1.382	1.582	1.772	1.980	2.195	2.440
5	.205	.280	.346	.418	.505	.613	.736	.890	1.058	1.140	1.306	1.46?				
Max.	.205	.280	.359	.470	.599	.751	.908	1.088	1.281	1.474	1.674	1.840	2.008	1.980	2.382	2.585
Min.	.116	.170	.230	.307	.401	.525	.660	.800	.935	1.070	1.230	1.400	1.570	1.380	2.020	2.440
Aver.	.166	.232	.314	.397	.500	.617	.743	.886	1.035	1.186	1.359	1.563	1.767	1.930	2.199	2.513
	9	9	9	9	9	9	9	9	9	9	7	5	4	2	3	2

Specimen	Thickness of spirotheca																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	.009	.010	.011	.010	.012	.012	.013	.013	.010	.013	.012	.013	.015	.013	.014	.014	
2	—	.008	.010	.010	.010	.010	.010	.010	.011	.011	.011	.014	.013	.013			
3	—	—	.011	.010	.010	.011	.012	.012	.011	.012	.011						
4	.010	.009	.010	.010	.010	.012	.011	.013	.012	.011	.012	.012	.012	.012	.013	.013	.013
5	.008	.009	.010	.011	.011	.012	.013	.011	.012	.013	.012	.013	—				
Aver.	.008	.009	.010	.010	.011	.011	.012	.012	.011	.012	.012	.013	.013	.013	.014	.014	

Specimen	Ratio of Hl./Rv.															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	—	1.2	1.2
2	1.6	1.6	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
3	1.1	1.2	1.3	1.4	1.4	1.4	1.5	1.6	1.6	1.5						
Aver.	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.4	1.3	1.2
	4	4	4	4	4	4	4	4	4	4	2	2	2	1	2	1

Specimen	Septal count															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	6	12	13	12	14	16	19	19	19	20	23	21	25	23	23	24
5	7	13?	13	14?	16?	18?	16?	16?	17?	19?	22?					

form agrees with the Kuma one in the shell form, the prolocular size and the rate of expansion, and seemingly with the British Columbian form in the septal structures.

Future study on more sufficient materials seems necessary for the final specific determination of this species.

Occurrence.—Yabeina sp. A has been found in the No. 1 limestone of Section XXVII (Loc. 1) and in huge limestone boulders of the limestone conglomerate of Loc. 765 (No. 1 limestone of Section XV), and Loc. 2 and 233, all of them are referred to the Puα zone.

Subfamily SUMATRININAE KAHLER and KAHLER, 1946 emend. KANMERA, 1957

Genus *Afghanella* THOMPSON, 1946

Afghanella schencki THOMPSON

Pl. 48, figs. 1–10

1946. *Afghanella schencki* THOMPSON. Jour. Paleontology, Vol. 20, No. 2, pp. 153–155, Pl. 25, figs. 1–12.
1956. *Afghanella schencki* CHEN. Palaeontologia Sinica, New Ser. B, No. 6, pp. 67, 68, Pl. XII, figs. 4–9.

As the genotype of the genus *Afghanella* THOMPSON, *A. schencki*, was described by THOMPSON (1946) very much in detail and the Akiyoshi specimens are almost identical with the original type from the Bamian limestone of Afghanistan, further discussion seems unnecessary here, except for giving the statistical data of the Akiyoshi form.

Occurrence.—Afghanella schencki THOMPSON is found only in the Nos. 4 and 5 limestones of Section I (Loc. 286 and 287, respectively) and No. 8 limestone of Section X (Loc. 567). The stratigraphical range of this species is of the Pmα to Pmβ subzone in the Akiyoshi limestone group.

Table 92. Table of Measurements (in Millimeters) of *Afghanella schencki* THOMPSON

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.
1	567	2020	48	1	4.02	2.45	1.7
2	567	2019	48	2	3.35	1.72	2.0
3	HASHIMOTO's collection	6C*-1	48	3	4.34+	2.46+	1.8
4	567	2013	48	4	×	2.24	×
5	567	2027	48	5	×	1.86	×
6	287	2173	48	6	×	1.8+	×
7	287	2172	48	7	×	1.85+	×

* 6C in HASHIMOTO's collection is the same locality as Loc. 287.

Specimen	Prol.	Radius vector											
		1	2	3	4	5	6	7	8	9	10	11	12
1	.110	.093	.121	.175	.243	.307	.386	.490	.610	.772	.920	1.070	1.230
2	.16+	.110	.153	.233	.322	.418	.550	.692	.840	.990	1.130		
3	.159	.123	.172	.239	.320	.424	.555	.686	.852	1.021	1.190		
4	.14+	.104	.162	.230	.307	.421	.531	.674	.858	1.034	—		
5	.142	.107	.159	.224	.307	.411	.522	.693	.834	.984			
6	.175	.123	.197	.279	.368	.480	.620	.768	.920				
7	.109	.100	.150	.211	.290	.380	.485	.610	.740	.891	1.030		
Max.	.206	.138	.224	.297	.368	.510	.650	.768	.998	1.200	1.430		
Min.	.086	.072	.110	.160	.224	.300	.383	.490	.610	.772	.920		
Aver.	.136	.103	.158	.221	.305	.402	.517	.649	.784	.943	1.099		
	29	31	33	33	33	33	32	29	25	21	9		

Specimen	Thickness of spirotheca												
	0	1	2	3	4	5	6	7	8	9	10	11	12
1	.008	.007	.006	.007	.007	.009	.007	.008	.008	.011	.009	.009	.011
2	—	.005	.004	.006	.008	.007	.008	.008	.010	.011			
3	.009	.007	.008	.009	.009	.009	.009	.009	.010	.010	.011		
4	.009	.008	.007	.007	.007	.008	.008	.010	.010	.010			
5	—	—	—	.008	.008	.009	.010	.009	.008	.010			
6	.008	.006	.006	.008	.008	.008	.009	.009	.010				
7	—	.007	.007	.008	.008	.008	.008	.009	.009	.010			
Max.	.009	.008	.008	.009	.009	.009	.010	.010	.010	.011			
Min.	.008	.005	.004	.006	.007	.007	.007	.008	.008	.010			
Aver.	.008	.006	.007	.008	.008	.008	.008	.009	.009	.010			
	4	7	8	8	8	8	8	8	8	7			

Specimen	Ratio of Hl./Rv.											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.2	1.4	1.5	1.6	1.7	1.8	1.8	1.9	—	1.8	1.7	1.7
2	1.5	1.8	1.6	1.6	1.6	1.6	1.6	1.7	1.7			
3	1.2	2.0	2.1	2.1	2.1	1.8	1.8	1.8	1.8	1.8		
Max.	1.6	2.0	2.1	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.7	
Min.	1.2	1.0	1.1	1.2	1.3	1.4	1.4	1.4	1.5	1.6	1.6	
Aver.	1.4	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.7	1.7	
	6	8	9	10	10	10	9	9	6	3	2	

Specimen	Septal count								
	1	2	3	4	5	6	7	8	9
4	—	—	17	15	16	19	21	21?	24
5	7 ?	13	17	20	21?	23?	26?	27?	
6	8	13	16	19	19	19?	21?		
7	7	11	15	15	17?	14?	17	18?	—
Aver.	7	12	16	17	18	19	21	22	24

Afghanella ozawai HANZAWA

Pl. 48, fig. 11–17

1925. *Yabeina schellwieni* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XLV, Art. 6, pp. 60, 61, Pl. X, figs. 3a, 4.
1927. *Cancellina schellwieni* OZAWA. Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. II, Vol. II, Pt. 3, p. 161, Pl. XXXIV, fig. 18; Pl. XLIV, fig. 1b; Pl. XLV, fig. 3.
1954. *Afghanella ozawai* HANZAWA. Japan. Jour. Geol. Geogr., Vol. XXIV, pp. 3–7, Pl. I, Pl. II, figs. 1–3.

The shell of *Afghanella ozawai* HANZAWA is small for the genus and inflated fusiform, with straight axis of coiling, gently convex to very slightly concave lateral slopes, and bluntly rounded poles. One of the illustrated axial section (Pl. 48, fig. 11) is approximately 3.7 mm in length and 1.9 mm in width, giving a form ratio of 1.9. The first one or two volutions are seemingly ellipsoidal, and beyond the second or third volution the axis becomes gradually extended, resulting in that the shell retains almost the same axial profile. Average ratios of the half length to the radius vector of the first to eighth volution for eight specimens are 1.3, 1.4, 1.7, 1.8, 1.8, 1.8, 1.9, and 1.9, respectively.

The proloculus is small and spherical, with outside diameters of 90 to 190 microns, averaging 123 microns for fourteen specimens. The shell expands very slowly in the inner four volutions and slightly rapidly and almost uniformly from the fifth volution to maturity. Average radius vectors of the first to ninth volution of fifteen specimens are 95, 140, 183, 259, 339, 437, 526, 670, and 755 microns, respectively. The chambers are nearly the same in height throughout the length of the shell except in the very extreme polar regions.

The spirotheca is thin and seemingly composed of the tectum and very finely alveolar keriotheca. The alveoli are not discernible in the inner volutions but become clear at least in some part of the outer volutions. The thickness of the spirotheca is difficult to be measured exactly. Approximate thickness measured at the thinnest part between septula averages 7, 7, 7, 8, 8, 8, 9, 9, and 10 microns, respectively, in the first to ninth volution of six specimens. The proloculus wall is very thin, having an average thickness of 7 microns in five specimens.

The septa are formed of the downward deflection of the tectum and the anterior and posterior downward extension of the keriotheca. The lower half to two-thirds of most of the septa are solidified and pendant-shaped in cross section. The tips of the septa are often bending anteriorly at considerable high angles.

The axial septula begin to appear in the third or fourth volution where they are very primitive in development, being represented by only low ridges on the lower surface of the spirotheca. They become distinct in the fifth or sixth volution where they are short and pendant-shaped in cross section. One, very rarely two, axial septula occur between adjacent septa in the outer volutions.

Table 93. Table of Measurements (in Millimeters) of *Afghanella ozawai* HANZAWA

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.
1	567	2023	48	11	3.70	1.93	1.9
2	287	2178	48	12	2.8+	1.36	2.1
3	567	2019	48	13	2.11	1.29	1.6
4	567	2027	48	14	1.83	0.95	1.9
5	287	2178	48	16	×	0.92	×
6	287	2178	48	17	×	1.38	×

Specimen	Prol.	Radius vector										
		1	2	3	4	5	6	7	8	9	10	11
1	$\frac{.115}{.145}$ ×	.100	.141	.193	.261	.365	.494	.635	.797	.960		
2	.100	.082	.112	.151	.200	.273	.360	.445	.540	.682		
3	.190	.138	.205	.294	.386	.498	.613					
4	.138	.098	.150	.205	.285	.374	.469					
5	$\frac{.101}{.130}$ ×	.101	.130	.175	.230	.300	.381	.485				
6	—	—	.138	.187	.261	.338	.411	.546	.635			
Max.	.190	.138	.205	.294	.386	.498	.613	.748	.890	.960		
Min.	.090	.075	.102	.145	.200	.260	.330	.412	.540	.630		
Aver.	.123	.095	.140	.183	.259	.339	.437	.526	.670	.755	.900	1.070
	14	14	15	15	15	15	13	11	6	4	1	1

Specimen	Thickness of spirotheca										
	0	1	2	3	4	5	6	7	8	9	10
1	.009?	.008	.007?	.008	.008	.009	.009	.008	.009	.010	
2	.008	.006	.007	.007	.008	.008	.008	.008	.008	.010	.010
3	.005	.006	.006	.006	.008	.006	.009	.010			
4	.008	.006	.006	.007	.008	.008	.008				
5	.005	.007	.007	.007	.007	.009	.008				
6	—	—	.006	.005	.007	.007	.008	.008	.010		
Aver.	.007	.007	.007	.007	.008	.008	.008	.009	.009	.010	

Specimen	Ratio of Hl./Rv.								
	1	2	3	4	5	6	7	8	9
1	1.0	1.6	1.8	2.0	1.9	1.9	2.0	2.0	
2	1.2	1.2	1.6	1.9	2.0	1.8	1.8	1.8	1.8
3	1.6	1.5	1.5	1.6	1.6	1.6			
4	1.3	1.5	1.5	1.4	1.5	1.6			
Max.	1.6	1.6	2.3	2.3	2.0	2.0	2.0	2.0	
Min.	1.0	1.2	1.5	1.4	1.5	1.6	1.8	1.8	
Aver.	1.3	1.4	1.7	1.8	1.8	1.8	1.9	1.9	1.8
	7	6	8	8	7	7	3	3	1

Specimen	Septal count						
	1	2	3	4	5	6	7
5	6	13	15	18	20	22?	
6	—	—	15	16	19	20	20

The primary spiral septula occur throughout the shell, probably except in the first volution. They are, however, rather primitive, being the short downward deflection of the spirotheca and not pendant-shaped in cross section. The lower edges of most of the primary spiral septula are in contact with the parachomata which seem to be massive. The secondary spiral septula do not occur at least in the inner four to five volutions and are very primitive in the outer volutions. They are also not pendant-shaped in cross section but are low triangular or semi-elliptical ridges on the lower surface of the spirotheca.

The foramina are not observable in the inner volutions but become more or less distinct beyond the sixth volution. Their exact number is not counted with certainty.

Remarks.—Due to the insufficiency of the materials at my disposal, this form was left unnamed and was only listed as *Afghanella* sp. A in the Parts I and II (the stratigraphical part) of this study. However, later studies on this form have demonstrated that it is almost identical with *A. ozawai* recently established by HANZAWA (1954). The latter species is, as discussed by HANZAWA, distinguished from *A. schencki* THOMPSON by its generally smaller size of the shell, slower rate of expansion, and later appearance of the axial and the secondary spiral septula. Although HANZAWA stated that the insertion of the secondary spiral septula first takes place in the eighth volution in *A. ozawai*, his illustrations show that it occurs earlier—in the seventh volution of fig. 1 of Pl. I and in the fifth volution of fig. 3 of the same plate. The secondary spiral septula become distinct in the fifth or sixth volution of the Akiyoshi specimens in the present collection and also in the sixth volution of the OZAWA's illustration (fig. 4 of Pl. X).

Biologically speaking this species is considered to be more primitive than *A. schencki* in any respect, although these two species occur together.

Because HANZAWA did not designate the type specimen for his species and the species was named after the late Dr. OZAWA, the OZAWA's specimen illustrated as fig. 4 of Pl. X should naturally be designated as the lectotype. However, unfortunately to us, that specimen is missing from his collection kept in the University of Tokyo. To avoid future confusion, therefore, it seems advisable to designate the HANZAWA's specimen (IGPS coll. cat. no. 711) illustrated as fig. 1 of Pl. I (also fig. 3 of Pl. II) as the neotype of this species.

Occurrence.—*Afghanella ozawai* HANZAWA occurs in the Pmα and Pmβ subzones and has been found in the Nos. 4 and 5 limestones of Section I (Loc. 286 and 287, respectively) and No. 8 limestone of Section X (Loc. 567).

Genus *Sumatrina* VOLZ, 1904

Sumatrina longissima DEPRAT

Pl. 48, figs. 18–25

1914. *Sumatrina longissima* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. III, fasc. 1, pp. 36, 37, Pl. V. figs. 1–6.
1924. *Sumatrina annae* COLANI. [partim]. Mém. Serv. Géol. l'Indochine, Vol. XI, fasc. 1, Pl. XXI, fig. 12.
1935. *Sumatrina longissima* GUBLER. Mém. Soc. Géol. France, No. 26, pp. 130–132, Pl. V, figs. 1, 2, 5, 6, 12, 18; Pl. VI, fig. 6; Pl. VII, fig. 9.
1956. *Sumatrina longissima* CHEN. Palaeontologia Sinica, New Ser. B, No. 6, pp. 70, 71, Pl. VII, figs. 4–6.

The shell of *Sumatrina longissima* DEPRAT is moderate in size and elongate cylindrical, with straight, uneven to slightly concave lateral slopes and bluntly pointed poles. Since completely preserved axial section is not available in my collection the exact axial length is not known. However, a half length and a width of one of the illustrated axial section (Pl. 48, fig. 18) are 3.94 mm and 1.61 mm, respectively, and those of the other axial section (Pl. 48, fig. 19) are about 4.13 mm and 1.66 mm, respectively. These figures show that the form ratio of this species is at least 4.9 or so. The shell assumes spherical to subspherical shape in the first volution and short fusiform in the second volution. Beyond the third volution the axis becomes extended very rapidly.

The proloculus is medium to rather large in size and spherical to ellipsoidal in shape, with an outside diameter ranging from about 176 to 432 microns, and averaging 306 microns for fourteen specimens. The expansion of the shell is very slow in the inner three volutions and becomes considerably rapid and almost uniform from there to maturity. Average radius vectors of the first to seventh volution of fourteen specimens are 193, 262, 330, 433, 555, 692, and 826 microns, respectively.

The spirotheca is extremely thin and seems to consist of a single dense layer. Although the true thickness of the spirotheca is hard to be measured, it seemingly does not exceed 11 microns even at the thickest part. Average thickness of the spirotheca of the first to eighth volution for thirteen specimens is 7, 8, 8, 9, 8, 9, 9, and 10 microns, respectively. The proloculus wall, consisting of a single dense layer, is seemingly a little thicker than the spirotheca, being 9 to 14 microns in thickness, and averaging 11 microns in eight specimens.

The septa are formed of the downward deflection of the thin dense layer of the spirotheca. They are pendant-shaped in cross section, and their lower part is coated with dense calcite deposits and bends anteriorly at considerable high angles. Because exactly oriented and well preserved sagittal section is not available, the septal count of this form cannot be determined with certainty. There are, however, about 9, 10, 12, 14, 17, 18, 21, 25, and 26 septa present in the first to ninth volution of one of the illustrated sagittal section (Pl. 48, fig. 23).

The axial septula present throughout the shell. Although their number somewhat varies in different chamber, three axial septula appear even in the innermost volution. Beyond the sixth volution to maturity four to six axial septula occur between adjacent septa. They are short and nearly the same in shape, being pendant-shaped in cross section. The primary spiral septula extend down from the base of the spirotheca. They are in contact with the tops of the parachomata almost completely across the chambers. The secondary spiral septula also occur throughout the shell. One to three of them are introduced between each pair of adjacent primary spiral septula in the inner few volutions, and three to four are usually in the outer volutions. They are also short and nearly equal in length, and are pendant-shaped as well as axial septula.

Remarks.—The above description is based entirely on the Akiyoshi specimens which are agreeable with those described from Cambodge by DEPRAT (1914) and GUBLER (1935) in almost all the important characteristics except that the former has larger proloculus and more rapid rate of expansion. So far as these characters are concerned the species seemingly has a considerable degree of variation within the species.

In reviewing the species of *Afghanella* and *Sumatrina*, HANZAWA (1954) recently expressed an opinion that *Sumatrina longissima* DEPRAT and *S. gemmellaroi* SILVESTRI should be regarded as a subspecies of *S. annae* VOLZ, because the former two species are difficult to distinguish from each other in many respects and they differ from the last named species only in the form ratio.

Biologically speaking, however, *S. longissima* seemingly is a little more advanced in the septal structure than *S. annae*; namely, so far has been described and illustrated by earlier workers, the maximum number of the axial septula between adjacent septa is 3 to 5 in *S. annae*, while it ofen attains 6 in *S. longissima*; and, moreover, the axial septula and the secondary spiral septula of the former are generally slightly longer than those of the latter. Also, these two kinds of septula are more uniform in length and more typically pendant-shaped in *S. longissima* than in *S. annae*, although the difference is slight.

It seems advisable, therefore, to regard *S. longissima* and *S. annae* as two distinct species, though *S. longissima* and *S. gemmellaroi* may probably be conspecific with each other.

Occurrence.—*Sumatrina longissima* DEPRAT is only found in the Puα zone in the Akiyoshi limestone group, and was collected from a huge limestone boulder in the limestone conglomerate (No. 1 limestone) of Section XV (Loc. 765), No. 1 limestone of Section XVI (Loc. 370), and Loc. 2, 12, and 768.

Table 94. Table of Measurements (in Millimeters) of *Sumatrina longissima* DEPRAT

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.
1	768	2321	48	18	7.9+	1.6+	4.9
2	765B	2266	48	19	8.3+	1.7+	5.0
3	12	2107	48	20	5.4+	1.18	4.6
4	768	2314	48	21	3.6+	1.19	3.0
5	765B	2264	48	22	×	1.51	×
6	370	2200	48	23	×	2.25	×

Specimen	Prol.	Radius vector								
		1	2	3	4	5	6	7	8	9
1	.424	.285	.332	.401	.530	.690	.828			
2	.210 .288 ×	.163	.214	.296	.370	.480	.635	.83+		
3	.188	.159	.221	.276	.368	.491				
4	.432	.276	.362	.442	.574	—				
5	.239 .288 ×	.172	.221	.297	.454	.574	.683	—		
6	.316	.190	.245	.291	.353	.470	.630	.790	.970	1.130
Max.	.432	.285	.362	.442	.574	.690	.828	.970		
Min.	.176	.130	.184	.261	.350	.470	.57+	.68+		
Aver.	.306	.193	.262	.330	.433	.555	.692	.826	.970	1.130
	14	12	14	14	13	10	8	6	1	1

Specimen	Thickness of spirotheca								
	0	1	2	3	4	5	6	7	8
1	.011	.006	.007	.007	.009	.009	.010		
2	.009	.007	.009	.009	.006	.007	.007	.007	
3	—	.008	.009	.009	.009	.009			
4	—	.008	.008	.009	.011				
5	.010	—	.007	.008	.008	.009			
6	.014	.007	.008	.008	.009	.010	.010	.009	.011
Max.	.014	.009	.009	.009	.011	.010	.010	.011	
Min.	.009	.006	.007	.007	.008	.007	.007	.007	
Aver.	.011	.007	.008	.008	.009	.008	.009	.009	.010
	8	11	13	12	12	10	7	5	2

Specimen	Ratio of Hl./Rv.							Septal count								
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9
1	1.1	2.7	3.5	4.8	4.6	4.9										
2	1.2	3.7	3.4	3.6	4.0	4.0	4.2									
3	1.2	1.4	3.8	4.9	5.4											
4	1.1	1.7	2.7	3.0												
6								9	10?	12?	14?	17?	18?	21	25?	26?
Max.	2.0	3.7	3.8	4.9	5.4	5.6	5.1									
Min.	1.1	1.4	2.7	3.0	4.0	4.0	4.2									
Aver.	1.4	2.5	3.2	4.1	4.7	4.8	4.6									
	6	6	6	5	3	3	2									

Sumatrina annae VOLZ

Pl. 48, figs. 26–33

1904. *Sumatrina annae* VOLZ. Geol. u. Paläont. Abhandl. N. F. Bd. VI, Heft 2, pp. 98–100, text-figs. 27–31.
1906. *Neoschwagerina annae* YABE. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XXI, Art. 5, Pl. II, fig. 4.
1906. *Sumatrina annae* DOUVILLÉ. Bull. Soc. Géol. France, 4e Sér. Tome VI, Pl. XVIII, fig. 3.
1912. *Neoschwagerina* (*Sumatrina*) *annae* DEPRAT. Mém. Serv. Géol. l'Indochine, Vol. I, fasc. 3, pp. 56, 57, Pl. V, figs. 1–3; text-figs. 30a–h.
1924. *Sumatrina annae* COLANI. Mém. Serv. Géol. l'Indochine, Vol. XI, fasc. 1, pp. 150–152, Pl. XX, fig. 20; Pl. XXI, figs. 1–8, 10–13, 16–28.
1925. *Sumatrina annae* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XIV, Art. 4, Pl. II, figs. 11, 12?.
1925. *Sumatrina annae* OZAWA. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XIV, Art. 6, p. 64, Pl. I, figs. 1b; Pl. X, fig. 8.
1935. *Sumatrina annae* GUBLER. Soc. Géol. France, Mém. No. 26, pp. 127–130, Pl. V, figs. 8, 11.
1937. *Sumatrina annae* THOMPSON & FOSTER. Jour. Paleont., Vol. 11, No. 2, pp. 143, 144, Pl. 23, fig. 13.
1951. *Sumatrina annae* THOMPSON. Contrib. Cushman Found. Foram. Research, Vol. 2, Pl. 9, figs. 4, 5.
1954. *Sumatrina annae* HANZAWA. Japan. Jour. Geol. Geogr., Vol. XXIV, pp. 7–13, Pl. II, fig. 4; Pl. III.
1956. *Sumatrina annae* CHEN. Palaeontologia Sinica, New Ser. B, No. 6, pp. 69, 70, Pl. VII, figs. 7, 8.

The shell of *Sumatrina annae* VOLZ is rather small and elongate fusiform with almost straight to slightly arching axis of coiling, gently convex to slightly irregular lateral slopes, and bluntly pointed poles. Mature shell of seven to eight, rarely eight and a half, volutions is 4.5 to 5.7 mm long and 1.3 to 2.1 mm wide, attaining a form ratio of 2.4 to 3.4. The first volution is subspherical to short ellipsoidal in shape, and the axis becomes extended rapidly from the second volution. Average ratios of the half length to the radius vector of the first to eighth volution in ten specimens are 1.8, 2.2, 2.6, 2.8, 3.0, 3.0, 3.1, and 3.0, respectively.

The proloculus is spherical to ellipsoidal, and considerably varies its diameter in individuals. The outside diameter is ranging from 160 to 380 microns, averaging 243 microns in forty-one specimens. The shell expands rather slowly in the inner three to four volutions and more or less rapidly and almost uniformly beyond the fourth or fifth volution to maturity. Average radius vectors of the first to eighth volution of forty-two specimens are 164, 225, 287, 373, 472, 594, 731, and 877 microns, respectively.

The spirotheca is exceedingly thin, and seemingly consists of a single dense layer in which no alveolar-like structure is observed. Although the true thickness of the spirotheca is rather diffiult to be measured, approximate thickness of spirotheca in the first to eighth volution in fourteen specimens averages 8, 8, 9, 9, 9, 10, 10, and 10 microns, respectively. It seemingly does not exceed 14 microns even

Table 95. Table of Measurements (in Millimeters) of *Sumatrina annae* VOLZ

Specimen	Loc.	Pl.	fig.	L.	W.	R.	Prol.	Radius vector 1	2	3	4	5	6	7	8
1	127	48	26	5.74	1.82	3.2	.211/.245 ×	.153	.196	.264	.356	.480	.61+	.740	.890
2	54	48	27	3.53	1.41	2.5	.211/.257 ×	.166	.224	.282	.350	.440	.546	.671	.775
3	54	48	28	4.18	1.67	2.5	.205/.242 ×	.141	.187	.248	.335	.450	.555	.677	.825
4	54	48	29	4.0+	1.50	2.7	.325/.380 ×	.233	.294	.368	.469	.595	.720		
5	54	48	30	×	2.57	×	.262/.292 ×	.211	.288	.390	.516	.650	.825	.999	1.180
6	54	48	31	×	1.66	×	.267/.347 ×	.205	.270	.356	.450	.546	.690	.852	
7	54	48	32	×	1.61	×	.261	.187	.254	.316	.439	.543	.660	.797	
8	54	48	33	×	1.50	×	.196/.238 ×	.184	.251	.341	.442	.564	.671	.791	
						Max.	.380	.232	.294	.390	.516	.650	.825	.999	1.180
						Min.	.160	.110	.151	.210	.272	.345	.452	.567	.710
						Aver.	.243	.164	.225	.287	.373	.472	.594	.731	.877
							41	40	39	42	42	41	40	33	21

Specimen	Thickness of spirotheca 0	1	2	3	4	5	6	7	8
1	.010	.007	.009	.008	.010	.009	.009	.009	.009
2	.011	.008	.008	.009	.009	.008	.009	.010	—
3	.009	.008	.007	.007	.007	.007	.009	.009	.008
4	.009	.008	.008	.008	.009	.008	—		
5	.010	.009	.009	.009	.010	.009	.011	.011	.012
6	.012?	.007	.008	.009	.008	.009	.010	.010	
7	.011	.008	.008	.008	.008	.008	.010	—	
8	.012	.007	.008	.008	.008	.009	.008	.010	
Max.	.012	.009	.010	.010	.011	.010	.011	.011	.012
Min.	.009	.007	.007	.007	.007	.007	.008	.009	.008
Aver.	.010	.008	.008	.009	.009	.009	.010	.010	.010
	13	12	12	14	14	14	12	10	4

Specimen	Ratio of Hl./Rv. 1	2	3	4	5	6	7	8	Septal count 1	2	3	4	5	6	7	8
1	2.4	2.9	2.9	2.9	3.2	3.3	3.5	3.5								
2	1.3	1.5	1.9	2.1	2.1	2.2	2.3	2.3								
3	2.0	2.6	2.9	2.9	2.9	3.0	2.9	2.7								
4	1.2	2.2	2.7	2.8	3.1	3.0										
5									8?	11	16	17	18	20	23	23
6									8	14?	—	20?	21?	24	27	
7									8?	13?	19?	19?	18?	21		
8									8	14	16?	18?	18	21	24?	
Max.	2.4	2.9	3.2	3.6	3.5	3.5	3.7	3.5	10	14	19	20?	21?	24	27	24
Min.	1.2	1.5	1.9	2.1	2.1	2.2	2.3	2.3	8	11	14	15	16	17	18	23
Aver.	1.8	2.2	2.6	2.8	3.0	3.0	3.1	3.0	8	13	16	17	18	21	23	24
	6	7	9	10	9	9	7	4	8	9	8	9	9	8	6	2

at the thickest part in the outer volutions. The proloculus wall is also thin, with an average thickness of 10 microns in thirteen specimens.

The septa are typically pendant-shaped in cross section, and their lower part is mostly solidified and bending anteriorly. The septa are seemingly the same in structures as those of the spirotheca. Average septal counts of the first to eighth volution of nine specimens are 8, 13, 16, 17, 18, 21, 23, and 24, respectively.

The axial septula are well developed throughout the growth of the shell. One to two axial septula occur between adjacent septa of the inner two volutions of most of the specimens. In the third volution of some specimens three axial septula are seen between adjacent septa. The maximum number of the axial septula in the fourth to eighth volution is 3, 3, 5, 5, and 5, respectively. The axial septula are nearly the same in length and are pendant-shaped in cross section.

The primary spiral septula occur throughout the length of the shell, the lower surface of which is in contact with the tops of the parachomata across the chambers. The secondary spiral septula hang from the lower surface of the spirotheca. They are short, pendant-shaped and almost uniform in length throughout all the volutions. One to two secondary spiral septula are introduced between each pair of adjacent primary spiral septula in the inner three volutions. Beyond the fourth volution to maturity one to three of them are usually present.

The axial zone of some specimens is filled with the dense secondary deposits, but it is not certain that whether they are composed of crowded parachomata or are true axial fillings.

Remarks.—The above description is based entirely on the Akiyoshi specimens collected from the limestone lenses interbedded in the Shiraiwa formation of the Tsunemori group.

Recently HANZAWA (1954) has described and illustrated this species from many localities in the Yamaguchi and Hiroshima Prefectures. Although he discussed in detail the comparison between the species of *Sumatrina* found in Japan, and gave the detailed statistical data of *S. annae* measured from his specimens, he did not give the full description of this species. The Akiyoshi specimens I am studying have rather large proloculus and considerably rapid rate of expansion for *S. annae*. However, as shown in the HANZAWA's statistics, this species is rather wide in the range of the measurable characters, and the present Akiyoshi specimens seemingly are within the limit of variation of *S. annae* in all the essential characters.

Occurrence.—Although *Sumatrina annae* VOLZ has not been found in the Akiyoshi limestone group yet, it was found abundantly in the limestone lenses of Loc. 127 and Loc. 54 in the Shiraiwa formation of the Tsunemori group. Loc. 127, Hinaga, Higashi-shibukura, Ominé, Miné-shi is just the same locality of IGPS loc. Ya No.

7 whence all of the HANZAWA's illustrated specimens were collected.

Although a part of the Shiraiwa formation is equivalent in age to the Puα zone of the Akiyoshi limestone group, the species under consideration occurs in cobbles and boulders of the limestone conglomerate of Loc. 127 and 54. Therefore, the stratigraphical range of this species is not known exactly.

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The original manuscripts of the Parts A and B were completed in May, 1951 and December, 1955, respectively.

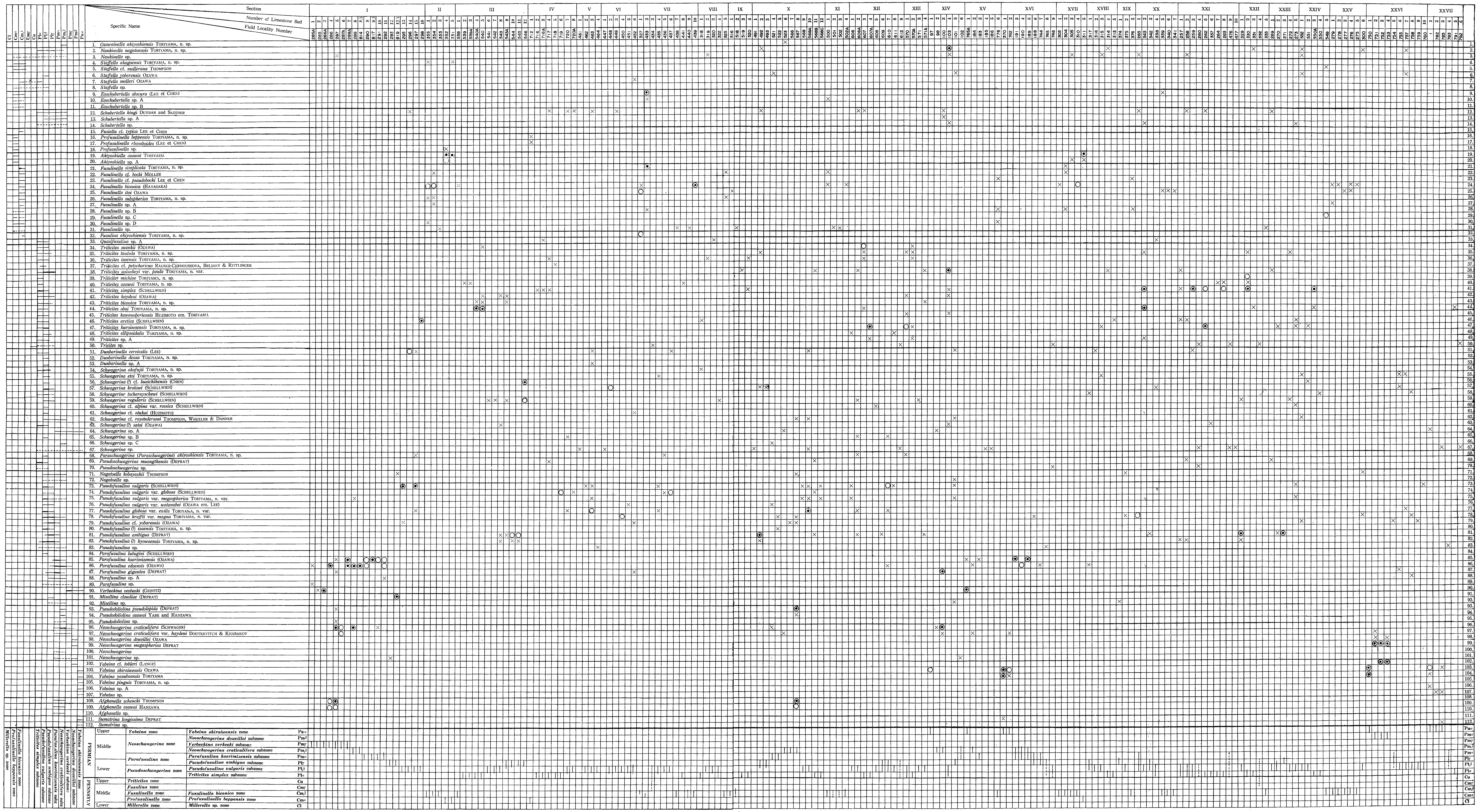

Chart 1. Distribution of the species collected from the localities belonging to the Section I to XXVII described in Part I of this Paper.

⊙ abundant ○ common × rare

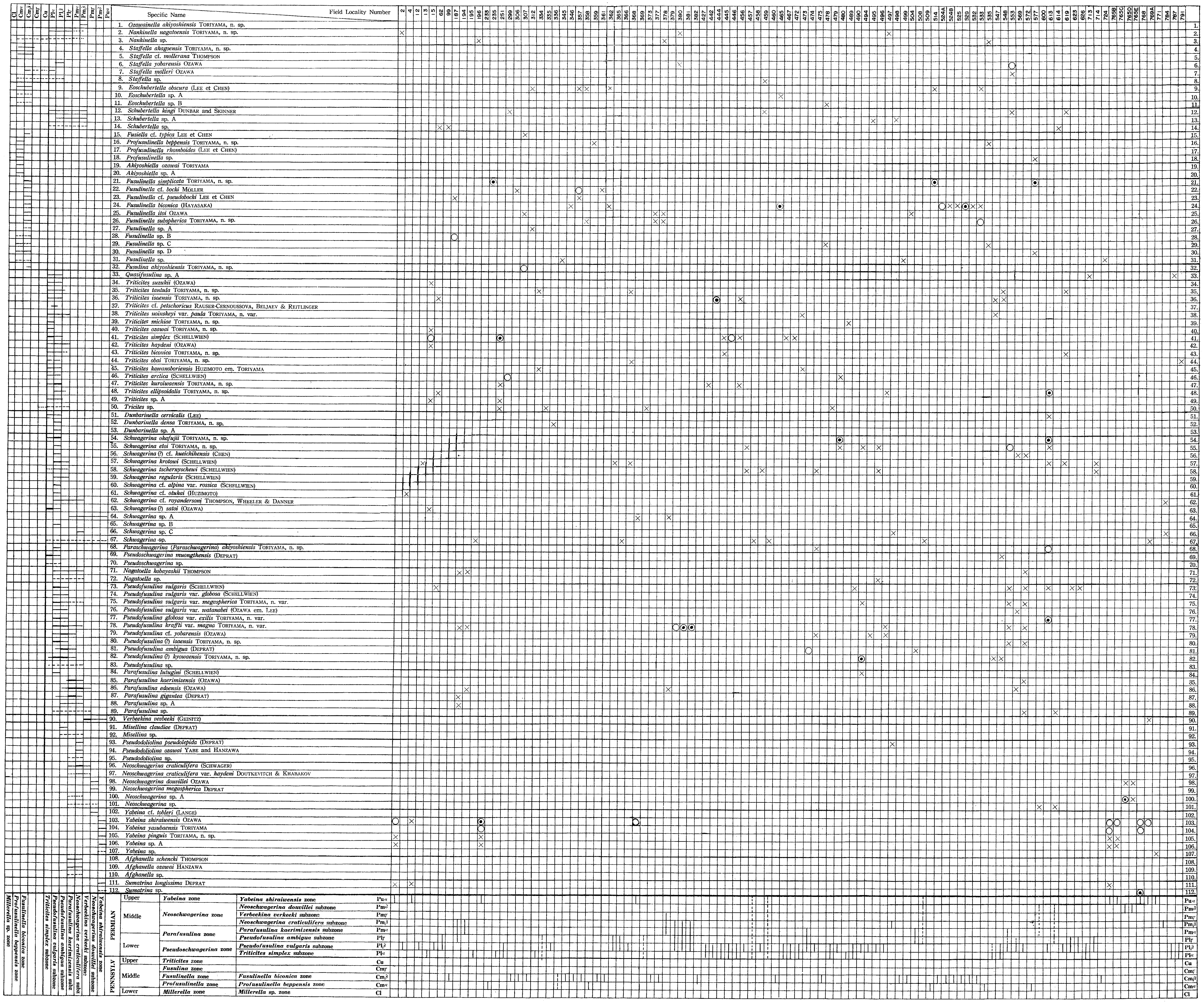

Chart 2. Distribution of the species collected from the localities not belonging to any of the Section described in Part I of this paper.

⊙ abundant ○ common × rare