九州大学学術情報リポジトリ
Kyushu University Institutional Repository

The Fusulinacean Zones of Japan

Toriyama, Ryuzo
Faculty of Science, Kyushu University

https://doi.org/10.5109/1543654

出版情報：九州大學理學部紀要 : Series D, Geology. 18 (1), pp.35-260, 1967-02-15. Faculty of Science, Kyushu University
バージョン：
権利関係：

KYUSHU UNIVERSITY

Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol. Vol. XVIII, No. 1,
pp. 35-260, Figs. 1-11, Correlation chart 1-2, Feb. 15, 1967

The Fusulinacean Zones of Japan

By

Ryuzo TORIYAMA

Abstract

The present paper deals with the fusulinacean zones of the Middle-Upper Carboniferous and Permian formations in the Japanese Islands, along with a description of stratigraphy and the fusulinacean faunas known up to the earlier time in 1966.

Chapter I is devoted to a general consideration of the fusulinacean zones and the divisions of the Middle-Upper Carboniferous and Permian. Chapters II to X respectively are concerned with the zone of *Millerella* (Onimaruan and Kamitakaran Stages), the zone of *Profusulinella* (Atetsuan Stage), the zone of *Fusulinella* (Akiyoshian Stage), the zone of *Fusulina* (Kurikian Stage), the zone of *Triticites* (Hikawan Stage), the zone of *Pseudoschwagerina* (lower-middle Sakamotozawan Stage), the zone of *Parafusulina* (upper Sakamotozawan-Nabeyaman Stage), the zone of *Neoschwagerina* (Akasakan Stage), and the zone of *Yabeina-Lepidolina* (Kuman Stage).

Contents

		Page
Introduction		35
Chapter I.	General consideration of the Fusulinacean zones of Japan	37
Chapter II.	The zone of *Millerella*	51
Chapter III.	The zone of *Profusulinella*	61
Chapter IV.	The zone of *Fusulinella*	65
Chapter V.	The zone of *Fusulina*	75
Chapter VI.	The zone of *Triticites*	80
Chapter VII.	The zone of *Pseudoschwagerina*	85
Chapter VIII.	The zone of *Parafusulina*	115
Chapter IX.	The zone of *Neoschwagerina*	140
Chapter X.	The zone of *Yabeina-Lepidolina*	170
List of Locality names		195
Alphabetical Index of locality names		210
References		217
Index		252

Introduction

The manuscript of the present paper was first prepared by the author in 1958 as the introductory part of the "Geology of Akiyoshi" (Vol. VII of this Memoirs). Unfortunately a very unfavourable economic situation existed at that time and his introductory part was, of necessity, omitted. However, a general summary of that manuscript at that time was later incorporated into the chapter on the

Received September 16, 1966

Permian Period of the "Geology of Japan" which was published on the occasion of the sixtieth birthday of Professor Teiichi KOBAYASHI in 1963.

Since then a great profusion of technical studies have been conducted concerning many geological aspects of Carboniferous–Permian formations in Japan. These geological works are housed in many different reports by different authors and, to date, a comprehensive summary under one cover is lacking. The author has taken a large part of this task by writing a comprehensive paper dealing in depth with the fusulinacean zones and faunas in the Carboniferous–Permian times. It is hoped that the present paper will provide a general understanding of this period of time, not only to the Japanese geologists but also to geologists worldwide.

The present paper may seem prolix, but detailed stratigraphical and paleontological information of each area must be known in order to make comprehensive zonation and correlation of the Carboniferous–Permian formations of the Japanese Islands. Some areas have been studied in great detail both in stratigraphical and paleontological sides, while others have been left virtually unstudied. Little can be stated about the unstudied areas other than their location, along with a brief account of rock facies and sometimes a list of fossil contents. Moreover it is very unfortunate to the foreign geologists who are interested in the Japanese Carboniferous–Permian stratigraphy and fusulinacean foraminifers that many of the publications in this country are written in Japanese, though a brief abstract is usually written in a European language. One purpose of the present paper is focused to get over this difficulty; namely in order to make foreign workers understand the results published in Japanese from the earlier time to the present. The present paper quotes these references as often as possible as well as giving an adequate description of the name, location and formation. On the other hand only a brief account has been given to the publications written in European language.

Thus the present paper attempts to describe the stratigraphy and fusulinacean faunas so far as known up to the earlier date of 1966, but it does not intend to discuss the geological history including sedimentology, paleogeography, structural evolution, and igneous activities. Another paper would be required of such subjects.

The distribution of the Carboniferous–Permian formations in the Japanese Islands is indicated in Fig. 1, and the locality number of exposures, chosen mostly from the formational name, is indicated in Fig. 2*. In Chapters II through X the description is arranged in the following units from north to south:

I. Kitakami and Abukuma massifs (including Choshi Peninsula), abbreviated to [Ka]
II. Inner zone of Northeast Japan, abbreviated to [Nei]
III. Kwanto massif, abbreviated to [Kw]
IV. Hida massif and Tamba zone, abbreviated to [Ht]

* Stratigraphy and/or fusulinacean fossils of some of the localities in Figs. 3-11 are not described in the text. These localities are only quoted from the fossil lists or fossil localities in the references or geological maps.

V. Inner zone of Southwest Japan, abbreviated to [Swi]

VI. Outer zone of Southwest Japan, abbreviated to [Swo]

In this paper the Middle–Upper Carboniferous is divided into six Stages and the Permian into four Stages though the Paleozoic stratigraphers in this country have not come to a complete agreement on this usage. Considering the status and dimension of a Series, most of the "Series" currently used among the Paleozoic stratigraphers of Japan should be ranked to a Stage or even to a Substage, because one "Series" often represents only one fusulinacean zone and sometimes even more than one "Series" is included in only a single fusulinacean zone.

In this paper the fusulinacean zones based on the genus level are still used, though such a usage as the zone of *Millerella*, the zone of *Profusulinella*, etc. is not advisable because it often produces ambiguity in a strict correlation and faunal comparison. Nevertheless, the available information on the fusulinacean-bearing strata is not enough to set up the standard specific zones which are applicable throughout the Middle Carboniferous to Permian, though in some areas detailed zonation based on the specific level has already been established.

Acknowledgements

For suggestions, criticism and continuous encouragement, the author expresses his most sincere gratitude to the staffs of the Department of Geology, Faculty of Science, Kyushu University, especially to Professor Tatsuro MATSUMOTO, Associate Professors Kametoshi KANMERA and Tsugio SHUTO. The author is indebted to Dr. Juichi YANAGIDA for his kind help in preparation of the correlation charts and figures, and also to Mrs. Miho MIWA and Misses Mutsuko IIO and Tomoko MIYAZAKI for the preparation of typescript and figures. The author's cordial thanks are due to Messers Michael MCCOLLUM and James Robert RUFF of the United States Army who kindly read over the manuscript and refined the sentence structure.

The financial support for the completion of this study was granted through the Scientific Research funds given by the Ministry of Education, Japanese Government.

Chapter I. The general consideration on the fusulinacean zones of Japan

1. The zone of *Millerella*

The lowest fusulinacean zone in Japan is the zone of *Millerella*, our knowledge of which has been considerably increased during the last decade, though there are still many problems remaining unsolved. In fact, there is not enough paleontological information available to establish the specific zone of *Millerella* throughout Japan.

Light was first thrown on the zone of *Millerella* by YABE (1949) followed by KANMERA (1952), TORIYAMA (1957), IGO (1957), FUJIMOTO and IGO (1958),

Carboniferous Research Subcommittee (Chairman, H. YABE, 1960), MURATA (1961), OKIMURA (1963, 1966), and others. The general characteristic features of the zone of *Millerella* of Japan have been summarized by FUJIMOTO and IGO (*op. cit.*) and the Carboniferous Research Subcommittee (*op. cit.*). Their major scheme is the division of the zone of *Millerella* into two parts and is presently acceptable.

The lower part is pretty well defined by the association of *Millerella japonica* KANMERA, *M. gigantea* KANMERA, *M. komatui* IGO, *M. discoidea* IGO, *Eostaffella kanmerai* (IGO), and such characteristic coral of the Onimaruan type as *Kueichouphyllum, Dibunophyllum, Lithostrotion, Palaeosmilia, Hexaphyllia,* etc. It is almost certain that the lower part of the zone of *Millerella* of Japan is correlative with the Upper Viséan in the European equivalent or the Chesterian of North America.

However, in the opinion expressed by the Mississippian Subcommittee (Chairman J. M. WELLER, 1948) and also by MOORE (1948) the Viséan–Namurian boundary may fall within the Chesterian; this means that the Chesterian is correlative with the Upper Viséan to Lower Namurian in European equivalent. Thus a question has been raised as to whether the lower part of the zone of *Millerella* of Japan is correlated entirely with the Upper Viséan or whether it ranges up to the Lower Namurian. The subdivision of the *Eostaffella kanmerai* zone in the Fukuji area proposed by MINATO and KATO (1957) has complicated the question, because their *Neokoninckophyllum nipponense* subzone contains no common element with the subjacent *Siphonodendron hidense* subzone which bears the typical Onimaruan coral fauna.

As KONISHI (1963) pointed out some of the formation referred to as the Onimaruan may attain higher stratigraphic position than the Onimaru "Series" defined at the type locality, and may possibly be correlative with the lower Namurian. FUJIMOTO and IGO (1958) are nearly of the same opinion, which is that the lower half of the zone of *Millerella* in Japan is equivalent with the Upper Viséan (*Dibunophyllum* zone) to the Lower Namurian (*Eumorphoceras* zone). With regards to the stratigraphical position of the upper limit of the Onimaruan, opinions are diverse between IGO and MINATO and his students. Discussion between them, which has not reached a definitive conclusion, has also been well summarized by KONISHI (*op. cit.*).

The upper part of the zone of *Millerella* has not been as exactly defined as the lower part. It was first found by IGO (1956, 1957) in the lower part of the Ichinotani Formation in the Fukuji area, which is only about 15 m thick. According to IGO it is characterized by the rather smaller sized species of *Millerella, M. bigemmicula* IGO, *Nankinella* cfr. *plummeri* THOMPSON, *Pseudostaffella kanumai* IGO, and *P. kanumai pausiseptata* IGO, without any association of the Onimaruan type of corals and species of *Profusulinella.*

OKIMURA (1966) has made a fine zonation on the pre-Moscovian formations based on the detailed micropaleontological studies on the smaller foraminifers and primitive fusulinaceans of the Atetsu, Taishaku and Akiyoshi limestones. Beneath the *Profusulinella toriyamai* – *P. beppensis* zone, the following five zones

are discriminated in descending order as (5) *Pseudostaffella antiqua* zone, (4) *Eostaffella* sp. A – *Millerella* sp. A zone, (3) *Mediocris* sp. A – *M. mediocris* zone, (2) *Endostaffella delicata* zone, and (1) *Endothyra* sp. A zone. The correlation of these zones with the European standard reference section was also given by OKIMURA; namely, zone (1), (2) and the lower half of (3) [=Onimaruan Stage] with the Lower, Middle and Upper Viséan, respectively, and the upper half of the zone (3) with the Namurian of Russia (Protova horizon) or the Lower Namurian of West Europe. The zone (4) and (5) are respectively correlative with the Lower and Middle Bashkirian. He inferred that the boundary between the Lower and the Upper Carboniferous is placed at the base of the *Eostaffella* sp. A – *Millerella* sp. A zone, and that there is probably an unconformable relationship between the Lower and the Upper Carboniferous. Because the upper half of the *Mediocris mediocris* zone is not present in the Kitakami massif, OKIMURA proposed a new stage "Ohkuboan" with the type locality at Okubo in the Akiyoshi area.

So far as the western part of Chugoku province is concerned, the zonation given by OKIMURA is plausible, but it is not known whether his zonation is applicable to the pre-Moscovian formations of other regions. Our knowledge of smaller foraminifers of other regions is too poor to discuss the problem.

The time and time-stratigraphic unit for the zone of *Millerella* has not yet been fixed. As for the lower part, the Onimaruan Stage has been familiar to the Japanese stratigraphers, though it is referred by OKIMURA (*op. cit.*) to the lower subzone of the *Mediocris mediocris* zone, and is not inclusive of the zone of *Millerella* defined by him. IGO (1956) proposed the Kamitakaran "Series" for the time-stratigraphic unit equivalent to the upper part of the zone of *Millerella* to the upper limit of the zone of *Fusulinella**, though he stated that it will be divided in future studies into two or three series or stages. In fact IGO (1961) himself found a characteristic disconformity between the zone of *Profusulinella* and that of *Fusulinella* in the Ichinotani Formation. Thus, the Kamitakaran seems to be changed in definition, and in this paper the Kamitakaran Stage is revised to cover only the upper part of the zone of *Millerella*.

The international correlation of the Kamitakaran Stage thus revised is still uncertain, though it is approximately assignable to the Upper Namurian of Western Europe or to the Ardian (Lower Pennsylvanian) of North America.

2. The zone of *Profusulinella*

Since the first finding of the zone of *Profusulinella* in the Akiyoshi limestone (TORIYAMA, 1954), some information concerning this zone has become available through ONUKI and YAMADA (1955), IGO (1956, 1957), YOKOYAMA (1957), OKIMURA (1958, 1963, 1966), SADA (1961, 1964, 1965), SAKAGAMI (1962), and HASE (1963, 1964, 1965).

---

* In the "Carboniferous System of Japan" (Carboniferous Research Subcommittee, 1960) the Kamitakaran is used for the standard division ranging from the upper part of the zone of *Millerella* to the zone of *Fusulinella*.

The general characteristics of the zone of *Profusulinella* has been summarized by FUJIMOTO and IGO (1958) and the Carboniferous Research Subcommittee (1960). Generally speaking, the zone of *Profusulinella* is dominated by rather primitive species of the zone genus, such as *P. rhomboides* (LEE et CHEN), *P. beppensis* TORIYAMA, *P. fukujiensis* IGO, *P. toriyamai* SADA, and several species of primitive fusulinaceans, *Millerella, Eostaffella, Staffella, Nankinella,* and *Eoschubertella.* However, local differences exist in faunal assemblage even within Southwest Japan. For example, in the Akiyoshi limestone the *Profusulinella beppensis* fauna contains representatives of *Akiyoshiella* and primitive member of *Fusulinella* together. They are not present in the Fukuji area where the upper half of the zone of *Profusulinella* is barren of fossils.

As already pointed out by FUJIMOTO and IGO (*op. cit.*), no representative of highly evolved form of *Profusulinella* nor any transitional form from *Profusulinella* to *Fusulinella* has been found in Japan. Accordingly, a complete evolutionary pattern of the genus *Profusulinella* has not been observed in Japan.

The standard time and time-stratigraphic units for the zone of *Profusulinella* of Japan has not been settled. The Nagaiwan "Series", which had long been regarded as the zone of *Fusulinella* in the type area of the Kitakami massif, was proved older than the Akiyoshian (zone of *Fusulinella*), being equivalent to the zone of *Profusulinella* and a part of the zone of *Millerella.* Since the Nagaiwa Formation is rather poor in fossil contents and its fusulinacean fauna has been so poorly understood, the Nagaiwan "Series" is not considered suitable for the standard reference section of the zone of *Profusulinella.* Thus IGO (1956) proposed the Kamitakaran "Series" in substitution for the Nagaiwan "Series". However, as already stated, the Kamitakaran has been changed in definition and, as suggested by KONISHI (1963), a better time-stratigraphic unit based on the definitive biostratigraphic evidence is advisable to assign the zone of *Profusulinella.* The fusulinellids of the zone of *Profusulinella* have been studied extensively in the Kodani Formation of the Atetsu limestone and the lower part of the Akiyoshi limestone Group. Thus the **Atetsuan** is proposed here either for the time-stratigraphic or the time unit equivalent to the zone of *Profusulinella* in Japan, with its type reference section in the middle part of the Kodani Formation of the Mitsudo Group. In the type Atetsuan, where it is called the *Profusulinella toriyamai* zone (SADA, 1965), the *Profusulinella* fauna contains *P. toriyamai* SADA, *P. rhomboides* (LEE et CHEN), *P.* cfr. *wangyui* SHENG, *P.* spp. A and B, *Nankinella plummeri* THOMPSON, *Staffella powwowensis* THOMPSON, *Eoschubertella lata* (LEE et CHEN), *E.* sp., and smaller foraminifers.

SADA (*op. cit.*) pointed out that the *Profusulinella toriyamai* fauna as a whole has a similarity to the *Profusulinella* fauna in the upper part of the Green Canyon Group in Powwow Canyon, Texas. This can also be correlative with the *Profusulinella* faunas of the lower part of the Big Saline Limestone and of the upper part of the Marble Fall Limestone in Texas.

Since the *Profusulinella beppensis* zone and its equivalent *P. fukujiensis* zone and *F. toriyamai* zone has been extensively studied paleontologically and

traceable areally in Southwest Japan, the zone of *Profusulinella* in Japan can then be called the *Profusulinella beppensis – P. toriyamai* zone.

3. The zone of *Fusulinella*

Among the Carboniferous fusulinacean zones, the zone of *Fusulinella* shows the largest extent in geographical distribution. For the standard time-stratigraphic unit equivalent to the zone of *Fusulinella* the Akiyoshian "Series" was proposed by TORIYAMA (1960). In the type Akiyoshian, the *Fusulinella biconica* zone is cropping out on the southern slope of the Akiyoshi plateau, Shuho-cho, Miné-gun, Yamaguchi Prefecture. The following species are the important elements of the type section of the Series; *Fusulinella simplicata* TORIYAMA, *F. biconica* (HAYASAKA), *F. itoi* OZAWA, *F.* cfr. *bocki* MÖLLER, *F.* cfr. *pseudobocki* (LEE et CHEN), *F. subsphaerica* TORIYAMA, *F. hanzawai* IGO*, *Fusulina* (*Beedeina*) *akiyoshiensis* TORIYAMA, *F. regularis* ISHII*, and *Wedekindellina* cfr. *matura* THOMPSON*. (Species with an * are reported by MURATA (1961), but not described).

Throughout the Akiyoshian zone of *Fusulinella* of Japan, the lower part of this zone is dominated by primitive representatives of the genus such as *F. simplicata* TORIYAMA and its allied species, *F. jamesensis* THOMPSON, PITRAT and SANDERSON, *F. kamitakarensis* IGO, *F. itadorigawensis* ISHII, and the upper part is dominated by an abundancy of more evolved forms such as *F. biconica* (HAYASAKA), *F. pseudobocki* (LEE et CHEN), and *F. asiatica* IGO ("*F. bocki*" of some authors). Thus, the lower part can be called the *Fusulinella simplicata* subzone and the upper the *F. biconica* subzone.

Besides the species of *Fusulinella,* various species of *Millerella, Eostaffella, Staffella, Ozawainella, Eoschubertella,* and *Fusiella* occur in the Akiyoshian and some of them are found throughout the whole range of the Akiyoshian, while others are restricted in the lower or upper part; e.g., *Fusiella typica* LEE et CHEN is limited in occurrence only in the *Fusulinella biconica* subzone.

The occurrence of *Fusulina* in the lower part of the zone of *Fusulinella* of Japan cannot be overlooked, though it is not common except in the Itadorigawa Group of Shikoku. ISHII (1956, 1958, 1961) gave a full account of this problem from the phylogenetical point of view of Fusulinidae, and confined the genus *Fusulina* to the species of *F. cylindrica*-type and the genus *Beedeina* to those of *F. girtyi*-type. ISHII is also of the opinion that *Fusulina* and *Beedeina* belong to a different stock of evolution, the former having evolved directly from *Profusulinella* through *Aljutovella* and appeared at approximately the same time as *Fusulinella.* FUJIMOTO and IGO (1958) came to nearly the same conclusion. ISHII's conclusion seems to be reasonable, but the association of primitive species of *Fusulinella* and species of *Beedeina* has not been found in the Akiyoshian rocks of other areas, whereas it is not uncommon to see the association of advanced species of *Fusulinella* and species of *Beedeina* and/or *Fusulina* in the upper part of the zone of *Fusulinella* or in the lower part of the zone of *Fusulina* in Japan.

With regards to the intercontinental correlation of the Akiyoshian, the lower and the upper subzone are respectively correlated with the Kashir and the Podol

bed of the Russian platform and with the upper Atokan and the lower Desmoinesian in the Mid-Continent of North America (ISHII, 1961; KONISHI, 1963). This means that the Akiyoshian is equivalent to the zone of *Fusulinella* plus the lower part of the zone of *Fusulina* (zone of *Beedeina* of ISHII) in the Mid-Continent standard. Thus, as mentioned already, the usage of a zone based on the generic rank is not advisable for the exact correlation in order to avoid confusion.

4. The zone of *Fusulina*

The Kurikian "Series" was established by KANMERA (1951) for the lowest fusulinacean zone of the Yayamadake limestone of South Kyushu. The type section of the "Series" (about 100 m) consists of white to white-grey massive limestone, most of which is biogenic calcarenites with some öolites and intercalations of basic tuff at various horizons. It is divided into three subzones in descending order:

upper *Fusulina ohtanii—Fusulinella gracilis* subzone
middle *Beedeina higoensis—Wedekindellina prolifica* subzone
lower *Staffella pseudosphaeroidea—Fusulinella* sp. subzone

The lower *Staffella pseudosphaeroidea – Fusulinella* sp. subzone is uncertain in stratigraphic position because none of the constituent species of this subzone gives us a clue for precise correlation; namely, as already pointed out by ISHII (1961), *Staffella pseudosphaeroidea* has a rather long stratigraphic range, ranging from the Bashkirian to the Mjatschkov in the Russian platform, and *Fusulinella* sp., although KANMERA (1954) stated that it closely resembles *F. pseudobocki* (LEE et CHEN), and has been left undetermined. It may be correlatable, however, at least with a part of *Fusulinella biconica* subzone of Akiyoshian.

The middle *Fusulina (Beedeina) higoensis – Wedekindellina prolifica* subzone consists only of the subzone species. *Fusulina (Beedeina) higoensis* is an advanced species of the subgenus *Beedeina,* whereas *Wedekindellina prolifica* is rather primitive for the genus *Wedekindellina,* being intermediate in morphological characters between *Fusulinella* and *Wedekindellina* (KANMERA, 1954). The latter species was considered to be referable to the genus *Pseudofusulinella* rather than *Wedekindellina* by ISHII (1961) who also gave a detailed account of comparison of the faunule of this subzone. In considering the general paleontological features of the two subzone species and stratigraphical occurrences of their allied forms, the *Fusulina (Beedeina) higoensis – Wedekindellina prolifica* subzone is correlated with the lower part of the Mjatschkov bed of the Russian platform or with the upper part of the Desmoinesian of Mid-Continent.

The upper *Fusulina ohtanii–Fusulinella gracilis* subzone comprises *Fusulina ohtanii* KANMERA and *Fusulinella gracilis* KANMERA in the main part, and *Fusulina kurikiensis* KANMERA (recorded first as *Quasifusulina kurikiensis* in KANMERA's paper of 1952) in the uppermost part. Paleontological resemblance of *Fusulinella gracilis* to the group of *F. mosquensis* including *F. provecta* SHENG of Penchi Series in the Taitzeho area and the highly evolved features of *Fusulina ohtanii* and *F. kurikiensis* led ISHII (1961) to the conclusion that the *Fusulina ohtanii–*

Fusulinella gracilis subzone is correlative with the upper part of the Mjatschkov bed or with the uppermost of the Desmoinesian.

Thus the Kurikian Stage of Japan as a whole is correlated with Mjatschkovian (upper Moscovian) of Russia and the upper Desmoinesian of Mid-Continent in North America, and the *Fusulina ohtanii – Fusulina (Beedeina) higoensis* zone is applicable to the stage. Such a usage as *Fusulina–Fusulinella* zone or *Fusulinella–Beedeina* zone is not advisable, because the stratigraphical range of either of these two genera are overlapping each other in the Akiyoshian or in the Kurikian.

The Kurikian Stage is not so wide in geographical distribution, being known only in the Kwanto massif, Hida massif and Tamba zone, and the Outer zone of Southwest Japan including the type area of the stage.

5. The zone of *Triticites*

It had long been believed that the zone of *Triticites* or the so-called "Uralian" is missing over extensive areas of East Asia including Japan until KANMERA, KAWADA and FUJIMOTO, and KANUMA independently reported the existence of the zone of *Triticites* in the Yayamadake limestone, the Omi limestone, and the Oppara Formation, respectively in 1951.

The Hikawan "Series" was proposed by KANMERA (1952) for the zone of *Triticites* of Japanese Carboniferous, with the type area in Yayamadake in South Kyushu. It occupies the middle part of the Yayamadake limestone and consists of white to grey massive limestone, locally very pisolitic and in places dolomitic and siliceous, with intercalations of basic lava and pyroclastics.

The Hikawan Stage comprises two divisions in the type area, the lower or *Triticites matsumotoi* subzone and the upper or the *T. yayamadakensis* subzone. The two subzones are characterized by the subzone species, while *Quasifusulina longissima* (MÖLLER) occurs throughout two subzones and indeterminable species of *Schubertella* and *Staffella* are found in parts of the upper subzone.

Besides the type area, the Hikawan is now known in Nakatsugawa and other areas in the Kwanto massif, the Omi limestone, the Ichinotani Formation and the Oppara Formation in the Hida massif, and the Shogase and Miyanokuchi Formations in Shikoku. The *Triticites* fauna dominating in these Hikawan formations comprises *Triticites matsumotoi* KANMERA, *T. yayamadakensis* KANMERA, *T.* cfr. *rhombiformis* ROSOVSKAYA, *T. exsculptus* IGO, *T. hidensis* IGO, *T. saurini* IGO, *T. sakagamii* IGO, *T. nakatsugawensis* MORIKAWA, *T. uemurai* MORIKAWA, *T. opparensis* KANUMA, *T. irasensis* KANUMA, *T. kiyomiensis* KANUMA, *T. pygmaeus* DUNBAR and CONDRA, without any association of the species of *Pseudoschwagerina* and its related forms. However, it cannot be overlooked that, as already pointed out by TORIYAMA (1954, 1957, 1958), FUJIMOTO and IGO (1958) and others, the basal part of the Sakamotozawan is dominated only by the *Triticites* fauna without association of *Pseudoschwagerina* and its allied forms which are characteristic of the Lower Permian. The *Triticites* fauna in this part of the Sakamotozawan consists of *Triticites kagaharensis* FUJIMOTO, *T. kawanoboriensis* FUJIMOTO, *T. satoi* FUJIMOTO, *T. subobsoleta* OZAWA, *T. ozawai* TORI-

YAMA, *T. simplex* (SCHELLWIEN), *T. rossicus* (SCHELLWIEN), *T. contractus* (SCHELLWIEN), *T. irregularis* (STAFF), *T. montiparus* [EHRENBERG (MÖLLER)], *T. petschoricus* RAUSER-CHERNOUSSOVA, BELJAEV and REITLINGER, *T. noinskyi* RAUSRE-CHERNOUSSOVA, *T. patulus* DUNBAR and NEWELL. Among these species, however, *T. simplex, T. montiparus, T. kagaharensis,* etc. were also recorded in the C3 Formation (the zone of *Triticites*) of the Omi limestone and will be discussed in Chapter VI. It is probable that the KAWADA's C3 Formation is not the Hikawan, but is of the Sakamotozawan age. If it is so, FUJIMOTO and IGO's (1958) consideration on the distinction between the Carboniferous type and the Permian type of *Triticites* seems to be more reasonable; namely that the two types are distinct from each other in general paleontological features.

It is noted, at the same time, that if the above is the case, the *Triticites* fauna of the Hikawan age of Japan is considerably less advanced than that of the Virgilian in North America. Thus questions have been raised that, *Triticites* has not evolved in Japan as high as it did in the Virgilan of North America or in the uppermost Carboniferous of Russia, and that if the *Triticites* fauna of the Permian type mentioned above is really of the Perman, regardless of the association with species of *Pseudoschwagerina* which is the most reliable index fossil of the Lower Permian. Concerned with this problem, KANUMA (1960) expressed an opinion that the primitive group of *Pseudoschwagerina* appeared earlier in the Upper Carboniferous in East Asia than in North America or Russia and therefore the *Triticites-Pseudoschwagerina* assemblage of East Asia is not of Permian, but of the Upper Carboniferous. The problem concerns the Carboniferous–Permian boundary in the Upper Paleozoic of Japan, but our present knowledge is not enough to settle these questions, and further detailed study is necessary before reaching any final conclusions.

6. The zone of *Pseudoschwagerina*

The Sakamotozawan has its type section along the Sakamotozawa valley of Hikoroichi-machi, Ofunato city, Iwate Prefecture. The type Sakamotozawan was studied by ONUKI (1938, 1939) first at length, and then MINATO (1941, 1944), MINATO *et al.* (1954, 1959, 1965), ONUKI (1956), and others have made many contributions to the stratigraphy of an extensive area over the whole Kitakami massif. However, their final results did not necessarily harmonize because of different interpretations of the facts. This was partly due to the fact that the correlation of the Sakamotozawa "Series" was discussed by the fusulinacean zone which was not based on the species level, but on the genus one, such as "the *Pseudoschwagerina* zone" or "the *Parafusulina* zone".

A better section is exposed in the Nagaiwa area (about 2 km north of the type section of Sakamotozawa) and was recently studied along with the type section at length by MIKAMI (1965), and KANMERA and MIKAMI (1965) not only from the paleontological but also from the sedimentological point of view. Their division of the type Sakamotozawa Formation is as follows in descending order:

Upper Subformation	Sd member	(5)	*Pseudofusulina ambigua* zone
		(4)	*P. fusiformis* zone
	Sc member	(3)	*P. vulgaris* zone

unconformity

Lower Subformation	Sb member	(2)	*Monodiexodina langsonensis* zone
		(1)	*Zellia nunosei* zone
	Sa member		

unconformity

Nagaiwa Formation

Since the faunal contents and characteristics of each zone and their correlation with other Lower Permian formations of Japan and other countries have been well explained by the joint authors no further discussion seems to be necessary. However, it should be noted that in the type Sakamotozawa Formation its basal part (Sa member) probably does not range down as low as the basal part of the *Triticites simplex* subzone of Akiyoshi or the *Quasifusulina longissima ultima* or the *Rugosofusulina arctica* subzone of the Atetsu limestone. Therefore, a reference section for the basal part of the Permian must be selected elsewhere. Thus, the lower limit of the Sakamotozawan Stage of Japan is, as TORIYAMA (1963) already defined, placed beneath the *Pseudoschwagerina morikawai* zone of the Yayamadake limestone of South Kyushu and its equivalent zone or subzone; namely, *Triticites simplex* subzone of Akiyoshi and *Quasifusulina longissima ultima* or *Rugosofusulina arctica* subzone of Atetsu, etc.; and the upper limit is settled on the top of the *Pseudofusulina ambigua* zone.

The Sakamotozawan Stage thus defined is a little different in its upper limit from that defined in the previous paper of TORIYAMA (1963) in which the Sakamotozawan Stage was correlated with the Wolfcampian of North America or the Sakmarian of Russia, because the Sakamotozawan in this sense had been rather familiar to the foreign workers (KAHLER, 1961; DUNBAR *et al.*, 1960). However, it has been now clarified that the Sakamotozawan ranges up to at least the *Pseudofusulina ambigua* zone, and there is a considerable and remarkable faunal change between the *P. ambigua* and the overlying *Parafusulina kaerimizensis* zone of the Nabeyaman age throughout the country. Moreover the definition of the Sakamarian has not yet been determined in Russia because of disagreement among workers.

The Sakamotozawan Stage is as a whole correlated, as discussed by most workers, with the Sakamarian (*s.l.*) in the sense of the Soviet-Delegation (GORSKY and STEPANOV, 1958) or the Asselian plus Sakamarian (*s.s.*) in the sense of RAUSER-CHERNOUSSOVA and her school, etc. With the Mid-Continent province of North America the exact correlation is not easy because of the deficiency in common species to both provinces, but, as KANMERA and MIKAMI discussed, the Sakamotozawan Stage can be correlated with the whole Wolfcampian Stage and the lower half of the Leonard Stage.

In this paper, the following zonation of the Sakamotozawan Stage is applied in descending order:

Pseudofusulina ambigua zone
Pseudofusulina vulgaris zone
Pseudoschwagerina morikawai zone

The above zonal division is at least applicable to the Sakamotozawan formations in Southwest Japan, though some local variation in species assemblage and in leading species has been known in the respective zone.

The lower, *Pseudoschwagerina morikawai* zone, whose basal part is perhaps missing in the type Sakamotozawa Formation, is well represented by the lowest fusulinacean zone of the Yayamadake, Akiyoshi and Atetsu limestones, and is correlated with the Asselian (RUZENCEV, 1954) of Southern Urals (KANMERA and MIKAMI, *op. cit.*).

The second or the middle, *Pseudofusulina vulgaris* zone is a well defined fusulinacean zone in the Lower Permian not only of Japan but also of the Tethyian region including China, Indochina and Carnic Alps. It consists of typical species of *Pseudofusulina* including the zone species or its subspecies with association of *Pseudoschwagerina* (advanced member like *P.* (*Robustoschagerina*) *schellwieni* and its allies), *Paraschwagerina, Nagatoella,* along with some rare survival species of *Triticites.*

The correlation of the *Pseudofusulina vulgaris* zone faces a problem. This zone has been referred to by most stratigraphers of Japan as the upper half of the "Sakmarian" (in the sense of the Wolfcampian equivalent) (TORIYAMA, 1954, 1957, 1963; IGO, 1959; SADA, 1963, etc.). However, the *Pseudofusulina vulgaris* zone in the type area of Kitakami massif was correlated by KANMERA and MIKAMI (*op. cit.*) with the upper half of the McCloud limestone of California and with the lower part of the Leonard Formation of Texas. They are also of the opinion that the upper half of the Sakamotozawa Formation is equivalent to the Sakmarian in the sense of RAUSER-CHERNOUSSOVA (1958, 1962), though MIKAMI (1965, p. 489) regarded his Sc member, *Pseudofusulina vulgaris* zone (the lower part of the upper subformation of Sakamotozawa Formation), as the equivalent of the upper part of the Wolfcampian or the Chuanshan Series.

There is still a problem concerning the Carboniferous-Permian boundary in Japan at present. If one follows RAUSER-CHERNOUSSOVA and most of the Chinese paleontologists including CHEN, SHENG and others, the boundary is placed at the base of the *Pseudofusulina vulgaris* zone. Presently this will not be accepted by most Japanese paleontologists.

The upper, the *Pseudofusulina ambigua* zone, is found widely in the Permian of Japan though the zone species is replaced by *P. kraffti magna,* as seen in the Atetsu limestone. The zone is flourished by species of *Pseudofusulina—ambigua, kraffti kraffti, kraffti magna, globosa exilis, fusuformis, japonica, uralica sphaerica,* etc. *Pseudofusulina vulgaris* and its subspecies and species of *Triticites* still exist in this zone (mostly in the lower part). Species of *Nagatoella* and *Schwagerina* often appear throughout or at least in some limited part of the zone.

It is noted that the stratigraphic unit equivalent to that ranging from the *Pseudofusulina vulgaris* zone to the *P. ambigua* zone is characterized by the *Missellina* fauna as well documented by KANMERA (1963). Taking *Misellina* as

a guide fossil, he divided the "*Misellina* zone" into the *M. ibukiensis* zone below and the *M. claudiae* zone above. The former is correlative with the *Pseudofusulina vulgaris* zone plus the lower part of the *P. ambigua* zone. The lowest part of the Kozaki Formation of South Kyushu is one of the best displays of the former. The *Misellina claudiae* zone and its equivalent is traceable in the uppermost part of the Lower Permian of Tethys.

The difference in the assemblage of species between the *Pseudofusulina ambigua* and the *Misellina claudiae* zone is quite clear. However, enough information has not been available to work out the question of whether the difference is due to paleogeographic conditions or not.

7. The zone of *Parafusulina*

The type reference section for this stage is the Yamasuge member of the Nabeyama Formation developed in the Kuzuu area of Tochigi city in the central northern part of Kwanto province.

Among the Permian fusulinacean zones of Japan the zone of *Parafusulina* is most uncertain, being often difficult to define the zone paleontologically. The reason for this uncertainty is that in Japan (1) the stratigraphical range of *Neoschwagerina* and that of *Parafusulina* considerably overlap each other; (2) the lower part of the so-called "*Parafusulina* zone" is dominated by various species of *Pseudofusulina* rather than the typical species of *Parafusulina*; (3) disagreement in generic assignment is often found—for example, as KANMERA and MIKAMI (1965) have cited, "*Fusulina japonica* GÜMBEL" is referred to *Pseudofusulina* by some, to *Parafusulina* by others, and even to *Schwagerina* by another; (4) moreover, if one puts stress on the first appearance of *Neoschwagerina*, most, if not all of the "*Parafusulina* zone" is included in the "*Neoschwagerina* zone".

In the type area of the Nabeyaman Stage, the Yamasuge limestone member (the lower part of the Nabeyaman Formation of the Aso Group) is dominated by the *Parafusulina yabei* (*s.l.*) faunule which comprises *P. yabei yabei*, *P. yabei nabeyamensis*, *P. yabei tomuroensis*, *P. yabei hanzawae*, *P. kaerimizensis*, and *P. nakamigawai*. In addition to the above *Parafusulina* faunule, FUJIMOTO (1961) listed the following species in the Yamasuge limestone member: *Schubertella kingi* DUNBAR and SKINNER, *Minojapanella elongata* FUJIMOTO and KANUMA, *Schwagerina krotowi* (SCHELLWIEN), *S. guembeli* DUNBAR and SKINNER, *Pseudofusulina granum-avenae* (ROEMER), *P. ambigua* (DEPRAT), and *Pseudodoliolina ozawai* YABE and HANZAWA. No species of *Neoschwagerina* appear in the Yamasuge limestone member.

The *Parafusulina kaerimizensis* zone of the Akiyoshi and Atetsu limestones is also a good example of the Nabeyaman in which *P. kaerimizensis* and its allies are remarkably predominant, but representatives of neoschwagerinid sometimes are associated with in the upper part. [According to NAGAMI (1961) no species of *Neoschwagerina* occur in his ${}_{u}P_{3-\beta}$ (*P. kaerimizensis* zone)].

It should be stated here that a different biofacies is found in the Nabeyaman Stage, which is typically represented by the *Neoschwagerina simplex* zone of the Kozaki Formation of South Kyushu. The said zone comprises

Neoschwagerina simplex, Cancellina tenuitesta, Verbeekina sphaera, Yangchienia compressa, Parafusulina kaerimizensis, and *P.* cfr. *sapperi,* and its contemporaneity with the *Parafusulina kaerimizensis* zone of the Akiyoshi and Atetsu limestones has been verified by concrete paleontological evidence (KANMERA, 1961, 1963).

The fusulinacean fauna closely related to the *Neoschwagerina simplex* fauna is traceable in the Tethys Seaway. The *Cancellina* subzone of the Maokou limestone in Kueichou, Kwangsi and Szechuan is characterized by the association of *Cancellina primigena* (HAYDEN), *C. neoschwagerinoides* (DEPRAT), *Pseudodoliolina ozawai* YABE and HANZAWA, *Yangchienia compressa* (OZAWA), and various species of *Parafusulina* including *P. yabei* HANZAWA, *P. akasakensis* (DEPRAT), *P. splendens* DUNBAR and SKINNER, *P. sapperi* (STAFF), *P. gruperaensis* (THOMPSON and MILLER), etc., along with several species of *Pseudofusulina* (SHENG, 1963). There is no doubt about the contemporaneity of the *Neoschwagerina simplex* fauna with *Cancellina primigena* fauna, the latter of which is also known in Pamir and Afghanistan.

Thus, it seems most proper to distinguish two biofacies in the Nabeyaman Stage of Japan, the *Parafusulina kaerimizensis* and the *Neoschwagerina simplex,* each of them characterizes the respective fusulinacean zone in the stage.

A short remark is given here to the Nabeyaman Stage in the type area of the Kitakami massif. The upper part of the Sakamotozawa Formation and the lower part of the Kanokura Formation were referred to the "*Parafusulina* zone" by most workers, but recently only the lower part of the Kanokura Formation has been assigned to the "*Parafusulina* zone", which is characterized by the *Monodiexodina matsubaishi* and *Lyttonia* fauna.

8. The zone of *Neoschwagerina*

The Akasakan Stage has its type reference section along the southeastern slope of the Kinshozan hill of Akasaka-cho, northwest of Ogaki city, Gifu Prefecture. The Akasaka limestone, which consists exclusively of massive white to dark-grey limestones, was studied by the Akasaka Research Group (MORIKAWA *et al.*, 1956) and MINATO and HONJO (1956), resulting in that they did not arrive at the same or nearly the same conclusion, but came to a considerable discrepancies in biostratigraphical zonation, specific assemblage and range, etc. Thus in this paper, OZAWA's general scheme of biostratigraphic division will still be accepted though it was completed forty years ago.

Of the five zones defined by OZAWA, namely, Np, Nn, Nc, Nm, and Ng in ascending order, the lower two and the uppermost one are not included in the present definition of the Akasakan Stage. The lowest Np (Benijima limestone) is referred to the Sakamotozawan, and the second lowest Nn to the Nabeyaman Stage, while the uppermost Ng is assigned to the Kuman Stage. Thus the type Akasakan is divisible into two zones, *Neoschwagerina craticulifera* zone below and *N. margaritae* zone above.

The *Neoschwagerina craticulifera* zone shows a considerable wide geographical distribution among the Permian fusulinacean zones of Japan, though

it is not present in the standard area of the Kitakami massif. The zone species is a rather primitive representative of the genus and the associated species are *Neoschwagerina craticulifera haydeni* DOUTKEVITCH (in Akiyoshi), *N. colaniae* OZAWA (in Akasaka and Ibukiyama), *N. rotunda* DEPRAT (in Kozaki Formation), *Afghanella schencki* THOMPSON, *Pseudodoliolina pseudolepida* (DEPRAT), *P. ozawai* YABE and HANZAWA, *Verbeekina verbeeki* (GEINITZ), and several species of *Parafusulina* and *Pseudofusulina* (*Parafusulina kaerimizensis* (OZAWA), *P. edoensis* (OZAWA), *Pseudofusulina japonica* (GÜMBEL) etc.) often appear in the zone.

The upper, *Neoschwagerina margaritae* zone, is also well recognizable in the Middle Permian of Japan, though the zone species is sometimes replaced by *N. douvillei* OZAWA. Besides these species, *Verbeekina verbeeki* (GEINITZ), *Pseudodoliolina pseudolepida* (DEPRAT) often appear along with some species which flourished in the lower *Neoschwagerina craticulifera* zone such as *N. craticulifera* (SCHWAGER) (*s.s.*), *N. craticulifera haydeni* DOUTKEVITCH, *N. colaniae* OZAWA, *Pesudodoliolina ozawai* YABE and HANZAWA, *Misellina lepida lepida* (SCHWAGER), and some species of *Parafusulina* and *Pseudofusulina* still exist in this zone.

Like the *Parafusulina kaerimizensis* zone of the Nabeyaman Stage, neither the *Neoschwagerina craticulifera* nor the *N. margaritae* zone has been found in the Kitakami massif, but, as already stated by many previous workers, the lower part of the Iwaizaki stage, which yields *Pseudofusulina paramotohashii* MORIKAWA, *P. oyensis* MORIKAWA, *P. kikuchii* MORIKAWA, and *Verbeekina* sp. together with species of *Parawentzelella, Yatsengia, Iranophyllum,* and *Waagenophyllum,* is correlated with the "*Neoschwagerina* zone".

The "*Neoschwagerna* zone" is also well traceable along the Tethys Seaway —South China, Indonchina, Thailand, Pamir, Afghanistan, Iran, etc., though in some of them there is not enough available information to define the detailed biostratigraphic zonation and to determine the relationship between the stratigraphic division and their faunal contents. However, as pointed out by THOMPSON (1946) and others, the coexistence of the *Neoschwagerina craticulifera* fauna and species of *Polydiexodina* is noteworthy.

9. The zone of *Yabeina-Lepidolina*

The Kuman Stage, the uppermost division of the Permian of Japan, has its type locality in the upper valley of Hikawa, Yatsushiro-gun, Kumamoto Prefecture. The Kuma Formation, 900 m in thickness, consists of conglomerate, sandstone and black shale, with black impure limestone at several horizons. Chert is not present in the formation. The type Kuman, as discussed by KANMERA (1953, 1954) at length, has a very characteristic fossil assemblage called the *Lepidolina toriyamai* fauna, which comprises *L. toriyamai* KANMERA, *Yabeina yasubaensis* TORIYAMA, *Y. columbiana* (DAWSON), *Y. gubleri* KANMERA, *Verbeekina* (?) sp., *Pseudodoliolina pseudolepida gravitesta* KANMERA, *Parafusulina* (?) sp., *Schwagerina pseudocrassa* KANMERA, *S.* aff. *acris* THOMPSON, *Dunbarula* (?) sp., *Codonofusiella cuniculata* KANMERA, and *Rauserella* sp.

Lepidolina is considered to be most evolved among neoschwagerinids, and

the *Lepidolina toriyamai* fauna mentioned above is devoid of any representative of *Neoschwagerina*. Thus KANMERA (*op. cit.*) insisted that the *L. toriyamai* zone of the Kuma Formation is the stratigraphically highest zone among the known fusulinacean zones of Japan. The *Yabeina shiraiwensis* zone of the Akiyoshi limestone, which comprises *Y. shiraiwensis* OZAWA, *Y. yasubaensis* TORIYAMA, *Y. pinguis* TORIYAMA, *Sumatrina longissima* DEPRAT, and *Schwagerina* sp., was correlated with the lower part of the Kuma Formation (TORIYAMA, 1954, 1957, 1958).

In contrast with the above conclusions, HANZAWA and MURATA (1963) expressed quite a different opinion about the stratigraphical position of the zone of *Yabeina globosa* and the phylogeny and the systematics of the Neoschwagerininae and Sumatrininae. They discarded *Yabeina shiraiwensis* OZAWA, *Y. yasubaensis* TORIYAMA, *Y. pinguis* TORIYAMA, *Y. hayasakai* OZAWA, and *Neoschwagerina megasphaerica* OZAWA as synonymies of *Yabeina multiseptata* DEPRAT. Besides the above, they also discarded many other species as also being synonymous. They regarded the *Yabeina globosa* zone as the highest fusulinacean zone in Japan.

A marked discrepancy in the stratigraphical position between the *Lepidolina toriyamai* zone and the *Yabeina globosa* zone came from the facts that (1) the stratigraphical relationship between the Kuma Formation and the under- or over-lying formation is not known because they are in tectonic contact in the type area, and (2) the two zones do not occur together, having a different geographical distribution.

Having reviewed and criticized the results of HANZAWA and MURATA together with those of others, YABE (1964) stated that there is no positive evidence in favor of the view that the *Lepidolina toriyamai* zone* is higher than the *Yabeina globosa* zone in stratigraphical position or *vice versa*; and in his latest two papers (1966) he came to a conclusion that the *Yabeina shiraiwensis* zone is lower than the *Lepidolina toriyamai* zone, and the two combined are equivalent to the *Yabeina globosa* zone.

Since the conclusion given by HANZAWA and MURATA bears a partly logical contradiction derived from their overlooking the existing facts and from their misunderstanding in biostratigraphical consideration, regarding a rather general feature as only local one. In the light of present knowledge some of their conclusions, especially on the biostratigraphical studies and on the phylogeny of Neoschwagerininae are hardly acceptable. Thus, the conclusion given by YABE (*op. cit.*) seems to be sound and acceptable at least so far as the available evidence is concerned. It should be noted that *Yabeina shiraiwensis* OZAWA ranges up into a part of the *Lepidolina toriyamai* zone. It may be assumed that the top of the *Lepidolina toriyamai* zone is higher than that of the *Yabeina globosa* zone, though no positive evidence has been found to verify this conjecture. YABE recognized *Lepidolina* as a subgenus under the genus *Yabeina* and proposed the **Kinshozan Series** for the *Yabeina* zone of Japan, including *Y. globosa* zone and its equivalent, the *Yabeina shiraiwensis* plus the *Lepidolina toriyamai* zone.

* YABE has left the zone without giving zone species in his first paper (1964).

Kinshozan is the type locality of the Akasakan Stage.

Having dealt with *"Lepidolina" shiraiwensis* (OZAWA) at length from the statistical point of view, HASEGAWA (1965, 1966) has come to a similar view; namely, the uppermost fusulinacean zone of Japan is represented by two bioseries, one is the *Yabeina globosa* – *"Gublerina" elongata* [=*Lepidolina elongata*], and the other is the *Lepidolina kumaensis* – *L. shiraiwensis*. According to him, two bioseries originated from the common ancester *Misellina claudiae* and developed along different stock of evolution, and, therefore, the genus *Lepidolina* is clearly distinguishable from the genus *Yabeina,* whatever the genus name may be.

In this paper the Kuman Stage is used for the zone of *Yabeina-Lepidolina* in Japan, because the Kuman was already given to the time-stratigraphic unit equivalent to the *Yabeina shiraiwensis* and the *Lepidolina toriyamai* zone.

There are rather considerable difference in the faunal constituents and rock facies between the *Yabeina shiraiwensis* – *Lepidolina toriyamai* suite and the *Yabeina globosa* zone. Thus the Kuman biofacies is proposed for the former fauna and the Kinshozan biofacies for the latter.

Since the *Lepidolina toriyamai* and the *Yabeina shiraiwensis* zone are widely distributed throughout the Permian of Japan, the Kuman Stage is as a whole designated the *Y. shiraiwensis* – *L. toriyamai* zone.

Chapter II. The Zone of *Millerella*

I. Kitakami and Abukuma massifs

A. Southern part of the Kitakami massif

YABE (1939) is the first who confirmed the existence of the zone of *Millerella* in the southern Kitakami massif, and described *Millerella* sp. from Sakamotozawa [Ka 25] and two other localities in Hikoroichi. This species occurs in the *Dibunophyllum* limestone with *Diphyphyllum flexisus* and *Hexaphyllia kitakamiensis* which are characteristic Onimaruan corals and referred to the upper Visean in the European equivalent. According to KANMERA (1952), *M.* sp. of Kitakami massif is conspecific with *M. japonica* KANMERA described from the Kakisako Formation of South Kyushu, and there is no doubt of dating of the upper Visean to the Onimaru and Kakisako Formations.

OKIMURA (1965) recently reported the occurrence of *Endothyranopsis hirosei* OKIMURA and other species of smaller foraminifers from the upper part of the Onimaru Formation in the type area. From a faunal comparison with the European forms he concluded that the occurrence of *Endothyranopsis* is conformative of the upper Visean age for the Onimaru Formation.

Species of *Millerella* were also found by YAMADA (1955; in ONUKI, 1956; 1958) in the lower part of the Nagaiwa Formation in the type area [Ka 24] which conformably overlies the Onimaru Formation. Since no other species have been associated with *Millerella* sp. he has referred this part of the Nagaiwa Formation to the zone of *Millerella*.

B. Northern part of the Kitakami massif

The northern type of Paleozoic rocks of Kitakami massif is generally distinguished from the southern type in lithologic difference (MINATO, 1950; ONUKI, 1956). This type of Paleozoic rocks is represented by thick bedded sandstone, shale, chert, limestone, and schalstein, and is almost barren of fossils except for Permian fusulinaceans in a few localities. Recently YOSHIDA and KATO (1962) reported *Millerella* sp. and *Endothyra* sp., together with *Pseudodolodotia kakimii* MINATO and other Onimaruan type of corals from the limestones of the Kogawa Formation [Ka 12] in the Kamaishi area. Because the lithology, thickness, and faunal contents of the Kogawa Formation are similar to those of the southern type Onimaruan of Kitakami massif, TAKEDA and YOSHIDA (1962) are of an opinion that the differentiation of facies between the northern and southern types did not take place in the Onimaruan time, but began later in the Permian. The Onimaruan corals are also known from the Shiba Formation [Ka 20] of the Hitokabe area (HIROKAWA and YOSHIDA, 1954), the Takezawa Formation of the Nagasaka area [Ka 34] (TACHIBANA, 1952) along with other areas, but no representatives of *Millerella* and its allied forms have been reported.

C. Abukuma massif

In the Abukuma massif species of *Millerella* and *Ozawainella* have been found along with the typical Onimaruan corals in the middle part of the Tateishi Formation [Ka 51] of the Soma district (SATO in MINATO, 1955). The Ayukawa Formation [Ka 58] of the Hitachi area is also regarded as the Onimaruan representative although no fusulinaceans have been found.

II. Kwanto massif

Although detailed information has not been available, the Kawamo Formation [Kw 11] of the Ashio massif is referred by HIDA and FUJIMOTO to the Onimaruan age. The Shiroi limestone [Kw 18] of the northern part of the Kwanto massif, in which *Arachnolasma* cfr. *sinense* (YABE et HAYASAKA) was described by MINATO (1947), is also referred to the same age, but no fusulinaceans have been found there.

III. Hida massif and Tamba zone

1. Omi limestone

The lowest division of Omi limestone [Ht 1] was referred by HAYASAKA (1922, 1924) to the *Gigantoproductus* zone which is very prolific in brachiopod and coral faunas including *G. edelburgensis* (PHILLIPS) and other species. HAYASAKA stated that the *Gigantoproductus* zone is the uppermost part of the Lower Carboniferous or the transitional zone between the Lower and Upper Carboniferous. KAWADA (1954) who studied the limestone in some detail considered that, based on the coral contents, his lowest division (C1) is equivalent to the Onimaruan (upper Viséan) though he did not find any fusulinacean. MINATO (1955) also referred the *G. edelburgensis* zone to the Onimaruan. According to FUJITA (1958) the lowest division, his C_1 zone yields *Millerella* sp.

throughout the zone without any association of other fusulinaceans. Thus, he named the C_1 zone the *Millerella*-coral-branchiopod zone and correlated it with the Ardian of North American or the Namurian of Europe. The "schalstein bed" which was regarded by KAWADA as the base of the Omi limestone is considered by FUJITA (1958) to be the intrusive dyke formed coevally with the thrusting.

IGO and KOIKE (1964) recently described Carboniferous conodonts from the C_1 zone, and based on the ammonite fauna which occurs together with conodonts, they proved that the conodont fauna of the Omi limestone indicates the Upper Namurian *Reticuloceras* zone of western Europe or Lower Pennsylvanian of North America. Their conodont fauna contains 16 species of 11 genera, including *Hindeodella asiatica* IGO and KOIKE along with other newly described species.

The Kotakigawa Formation [Ht 3] which is a representative of non-calcareous facies in this area, is developed to the east of Myojo limestone [Ht 2] and is dated as Lower Carboniferous. KONISHI (1956) described *Anatolipora carbonica* and other species of calcareous algae with *Eostaffella rotaralia* (MS) and *E.* sp. Unfortunately much still remains unsolved about the stratigraphy and paleontology of this formation.

2. Hongo and Arakigawa area

The Arakigawa Formation [Ht 22] and the Hongo Formation* [Ht 18], which are developed to the northeast of Takayama city, are referred by ISOMI and NOZAWA (1957) to the Upper Viséan in age, although no fusulinaceans have been reported. The finding of *Goniatites* sp. (IGO, 1964) in the upper part of the Hongo Formation furnishes positive evidence for dating this formation.

3. Fukuji area

The Paleozoic rockes are widely distributed in the Hida massif of North Central Japan and furnish us with a variety of important stratigraphical and paleontological information. Especially noteworthy is IGO's works on the Fukuji area which are most comprehensive in biostratigraphy and paleontology of the northeastern part of the Hida massif.

IGO divided the Carboniferous and Permian rocks of the Fukuji area into the upper Sorayama [Ht 25] and the lower Ichinotani Group [Ht 27], of which the latter comprises six fusulinacean zones ranging from the zone of *Millerella* to that of *Pseudoschwagerina*. The lowest zone of *Millerella* is about 45 m in thickness and divided into two subzones; namely, the lower *Eostaffella kanmerai* subzone which contains *E. kanmeri* IGO, *Millerella discoidea* IGO, *M. bigemmicula* IGO, and *M.* sp., while the upper *Millerella bigemmicula – Pseudostaffella kanumai* subzone contains *M. bigemmicula* IGO, *M.* cfr. *marblensis* THOMPSON, *M.* sp., *Eostaffella* sp., *Nankinella* cfr. *plummeri* THOMPSON, *N.* sp., *Staffella* sp., *Pseudostaffella kanumai* IGO, and *P. kanumai pauciseptata* IGO. Since many species of corals and brachiopods of the Onimaruan type are found together, the lower sub-

* Because of the similarity of lithology, FUJIMOTO, KANUMA and IGO (1962) revised the definition of the Arakigawa Formation, uniting the Arakigawa Formation of ISOMI and NOZAWA and the Hongo Formation of KAMEI.

zone is correlated without doubt with the Onimaru Stage of the Kitakami massif.

KATO (1959) recently expressed a somewhat different opinion concerning the correlation of the whole zone of *Millerella* of Ichinotani [Ht 27] with the Onimaruan. According to MINATO and KATO (1957), IGO's lower subzone is further divided into two coral subzones, the lower *Siphonodendron hidense* KATO and the upper *Neokoninckophyllum nipponense* KATO. KATO is of the opinion that the former is clearly correlative with the Onimaruan but the latter is, from its faunal aspect, a little younger, being equivalent to the Namurian Stage of the European division. The discussion concerns the fundamental problems of the international correlation of the Carboniferous divisions, and more study in the future will need to be completed before any final conclusion is agreeable.

IGO also correlated the lower subzone (*E. kanmerai* subzone) with the Chesterian of North America, because species of *Millerella* from the subzone show a considerable faunal affinity with those of Chesterian, though there is no common species between them.

The upper *Millerella bigemmicula–Pseudostaffella kanumai* subzone is correlated by IGO with the Ardian of North America. The faunal assemblage of this subzone presents a considerable similarity to that of a part of the Green Canyon Group of Llano Uplift in Texas and New Mexico and of the Keany Formation of Kansas, where species of *Millerella* are associated with those of *Nankinella* and *Pseudostaffella* but species of any higher forms are absent.

It should be noted that the zone of *Millerella* is conformably overlain by the zone of *Profusulinella* in the Fukuji area.

IV. Chugoku massif

1. Atetsu plateau

OKIMURA (1958) reported the probable existence of the zone of *Millerella* in the Atetsu limestone, Okayama Prefecture. The Carboniferous of the Atetsu limestone is named the Mitsudo Group [Swi 33] and divided into two formations, the upper Kodani [Swi 38] and the lower Nagoé [Swi 32]. The former comprises massive limestone in the upper part and alternations of limestone and chert in the lower part. The latter (Nagoé Formation, 135 m) consists of alternations of agglomeratic tuff and limestone-chert in the upper, alternations of schalstein and limestone in the middle, and schalstein in the lower part. OKIMURA first (1958) made the zonation of the Mitsudo Group based on the endothyroids, but in his latest study (1966) he divided the group into the following zones based on the primitive fusulinaceans and smaller foraminifers (in descending order):

Kodani Formation
- 7. *Fusulinella imamurai* zone
- 6. *Profusulinella toriyamai* zone (≒The upper half of the "*Atetsuella*" *meandera* zone)
- 5. *Pseudostaffella antiqua* zone
- 4. *Eostaffella* sp. A zone (≒The uppermost part of "*Endothyra spiroides*" zone+"*E. symmetrica*" zone)

~~~~~~~~~~ disconformity ~~~~~~~~~~
~~~~~~~~~~

Nagoé Formation
- 3. *Mediocris* sp. A zone (≒"*Endothyra spiroides*" zone)
- 2. *Endostaffella delicata* zone (="*Plectogyra primaeva*" zone
  - *E. masanae* subzone
  - *E. breviscula* subzone
- 1. *Endothyra* sp. A zone (≒"*Plectogyra communis* zone)

[Zones in the parentheses are those given by OKIMURA in his first report (1958)]

Through a detailed comparison of the foraminiferal faunal assemblage and characteristics, OKIMURA correlated the zone 1, 2, and the lower part of 3 respectively with the Lower, Middle and Upper Viséan, and the upper half of the zone 3 with the Namurian (Protova horizon) of Russia. Accordingly, this means that only the lower half of the *Mediocris* sp. A zone with its equivalent *M. mediocris* zone in the Taishaku and Akiyoshi limestones is correlated with the Onimaru Formation in the Kitakami massif. Inasmuch as a horizon equivalent to the upper half of *M. mediocris* zone does not exist in the standard area in the Kitakami massif, OKIMURA is of the opinion that this horizon may be referable to the hiatus between the Onimaru and the Nagaiwa Formation. For this part he proposed a new stage name, Ohkuboan, with the type locality at Okubo [Swi 97′] in the Akiyoshi area.

The lower two zones of the Kodani Formation are characterized by the rapid increase of primitive fusulinacean *Eostaffella, Millerella,* etc. and a rapid decrease of endothyroids at the same period of time. This faunal change is very evident and traceable throughout the Chugoku region. These two zones are nearly the same in their faunal constituent, though the *Pseudostaffella antiqua* zone is distinguished from the underlying *Eostaffella* sp. A zone by having *Pseudostaffella antiqua* (DOUTKEVITCH) and "*Atetsuella*" *meandera* OKIMURA. These two zones are referred to as the uppermost part of the *Millerella–Eostaffella* zone of Japan.

The Atetsu limestone has also been studied by SADA (1960, 1961, 1963, 1964, 1965) in greater detail so far as the fusulinaceans are concerned. He referred the Nagoé Formation to the *Endothyra–Plectogyra* zone above which the Kodani Formation of the Lower-Middle Pennsylvanian conformably rests. The latter is divided into the *Millerella bigemmicula–Eostaffella kanmerai* zone, the *Profusulinella toriyamai* zone and the *Fusulinella imamurai* zone in ascending order. SADA (1964) described the following species in his *Millerella bigemmicula–Eostaffella kanmerai* zone: *Millerella inflecta* THOMPSON, *M. bigemmicula* IGO, *Eostaffella kanmerai* (IGO), *E.* spp. A, B, C, and D, and *Pseudostaffella* cfr. *kanumai* IGO.

Comparing the above fauna with the *Millerella* faunas of other areas, SADA (1965) came to a conclusion that the Atetsu fauna is distinguished from both the Onimaru and the Kakisako fauna in specific assemblage but is similar or nearly equivalent to the *Millerella* fauna of the Ichinotani Formation of the Hida massif and the Akiyoshi limestone Group. He is also of the opinion that the *Millerella bigemmicula–Eostaffella kanmerai* zone of the Atetsu limestone is possibly referable to the *Millerella* zone of Chesterian-Morrowan of North America.

2. Oga plateau

The probable existence of the zone of *Millerella* has been reported by YOSHIMURA (1961) in the basal part of the Middle Formation of the Koyama Group [Swi 49] in the Oga area. Although no species of *Millerella* have been reported, *Clisiophyllum awa* (MINATO) has been abundantly found in the limestone immediately above the schalstein of the Lower Formation. YOSHIMURA correlated the lower part of the Middle Formation of the Koyama Group with the Kodani Formation of the Mitsudo Group in the Atetsu limestone.

3. Nakamura limestone

The equivalent of the Koyama limestone in the northwest of Nariwa is called the Nakamura limestone [Swi 54], and a zone of *Millerella* has been found by KANMERA and OTA (1957*) in the lowest part. According to a recent study by OKIMURA (1966), *Endothyra* spp., *Endothyranopsis* spp., *Mediocris mediocris* (VISSARIONOVA), *Palaeotextularia* cfr. *consobrina* LIPINA, *Eostaffella* sp., *Pseudoendothyra* cfr. *spiroides* (ZELLER), etc. are found in the lowest part of the Nakamura limestone. The faunal assemblage shows that the lower part of the Nakamura limestone is correlative with the upper part of the Nagoé Formation in the Atetsu area already mentioned.

YOSHIMURA (1961) is of the opinion that the Nakamura limestone is in fault contact with the underlying Fuka Formation in this area. The latter, which consists of sandstone, clayslate, and their alternation, has been regarded as the Middle Carboniferous.

To the south of Nariwa-machi is developed the Paleozoic complex which is the basement of the Triassic Nariwa Group and has long been called the metamorphic Paleozoic of uncertain age. TERAOKA (1959) has recently divided this Paleozoic complex into the lower semi-schist Formation and the upper Kurohagi Formation [Swi 50]. The latter consists mainly of clayslate about 250 m thick and yields *Lonsdaleoides* cfr. *toriyamai* MINATO, *Millerella marblensis* THOMPSON, *Staffella* sp., *Plectogyra* sp., and *Textularia* sp. TERAOKA referred the Kurohagi Formation to the zone of *Millerella* and the semi-schist Formation to the lowest Pennsylvanian or to the uppermost Mississippian.

4. Taishaku plateau

Taishaku plateau [Swi 59] is well known for the Upper Paleozoic of Southwest Japan. Although a considerable amount of light has been thrown by pioneer workers such as YOSHINO (1937), HANZAWA (1942), FUJIMOTO (1944), and MOCHIZUKI and SENDO (in KOBAYASHI, 1950) on the biostratigraphical side, little is known of the paleontological side of this plateau. The Carboniferous of this plateau is the Taishakugawa Group which was first divided by YOKOYAMA (1957) into the lower Dangyokei and the upper Eimyoji Formation. Later

* KANMERA and OTA (1957): The Carboniferous of Bitchu-machi and its environs, mid-valley of Nariwa-gawa, Okayama Prefecture. *Bull. West. Japan Branch, Geol. Soc. Japan*, (20) [mimeographed].

AKAGI (in FUJIMOTO and IGO, 1958) revised the division of this group, dividing it into three formations, the lower Dangyokei, the middle Eimyoji, and the upper Taishaku Formation which were respectively referred to the zones of *Nagatophyllum-Millerella, Profusulinella,* and *Fusulinella-Fusulina.* HASE (1964) has recently put the division of this group back to its original definition given by YOKOYAMA.

The Dangyokei Formation [Swi 60] consists mainly of andesitic lava flow and "schalstein" with intercalations of limestone lens, and yields *Nagatophyllum satoi* OZAWA, *N.* sp., *Thysanophyllum* sp., *Lithostrotionella taishakuensis* YOKOYAMA, *L.* cfr. *tingi* CHI, *"Dibunophylloides" ofukense* (OZAWA), *Clisiophyllum awa* (MINATO), *Taishakuphyllum rostfer* MINATO, and *Staffella* sp. in the h_1 horizon which is found in the upper part of the formation.

As for the stratigraphical position of the Dangyokei Formation, opinions are diverse among the previous workers. It has been correlated with either the upper Lower Carboniferous [=Upper Viséan=Onimaruan] (FUJIMOTO, 1944) or the lower Upper Carboniferous [Bashikirian=Atetsuan] (MINATO, 1949). YOKOYAMA (1957) regarded his h_1 horizon of the Dangyokei Formation as the upper subzone of the zone of *Millerella* [=Kamitakaran].

Akagi (*op. cit.*) has found that the Tameshige Formation [Swi 56] which is developed in the eastern part of the plateau, contains *Lonsdalleia* sp. and *Clisiophyllum awa* (MINATO). He assumed that the Tameshige Formation laterally dies out and changes into the Dangyokei Formation of the southern part in which prolific *Millerella* fauna occurs, and that the Dangyokei Formation and the Eimyoji Formation (zone of *Profusulinella*) are partly contemporaneous with each other. Thus AKAGI considered that the first appearance of the coral fauna of *Nagatophyllum satoi* and *Clisiophyllum awa* may be younger than the Onimaruan but slightly older than the zone of *Profusulinella* or nearly of the same age.

Since the Dangyokei Formation is clearly lower in the stratigraphical position than the Eimyoji Formation which is referable to the zone of *Millerella* to the zone of *Fusulinella,* and any fusulinaceans which are characteristic to the zone of *Millerella* have not been found in the Dangyokei Formation except in the uppermost part, HASE (1964) has considered that the Dangyokei Formation is referred to the upper Lower Carboniferous.

Through the detailed micropaleontological study on smaller foraminifers, OKIMURA (1966) has recently made the zonation of the Taishakugawa Group as follows:

Eimyoji Formation	6. *Fusulinella biconica* zone
	5. *Profusulinella* sp. zone
	4. *Pseudostaffella antiqua* zone
	3. *Millerella* sp. A zone
Dangyokei Formation	2. *Mediocris mediocris* zone
	1. *Endostaffella delicata* zone

The faunal assemblage and characteristics show that the lower four zones

are certainly correlative with nearly the same four zones in the Atetsu and Akiyoshi limestones. According to OKIMURA's conclusion it should be noted that the lowest *Endostaffella delicata* zone is older than the Onimaruan and is correlated with the Kotsuboan substage of the Lower Carboniferous.

5. Fuchu area

The Fuchu area belongs to the San'yo branch of the Sangun metamorphic zone where the non-metamorphosed Paleozoic develops in the northern part and the weakly metamorphosed Paleozoic rocks occur in the southern part. The former is presumed to superimpose the latter conformably.

HASE (1964) has recently found that small limestone masses of Carboniferous and Middle Permian appear close to the northern margin of the weakly metamorphosed rocks. The former are presumed to be sandwiched into or thrust upon the latter. The limestone exposed at Yakawa [Swi 64], Iseki and Kinbara, all in Sanwa-cho are massive, greyish-white in color, and oolitic. OKIMURA (in HASE, *op. cit.*) identified *Pseudoendothyra* sp. and species of *Tuneritina, Palaeotextularia, Climacammina, Plectogyra, Endothyranopsis,* and *Granuliferella.* Because these small foraminifers bear Viséan aspect and the associated fauna has no species characteristic to the stratigraphically higher fusulinacean zones than the zone of *Millerella,* OKIMURA (*op. cit.*) is of an opinion that these limestones are Viséan in age.

6. Akiyoshi limestone

The basal part of the Akiyoshi limestone Group [Swi 100] is represented by "schalstein" of about 20 m in thickness. TORIYAMA (1957, 1958) has confirmed the existence of the zone of *Millerella,* designating *M.* sp. α zone (Cl). However he did not give a description of its fauna nor clarify the stratigraphical relationship between his Cl zone and the OZAWA's *Nagatophyllum satoi* subzone.

MURATA (1961) has made some contributions to the zonation of the lowest part of the Akiyoshi limestone. He set the *Endothyra* zone (C_I) and the *Millerella* zone (C_{II}) below the *Profusulinella* zone (C_{III}). The former is characterized by *Endothyra* cfr. *symmetrica* ZELLER, *E. spiroides* ZELLER, *E.* sp., *Plectogyra* spp., *Meniscophyllum longiseptata* MINATO, and *Clisiophyllum okuboense* MURATA (MS). Since no species of *Millerella* have been found in this zone MURATA regarded it as being equivalent to *Endothyra symmetrica* zone of the Atetsu limestone (OKIMURA, 1958), referring it to the lower Viséan or to the lower Chesterian to Meramecian. The latter, *Millerella* zone, comprises *M. komatui* IGO, *M. uzurensis* MURATA (MS) mainly in the lower part, *M.* cfr. *marblensis* THOMPSON in the middle and upper, and *Eostaffella* sp. A and *Staffella akagoensis* TORIYAMA in the upper. Besides fusulinaceans, *Nagatophyllum satoi* OZAWA, *Lonsdaleoides enormis* OZAWA, *L. toriyamai* MINATO, *Clisiophyllum awa* (MINATO), *Amigdalophyllum naosoidea* MINATO, *Stylidophyllum* sp., and prolific brachiopod and bryozoan faunas are also found together. It should be noted that the occurrence of *Millerella komatui* IGO is common to the Ichinotani Formation [Ht 27] of the Fukuji area.

Independently of MURATA, OKIMURA (1963) studied the lower part of the Akiyoshi limestone Group, and distinguished five foraminiferal zones based on the smaller foraminifers, but later he (1966) revised his zonation by more detailed study on the primitive fusulinaceans and smaller foraminifers. OKIMURA's latest division in the lower part below the *Profusulinella beppensis* zone is as follows in descending order;

6. *Profusulinella beppensis* zone
5. *Pseudostaffella antiqua* zone
4. *Millerella* sp. A zone { *Eostaffella ikensis* subzone / *Millerella* sp. A subzone }
3. *Mediocris mediocris* zone
2. *Endostaffella delicata* zone { *Eodothyra sumiyae* subzone / *Endothyra similis* subzone }
1. *Endothyra* sp. A zone

The lowest zone consists mostly of schalstein with thin chert and limestone lenses and is characterized by the occurrence of the zone species and indeterminable species of *Tetrataxis* and *Neotuberitina*. It is correlated by OKIMURA with the Maidean substage of the Lower Carboniferous.

The lower subzone of the *Endostaffella delicata* zone is made of oolitic limestone with intercalation of schalstein and chert, and is characterized by the occurrence of *Mikhailovella, Endostaffella delicata* ROSOVSKAYA, *Endothyra similis* RAUSER, *E. omphalota samarica* RAUSER, together with many species of smaller foraminifers. The upper subzone is very similar in lithology and faunal content to those of the lower subzone, but a few new members first appear in this subzone. They are *Endothyra sumiyae* OKIMURA (MS), *E. gigantea* (OKIMURA), *Pseudoendothyra* sp., *Endostaffella parva* (MÖLLER) and other species.

The third, *Mediocris mediocris* zone consists of oolitic limestone with clastic limestone of algal fragments in the upper part. Most characteristic feature of this zone is the occurrence of *Endothyranopsis* having arenaceous shell. In addition to the zone species, many species of *Endothyranopsis, Endothyra, Eostaffella,* and others are found in this zone.

The *Millerella* sp. A zone is divided into two subzones. The lower subzone consists of fine conglomeratic limestone, the faunal contents of which is rather similar to that of the lower zone, though some species are new to this subzone. *Millerella* sp. is the most dominant species in this subzone. The upper, *Eostaffella ikensis* subzone is of reef limestone facies, being characterized by an extreme abundance of the fusulinaceans and total disappearance of *Mediocris mediocris* and *Endothyra ex. gr. bradyi* which are characteristic of the lower zone.

The *Pseudostaffella antiqua* zone (only 5 m in thickness) is composed of massive limestone, having a similar foraminiferal fauna to that of the lower *Millerella* sp. A zone, but is distinguished from the latter by the occurrence of *Pseudostaffella ex. gr. antiqua* and the primitive fusulinacean *Eostaffella* and *Ozawainella* and the first appearance of *Endothyranella*.

OKIMURA considers that only the lower subzone of the *Mediocris mediocris* zone is correlative with the Onimaruan, and the upper subzone with the Ohkuboan

newly proposed by him. The *Millerella* sp. A zone and the *Pseudostaffella antiqua* zone are referred to the Nagaiwan Stage.

MINATO and KATO (1963) described many species of Coelenterata, Bryozoa, and brachiopods which were collected by HASEGAWA from the reddish tuffaceous shale developed below the *Nagatophyllum* zone in the southern margin of Akiyoshi plateau. Putting stress on the fact that the faunule contains no Onimaruan element, they assume that the reddish tuffaceous shale of the Akiyoshi limestone Group is possibly the lowest Namurian in age.

Thus MINATO and KATO (*op. cit.*) and OKIMURA (*op. cit.*) are not in agreement with each other in the dating of the basal part of the Akiyoshi limestone Group. As stated above, OKIMURA regards his *Endothyra* sp. A zone as the Lower Viséan Maidean substage, and the reddish tuffaceous shale under consideration is clearly stratigraphically lower than the *Endothyra* sp. A zone.

The problem has been discussed at length by YANAGIDA (1965) who also did not agree with MINATO and KATO's conclusion. From the reddish tuffaceous shale he found the brachiopod fauna comprising *Rhynchopora* sp., *Setigerites* sp., *Werriea* cfr. *australis* CAMPBELL, *Schuchertella* spp., *Orbinaria* sp., *Eomarginifera* aff. *paradoxa* (CAMPBELL), and *Quadratia* sp. They are too poorly preserved to give the exact stratigraphical age, but the faunal assemblage shows that it is probably assignable to the Lower to Middle Viséan. It is difficult to date them as the Namurian as MINATO and KATO assumed. In the oolitic limestone about 10 m below the reddish tuffaceous shale, YANAGIDA and OTA (in YANAGIDA, 1965) found another brachiopod-coral fauna which contains *Syringothyris* spp., *Schizophoria* cfr. *resupinata, Leptagonia* sp., *Spirifer* spp., *Zaphrentoides* sp., and *Cyathaxonia* sp., and this fauna is dated as the Upper Tournaisian to the Lower Viséan. However, this conclusion does not accord with that of OKIMURA (1966) who insisted that the brachiopod-coral fauna was found in the lower part of his *Endostaffella delicata* zone that is of the lower Middle Viséan. Thus the problem concerning the stratigraphical position of the lower part of the Akiyoshi limestone Group has not yet been settled satisfactorily.

YANAGIDA (1962, 1963, 1965) also described 21 species of 18 genera of brachiopods including one new species each of *Brachythyris* and *Yanishewskiella* collected from the "Uzura" quarry which belongs to the zone of *Millerella*. The faunal assemblage shows that the fauna is closely allied to the upper Viséan brachiopods of Europe, southern Asia and Australia.

Among the non-calcareous formations developed around the Akiyoshi limestone Group, the lower part of the Oda [=Ota] Group [Swi 96] is only referred to the Carboniferous. The name Tsuzumigatake Formation was first given by TORIYAMA (1954) to the lowest part of the Oda Group which consists mainly of chert, but MURATA (1961) who restudied the group proposed the Futagami Formation [Swi 102] in which the Aratakiyama Formation of TORIYAMA was also included. Since MURATA found indeterminable species of *Endothyra, Plectogyra,* and bryozoans including *Fistulipora* and others without any association of fusulinacean, he correlated the formation to the Lower Viséan or to his C_I zone of the Akiyoshi limestone Group. However, as mentioned above, there are still

problems concerning the stratigraphical position of the basal part of the Akiyoshi limestone. Thus the stratigraphical lower limit of the Futagami Formation has not been settled yet. The stratigraphical relationship between the Futagami Formation and the overlying Permian Yaégahara Formation is not exactly known, though MURATA assumed an unconformable relationship because of the presence of conglomeratic or coarse sandstone at the base of the Yaégahara Formation.

V. Outer zone of Southwest Japan

KANMERA (1952) described four species of *Millerella*, two new and two indeterminable, from the Kakisako Formation [Swo 138] of South Kyushu where the existence of the Lower Carboniferous corals had previously been reported. Of the species described by KANMERA, *Millerella japonica* KANMERA is regarded as being conspecific with *M.* sp. described by YABE (1949) from the Kitakami massif, while *M. gigantea* which is large for the genus and somewhat resembles *Eostaffella circuli* (THOMPSON) described from the Belden Formation of the earliest Pennsylvanian age, although the two forms are clearly distinguishable from each other. As KANMERA mentioned the fusulinaceans and corals of the Kakisako Formation are without doubt referred to the Onimaruan.

The Katauchi Formation [Swo 118] of the Usuki area, in which an indeterminable species of *Millerella* was found, is considered by FUJII (1954) to be probably of the Onimaruan.

The Yuzuruha Formation [Swo 132] of the Kuraoka area, consisting of clayslate and sandstone with intercalation of limestone, conglomerate, diabase, and schalstein, is referred by KAMBE (1957) to the Onimaruan. *Millerella* sp., *Diphyphyllum* sp. and cyathophylloid corals are also found in the limestone.

Chapter III. The Zone of *Profusulinella*

I. Kitakami massif

Although the Kitakami massif is the standard area for the Upper Paleozoic of the Japanese Islands, critical discussion on the fusulinacean zones is not adequate in this area. The Nagaiwa Formation [Ka 24], which had long been regarded as the type of the zone of *Fusulinella*, is according to MINATO *et al.* (1953) 710 m in the maximum thickness and rather poor in fossil content. In their H_0 horizon *Fusulinella* sp. was reported with such coral fauna as *Chaetetes* sp., *Thysanophyllum aseptatum* DODROLYUBOVA, *Lithostrotionella* sp., and *Diphyphyllum equiseptatum* YABE and HANZAWA. Accordingly, MINATO *et al.* considered that the H_0 horizon is correlated to the zone of *Fusulinella* with certainty, and at the same time they pointed out that there is a possibility of finding the zone of *Fusulina* and/or *Triticites* in the upper part of the Nagaiwa Formation if its great thickness is taken into account. Nevertheless, ONUKI and YAMADA (1955) distinguished ten fossil zones in the Nagaiwa Formation of the type locality where it attains 460 m in thickness. In the upper eight zones they found species of *Profusulinella, Pseudostaffella, Millerella, Eoschubertella*?, and *Ozawainella*, together with the coral faunas which were already reported by MINATO *et al.*

ONUKI and YAMADA therefore referred the upper eight fossil zones to the zone of *Profusulinella* of the Atokan age, and the lower two zones with species of *Millerella, Thysanophyllum* and *Chaetetes* to the zone of *Millerella* of the Ardian age. They insisted that, in the type area of the Nagaiwa Formation, the fusulinacean zones above the zone of *Fusulinella* are lacking. ISHIZAKI (1964) has recently obtained new information on the ostracod obtained in the limestones of the Nagaiwa Formation. This fauna comprises ten species of six genera most of which are new to science.

II. Hida massif

1. Omi limestone

Although *Profusulinella* had not been found in the lowest division (C_1) of the Omi limestone [Ht 1], recent study by SAKAGAMI (1962) has verified the existence of a zone of *Profusulinella*. According to him, specimens of *Profusulinella* were found in the C1 of KAWADA or the *Millerella*-coral-brachiopod zone of FUJITA (1958). Furthermore KATO and NAKAMURA (1962) reported the occurrence of a goniatite which belongs to *Eoasianites* RUZHENCEV and is comparable to *E. orientale* (YIN) from China. The joint authors are of the opinion that the Bashkirian exists in the C1 of the Omi limestone, and SAKAGAMI's discovery of *Profusulinella* is a positive verification of their age-determination.

2. Fukuji area

Through the continuous efforts of FUJIMOTO and his collaborators, the Paleozoic stratigraphy and paleontology of the Hida massif, central Japan have been much clarified in these years. Especially worthy of mention are IGO's works on the Ichinotani Group [Ht 27]. According to him, the zone of *Profusulinella* in the Fukuji area is named *P. fukujiensis* zone, consisting of dark grey limestone of only 5 m in thickness. Its main component species is the zone species, *P. fukujiensis* IGO, occurring with the accompanying subordinate species of *Millerella* sp., *Eostaffella ampla* (THOMPSON) and *Pseudostaffella* sp.

Paleontological comparison between *Profusulinella fukujiensis* of the Ichinotani Formation [Ht 27] and *P. beppensis* of the Akiyoshi limestone Group [Swi 100] shows that they are very closely allied with each other, and perhaps one and the same species. Therefore both of the zones of *Profusulinella* are regarded to be equivalent in age at least in their main parts. However, in the Akiyoshi limestone Group *Profusulinella beppensis* occurs with *Akiyoshiella ozawai* TORIYAMA, *A.* sp. A, and a primitive form of *Fusulinella,* while in the Ichinotani Formation no representatives of *Akiyoshiella* nor of *Fusulinella* have been found yet. This indicates, therefore, that the upper limit of the zone of *Profusulinella* may be stratigraphically a little higher in the Akiyoshi limestone Group than in the Ichinotani Formation. In this regard the followng facts cannot be overlooked; namely the limestone of the *P. fukujiensis* zone is only 5 m in thickness and is disconformably overlain by the limestone of the *Fusulinella kamitakarensis* zone (IGO, 1961). The disconformity is shown by the development of the residual sharpstone conglomerate in the basal part of the *F. kamitakarensis* zone. The

stratigraphical relationship mentioned above is, as IGO discussed at length, very important to the consideration of paleogeographical and sedimentological condition of this area.

III. Chugoku massif

1. Atetsu plateau

The zone of *Profusulinella* has been ascertained by OKIMURA (1958) to be in the lower part of the upper half of the Kodani Formation [Swi 38] of the Mitsudo Group, which is developed in the northern part of the Atetsu plateau. Although it comprises species of *Profusulinella, Schubertella, Eoschubertella, Fusiella, Pseudostaffella, Millerella,* and *Plectogyra,* paleontological features of this fauna have not been clarified by OKIMURA. SADA (1961, 1964, 1965) who studied the same area set up the *Profusulinella toriyamai* zone in the Atetsu limestone, and described five species of *Profusulinella* together with species of *Nankinella, Staffella* and *Eoschubertella.* The faunal assemblage shows that the zone of *Profusulinella* has much in common with the *Profusulinella beppensis* zone of the Akiyoshi limestone Group, *P. fukujiensis* zone of the Hida massif, and the lower part of the Huanglung limestone of China. It is noted however that some American elements such as *Nankinella plummeri* THOMPSON and *Staffella powwowensis* THOMPSON are mixed with the Tethysian ones.

2. Oga plateau

The Oga plateau and its adjacent areas comprise one of the most important fields for studying the geotectonics of Southwest Japan, and have been studied by many pioneer students. Recent studies of IMAMURA and his collaborators have made many contributions to the geology of this area. In the Oga area [Swi 47], *Profusulinella* sp. and *Plectogyra* sp. were found by YOSHIMURA (1961) in the lower part of the middle formation (250 m) of the Koyama Group. According to him it is difficult to set up the fossil zone in this formaton because of the poor occurrence of fossils. Nevertheless he correlated the lower part of the middle formation with the Kodani Formation of the Mitsudo Group of the Atetsu limestone.

In the Hane area, located to the northeast of the Oga area, a thick limestone formation called the Nakamura limestone [Swi 45] is developed. KANMERA and OTA* believe that the zone of *Profusulinella* exists between the zone of *Millerella* and *Fusulinella* in the lower part of the Nakamura limestone, though the faunal characteristics are not known.

3. Taishaku plateau

YOKOYAMA (1957) recognized five fossil zones in the Pennsylvanian part of the Taishaku limestone, which is called the Taishakugawa Group. The Eimyoji Formation [Swi 59], the upper division of the group, consists of thick massive limestone in which YOKOYAMA's h_2 to h_5 horizons are contained. He referred the

* KANMERA and OTA (1957): The Carboniferous of Bitchu-machi and its environs, mid-valley of Nariwa-gawa, Okayama Prefecture. *Bull. West Japan Branch, Geol. Soc. Japan* (20) (mimeographed).

h_4 to the zone of *Profusulinella* whose constituent species are indetermiable species of *Profusulinella, Pseudostaffella* and *Millerella,* in addition to the coral species, *Lophophyllidium*? sp. and *Chaetetes* spp. However none of the fusulinacean species have been described, and its faunal characteristics are not exactly known. According to FUJIMOTO and IGO (1958), however, the following species are found in the Dangyokei Formation [Swi 60]: *Millerella* sp., *Paramillerella* sp., *Staffella* sp., *Pseudostaffella* sp., *Ozawainella* cfr. *angulata* (COLANI), *O.* sp., *Profusulinella rhomboides* (LEE et CHEN), *P.* sp., *Taishakuphyllum rostfer* MINATO, *Lonsdaleoides toriyamai* MINATO, *Chaetetes* sp., and *Carcinophyllum* sp. Since species of *Profusulinella* are most characteristic, AKAGI (in FUJIMOTO, 1960) assumed that the Eimyoji Formation is of the zone of *Profusulinella.*

4. Jinseki-Yuki area

To the north of Kuregatoge in the Jinseki-Yuku area which is located to the south of the Taishaku area, HASE (1965) found *Profusulinella*-bearing limestone presumed to be in tectonic contact with the Yoshii Group of the non-calcareous facies which is developed widely in this area. Although it exists in the same limestone mass together with that which comprises *Yabeina shiraiwensis,* HASE has suggested an unconformity in the limestone mass which is presumed to be equivalent to the pre-Maki unconformity of IMAMURA (1959).

Another *Profusulinella*-bearing limestone was found by HASE 6 km NW of Yuki-machi which is probably the southern extension of the Taishaku limestone. *Profusulinella rhomboides* (LEE et CHEN) was found at one locality and *P.* sp. and *Fusulinella*? sp. at another. HASE has correlated this limestone with the Eimyoji Formation of the Taishaku area. It is noted that this *Profusulinella*-bearing limestone is overlain by the limestone conglomerate in which *Pseudoschwagerina* sp. is found.

5. Fuchu area

The Pennsylvanian limestones are known to occur nearly parallel to the weakly metamorphosed Paleozoic rocks of Permian age which belong to the so-called "San'yo branch" of the Sangun metamorphic zone (HASE, 1963, 1964). HASE reported indeterminable species of *Profusulinella, Akiyoshiella* (?), *Staffella, Pseudostaffella* (?), and *Eoschubertella* with smaller foraminifers of the Pennsylvanian type in several limestone masses in the environs of Kobatake [Swi 65] and Joé [Swi 66], Sanwa-cho. Thus he referred these limestones to the zone of *Profusulinella* with a possibility of having the zone of *Millerella* in their lower part.

6. Akiyoshi area

Profusulinella beppensis zone was set up by TORIYAMA (1954) as the lowest fusulinacean zone in the Akiyoshi limestone Group [Swi 100], in which, besides the zone species, *P. beppensis* TORIYAMA, *P. rhomboides* (LEE et CHEN), *P.* sp. A*, *Akiyoshiella ozawai* TORIYAMA, *A.* sp. A, *Fusulinella* sp. C, *Nankinella* sp.,

* Restudying this species together with the specimens from the Atetsu limestone, SADA (1961) set up a new species, *P. toriyamai.*

Staffella akagoensis TORIYAMA, and *Eoschubertella obscura* (LEE et CHEN) have also been listed. Having described these species, TORIYAMA (1957, 1958) clarified that the zone of *Millerella* exists below the *Profusulinella beppensis* zone although its fauna has not been described yet. Meanwhile, MINATO and KATO (1957) set up the coral zones in the Pennsylvanian part of the Akiyoshi limestone Group. Of which the "*Dibunophylloides*" *ofukuense* zone is correlated with the *Fusulinella biconica* zone and the upper half of the *Stylidophyllum* sp. subzone of the *Clisiophyllum awa* zone with the *Profusulinella beppensis* zone. To determine the exact stratigraphical range of the *Profusulinella beppensis* zone, as well as its stratigraphical relation with the underlying *Millerella* sp. zone, greater study in the future is necessary.

Except the areas mentioned above there is no place where the formations referable to the zone of *Profusulinella* have been ascertained by exact paleontological evidence. It is probable that the zone of *Profusulinella* will be found in the formations of the so-called "Moscovian", especially in those ranging continuously from the zone of *Millerella* to the zone of *Fusulinella* or higher zones without any stratigraphical break.

Chapter IV. The Zone of *Fusulinella*

I. Kitakami and Abukuma massifs

In these massifs there are no places where the existence of the zone of *Fusulinella* has been confirmed by paleontological evidence. This may be due to strong denudation of the pre-Sakamotozawan (or pre-Wolfcampian) ages.

II. Kwanto massif

The Toriashi hill, situated to the northeast of the Kwanto plain, is for the most part composed of Paleozoic rocks with intrusion of granitic rocks. In the Kasama Formation [Kw 2] of the Toriashi Group *Fusulinella* sp., *Ozawainella* cfr. *angulata* (COLANI), *O.* sp., and smaller foraminifers were reported by FUJIMOTO (1938) from Oizumi [Kw 3], Iwase-machi, Ibaragi Prefecture. He referred the Kasama Formation to the Late Carboniferous, younger than the Moscovian and not younger than the "Uralian".

The main part of the Kwanto massif is one of the classical localities in the study of the Paleozoic geology of Japan. Through the continuous efforts of FUJIMOTO, the stratigraphy of this massif has been greatly clarified. In the valley of Kan'nagawa, the type area of the massif, the following order of succession was set forth by FUJIMOTO (1936) in descending order:

Upper Permian	Kamiyoshida Formation
↑	
Moscovian	Mamba Eormation
	Kashiwagi Formation
	Sakahara Formation

Of the above, the Mamba Formation [Kw 12] of 1700 m thickness consists mainly of schalstein with many intercalation of fusulinacean-bearing limestone

in which FUJIMOTO distinguished five fusulinacean zones.

The lowest zone was named by him *Fusulinella bocki* zone, the component species of which are *F. bocki* (MÖLLER), *F. biconica* (HAYASAKA) and *F. tudai* FUJIMOTO obtained from Futagoyama [Kw 20], Chichibu-gun. According to recent study of TAKAOKA (1966) the *Fusulinella-Fusulina* zone of the Futagoyama limestone comprises *Beedeina ichinotaniensis* (IGO), *B. lanceolata* (LEE et CHEN), *Fusulinella pseudobocki* (LEE et CHEN), and *F. asiatica* IGO. The faunal assemblage shows that the lowest part of the Futagoyama limestone is correlated with the middle part (*Fusulinella asiatica* subzone up to *Beedeina ichinotaniensis* – *B. lanceolata* subzone) of the Ichinotani Formation in the Fukuji area. The *Fusulinella-Fusulina* zone is in tectonic contact with the *Triticites* zone in the Futagoyama area. Besides the above, FUJIMOTO (1936) described and illustrated *Fusulinella irumensis* FUJIMOTO and *F. compressa* FUJIMOTO from several localities in the massif. These species were found with species of *Pseudofusulina* and even with species of *Neoschwagerina*. Hence they are regarded as the derived fossils.

FUJIMOTO also described *Fusulina* (*Beedeina*) *girtyi* (DUNBAR and CONDRA) from Raidenyama [Kw 39] and Unazawa [Kw 36]. Since the species from Raidenyama was reported with schwagerinids, MINATO (1955) was of the opinion that there is a possibility of *Fusulina* (*Beedeina*) *girtyi* being a derived fossil. However, as stated by FUJIMOTO himself, the Raidenyama specimens are extremely poor in preservation, and their generic reference is very questionable. On the other hand, the specimens from Unazawa seem to be not conspecific with the Illinois specimens of *F.* (*B.*) *girtyi*, though both are very closely related with each other, and the latter is seemingly more biologically advanced than the former.

In the Nakatsugawa area [Kw 24], the central part of the Kwanto massif, the lower part of the Ishifune Formation is referred by FUJIMOTO *et al.* (1957) to the Moscovian. They distinguished *Fusulinella bocki* (MÖLLER), *F. pseudobocki* (LEE et CHEN) and *Fusulina quasicylindrica* (LEE) in the formation.

In the south-eastern part of the massif fusulinacean fossils of the Pennsylvanian age are known to occur in several localities, none of which have been described nor illustrated except the fauna described by FUJIMOTO.

The fusulinacean fossils collected by TAKAGI (1944) from the pebbles of the limestone conglomerate of Zengosasu, Shozawa, Ome city [Kw 38] and described by TORIYAMA (1947) contain *Eoschubertella obscura* (LEE et CHEN), *Profusulinella* cfr. *fittsi* (THOMPSON), *Fusulinella* cfr. *pseudobocki* (LEE et CHEN), *Triticites cullomensis* DUNBAR and CONDRA, and *T.* cfr. *powwowensis* DUNBAR and SKINNER. The age of the limestone conglomerate of Zengosasu was first considered by TORIYAMA to be Moscovian rather than early Uralian, though he correlated it with the Sakuradani conglomerate [Swo 50] of Shikoku. However, this was not correct. It may be at least the post-Hikawan in age, because the two last named species of *Triticites* are known to associate with species of *Pseudofusulina* in other localities in the Kwanto massif.

III. Hida massif and Tamba zone

1. Omi limestone

The Omi limestone [Ht 1] is one of the classical localities in the study of the Paleozoic stratigraphy of Japan. HAYASAKA (1918, 1921, 1924) first set the *Fusulinella* zone in the thick, massive limestone complex and described "*Neofusulinella*" *biconica* with many species of brachiopods. KAWADA (1954) and FUJITA (1958) studied the stratigraphy and geologic structure of this area in some detail, but their paleontological study has not yet been published.

According to KAWADA, his division C2 of about 400 m thick is correlated with zone of *Fusulinella*, the characteristic species of which are *F. bocki* MÖLLER, *F. biconica* (HAYASAKA), and *Fusulina* (*Beedeina*) cfr. *girtyi* (DUNBAR and CONDRA). The last named species, which is restricted in stratigraphical occurrence to the upper part of the KAWADA's C2 formation, is not found in FUJITA's C_2 zone. Although there is no evidence to verify the stratigraphical break in the thick limestone, the C2 of the zone of *Fusulinella* is directly overlain by the C3 of the zone of *Triticites*. In the latter, *Fusulinella* cfr. *bocki* MÖLLER is still existing in association with many species of *Triticites* most of which seem to be component species of the Lower Permian Sakamotozawan, rather than of "Uralian" Hikawan. Is there a Kurikian zone of *Fusulina* or *Beedeina* in this area? This question remains unsolved.

2. Fukuji and Nyukawa areas

The zone of *Fusulinella* is well developed in the Fukuji area of the Hida massif. KAMEI (1952) first carried out the stratigraphical study on the Kansaka limestone [Ht 24] and later IGO (1956, 1957) published detailed stratigraphical and paleontological studies of the Ichinotani Formation.

According to KAMEI the following fusulinacean species are found in the Kansaka limestone, though the fossils are not well preserved: *Fusulinella bocki* (MÖLLER), *F.* sp., *Textularia* cfr. *gibbosa* D'ORBIGNY, Dibunophylloid and Camorphylloid corals.

The Ichinotani Formation [Ht 27], developed west of Fukuji, contains a zone of *Fusulinella* of about 150 m thickness in its middle part, and is divided by IGO into two subzones. The lower *Fusulinella kamitakarensis* subzone comprises only *F. kamitakarensis* IGO and *Staffella powwowensis* THOMPSON, of which the former is more primitive in shell character and smaller in size than *F. simplicata* TORIYAMA which is known from the lower part of the Cmβ zone of the Akiyoshi limestone Group. Biologically speaking, *F. kamitakarensis* is seemingly the most primitive species of the genus hitherto known in Japan.

The upper *Fusulinella asiatica* subzone is characterized by the association of various species of *Fusulinella* and some primitive genera. All the species of *Fusulinella* in this subzone are more advanced than *F. kamitakarensis* IGO which is characteristic of the lower subzone. IGO emphasized the occurrence of *F.* cfr. *gracilis* KANMERA in the upper part of the *F. asiatica* subzone. However, the said species is, according to KANMERA (1952), characteristic of the *Fusulina ohtanii* subzone (the lower subzone of the zone of *Fusulina*) of the Yayamadake

Group [Swo 136] of South Kyushu. It is not improbable that the *Fusulinella asiatica* subzone of the Hida massif contains a part which may be equivalent to the *Fusulina ohtanii* subzone of South Kyushu, although more study is needed to determine the stratigraphical range of the species under consideration.

It is also noted that *Fusulinella jamesensis* THOMPSON, PITRAT and SANDERSON is the typical member in the lower part of the *F. asiatica* subzone. This species was originally reported from the Cache Creek limestone of central British Columbia in association with *Akiyoshiella toriyamai* T. P. and S. The joint authors (1953) distinguished three groups of specimens and stated that it is possible, but not probable, that these three groups of specimens are representatives of the same species. The second group in which the holotype specimen is included closely resembles *Fusulinella simplicata* TORIYAMA of the Akiyoshi limestone Group [Swi 100], although the spirotheca is much thinner and the proloculus is larger in the latter. *F. jamesensis* of the Hida massif is also referred to the second group of the British Columbian form.

Recent study of IGO (1960, 1961) on the red-purple shale intercalated in the limestone of the Ichinotani Formation [Ht 27] is noteworthy. He found that the red-purple shale is a non-marine bed which was re-deposited secondarily in a lake basin. He also pointed out the disconformity beneath the zone of *Fusulinella* in this area.

In short, the zone of *Fusulinella* of the Ichinotani Formation is very important in the study of the Middle Carboniferous stratigraphy and paleontology of Southwest Japan because of its faunal characteristic and sedimentary features.

The Arakigawa Formation [Ht 22] which is developed in the Hongo area consists mainly of schalstein with limestone lenses. *Fusulinella* sp. was once reported by SHIBATA (in FUJIMOTO *et al.*, 1962) from the crystalline limestone of 30 m thickness found at Matsumoto, northeast of Takayama city. Corals, brachiopods and trilobites are also found in this formation (FUJIMOTO *et al., op. cit.*).

In the northern part of Nyukawa-mura, which is located to the east of Takayama city, the Nakahata Formation [Ht 34] is limited in its distribution. According to ISOMI and NOZAWA (1957) it consists of clayslate and lenticular limestone in which *Fusulinella* cfr. *pseudobocki* (LEE et CHEN), *F.* cfr. *bocki* MÖLLER, and *Fusulina* cfr. *cylindrica* FISCHER de WALDHEIM were found by the joint authors.

ISHIZAKI (1963) recently described *Eoschubertella obscura* (LEE et CHEN), *Fusulinella* aff. *elegantula* ISHII, *F.* cfr. *rhomboides* (LEE et CHEN), *F. jamesensis* THOMPSON, PITRAT and SANDERSON, and *Protriticites nakahatensis* ISHIZAKI from the same formation. *F. jamesensis* is, according to him, conspecific with some of the species previously reported as *Fusulinella pseudobocki* (LEE et CHEN). He also states that the Nakahata Formation appears lenticular in shape, squeezed out along or with the sheared zone in the extensively developed Permian Junigatake Formation. It is therefore not practical to discuss the stratigraphical relationship between the *Protriticites* zone of Ishizaki and the under- or over-lying fossil zone. The material on which his new species *Protriticites nakahatensis* is based is not enough for detailed micropaleontological discussion.

Southwest of Takayama city in the boundary area of the Mino and Hida provinces, the Upper Paleozoic rocks are collectively called the Nohi Group and have been studied in detail by KANUMA (1952, 1953, 1958, 1959). He divided the Nohi Group into two formations, the upper Oppara [Ht 40] and the lower Akiyama [Ht 41]. Although *Fusulinella bocki* MÖLLER and *F. pseudobocki* (LEE et CHEN) were described by KANUMA (1953) from the lower fossil zone of the Akiyama Formation, the lower part of the formation was referred by him to the Kurikian Stage. However, it is perhaps true that the lower half of the Akiyama Formation is correlative with the *Fusulinella asiatica* subzone of the Fukuji area, and also with the Cmβ zone of the Akiyoshi limestone of the Chugoku massif.

3. Kamianama area

The Ashidani Formation [Ht 74] is developed in the Nojiri area, Kamianama and is divided into two members, the lower schistose sandstone and the upper phyllite. Conglomerate, schalstein and limestone are intercalated in the latter (KAWAI, HIRAYAMA and YAMADA, 1957). Although the occurrence of *Fusulinella* sp. in the limestone exposed in Ashidani valley gives the Akiyoshian age to the Ashidani Formation, the stratigraphical relationship is not known because of fault contact between this formation and the Silurian Kamianama Group [Ht 75], Permian Nojiri Formation [Ht 73] and the Jurassic Tetori Group.

4. Nishitani area

The Akyu Formation [Ht 78] (1400 m) in the Nishitani area consists mainly of schalstein with intercalation of limestone in which *Fusulinella pseudobocki* (LEE et CHEN) and *F.* cfr. *bocki* MÖLLER were reported by KOBAYASHI (1954). The Akyu Formation is in contact with the over- or under-lying formation by fault relation.

The Akyu, Kumokawa and Ananori Formations of KOBAYASHI (1954), each of which is in fault contact with the other, were dated by KAWAI, HIRAYAMA and YAMADA (1957) to the Permo-Carboniferous. Their Fujikuradani Formation, from lithological and structural aspects, is regarded as the Permian with a possibility of being part of the Carboniferous.

The Isetoge Formation [Ht 76] developed in the upper valley of Kuzuryugawa is the equivalent to the Akyu Formation mentioned above. It consists mainly of black-grey to grey limestones with black shale, attaining a thickness of 70 to 80 m. FUJIMOTO *et al.* (1962) reported *Fusulinella* cfr. *biconica* (HAYASAKA), *F. jamesensis* T.P. and S., *Eoschubertella* sp., *Fusiella* sp., *Millerella*? sp., *Fusulina* sp., and *Campophyllum* sp. The stratigraphical relationship is mostly in fault contact with the surrounding rocks, but at Isetoge the formation is overlain

---

* In the Ashidani Formation, *Fusulinella pseudobocki* (LEE et CHEN) and *F.* cfr. *bocki* MÖLLER were reported by KAWAI (1964) and previously found by KOBAYASHI (1954) in the Akyu Formation.

** Most of the Akyu Formation of KOBAYASHI was included into the Permian Nojiri Formation by KAWAI, HIRAYAMA and YAMADA (1957).

unconformably by the Lower Permian Oboradani Formation.

5. Imajo area

The Nanjo Group and its equivalent unnamed formations are distributed to the southeast of Imajo. According to ISOMI (1955) the Yunoo Formation [Ht 82], consisting of alternation of sandstone and shale with intercalation of chert and limestone yields *Fusulinella bocki* MÖLLER, and its equivalent unnamed formations contain rather prolific *Fusulinella* faunule comprising *F. pseudobocki* (LEE et CHEN), *F. schwagerinoides* (DEPRAT), *F.* cfr. *colanii* (LEE et CHEN), *F. biconica* (HAYASAKA) and *F.* spp. with fragments of *Fusulina*? sp. Although these formations have been referred by ISOMI to the upper Middle Moscovian, further detailed study is seemingly necessary.

6. Upper valley of Ibigawa-Tokuyama and Sakauchi areas

In the northwestern part of Gifu Prefecture, the Paleozoic rocks are developed in Tokuyama and Sakauchi areas and have recently been studied by KAJITA (1963) who divided them into the Tokuyama and the Sakauchi Formation.

The Tokuyama Formation [Ht 52] (7000 m), consisting mainly of graywacke sandstone with chert and siliceous slate, is correlated to the Nanjo Group of the Imajo area based on the striking similarity in facies. KAJITA pointed out that the formation is referable to the Permian Neo facies of Hida massif (IGO, 1960). Thus he inferred that the Tokuyama Formation ranges from the Upper Carboniferous to the Lower Permian, although no fossils have been found in this formation.

The Tokuyama and the Sakauchi Formation are of the tectonic relation, though they might have been conformable with each other (KAJITA, *op. cit.*).

7. Ibukiyama area

In the east of Ibuki massif, the Upper Paleozoic rocks are rather widely developed. SEKI (1939) referred the lowest division, the Otaki Formation [Ht 62], to the Middle Carboniferous in which *Fusulinella* cfr. *biconica* (HAYASAKA) and *Staffella* sp. were reported with *Nagatophyllum satoi* OZAWA and *Chaetetes* sp. Having found that a part of SEKI's Otaki Formation is not Carboniferous, but Permian in age, ISOMI (1953) restricted the formation to the Carboniferous part and found *Fusulinella biconica* (HAYASAKA) and *F.* sp. with coral species such as *Clisiophyllum awa* (MINATO), *Nagatophyllum satoi* OZAWA and *Lithostrotion* cfr. *somaense* YABE and HAYASAKA in four separated localities in Oishi [Ht 63] and Otaki [Ht 62], Tarui-machi.

Having studied the same area, KANUMA, TAKAHASHI and MORI (1961) presented the different results concerning the stratigraphical age of the Otaki Formation and the stratigraphical relationship between the Oishi and Otaki Formations. According to them the Otaki Formation is not referred to zone of *Fusulnella* but is referable rather to the zones of *Fusulina* and *Triticites*. The joint authors are of the conclusion that the Otaki Formation is conformably overlain by the Oishi Formation [Ht 63] of Lower Permian.

IV. Chugoku massif

The central part of the Chugoku province is an important area for studying the Upper Paleozoic of Japan where a rather thick limestone predominates in the facies (KOBAYASHI's para-Akiyoshi facies). Although our knowledge on the stratigraphical side of this region has been greatly increased in the past few years, the paleontological side has been studied only a little.

1. West-central part of Hyogo Prefecture

In the central part of Hyogo Prefecture, the Upper Paleozoic rocks are found in several separated areas, most of which are lithologically referred to as the Yamaguchi facies of KOBAYASHI. The Hikami Formation [Swi 12], developed to the northwest of the Ikuno mine, is composed of grey-black phyllitic clayslate with intercalations of green-grey phyllitic clayslate, sandy clayslate, sandstone, chert, and limestone. Since HIROKAWA, TOGO and KAMBE (1954) reported *Fusulinella* sp. from small limestone lens exposed at Nakayashiro [Swi 13], Yamaguchi-mura, Asaki-gun, a part of the formation is at least referable to the Akiyoshian. Further details are not known on the stratigraphy of this formation and its relationship with other Paleozoic formations.

The Mikazuki Formation [Swi 25] developed near the prefectural boundary between Hyogo and Okayama is composed mainly of phyllite and sandstone with association of clayslate, chert and diabase. Although no positive evidence for the geological dating has been obtained, the Mikazuki Formation is correlated wth the Hikami Formation because of the similarity in lithological characteristics (KAMBE and HIROKAWA, 1963).

2. Atetsu plateau

IMAMURA and his collaborators have made many contributions to clarify the geology of this area. IMAMURA, SADA and OKIMURA (in IMAMURA, 1959) revised the stratigraphic division of this area by assigning the Mitsudo, Sabushi and Yukawa Groups for the Lower to Middle Carboniferous, Lower to Middle Permian, and Middle to Upper Permian, respectively.

The Kodani Formation [Swi 38], the upper division of the Mitsudo Group, is equivalent to the lower part of the Toyonaga Formation [Swi 39] of KOBAYASHI and MOCHIZUKI (1938). OKIMURA (1958) and IMAMURA (1959) proved that the zone of *Fusulinella* is developed in their Kodani Formation, which was named *F. imamurai* zone by SADA (1964, 1965) who described four species—*F. imamurai* SADA, *F.* n. sp. (?) cfr. *subrhomboides* LEE et CHEN, *F. hirokoae* SUYARI, and *F.* sp. A from that zone together with a primitive species of *Fusulina*. The faunal assemblage and characteristics show that the *F. imamurai* zone of the Atetsu limestone is certainly correlated with the *F. biconica* zone of the Akiyoshi limestone Group.

3. Oga plateau

The Koyama limestone [Swi 49] developed in the southern part of the Oga plateau was regarded by KOBAYASHI (1950) as having the zone of *Fusulinella* in

the basal part. According to IMAMURA (1959) and YOSHIMURA (1961) the Koyama limestone Group (560 m+) yields *Plectogyra* faunule in the lower formation, and the *Clisiophyllum awa* faunule and the *Fusulinella* faunule in the lower part of the middle formation. KANMERA and OTA* also found the zones of *Millerella, Profusulinella* and *Fusulinella* in the lower and middle parts of the Nakamura limestone [Swi 45] in the northern part of the Oga plateau which is regarded by KOBAYASHI as a whole as Permian. Although no species have been described it is noted that the zone of *Fusulinella* is directly overlain by the zone of *Pseudoschwagerina* in the Koyama and the Nakamura limestone as well as in the Kodani Formation of Atetsu plateau.

4. Taishaku plateau

The Upper Paleozoic rocks of the Taishaku area [Swi 59] were formerly studied by HANZAWA (1941) and FUJIMOTO (1943), and FUJIMOTO and HARA (1951). FUJIMOTO reported 51 species of 17 genera from 61 localities although none of them has been described. He recognized six fossil zones, the lower second of which was assigned the zone of *Fusulinella,* yielding *Profusulinella rhomboides* (LEE et CHEN), *Fusulinella bocki* MÖLLER, *Eoschubertella obscura* (LEE et CHEN), *Fusiella* aff. *typica* LEE et CHEN, and *Ozawainella angulata* (COLANI). YOKOYAMA (1959) also recognized the development of the zone of *Fusulinella* in this area in his recent studies. He divided the Carboniferous Taishakugawa Group into two formations, the lower Dangyokei [Swi 60] and the upper Eimyoji [Swi 59], the upper part of the latter was referred to the zone of *Fusulinella.* On the other hand FUJIMOTO and IGO (1958) further divided the upper division into the Eimyoji and the Taishaku Formation.

5. Akiyoshi plateau

The Akiyoshi limestone Group [Swi 100] is easily one of the best displays of the zone of *Fusulinella* in Southwest Japan. TORIYAMA's biostratigraphical study (1954) on this group shows that there is a possibility of dividing the *Fusulinella biconica* zone of this group into two subzones, the upper characterized by the association of *Fusulinella biconica* and *Fusulina akiyoshiensis,* and the lower by *Fusulinella simplicata.*

6. Handa limestone

The Handa limestone [Swi 79], which is located about 25 km northeast of the Akiyoshi limestone, contains the *Fusulinella* fauna in its lower part which was named by KAWANO (1961) *Fusulinella eopulchra* zonule. It is characterized by *F. eopulchra* RAUSER-CHERNOUSSOVA and *F. pseudobocki ovoides* RAUSER-CHERNOUSSOVA, with *Fusulina* sp., all of them have been described by him (1962) in detail. He correlated this faunule with the *Fusulinella biconica* zone (Cmβ) of the Akiyoshi limestone Group though there are no common species.

---

* See footnote of page 63.

V. Outer zone of Southwest Japan

A. Shikoku

It is well known that the zonal arrangement of the strata of the Outer zone of Southwest Japan is well represented in the southern half of Shikoku, where the formations range from Silurian to Permian, together with Mesozoic rocks of various ages, display complicated structure in the Chichibu terrain*. In spite of great efforts by many previous workers, there still remain unsolved problems concerning the geology of this part of the island. From the micropaleontological standpoint, our knowledge of the Paleozoic foraminifers is still poor.

Three structural zones (or belts) are generally recognizable in the eastern part of the Chichibu terrain of Shikoku. The northern one consists of Paleozoic formations, the central one is that in which Upper Paleozoic rocks and Mesozoic rocks ranging from Triassic to Cretaceous are repeatedly exposed, being separated by various types of faults, and the southern one consists of the Sambosan Group of Pennsylvanian to Triassic age.

According to ISHII *et al.* (1955) the characteristics of Paleozoic rocks in each zone are summarized as follows:

Northern zone: The Paleozoics range from Pennsylvanian to Upper Permian in age. The existence of Upper Permian Yasuba Formation [Swo 64] is characteristic. Structurally speaking, they often display very gentle basin or dome structure.

Central zone: The Paleozoics range from Pennsylvanian to the middle Middle Permian in age, though partly including Upper Permian. The Lower Permian Onji Group of conglomeratic facies and the middle Middle Permian Nomura Group of tuffaceous breccia facies are characteristic of this zone. In structure, the Paleozoics form typical zonal arrangement with mostly northward dip of moderate to high angles. Deformation and metamorphism seen in the Paleozoics differ in grade from those in the Mesozoics.

Southern zone: This is called the Sambosan zone in which continuous strata of chert and limestone are seen. The Paleozoics range from at least the Middle Pennsylvanian to upper Middle Permian. From the structural standpoint there is no difference in the grade of deformation and metamorphism between Permian and Mesozoic rocks as recognized in the field, but not so between Pennsylvanian and Permian rocks.

The tectonic line (or belt) that divides the northern and the central zone is called the Kurosegawa tectonic line or the Otaru–Suita tectonic line (SUYARI, 1961), and that which divides the central and the southern zone is the Uonashi-Kambaradani thrust or the Kambaradani-Iwagai tectonic line (SUYARI, *op. cit.*).

SUYARI's recent study (1961) has contributed much to the geology and paleontology of the Chichibu terrain of Shikoku. Based on the fusulinaceans he distinguished the following fusulinacean zones in ascending order: *Fusulinella-Fusulina, Triticites, Pseudoschwagerina, Schwagerina, Misellina, Yabeina-Neoschwagerina,* and *Lepidolina* zones.

---

* SUYARI (1961) called it the "Tosa structural belt".

SUYARI divided his *Fusulinella-Fusulina* zone into the lower *Fusulinella bocki – F. prolifica* and the upper *F. hirokoae* subzone. Considering the faunal characteristics, he correlated the lower subzone with the *Fusulinella biconica* zone of the Akiyoshi limestone, the greater part of the *F. asiatica* subzone of Fukuji and the Itadorigawa Formation of West Shikoku, and the upper subzone with the *Fusulina* zone of Yayamadake limestone or the upper part of the *Fusulinella asiatica* subzone plus *Fusulina* zone of Fukuji.

1. Sakuradani area

TORIYAMA (1944) described the Pennsylvanian fusulinaceans collected by KOBAYASHI from the limestone conglomerate found at Sakuradani [Swo 50], Tokushima Prefecture. This was named the Sakuradani conglomerate and yields *Ozawainella angulata* (COLANI), *Fusulinella bocki* MÖLLER, *F. colanii* (LEE et CHEN), *F. compressa* (OZAWA), *Fusulina konnoi* OZAWA, *F. lanceolata* LEE et CHEN. Since all the specimens of these species were found in the pebbles of the limestone conglomerate, the age of the conglomerate could not be determined beyond that it was Moscovian or post-Moscovian. However, it has been shown that the Sakuradani conglomerate is a member of the Middle Permian Hisone Group developed in the central zone of the Chichibu terrain (SUYARI, 1956, 1958). ISHII *et al.* (1953) also reported *Fusulinella* sp. from Sakuradani which is presumed to be derived from the Paleozoic rocks of the northern zone.

2. Daigo area

The Daigo Group [Swo 42], with the type locality at the vicinity of Daigo, Anan city, Tokushima Prefecture, is developed in the southern zone of the Chichibu terrain. It contains the zone of *Fusulinella-Fusulina* in the lower part which was named by SUYARI (1961) the *Fusulinella bocki – F. prolifica* subzone. However, in the Daigo Group one of the subzone species, *F. prolifica* is unknown. *F. prolifica* is a constituent species of the *Fusulinella-Fusulina* zone of the Shogase Formation in which it occurs with species of *Fusulina*. Therefore, most of the *F. bocki – F. prolifica* subzone is referable to the zone of *Fusulina* rather than to the zone of *Fusulinella*.

3. Itadorigawa area

ISHII (1956) carried out detailed biostratigraphical study on the Itadorigawa Formation [Swo 103] of Ehime Prefecture. According to him the Itadorigawa limestone of about 22 m thickness is divided into three fossil zones, It_1, It_2, and It_3. On the order of succession of species of *Fusulinella* and *Fusulina* through the three fossil zones and on the faunal association in them, ISHII emphasized the fact that although the fossil zones It_1 and It_3 are characterized by the primitive species of *Fusulinella*, the intermediate It_2 is dominated by such cylindrical form of *Fusulina* having strong septal fluting as *F. kanmerai* ISHII, *F. regularis* ISHII and *F. elliptica* ISHII. Having studied this fauna with other Middle Pennsylvanian fusulinaceans known in Japan, ISHII (1958) expressed an opinion that species hitherto regarded as *Fusulina* can be grouped into two

genera, namely *Beedeina* (*Fusulina girtyi* DUNBAR and CONDRA and its allies) and *Fusulina auct.* (*Fusulina cylindrica* FISCHER de WALDEHEIM and its allies), and that *Fusulina* thus defined appeared in the Eurasian realm as early as *Fusulinella* with the stratigraphical range covering at least whole Moscovian stage, while *Beedeina* appeared later in the later half of the Moscovian. ISHII's conclusion is worthy to note and implicative in that the phylogenetical development of fusulinaceans cannot be considered without due regard to paleogeographical development.

B. Kyushu

In Kyushu Islands, rocks referred to the zone of *Fusulinella* with concrete paleontological evidence are very few in distribution. In the valley of Kumagawa, South Kyushu, the Amatsuki Formation [Swo 150] is known to be the Middle Pennsylvanian in age from which KANMERA (1952) and MATSUMOTO and KANMERA (1964) reported *Fusulinella bocki* MÖLLER, *F.* sp., *Profusulinella* (?) sp., *Staffella* sp., and *Chaetetes* sp., none of which have been described. The stratigraphical relationship between the Amatsuki Formation and over- or under-lying rocks is not known because they are in tectonic contact in field.

Chapter V. The Zone of *Fusulina*

I. Kwanto massif

In the standard area of the Kannagawa valley, the lower part of the Mamba Formation [Kw 12] has been inferred by FUJIMOTO (1960) to cover the Moscovian and "Uralian", but there is no paleontological evidence to verify the presence of the zones of *Fusulina* and *Triticites*. The zone of *Fusulina* has been ascertained only in the Nakatsugawa area where the Ishifune Formation [Kw 24′] of about 750 m thickness is assumed to be Moscovian in age. The zone of *Fusulina* which is found between the zones of *Fusulinella* and *Triticites* yields *Ozawainella angulata* (COLANI), *Staffella pseudosphaeroidea* DOUTKEVITCH, *Eoschubertella* sp., *Fusulina* (*Fusulina*) *quasicylindrica* (LEE), *F.* (*F.*) cfr. *fava* (LEE et CHEN), *Fuslina* (*Beedeina*) *cheni* IGO, *F.* (*B.*) cfr. *girtyi* (DUNBAR and CONDRA) and *Fusulinella* sp. (FUJIMOTO and IGO, 1958).

Besides the above, *Fusulina* (*Beedeina*) *girtyi* (DUNBAR and CONDRA) was described by FUJIMOTO from the limestone of Unazawa [Kw 36] which is intercalated in the alternation of sandstone and shale of about 200 m thickness in the Shiromaru Paleozoic zone [Kw 37] of FUJIMOTO. The stratigraphical and paleontological remarks on this species were given in the preceding chapter (p. 66). *Fusulina cylindrica* FISCHER de WALDHEIM was also reported by KOBAYASHI *et al.* (1943) from the same locality of Unazawa.

Fusulina (*Beedeina*) *girtyi* (DUNBAR and CONDRA), *F.* (*B.*) *schellwieni* (STAFF) and *F.* (*B.*) sp. were found by SAKAGAMI (in FUJIMOTO, MORIKAWA and FUJIYAMA, 1955) near Ome city, southern part of the Kwanto massif, but none of them have been described.

The Kasama Formation [Kw 2] (1400 m) may, in part, be equivalent to part

of the Kurikian, although no paleontological evidence has been found to support this statement.

II. Hida massif and Tamba zone

1. Fukuji area

One typical display of the zone of *Fusulina* in Japan is seen in the Ichinotani Group [Ht 27] of the Hida massif. IGO (1958) gave a definition of the zone of *Fusulina* in this area and regarded the first appearance of the genus *Fusulina* as the lowest limit of the zone. According to him there is no stratigraphical hiatus between the zone of *Fusulina* and the underlying zone of *Fusulinella*. IGO's division and component species are as follows in descending order:

Fusulina (*Beedeina*) *lanceolata* – *F.* (*Beedeina*) *ichinotaniensis* subzone: *Ozawainella angulata* (COLANI), *Nankinella* sp., *Staffella* sp., *Fusiella typica* LEE et CHEN, *F. hayashii* IGO, *F. inouei* IGO, *Pseudostaffella sphaeroidea* (MÖLLER), *Hidaella kameii* FUJIMOTO and IGO, *Fusulina* (*Beedeina*) *lanceolata* (LEE et CHEN), *F.* (*B.*) *cheni* IGO, *F.* (*B.*) *ichinotaniensis* IGO, *F.* (*B.*) *ichinotaniensis rotunda* IGO, *F.* (*B.*) cfr. *girtyi* (DUNBAR and CONDRA), and *F.* sp.

Fusulina (*Fusulina*) *fujimotoi* subzone: *Millerella* sp., *Ozawainella angulata* (COLANI), *Fusiella typica* LEE et CHEN, *Eoschubertella lata* (LEE et CHEN), *Fusulinella asiatica* IGO, *F.* sp., *Fusulina* (*Fusulina*) *fujimotoi* IGO, and *F.* sp. A

IGO pointed out a conspicuous difference between the two subzones stating that the upper subzone is characterized by the occurrence of various species of relatively large *Fusulina*, *Pseudostaffella sphaeroidea*, aberrant *Hidaella*, and advanced representatives of *Fusiella* and being entirely void of *Fusulinella*.

It is also noted that the subzone species of the upper subzone, *Fusulina* (*Beedeina*) *ichinotaniensis* IGO, is very similar to *F.* (*B.*) *akiyoshiensis* TORIYAMA which is only a single known species of the genus *Fusulina* in the upper part of *Fusulinella biconica* zone of the Akiyoshi limestone Group [Swi 100] of Southwest Japan.

As IGO stated there is a rather striking difference between the fauna of the zone of *Fusulina* of the Hida massif and that of the Yayamadake limestone [Swo 136] of South Kyushu, even though the two faunas may be equivalent in age. Therefore IGO is of the opinion that two groups of *Fusulina* of Hida and South Kyushu might have been derived from different ancestors, being polyphyletic in origin and evolved in parallel.

2. Itoshiro area

In the Itoshiro area [Ht 70] located in the southeastern part of Fukui Prefecture, KONISHI (1954) described *Fusulina* sp. A and *F.* sp. B cfr. *F. lanceolata* (LEE et CHEN) with three species of *Caninia* from the Shimozaisho alternation of limestone and clayslate (250 m) [Ht 71], referring them to the Moscovian in age. They are not adequate for detailed paleontological study due to the unfavourable state of preservation, but their occurrence is important to verify the existence

of the zone of *Fusulina* even in the Hida gneiss terrain.

IGO's recent discovery of *Diphyphyllum* cfr. *delicutum* MINATO and KATO from the Shimozaisho limestone is a positive, though not decisive, evidence for the dating of the limestone to the Moscovian.

3. Nyukawa area

In the central part of the Hida massif the Carboniferous rocks are known to occur in several separated areas. The Nakahata Formation [Ht 34], consisting of clayslate and lenticular limestone, is referred by ISOMI and NOZAWA (1957) to the zone of *Fusulina* because of the faunal assemblage of *Fusulinella* cfr. *pseudobocki* (LEE et CHEN), *F.* cfr. *bocki* MÖLLER, and *Fusulina* (*Fusulina*) cfr. *cylindrica* FISCHER de WALDHEIM. Prior to ISOMI and NOZAWA, TAKANO (1951, 1952, 1956) reported the occurrence of *Fusulinella compressa* OZAWA, *F. acuminata* THOMPSON, *F. pseudobocki* (LEE et CHEN), *F. furnishi* THOMPSON, and *F.* sp., but none of them were described. Although it is said that *F. acuminata* and *F. furnishi* are respectively conspecific with the American species, it is noticeable in paleogeographical consideration if they are truely conspecific. TAKANO correlated them to the zone of *Fusulinella*. ISOMI and NOZAWA also emphasized the occurrence of a "peculiar form" of fusulinacean, which is intermediate in shell characters between *Fusulina* and *Schwagerina*, having a rather large shell, thin spirotheca, and strong septal fluting. According to them the spirothecal structure of this form is "*Fusulinella* type" in the early stage of growth but becomes to "*Schwagerina* type" at least in the late stage. The true nature of this form is stil not known since they have not been described in detail nor illustrated yet.

4. Hachiman area

The Akiyama Formation [Ht 41] of the Nohi Group in the southwestern part of the Hida massif was referred to the zone of *Fusulina* by KANUMA (1953, 1958, 1959) who described *Fusulinella bocki* MÖLLER, *F. biconica* (HAYASAKA), *F. colanii* LEE et CHEN, *Fusulina quasicylindrica* (LEE), and *Wedekindellina* (?) *hidensis* KANUMA. Of these species, the last named one is, as already pointed out by KANUMA (1954), closely related to *Wedekindellina prolifica* KANMERA which is the characteristic species of the *Fusulina* (*Beedeina*) *higoensis–Wedekindellina prolifica* subzone of the Yayamadake limestone of South Kyushu. However, KANUMA's specimens are so insufficient that a more detailed comparison is not advisable here, though there is a possibility that these two species are conspecific with each other.

5. Akasaka area

Although the Otaki Formation [Ht 62], developed about 5 km west of Akasaka, was referred by ISOMI (1955) to the zone of *Fusulinella*, KANUMA, TAKAHASHI and MORI (1961) have recently stated that the formation contains the zone of *Fusulina* in its lower part. According to them, *Wedekindellina* (?) *hidensis* KANUMA occurs with *Fusulinella* sp. in the blue grey limestone which is about 40 m in thickness. The joint authors are of a quite different opinion from

ISOMI's result on the stratigraphical relationship between the Otaki Formation and the overlying Oishi Formation [Ht 63] of Lower Permian.

6. Imajo area

The Imajo Formation [Ht 85] of the Nanjo Group developed in the western part of the Hida massif may be inferred to be equivalent to the zone of *Fusulina*. Although the formation, consisting of chert 300 m in thickness, is barren of fossils, the underlying Yuo Formation is probably a representative of the zone of *Fusulinella*, yielding *F. bocki* MÖLLER in the limestone which is intercalated with the alternation of sandstone and shale.

III. Outer zone of Southwest Japan

A. Kii peninsula

As will be mentioned in Chapter VII, the Aso-Gokasho area in the eastern part of Kii peninsula was studied from the structural viewpoint by KIMURA (1957) who distinguished three facies in the Paleozoic in this area. The formatons referred to as the Ogawago facies in the Ryusenzan area and the Ichinose facies in the Kirihata area [Swo 10] contain Middle Carboniferous fusulinaceans. KIMURA (1957) and IIZUKA (1928) respectively reported *Fusulina* sp. from the northeast of Iseji and "*Fusulina*" sp. from the southeast of Funakoshi, both in the Ryusenzan area [Swo 13]. KIMURA also reported *Wedekindellina* (?) sp. and *Fusulinella* sp. from the Kirihara area [Swo 10]. Since none of these species have been described, its paleontologic characteristics are unknown. The stratigraphic relationship between the zone of *Fusulina* and zone of *Pseudoschwagerina* in these areas is also not clear.

B. Shikoku

1. Eastern part (Kamodani area)

The Daigo Group [Swo 42], consisting of the alternation of sandstone and shale, along with intercalations of schalstein and limestone, is developed in the southern belt of the Chichibu terrain of Tokushima Prefecture. SUYARI (1961) referred the Daigo Group to his *Fusulinella–Fusulina* zone, the upper half of which, the *Fusulinella hirokoae* subzone, comprises *F. hirokoae* SUYARI, *F. colaniae meridionalis* RAUSER-CHERNOUSSOVA, *F. schwagerinoides* (DEPRAT), *F.* sp., *Fusulina* (?) sp., and *Fusulina* (*Beedeina*) *higoensis* KANMERA. SUYARI believes that the *Fusulinella–Fusulina* zone of Shikoku is equivalent to the middle upper part of the Oklan of North America or of the Moscovian of Russia. It should be noted that the *Fusulinella hirokoae* subzone is, judging from its faunal contents, seemingly corresponding to the lower part of the zone of *Fusulina* found in South Kyushu and Hida massif. It is not known whether the alternation of sandstone and mudstone of at least 100 m thickness in the upper part of the Daigo Group is equivalent to the upper part of the Kurikian.

2. Central part (Ino area)

The Carboniferous rocks called the Shogase Formation [Swo 70] (KATTO

and KAWASAWA, 1958) sporadically occur in the northern zone of the Chichibu terrain in the central part of Kochi Prefecture. At the type locality, according to SUYARI (1961), the formation consists of dark purple to green tuff with intercalation of limestone lenses of about 10 m thickness. SUYARI (1961, 1962) stated that the zone of *Fusulina* is present in the lower part of the Shogase Formation which is developed as small outcrops in the area covering parts of northwestern Ino-cho, eastern Tosa-Yamada-machi, and northern Sakawa-machi. He described *Fusulinella prolifica* THOMPSON and two indeterminable species of *Beedeina* as the elements of the *Fusulinella–Fusulina* zone of the Shogase Group. If his identification is correct, the occurrence of *Fusulinella prolifica* THOMPSON is worthy to note. The said species was originally described from the Atoka Formation of Oklahoma, and it has never been reported from the Tethysian realm including Japan.

Besides the type locality, the Shogase Formation is known at several other places, but it is always in fault contact with the surrounding rocks, resulting in that the stratigraphical relationship between the Shogase Formation and the over-lying formation is not known, though SUYARI presumed a disconformity between the Shogase Formation and the Sakamotozawan Kameiwa Formation [Swo 22].

Besides the above, *Fusulina* (*Beedeina*) *lanceolata* (LEE et CHEN) was described by TORIYAMA (1944) from the limestone pebbles of the Sakuradani conglomerate [Swo 50], but the specimens are so poor in preservation and insufficient in number that further comparison is difficult. Moreover, as already stated in the preceding chapter, the Sakuradani conglomerate is not Carboniferous in age but is a member of the Permian Hisone Group.

C. Kyushu

The Yayamadake [Swo 136] of South Kyushu, the type locality of the Kurikian "Series", was studied in detail by KANMERA (1952) who divided the zone of *Fusulina** of Yayamadake limestone into three subzones; the lower *Staffella pseudosphaeroidea* subzone of at least 20 m thickness characterized by *Staffella pseudosphaeroidea* DOUTKEVITCH, *Fusulinella* sp. (a form resembling *F. pseudobocki* (LEE et CHEN)) and *Nankinella* sp.; the middle *Fusulina* (*Beedeina*) *higoensis* subzone of about 50 m by *F.* (*B.*) *higoensis* KANMERA and *Wedekindellina prolifica* KANMERA; and the upper *Fusulina ohtanii* subzone of about 30–40 m by *F. ohtanii* KANMERA and *Fusulinella gracilis* KANMERA in its lower part and *Fusulina kurikiensis* KANMERA in its upper part. All the species mentioned above were fully described and illustrated by KANMERA.

The species of *Fusulina* which characterise the zone of *Fusulina* of the Yayamadake limestone are entirely different from those hitherto known in the Moscovian rocks of Japan—*F. quasicylindrica* (LEE), *F. konnoi* OZAWA, *F.* (*B.*)

* KANMERA defined the zone of *Fusulina* as ranging from the first appearance of species of *Fusulina* to immediately beneath the first appearance of species of *Triticites;* so thus defined, the zone of *Fusulina* of the Yayamadake limestone is considered to be the middle and upper parts of the zone of *Fusulina.*

akiyoshiensis TORIYAMA, *F.* (*B.*) *lanceolata* (LEE et CHEN), etc. Yayamadake species are more advanced in development than the latters. According to KANMERA *Fusulinella gracilis* is the most advanced form for the genus.

KANMERA correlated the zone of *Fusulina* of the Yayamadake limestone with the upper Desmoinesian of North America or with the upper Moscovian of Russia. It should be noted that the zone of *Fusulina* is covered by the zone of *Triticites* with a presumed unconformity. It is known that in North America the stratigraphical distribution of the genus *Fusulinella* ranges from the upper half of the Atokan to the lower half of the Desmoinesian. The occurrence of *Fusulinella gracilis* in the upper part of the zone of *Fusulina* in the Yayamadake limestone, which is equivalent in age with the upper half of the Desmoinesian, is therefore important in the consideration of the stratigraphical range of the genus *Fusulinella* in Japan.

The Futami Formation [Swo 145] (100 m) occurs in the Futami area, southwest of Yatsushiro city with a limited distribution. It consists mainly of highly cleaved slate, with thin beds of very fine-grained sandstone in the lower part and a limestone lens and chert bed in the middle. The limestone lens yields *Fusulinella kanmerai* ISHII*, *F.* sp. and *Chaetetes,* and is referred to the lower part of the Kurikian (MATSUMOTO and KANMERA, 1952, 1964).

Chapter VI. The Zone of *Triticites*

The fusulinacean zone, here designated the zone of *Triticites,* is equivalent to the Kawvian of North America and to the C_3 of Russia including the "*Schwagerina* horizon".

Before 1951 it was believed that the zone of *Triticites* or the so-called "Uralian" formation was not present in the Upper Paleozoic rocks of Japanese islands in spite of the fact that there is no apparent physical break between the zone of *Fusulinella* and the overlying Permian zone of *Pseudoschwagerina.* In 1951, KANMERA, KANUMA, and FUJIMOTO and KAWADA independently discovered the zone of *Triticites* in the Yayamadake limestone [Swo 136] of South Kyushu, the Ichinotani Group [Ht 27] of the Hida massif, and the Omi limestone [Ht 1], respectively. KANMERA proposed the Hikawan Stage for the time-rock unit representing the zone of *Triticites* in Japan.

I. Kitakami and Abukuma massifs

Although the Kitakami massif is the standard area of the Upper Paleozoic of Northeast Japan, rocks of the Hikawan age have never been found there. The significance of the pre-Sakamotozawan unconformity has been emphasized by MINATO (1942) and his collaborators repeatedly. After studying the type locality of the Kitakami massif, MORIKAWA (1953) insisted that the Upper Carboniferous zone of *Triticites* exists in the Kanokura valley [Ka 29]. However, the fusulinacean species of this "*Triticites* zone" are seemingly not the

* This species was listed as *Fusulina* cfr. *konnoi* OZAWA in MATSUMOTO and KANMERA (1952).

Upper Carbonferous element, but are presumed to be the component of the Permian zone of *Pseudoschwagerina*.

II. Kwanto massif

1. Okuchichibu area

Two years after the first discovery of the Hikawan zone of *Triticites* in Japan, MORIKAWA (1953) found the *Triticites* fauna, in which no species of *Pseudoschwagerina* nor of *Pseudofusulina* are present, from Mujinazawa valley [Kw 22] of the Kwanto massif. Because of its primitive aspect in shell structure, he compared it with the Hikawan faunas of the Yayamadake limestone [Swo 136] of South Kyushu and of the Oppara Formation [Ht 40] of the Hida massif, concluding that it is of the "Uralian" age. The *Triticites* fauna of Mujinazawa valley contains *T. nakatsugawensis* MORIKAWA, *T. nakatsugawensis hemmii* MORIKAWA, and *T. uemurai* MORIKAWA, along with *T. kagaharensis* FUJIMOTO and *T.* cfr. *plummeri* DUNBAR and SKINNER, the latter three species of which have long been known to occur in the Lower Permian of the Kwanto massif. Considering this confusion, MINATO (1955) expressed an opinion that it would be premature to give a final conclusion as to the age of this fauna. In addition MORIKAWA and KAWADA (1953) obtained *T. nakatsugawensis* together with *Pseudoschwagerina muoungthensis* (DEPRAT) and *Quasifusulina longissima* (MÖLLER) from Maemonkura valley which is located about 4 km NE of Mujinazawa [Kw 22], the type locality of *T. nakatsugawensis*. Accordingly, the said species may perhaps be Hikawan in age, but it may still be possible to assign it as an element of the Lower Permian Sakamotozawan. If the *Triticites* fauna of Mujinazawa is Hikawan as MORIKAWA considered, *T. nakatsugawensis* has a long stratigraphical range from the Hikawan to the Sakamotozawan.

2. Futagoyama area

Other Hikwan fusulinaceans have recently been found in the Futagoyama limestone [Kw 20], 7 km southwest of Mamba by TAKAOKA (1966) who described the following species in the *Triticites* zone: *Triticites ozawai* TORIYAMA, *T. samaricus* RAUSER-CHERNOUSSOVA, *T. uemurai* MORIKAWA, *T. kawanoboriensis* FUJIMOTO, *T. noinskyi* RAUSER-CHERNOUSSOVA, *T. yayamadakensis* KANMERA, *Quasifusulina longissima* (MÖLLER), *Rugosofusulina serrata* RAUSER-CHERNOUSSOVA, and *Pseudofusulina futagoensis* TAKAOKA. It is noted that some of these species are rather typical in the lower Sakamotozawan of other areas. In fact, TAKAOKA mentioned that *Quasifusulina longissima, Triticites noinskyi, T. yayamadakensis, T. ozawai,* and *Pseudofusulina futagoensis* are also found in the *Pseudoschwagerina* zone, and he presumed that the *Triticites* and the *Pseudoschwagerina* zone are of conformable relation in the Futagoyama limestone. The same remark expressed by MINATO in the above paragraph also pertains to this fauna of Futagoyama.

---

* MORIKAWA's fig. 20 (axial section) and fig. 21 (sagittal section) may not be conspecific with each other. He had some doubts concerning his identification of this species.

3. Toriashi massif

The Nanaai Formation [Kw 1] of the Toriashi Group, consisting chiefly of alternation of sandstone and shale, is developed to the north of Kasama. According to KAWADA (1953) this formation attains a thickness of 4000–5000 m, but is barren of fossils. However, since the underlying Kasama Formation is inferred to be of the Moscovian, it is not improbable that the Nanaai Formation may contain the Kurikian and/or the Hikawan.

III. Hida massif and Tamba zone

1. Omi limestone

FUJIMOTO and KAWADA (1951) found the zone of *Triticites* in the Omi limestone [Ht 1] which is one of the classical localities of the Japanese Paleozoic. The stratigraphy of this area was later studied in some detail by KAWADA (1954) and FUJITA (1958). KAWADA listed the following species as the constituent of his C_3, *Triticites* zone: *Triticites kagaharensis* FUJIMOTO, *T. minimus* (SCHELLWIEN), *T. skinneri* THOMPSON, *T. milleri* THOMPSON, *T. subventricosus* DUNBAR and SKINNER, *T. simplex* (SCHELLWIEN), *T. montiparus* [EHRENBERG (MÖLLER)], *Quasifusulina longissima* (MÖLLER), *Schubertella mexicana* THOMPSON, *Fusulinella biconica* (HAYASAKA), and *F. bocki* (MÖLLER), whereas FUJITA only listed *T. milleri* THOMPSON*, *T. minimus* (SCHELLWIEN), and *T.* cfr. *kagaharensis* (FUJIMOTO). Of these species *T. simplex, kagaharensis, montiparus,* and *Quasifusulina longissima* are Permian Sakamotozawan element in other areas in Japanese Paleozoic rather than being Hikawan in age. Therefore there is no positive evidence for denying that KAWADA's C3 and FUJITA's C_3 are of Permian age nor is there definite evidence supporting that they are of the Hikawan. In the writers' opinion the first choice is seemingly more reasonable. IGO (1958) also pointed out that KAWADA's C3 is not Hikawan, but the greater, if not the whole, of C3 should be referred to the Lower Permian. One must pay attention to the coexistence of the North American elements and the Tethysian elements. If KAWADA's identification is correct, mixture of both the elements is worthy to note in the paleogeographical consideration in Carboniferous–Permian times. Two species of *Fusulinella* listed by KAWADA are seemingly derived fossils.

2. Hachiman area

KANUMA (1951) first discovered the zone of *Triticites* in the Oppara Formation [Ht 40] which is of conformable relation with the underlying Akiyama Formation [Ht 41] of the zone of *Fusulina* and with the overlying Okumyogata Formation [Ht 42] of the zone of *Pseudoschwagerina*. According to KANUMA (1958)** the Oppara Formation is divided into two subzones; the lower *Triticites*

---

* *T. milleri* THOMPSON is a synonym of *T. cullomensis* DUNBAR and CONDRA (DUNBAR and HENBEST, 1942)

** In his first report of stratigraphy he listed the following species from the Oppara Formation: *Triticites pygmaeus* DUNBAR and CONDRA, *T. cullomensis* DUNBAR and CONDRA, *T. montiparus* (MÖLLER), *T.* sp., *Fusulina* sp., *Fusulinella* sp., and *Eoschubertella* sp. It is not clear why all of the species do not appear in his second report of stratigraphy.

opparensis subzone with *T. opparensis* KANUMA, *T. opparensis longiformis* KANUMA, *T. irasensis* KANUMA, *Quasifusulina longissima* (MÖLLER), and *Schubertella kingi* DUNBAR and SKINNER, and the upper *Triticites kiyomiensis* subzone with *Triticites kiyomiensis* KANUMA, *T. nakatsugawensis* MORIKAWA, *T. opparensis* KANUMA, *T. opparensis longiformis* KANUMA, *Quasifusulina* sp., and *Schubertella kingi* DUNBAR and SKINNER. KANUMA correlated the Oppara Formation with the Hikawan Stage of South Kyushu, the lower part of the C3 zone of the Omi limestone, and with the *Triticites* limestone of Mujinazawa of the Kwanto massif.

3. Fukuji area

In the Fukuji area, central part of the Hida massif, one can see one of the best displays of the Hikawan rocks in this country within the Ichinotani Formation [Ht 27]. The zone of *Triticites* of this area was named *Triticites exsculptus–T. hidensis* zone. The following species of this zone have been described by IGO (1957): *Quasifusulina longissima* (MÖLLER), *Triticites exsculptus* IGO, *T. exsculptus naviforme* IGO, *T. hidensis* IGO, *T. saurini* IGO, *T. sakagamii* IGO, and *T.* sp. A. From the faunal aspect he correlated *T. exsculptus – T. hidensis* zone with the Hikawan Stage of South Kyushu and with the Oppara Formation stated above. In his first report (1956) of stratigraphy, however, he expressed an opinion that the *T. exsculptus – T. hidensis* zone may be correlative with a part of the upper Hikawan which is, as KANMERA (1952) stated, presumed to be lacking in the Yayamadake limestone of South Kyushu. It is emphasized that the *T. exsculptus – T. hidensis* zone is overlaid by the *Pseudoschwagerina morikawai* zone without any physical break. IGO also pointed out the possibility of regarding the prolific *Triticites* fauna found in the lower part of the zone of *Pseudoschwagerina* of the Hida massif as the transitional fauna from the Carboniferous to the Lower Permian.

4. Imajo area

The Takura Formation [Ht 81], the uppermost division of the Nanjo Group, is presumed to be the Upper Carboniferous (ISOMI, 1955). However, it is barren of fossils and its stratigraphical position has not been exactly determined.

5. Ibuki massif

As already stated in the preceding chapter, the Otaki Formation [Ht 62], which was regarded by ISOMI (1955) as a representative of the zone of *Fusulinella,* is assumed to be a continuous sequence ranging from the zone of *Fusulinella–Fusulina* to that of *Pseudoschwagerina* (KANUMA, TAKAHASHI and MORI, 1961). According to the joint authors, the limestone of about 60–70 m thickness contains the zone of *Triticites* in its middle part, yielding *T. opparensis* KANUMA and *T. kiyomiensis* KANUMA. It is noteworthy that the Carboniferous and the Permian are of conformable relationship in this area as well as in the Oppara and the Fukuji areas.

IV. Outer zone of Southwest Japan

A. Kii peninsula

KUSAKABE and MIYAMURA (1958) reported the occurrence of the zone of *Triticites* in the Upper Paleozoic rocks developed in the southern part of Ise city, Mie Prefecture. According to them the zone of *Triticites* in this area, consisting of alternaton of sandstone and shale of about 560 m thickness with lenticular limestone lens [Swo 8′, Swo 13′], yields *Triticites nakatsugawensis* MORIKAWA, *T. yayamadakensis* KANMERA, *T. matsumotoi* KANMERA, *T. kawanoboriensis* FUJIMOTO, and *T. uemurai* MORIKAWA, all of which are typical Hikawan representatives except for *T. kawanoboriensis* which is known in the Sakamotozawan rocks of South Kyushu and other areas.

B. Shikoku

Although the Hikawan rocks had not been found in Shikoku Island for a long time, ISHII *et al.* (1957) found *Triticites–Fusulina* faunule in the limestone of the Notzu Formation [Swo 76] which is developed in the northern belt of the Chichibu terrain in Kochi Prefecture. However, this faunule is only comprised of new species of *Fusulina* and indeterminable ones of *Triticites* which have not yet been described, hence its faunal characteristics are unknown. Judging from the pattern of distribution, the Notzu Formation is the same as the Shogase Formation defined below by SUYARI (1961, 1962).

The Shogase Formation [Swo 70] developed in the northern belt of the Chichibu terrain, consists of dark purple to green tuff with limestones of about 10 m thickness. The upper part of this formation was designated by SUYARI as the zone of *Triticites,* constituent species of which are *T.* cfr. *rhombiformis* ROSOVSKAYA and *T. yayamadakensis* KANMERA. The Shogase Formation is overlain unconformably by the Kameiwa Formation of Lower Permian in some places, but it is in tectonic contact with the super- or subjacent formation in others.

The Miyanokuchi Formation [Swo 61] is present in the central belt of the Chichibu terrain, consisting of alternation of sandstone and mudstone (100 m+), chert (10 m+), oolitic limestone (30 m) and mudstone (100 m+). SUYARI described *Quasifusulina longissima* (MÖLLER), *Q.* cfr. *longissima compacta* (LEE), *Triticites matsumotoi kattoi* SUYARI and *T. matsumotoi suitaensis* SUYARI. Although there is no common faunal assemblage with the Shogase Formation, SUYARI correlated the Miyanokuchi Formation with the upper half of the Shogase Formation. The stratigraphical relation between the Miyanokuchi Formation and over- or under-lying formations is not known.

Yusuhara area

The Tsubonata Formation [Swo 97] was recently proposed by ISHIZAKI (1962) and is distributed in the environs of Yusuhara-cho, Kochi Prefecture, which belongs to the northern belt of the Chichibu terrain. Indeterminable species of *Quasifusulina*? and *Triticites* were reported by NAKAGAWA *et al.* (1959) and ISHIZAKI referred the Tsubonata Formation to the zone of *Triticites.* So far as the fusulinaceans are concerned it is not improbable that the Tsubonata Forma-

tion is Permian rather than Upper Carboniferous in age. Further investigation in the future seems necessary for concrete age determination.

C. Kyushu

KANMERA (1952, 1955) divided the zone of *Triticites* (the middle part of the Tobiishi Group) of the Yayamadake limestone [Swo 136] into two subzones. The lower *Triticites matsumotoi* subzone (100–125 m), which is underlaid by the *Fusulina ohtanii – Fusulinella gracilis* subzone with a presumable conformable relationship, is characterized by *T. matsumotoi* KANMERA and *Quasifusulina longissima* (MÖLLER). The former is more primitive than any species of *Triticites* known in Japan, resembling *T. whitei* RAUSER-CHERNOUSSOVA, BELJAEV and REITLINGER described from the Upper Carboniferous of Petschoraland of northern Ural. While in the upper *Triticites yayamadakensis* subzone the subzone species is more progressive than *T. matsumotoi* but more primitive than species of *Triticites* found in the overlying zone of *Pseudoschwagerina*. Since all the species found in the Hikawan of the Yayamadake limestone were described in detail by KANMERA no further discussion is necessary here.

Chapter VII. The Zone of *Pseudoschwagerina*

I. Kitakami and Abukuma massifs

In the Kitakami massif, the standard area of the Paleozoics of Northeast Japan, the Permian System in more widely distributed than any other systems. In the northern part of the massif some older rocks whose geological age had not been ascertained have recently been identified as being of the Permian age. However, fusulinacean fossils collected from many localities in the massif were generally not well preserved and deformed after fossilization. Their specific, sometimes even generic, identification was often difficult.

The Lower Permian of the Japanese Paleozoic is called the Sakamotozawan Stage, the type locality of which is the Sakamotozawa [Ka 25] and Nagaiwa [Ka 24] area, Hikoroichi-machi, Ofunato city in the southern part of the Kitakami massif.

A. Southern part of Kitakami massif

1. Hikoroichi and Setamai area

The Sakamotozawa Formation in the type locality and its adjoining areas was studied by ONUKI (1938, 1939, 1956), MINATO (1941, 1942), MORIKAWA (1953), MINATO *et al.* (1954, 1959, 1964), YAMADA (1955) and others mostly from the biostratigraphical viewpoint, and by HANZAWA (1938, 1939), TORIYAMA (1952), FUJIMOTO (1956), and MORIKAWA (1952) from the paleontological one. As a result of these studies more than forty species of fusulinaceans were recorded, although about two-thirds were listed without any description, including a large number of undetermined species. The zonation and the correlation of the type Sakamotozawa Formation based on the lithologic characters rather than the contained fauna itself, was undertaken by some authors, resulting in

conclusions not necessarily in sufficient agreement with one another. This was partly due to ambiguity on the stratigraphical distribution and assemblage of species and partly to the insufficient information on the described species most of which were in an unfavorable state of preservation.

Recently however, MIKAMAI (1965) and KANMERA and MIKAMI (1965) have made a great contributions towards clarifying not only the zonation but also the sedimentary features of the type Sakamotozawa Formation based on the detailed micropaleontologic and sedimentologic studies. They gave a full account of the stratigraphy and zonation and discussed at length the correlation of the Sakamotozawa Formation with other Lower Permian formations of Japan and other countries. The following is their scheme of zonation:

Upper Subformation	Sd	(30-40m)	*Pseudofusulina ambigua* zone
			Pseudofusulina fusiformis zone
	Sc	(55-60m)	*Pseudofusulina vulgaris* (s.l.) zone
unconformity			
Lower Subformation	Sb_3	(35-55m)	
	Sb_2	(55-80m)	*Monodiexodina langsonensis* zone
	Sb_1	(30-35m)	*Zellia nunosei* zone
	Sa	(35-50m)	

As they mentioned, it is noted that the Sakamotozawa Formation does not have the basal Permian. In other words, the basal member (Sa) of the formation probably does not extend down as low as the basal part of the *Triticites simplex* zone of Akiyoshi or the corresponding *Pseudoschwagerina morikawai* zone of the Kuma massif. The upper limit of the Sakamotozawa Formation, on the other hand, is well defined by the top of the *Pseudofusulina ambigua* zone which is correlated with the same zone of Akiyoshi and *P. kraffti magna* zone of Atetsu. Thus the Sakamotozawa Formation in the type area ranges from a horizon somewhat higher than the base of the Permian up to the *Pseudofusulina ambigua* zone.

2. Kesennuma area

The Kesennuma area [Ka 41], located to the south of the standard area, is also a classical locality in the Paleozoic stratigraphy and paleontology of Japan. Corals, pelecypods, gartropods, brachiopods and trilobites were found there by JIMBO early in 1887, and later *Michelinia* (*Protomichelinia*) *multitabulata* was described by YABE et HAYASAKA (1915) with *Axophylloides rikuzensis* YABE et HAYASAKA. The stratigraphy of this area was clarified by SHIIDA (1940) who also found many species of fusulinaceans, corals, brachiopods, and bryozoa, some of which are of the Nabeyaman age rather than the Sakamotozawan. KAMBE and SHIMAZU (1961) also reported *Pseudofusulina kraffti* (SCHELLWIEN) and indeterminable species of *Pseudofusulina, Parafusulina, Schwagerina,* and *Schubertella* from eleven localities in the Kesennuma area. It may be that the above faunal assemblage indicates the upper Sakamotozawan age.

3. Hitokabe area (Northwest of the Setamai area)

The Tochu Formation (900 m) [Ka 20] in the Yonesato and Kotomo areas

has been proven by paleontological evidence to be the Sakamotozawan (HIROKAWA and YOSHIDA, 1954). The formation consists mainly of clayslate and limestone with conglomerate (30 m in thickness) at the base. According to HIROKAWA and YOSHIDA, the calcareous conglomerate in the lower part yields *Pseudoschwagerina* sp. and *Pseudofusulina vulgaris* (SCHELLWIEN), and the greyish-white limestone interbedded in a little upper horizon comprises *Schwagerina* sp., *Wentzelella timorica* (GERTH) and indeterminable species of bryozoans. The Tochu Formation is, as a whole, coeval with the Sakamotozawa Formation of the type area with a possibility of having a part equivalent to the lower part of the Kanokura Formation. It is noticeable that the basal conglomerate of the Tochu Formation unconformably overlies the Shiba Formation of the Onimaruan or directly covers the Yonesato Formation of Lower Carboniferous.

4. Maiya area

Since the Maiya area [Ka 44] is one of the most important areas in the study of the Permian of the Kitakami massif, the stratigraphy and paleontology of this area have been studied by many workers. According to recent works of ONUKI *et al.* (1960) and CHISAKA (1962), the Permian of Maiya area is divided into the Nishikori, Rodai, Tenjinoki, Yamazaki, and Toyoma Formations in ascending order, the first of which is referred to the zone of *Pseudoschwagerina*.

The Nishikori Formation (50–80 m) [Ka 43] consists largely of dark grey bedded limestone with intercalations of sandstone and black slate, and yields fusulinaceans together with corals, bryozoans, brachiopods and trilobites. CHISAKA described the following fusulinacean species which are a little different from those listed by ONUKI *et al.* from the same formation: *Pseudoschwagerina schellwieni* HANZAWA, *Pss. (Zellia) nunosei* HANZAWA, *Nipponitella explicata* HANZAWA, *N. auricula* HANZAWA, *N. expansa* HANZAWA, *Pseudofusulina yubanosawensis* CHISAKA, *Psf. tschernyschewi* (SCHELLWIEN), *Psf. popoensis* CHISAKA, and *Psf. kraffti* (SCHELLWIEN). Due to the intense folding and faulting, the base of this formation is not known in the field, and CHISAKA presumed that the lowest part of the zone of *Pseudoschwagerina* is not presented in the Nishikori Formation.

UEDA (1963) presently believes that the Rodai and Nishikori Formations cannot be separated as lithologic unit and he combined the two formations into his "Nishikori Formation". IGO (1964), who studied the type locality of *Pseudoschwagerina (Robustoschwagerina) schellwieni* HANZAWA and described the species, also considers the Nishikori Formation to be a part of the richly calcareous facies of the Rodai Formation and not distinguishable from it. This species ranges from the upper part of *Pseudoschwagerina* zone up to the lower part of *Parafusulina* zone.

As a whole our knowledge concerning the fusulinaceans of Kitakami massif was not enough until KANMERA and MIKAMI's work on the fusulinaceans of the Sakamotozawa Formation appeared in 1965. The following was the only previously available information: HANZAWA's reports of 1938 on three species of the aberrant genus *Nipponitella* and of 1939 on two species of *Pseudoschwagerina*,

TORIYAMA's paper of 1952 on sixteen species of schwagerinids and neoschwagerinids, and FUJIMOTO's report of 1956 on "*Parafusulina matsubaishi**". Besides these works, MORIKAWA (1952) described three species of *Fujimotoella* from the limestone referred to the Sashizawa Stage in the Sakamotozawa valley [Ka 25], the type locality of the Sakamotozawan. However, his illustration shows that all his specimens from which the genus *Fujimotoella* was established are extremely deformed and very poorly preserved. They are perhaps elongated specimens of some species of *Parafusulina* or of *Pseudofusulina* which might have had a rather strong septal fluting before they were deformed and elongated. Such being the case, the genus *Fujimotoella* should be invalidated to avoid future confusion.

B. Northern part of the Kitakami massif

In this part of the massif Permian rocks are known to occur in several areas whose stratigraphy has been well reviewed by ONUKI (1956). According to him the Permian of the northern type is lithologically and areally divided into three parts which are characterized by the predominance of schalstein, chert, and alternation of limestone, schalstein and chert, respectively.

The Tsuchikura Formation (700–1000 m) [Ka 14] in the Kamaishi mine area [Ka 11] consists mainly of the so-called "schalstein" derived from andesitic lava and tuff. The upper part of the formation is contemporaneous but different in facies with the lower part of the overlying Kasshi Formation. They are sometimes interfingering each other. Although there is no paleontological evidence, the Tsuchikura Formation is supposed to be correlative with the Sakamotozawa Formation of the southern part of the massif (ONUKI, 1956).

The thick formation (ca 5000 m) extensively developed around Kamaishi city is called the Kamaishi Formation [Ka 11] (YOSHIDA, 1961) and is a typical representative of the northern type of Kitakami Paleozoic. It is composed mainly of clayslate, chert, and their alternation, with a subordinate amount of sandstone, limestone and schalstein.

YOSHIDA and KATADA (1964) reported *Pseudofusulina vulgaris* (SCHELLWIEN), and indeterminable species of *Pseudoschwagerina* (?), and *Codonofusiella* from the limestone lenses cropped out in several localities in Yamada-machi. The greater part of the Kamaishi Formation is referred to the Sakamotozawan, though *Neoschwagerina* sp. has also been known in the upper part of the formation.

The boundary zone between the northern and southern types of Paleozoic rocks in the Kitakami massif is called the Hayachine tectonic belt (YOSHIDA and KATADA, *op. cit.*) which is divided into the schalstein and the phyllite subbelt. The Kuribayashi Formation [Ka 9] (1500 m), developed in the latter subbelt, consists of black clayslate and tuffaceous sandstone with intercalations of tuff

* Having studied the specimens collected from Omotematsukawa and other localities in the southern part of the Kitakami massif, FUJIMOTO (1956) clarified that the slender fusulinacean which has long been believed to be *Parafusulina wanneri* (SCHUBERT) is different from that species and proposed a new specific name, *Parafusulina matsubaishi* FUJIMOTO. This new species was later transferred to the genus *Monodiexodina*. It is not certain that the specimens of "*Parafusulina wanneri*" reported from many localities in the Kitakami massif are all referable to this species.

and limestone conglomerate. Although *Endothyra* sp., *Millerella* sp. and *Lithostrotionella*? sp. have been found in the pebbles of limestone conglomerate, *Pseudofusulina* sp. and *Pseudoschwagerina* sp. have also been obtained in the matrices. The Kuribayashi Formation is therefore dated to the Early Permian. (YOSHIDA and KATO, 1962; YOSHIDA and KATADA, 1964).

Fusulinaceans have recently been discovered in several localities in the northern part of the massif, some of which are dated to the Sakamotozawan. Up to the present the following species are reported: *Pseudoschwagerina* sp. from Omatsu [Ka 15], Kamaishi city, Iwate Prefecture (in HANZAWA, 1954) and *Pseudoschwagerina* sp., *Nipponitella* sp., *Schwagerina* sp., and *Parafusulina* sp. from the limestone monument in front of Toyomane railroad station [Ka 5], Kamihei-gun, Iwate Prefecture (ONUKI, 1956).

According to YOSHIDA (1961) the Nakawada Formation, which is narrowly distributed north of Omatsu [Ka 15], Kamaishi city, has been proven to be the Sakamotozawan. It is sandwiched with faults in the Kogawa Formation [Ka 2] of the Onimaruan, and yields indeterminable species of *Pseudoschwagerina*, *Pseudofusulina* and *Lophophyllidium*.

C. Abukuma massif

In the Abukuma massif most parts of which are composed of metamorphic rocks, the Lower Permian rocks are known to occur. Overlying unconformably the *Chaetetes*-bearing Tateishi Formation, the Uwano Formation [Ka 53] yields species of *Pseudoschuwagerina*, and is regarded as the Sakamotozawan in age. However no species have been described from this massif. (HANZAWA, 1954).

II. Kwanto massif

As one of the classical localities in the study of the Paleozoic of Japan, the Chichibu district of the Kwanto massif has long been studied in depth by FUJIMOTO and his collaborators and recently by the Chichibu Research Group (1961, 1963). According to the Research group the Upper Paleozoic formations, most of which are Lower and Middle Permian, display the zonal arrangement in structure as well as in the Outer zone of Southwest Japan; namely, they develop in two main terrains, the northern and the southern. There is a considerable difference in facies between two terrains. The Mamba Group of FUJIMOTO is the main representative in the northern terrain.

In FUJIMOTO's study (1936) the middle part of the Mamba Group [Kw 12] in the Kannagawa area and the lower part of the Katsuboyama Zone [Kw 43] in the Katsuboyama area were assigned the *Pseudofusulina vulgaris* zone from which the following species were described:

Pseudofusulina vulgaris (SCHELLWIEN)
Psf. *vulgaris globosa* (SCHELLWIEN)
Psf. *multiseptata* (SCHELLWIEN)
Psf. *tschernyschewi* (SCHELLWIEN)
Schwagerina parvulus (SCHELLWIEN)
S. *krotowi* (SCHELLWIEN)
S. *crassiseptata* (SCHELLWIEN)
Rugosofusulina prisca (MÖLLER)
Triticites montiparus [EHRENBERG (MÖLLER)]

According to FUJIMOTO, however, the *Pseudofusulina vulgaris* zone is directly superposed by the *Neoschwagerina craticulifera* zone. This implies that the former zone is ranging upward into the Nabeyaman.

1. Futagoyama and adjacent areas

TAKAOKA (1966) has recently found the *Pseudoschwagerina* zone in the Tatorosan, Kanosan [Kw 13], Futagoyama [Kw 21], and Shiraishiyama limestones which are arranged in a nearly NW-SE direction along the southern margin of the northern belt in the Chichibu terrain (Chichibu Research Group, 1961, 1963). The *Pseudoschwagerina* zone comprises *Quasifusulina longissima* (MÖLLER), *Triticites uemurai* MORIKAWA, *T. yayamadakensis* KANMERA, *T. masekawaensis* KANUMA em. TAKAOKA, *T. noinskyi* RAUSER-CHERNOUSSOVA, *T. ozawai* TORIYAMA, *T. kagaharensis* FUJIMOTO, *Pseudoschwagerina orientale* FUJIMOTO, *Rugosofusulina serrata* RAUSER-CHERNOUSSOVA, *Pseudofusulina futagoensis* TAKAOKA, *P. kumasoana* KANMERA, *P. sokensis* RAUSER-CHERNOUSSOVA, *P. verneuili solida* (SCHELLWIEN), and *Schwagerina* cfr. *ahlfeldi* DUNBAR and NEWELL in the lower part, and *Paraschwagerina* (*Acervoschwagerina*) sp., *Schwagerina krotowi* (SCHELLWIEN), *Pseudofusulina tanoensis* FUJIMOTO, *P. santyuensis* FUJIMOTO, *P. kanoensis* TAKAOKA, *P. kraffti* (SCHELLWIEN) in the upper part. Since *Quasifusulina longissima, Triticites noinskyi, T. yayamadakensis, T. ozawai,* and *Pesudofusulina futagoensis* are also known in the *Triticites* zone which is found in the same limestone mass, TAKAOKA presumed that no unconformable relationship exists between the *Triticites* and the *Pseudoschwagerina* zone.

2. Nakatsugawa area

MORIKAWA and KAWADA (1953) studied the Upper Paleozoic of the Nakatsugawa area [Kw 24] and introduced the Iruma Group for the Permian of this area, the lower part of which is called the Kagemori Formation [Kw 27]. Further they divided the formation into the upper Kagemori [Kw 27] and the lower Rokusuke [Kw 23] Subformation. Although the former is referred to the *Pseudoschwagerina wongenhaoi* zone and the latter to the *Pseudoschwagerina* cfr. *muongthensis* zone, no descriptions have been given to the fossil contents. Subsequently FUJIMOTO and his students (1957) restudied the area and they gave another stratigraphical name to the Permian of this area. The Ryokami Group which conformably overlies the Ishifune Group of the Hikawan age, yields *Pseudoschwagerina muongthensis* (DEPRAT) in the lower part.

3. Shomaru-toge area

Having studied the Permian rocks of the Shomaru pass [Kw 31] and its environs, eastern part of the Kwanto massif, MORIKAWA (1955) divided the Permian into four fusulinacean zones without designating zone species, and introduced different stage names. He divided the zone of *Pseudofusulina* (Hanagiri Stage) into three subzones, the lower of which was correlated with the zone of *Pseudoschwagerina* of Russia and regarded as being the Sakmarian in age. It is certain that MORIKAWA's lower subzone is referable to a part of the Sakamotozawan because in his subzone are found *Triticites montiparus* [EHRENBERG

(MÖLLER)], *T. irregularis* (STAFF) and *T. contractus* (SCHELLWIEN) with fragment of *Pseudoschwagerina*. However, it is not known to what part of the Sakamotozawan his lower subzone is referable.

4. Nabeyama area

The Izuru Formation [Kw 5] (200 m) of the Aso Group developed west of Nabeyama is supposed to be the Lower Permian, main constituent of which is schalstein probably derived from basic volcanics and tuff. According to FUJIMOTO (1961) the Izuru Formation is conformably overlain by the Nabeyama Formation [Kw 4] of the Nabeyaman and underlain by the Aizawa Formation [Kw 7] of probably Lower Permian. The Izuru Formation is tentatively referred to the Sakamotozawan.

The Sano Group was proposed by HATORI (1965) for the Lower Permian of this area in which the Hata, Yamanaka, Nakazuma, and Aizawa Formations (in ascending order) are included. Although no paleontological evidences have been available in this group, HATORI emphasized an unconformable relationship between the Sano Group and the Tochigi Group of probable Carboniferous.

III. Hida massif and Tamba zone

A. Hida massif

1. Omi limestone

The stratigraphy of the Omi limestone [Ht 1] was studied at some length by KAWADA (1954) and FUJITA (1958). Both of them divided the Permian of this limestone into the lower P1 and the upper P2 Formation, and there is no conspicuous difference between the results of KAWADA and FUJITA. The lower, P1 is characterized mainly by species of *Pseudoschwagerina* and *Pseudofusulina*, and is named by them *Pseudoschwagerina–Pseudofusulina* zone. According to KAWADA species of *Pseudoschwagerina* and *Paraschwagerina* are found only in the lower part of the P1 Formation, whereas those of *Pseudofusulina* predominates in the upper part. KAWADA listed the following species in the lower part of the P1 Formation:

* *Eoschubertella mexicana* THOMPSON
* *Staffella* sp.
* *Schubertella* sp.
* *Triticites cullomensis* DUNBAR and CONDRA
* *T. simplex* (SCHELLWIEN)
* *T. skinneri* THOMPSON
* *T. montiparus* [EHRENBERG (MÖLLER)]
* *T. milleri* THOMPSON
* *T. kagaharensis* FUJIMOTO
* *T. minimus* (SCHELLWIEN)
T. cfr. *springvillensis* THOMPSON, VERVILLE and BISSELL
* *T. subventricosus* DUNBAR and SKINNER
* *T.* n. spp. (MS)
* *Quasifusulina longissima* (MÖLLER)
Pseudoschwagerina samegaiensis FUJIMOTO
Paraschwagerina n. sp. (MS)
Pseudofusulina sp.

It is noted that the species with an asterisk are also found in the KAWADA's C3 Formation, and that, according to his first report, *Fusulinella biconica* (HAYASAKA) and *F. bocki* MÖLLER are listed as the elements of the P1 Formation. Since paleontological study on these species have not been published, it is not advisable to give more critical discussion here. However, as already noted in the preceding chapter, there is no positive evidence to support that the C3 Formation of the Omi limestone is of the "Uralian" age.

The upper half of the P1 Formation is characterized by *Pseudofusulina vulgaris* (SCHELLWIEN), *Psf. kraffti* (SCHELLWIEN), and many species of *Pseudofusulina*, *Schwagerina krotowi* (SCHELLWIEN), and *Parafusulina* sp. Hence it is likely correlative with the P1β and/or P1γ zone of Akiyoshi limestone. It is also noted that *Hayasakaina kotakiensis* FUJIMOTO and KAWADA, which is regarded here as a specialized form of *Ozawainella*, occurs throughout the whole P1 Formation.

2. Fukuji area

In the Fukuji area the upper part of the Ichinotani Group and the lower formation of the Hirayu Group are correlated with the Sakamotozawan.

KAMEI (1952) once found *Pseudoschwagerina schellwieni* HANZAWA, *Ps.* sp. and *Pseudodoliolina* sp., together with coral fauna in the lower division of the Ichinotani Formation (of KAMEI, not of IGO) and he referred this formation to the Lower and Middle Permian.

IGO (1956, 1957) who studied the Paleozoic of the Fukuji area divided the Ichinotani Group into the Ichinotani Formation [Ht 27] and the Mizuyagadani Formation [Ht 29]. The former ranges from the zone of *Millerella* to that of *Triticites* and the latter conformably overlies the former. The Mizuyagadani Formation is designated the *Pseudoschwagerina morikawai* zone, in the lower part of which abundant specimens of the following species are obtained:

Schubertella kingi DUNBAR and SKINNER
S. masoni THOMPSON and HAZZARD
Quasifusulina longissima (MÖLLER)
Triticites kagaharaensis FUJIMOTO
T. simplex (SCHELLWIEN)

The zone species, *Pseudoschwagerina morikawai* IGO, scarcely occurs in the lower part, whereas it increases to a remarkable abundance in the upper part of the Mizuyagadani Formation, associating with *Rugosofusulina alpina nipponica* IGO and *Schwagerina* sp. On the contrary the species of *Triticites* listed above become few in number. It should be noted that the base of the Mizuyagadani Formation is characterized by abundant *Triticites* fauna without any species of *Pseudoschwagerina*.

IGO is of the opinion that the Carboniferous and Permian Systems are continuous in deposition, and that the fusulinacean fauna of the lower part of the *Pseudoschwagerina morikawai* zone indicates the transitional fauna between the two systems.

3. Hirayu area

To the southeast of the Ichinotani area is the Hirayu Group [Ht 30] which was once regarded by KAMEI (1952) as the Middle and Upper Permian age. Later IGO stated that the Hirayu Group ranges from the Sakamotozawan to the Akasakan and he (1959) discriminated three fusulinacean zones in this group. The lower zone of *Pseudoschwagerina* is further divided into the upper *Pseudofusulina vulgaris* and the lower *Triticites kawanoboriensis kaishodaniensis* subzone. The faunal characteristics of these subzones are respectively similar to those of the *Pseudofusulina vulgaris* and the *Triticites simplex* subzone of the Akiyoshi limestone Group. It is therefore beyond doubt that the lower part of the Hirayu Group is the Sakamotozawan and is contemporaneous but different in facies with the Mizuyagadani Formation of the Ichinotani Group. All the important species of the zone of *Pseudoschwagerina* of the Hirayu Group including *Pseudoschwagerina* (*Robustoschwagerina*) *schellwieni* HANZAWA were described by IGO (1959, 1964) in detail to which no further discussion is added.

4. Nyukawa area

To the east and northeast of Takayama city, the Paleozoic rocks are developed in three separated zones, which were studied first by TAKANO (1951, 1952) and later by ISOMI and NOZAWA (1957). According to the latter, the Sakamotozawan rocks which are called the Nyukawa Group [Ht 31–37] are found only in the southern zone, the middle one-third of which (ISOMI and NOZAWA's N_2 Formation) is composed mainly of schalstein and a number of limestone lenses. From thirteen localities they reported various species including *Acervoschwagerina endoi* HANZAWA, *Pseudoschwagerina* cfr. *schellwieni* HANZAWA, *Pseudofusulina* cfr. *fusiformis* (SCHELLWIEN and DYRHENFURTH), *Psf.* cfr. *japonica* (GÜMBEL), *Psf.* cfr. *vulgaris* (SCHELLWIEN), *Psf. ambigua* (DEPRAT), *Schwagerina* cfr. *tschernyschewi* (SCHELLWIEN), *Misellina* cfr. *aliciae* (DEPRAT), and *Neoschwagerina* cfr. *simplex* OZAWA. ISOMI and NOZAWA are of the opinion that these fusulinaceans range from the upper half of the zone of *Pseudoschwagerina* to the lower part of the zone of *Parafusulina*. It should be noted that *Acervoschwagerina* or *Pseudoschwagerina* sp. occurs together with *Misellina* cfr. *aliciae* (DEPRAT).

IGO (1964) has recently described *Pseudoschwagerina* (*Robustoschwagerina*) *hidensis* from the lower part of the *Parafusulina* zone of the Nyukawa Group, giving an account of the stratigraphical range of the genus *Pseudoschwagerina* and its allies which is in harmony with that given by ISOMI and NOZAWA.

Taking account of the sedimentological consideration of carbonate rocks, IGO (1960, 1964) restudied the Nyukawa Group in detail and classified three sedimentary areas. According to facies differentiation different formational names were given to each stratigraphical sequence of three areas.

The western area (Gombo area [Ht 36]) was an environment of open shallow sea in which intense submarine volcanism took place. In the late Sakamotozawan time "Shiroi bank" was formed (Shiroi Formation [Ht 35]) and was inhabited by various kinds of organisms. *Acervoschwagerina endoi* HANZAWA,

Pseudofusulina hexagonaria IGO and *P. tschernyschewi* (SCHELLWIEN) were the typical representatives of the fusulinacean in this environment. Thus the *Pseudofusulina hexagonaria–Acervoschwagerina endoi* zone has been designated to the Shiroi Formation. IGO correlated this zone with that ranging from the upper Sakamotozawan to the lower Nabeyaman.

The Sote Formation [Ht 32], which consists mainly of black shale with black sapropelic limestone, has characteristic feature which suggests shallow embayment. The "Sote Sea" was named by IGO to this embayment where many kinds of organisms also flourished. *Pseudoschwagerina hidensis* IGO was predominant in the lower part of the Sote Formation and *Acervoschwagerina endoi* HANZAWA, *Pseudofusulina parakraffti* IGO and *Misellina claudiae* (DEPRAT) were in the middle part (upper Sakamotozawan).

The eastern area had geosynclinal environment and the main constituent is a typical graywacke with various kinds of limestone in many horizons. *Pseudofusulina vulgaris* and its allies are typical representative.

IGO pointed out that a clear local differentiation is seen in the fusulinacean assemblage of the same age, which is considered to be the results from the difference in characteristics of sedimentary environments.

5. Hongo-Arakigawa area

In the Hongo-Arakigawa area, northeast of Takayama city, Upper Paleozoic rocks are known to occur and were first classified by KAMEI into the Kurahashira [Ht 20], Hongo [Ht 18], and Kunimiyama [Ht 19] Formations in descending order. Later, ISOMI and NOZAWA (1957) divided them into the upper Moribu [Ht 21] and the lower Arakigawa Formation [Ht 22]. The Moribu Formation (700 m) consists mainly of clayslate with intercalation of sandstone and limestone and conglomerate at the base. Although no reliable fossils for dating have been found in this formation, the granitic rock bearing conglomerate of the basal part is correlated to the Osobudani conglomerate [Ht 28] of the Ichinotani area, and the Moribu Formation is as a whole regarded as the Permian. IGO (in FUJIMOTO *et al.*, 1962) believes that the Moribu Formation unconformably covers the Arakigawa Formation of Lower-Middle Carboniferous.

6. Hachiman area

The geology of the southern part of the Hida massif and the northeastern part of the Mino massif has recently been studied by KANUMA (1959) in detail. The Permian rocks of this area develop in three parts, north, central, and south.

The Okumyogata Formation (750 m) [Ht 42] in the northern part and the Akuda Formation (400 m) [Ht 45] of central part are referable to the Sakamotozawan. In the basal part of the Okumyogata Formation *Pseudoschwagerina orientale* FUJIMOTO occurs with a species of *Triticites* of much advanced type. However, in the type section of the formation at Akiyama *Pseudoschwagerina orientale* appears in much higher horizon (about 370 m) above the base of the Permian. In another section at Irasubora, Oppara [Ht 40], *Pseudofusulina utaensis* THOMPSON and BISSEL occurs at the horizon 18 m above the base,

Schubertella sp. β, *Pseudofusulina paracontractus* KANUMA and *Psf. parvulus* (SCHELLWIEN) 30 m above the base, and *Triticites kawanoboriensis* FUJIMOTO, *T. onoensis* KANUMA, *T. subnathorsti* (LEE), *T. plummeri* DUNBAR and CONDRA, and *T. cullomensis* DUNBAR and CONDRA 145 m above the base.

It is worthy to note that the limestone of about 25 m thickness at O-irasubora is continuous from Carboniferous to Permian without any stratigraphical break. KANUMA (1960) is of the opinion that a less advanced type of *Pseudoschwagerina*, which occurs with species of *Triticites*, is not Permian in age but should be regarded as the Carboniferous element. All the fusulinaceans collected by him have been described in a series of papers (1958, 1959, 1960).

7. Kami-anama area

The Kami-anama area is located in the western margin of the Hida massif and was surveyed by HAYASAKA *et al.* (in FUJIMOTO, 1953). The Permian rocks of this area were called the Nojiri Group [Ht 73] and the Otani conglomerate [Ht 72] of the basal part covers the underlying Carboniferous formation with a clino-unconformity. Because *Triticites nakatsugawensis* MORIKAWA, *T. montiparus* [EHRENBERG (MÖLLER)], *T. uemurai* MORIKAWA, *Quasifusulina longissima* (MÖLLER), and *Pseudoschwagerina* sp. have been found in the grey to blackish-grey massive limestone near the base of the conglomerate, OZAKI *et al.* (1954) regarded the Otani conglomerate as the Sakamotozawan in age. Subsequently, FUJIMOTO *et al.* (1962) separated this massive limestone from the Otani conglomerate and introduced a new name, the Oboradani Formation for it. However, OSHIMA* recently clarified that the Otani conglomerate is not Permian, but Mesozoic though its exact age is not known. (See also page 125 of next chapter)

8. Funafuseyama area

Funafuseyama and its environs are known to have a wide distribution of Upper Paleozoic rocks. The Funafuseyama Formation [Ht 48] (600–800 m) is a representative of calcareous facies, main constituent of which is greyish-white to greyish-black limestone and dolomitic limestone. The basal part of the formation consists of meta-basalt with red chert, above which the *Pseudofusulina vulgaris* zone is found in the brecciated limestone and dolomitic limestone. Except for the zone species, the faunal assemblage is not known (OGAWA and IGO in FUJIMOTO *et al.*, 1962).

The representatives of the non-calcareous facies in the Funafuseyama area are the Taniai Formation (2800 m) [Ht 50] and the Kanzaki Formation (1700 m) [Ht 49] in the southern part and the Mandokoro Formation [Ht 47] in the north. The first two make a conformable sequence on which the Funafuseyama limestone rests. The latter was considered to be a *Klippe* on the Kanzaki Formation, but, according to IGO and OGAWA (in FUJIMOTO *et al.*, 1962), it is not a *Klippe* but is in contact with a normal fault to the Kanzaki Formation. All these non-calcareous formations yield no fossils for an age determination.

---

* OSHIMA, H.; Palaeozoic and Mesozoic Formations in the central part of Izumi-mura, Fukui Prefecture. Graduation thesis (No. 189) of Kyushu University, 1965

The Samondake Formation [Ht 51] found to the north of the Funafusayama area is also considered to be of the Permian, although it is barren of fossil content (KAWAI, 1957).

9. Neo and Ibigawa area

A wide area covering the northwestern part of Gifu Prefecture (Motosu-gun and northern part of Ibi-gun) is an Upper Paleozoic terrain of which little is known. According to IGO (in FUJIMOTO *et al.*, 1962) the Uoganeyama Formation [Ht 57] in this area consists of chert and schalstein with a limestone member of about 200 m thickness. *Acervoschwagerina endoi* HANZAWA and *Pseudofusulina kraffti* (SCHELLWIEN) are known in the lower part, and *Parafusulina* sp. in the upper part of the limestone above which thick chert is superposed. Hence the Uoganeyama Formation is dated as the Sakamotozawan to the Nabeyaman.

As already mentioned in the Chapter IV, the Tokuyama Formation [Ht 52] (700 m) which occurs mainly in the Tokuyama area, upper valley of Ibigawa area, was referred by KAJITA (1963) to the Upper Carboniferous to Lower Permian from the lithological point of view. Recent study of KAWAI (1964) stated that the Tokuyama Formation* ranges from the upper Lower to lower Middle Permian with a possibility of having the zone of *Yabeina* in part. KAWAI reported 19 species of fusulinaceans from many localities, of which *Pseudofusulina japonica* (GÜMBEL), *Parafusulina kaerimizensis* (OZAWA) and *Neoschwagerina craticulifera* (SCHWAGER) are characteristic. It is noteworthy that thin coal seams occur above the *Pseudofusulina* cfr. *vulgaris* zone near Kashiwaradani, and also that *Bellerophon* occurs abundantly in the black limestone. The Tokuyama Formation is separated from the surrounding rocks by the low angled Tokuyama thrust (KAWAI, *op. cit.*).

The Paleozoic rocks distributed along the upper valley of Ibigawa [Ht 55, 56] were also studied at some length by MIYAMURA (1965) who did not follow the previous workers (KAJITA, 1963; KAWAI, 1964) in the stratigraphic division. He divided the Paleozoic terrain into six blocks throughout which two fusulinacean zones are distinguished, the lower *Pseudofusulina* and the upper *Parafusulina* and *Neoschwagerina* zone. The *Pseudofusulina* zone comprises three species of *Triticites*, one of *Acervoschwagerina*, two of *Paraschwagerina*, ten of *Pseudofusulina*, and two of *Schwagerina*, of which *Pseudofusulina vulgaris* (SCHELLWIEN) and *P. globosa* (SCHELLWIEN) are the most characteristic species. The lower part of the Sakamotozawan is not clearly known in this area.

10. Akasaka area

The Akasaka limestone [Ht 65], one of the classical localities in the study of the Paleozoic of Japan, is located 3 km northwest of Ogaki city. The stratigraphy and the fusulinacean fauna of the Akasaka limestone were studied by OZAWA (1927) at length almost forty years ago. His zonation of the limestone is still being evaluated with a little emendation. OZAWA's lowest division, the

* KAWAI revised the definition of the formation and his Tokuyama Formation includes the Funafuseyama and Kanzaki Formations of KOBAYASHI and FUJIYAMA.

Benijima zone, is so poor in fossil content that only *Pseudofusulina ambigua* (DEPRAT) and *P. granum-avenae* (ROEMER) were described. Later FUJIMOTO (1941) reported *Pseudoschwagerina schellwieni* HANZAWA and *Pseudofusulina vulgaris* (SCHELLWIEN) in the limestone erratics obtained from a quarry at the southern side of Kinshozan. This led him to the conclusion that the Benijima zone of the Akasaka limestone or the underlying formation might be correlated with the zone of *Pseudoschwagerina.*

Having reexamined FUJIMOTO's material, IGO (1964) clarified that *Pseudoschwagerina (Robustoschwagerina) schellwieni* HANZAWA associates with *Pseudofusulina vulgaris* (SCHELLWIEN), *Schwagerina* n. sp., and *Minojapanella elongata* FUJIMOTO and KANUMA. He also gave an account of the stratigraphical range of *P. (R.) schellwieni.*

The Akasaka limestone was restudied by MORIKAWA *et al.* (1956) and MINATO and HONJO (1959). MORIKAWA *et al.* did not find any species of *Pseudoschwagerina* in their lower formation but found many species of *Schwagerina, Parafusulina* and *Pseudofusulina,* and in the upper part of the lower formation they reported *Pseudodoliolina ozawai* YABE and HANZAWA and *Verbeekina sphaera* OZAWA. If their observation is correct there is no formation referable to the Sakamotozawan in the Akasaka limestone.

11. Imajo area

Along the upper reaches of Hinokawa a vast area is occupied by the Upper Paleozoic rocks. The Takura Group [Ht 81] named by KITA contains *Pseudofusulina vulgaris* (SCHELLWIEN), *Psf. japonica* (GÜMBEL), and other species of schwagerinids in the limestone intercalated in the lower part of the group, and referred by ISOMI (1955) to the upper part of the zone of *Pseudoschwagerina.*

B. Northern and eastern parts of Tamba zone

1. Wakasawan area

The Wakasawan area [Ht 87–90] in the eastern part of Fukui Prefecture is the Upper Paleozoic terrain of the Tamba zone, and was surveyed by HIROKAWA, ISOMI and KURODA (1957) and ISOMI and KURODA (1958). According to ISOMI and KURODA the Permian of this area is divided structurally by the Saburi-Iimori fault into the northern and southern parts.

The southern part [Ht 87′, 88′] is a representative of the Tamba zone proper, characterized by thick alternation of chert and clayslate, with intercalations of limestone lenses. The joint authors (1958) divided the Permian in this part into five formations* without giving formation names. The formation II is very prolific in fusulinacean fossils, and thirty-six species, mostly of schwagerinids, have been listed from fifty-seven localities, of which *Pseudofusulina vulgaris* (SCHELLWIEN) and its allies and *Psf. japonica* (GÜMBEL) are the most characteristic representatives. Hence their formation II is certainly referable to the upper Sakamotozawan. The formation I, which consists of predominant chert

* The five formations (I, II, III, IV, and V) of ISOMI and KURODA (1958) are reverse in order to those of HIROKAWA, ISOMI and KURODA (1957), to the former of which the present formational division is followed.

and subordinate clayslate, may be the lower Sakamotozawan, though there is no paleontological evidence to verify this assumption.

2. Ibukiyama-Samegai area

Ibukiyama-Samegai area [Ht 96–100] covering the boundary area between Gifu and Shiga Prefectures consists of calcareous and non-calcareous groups, the former of which thrust over the latter in the east side. The stratigraphy of this area was studied in some detail first by SEKI (1939), though KOTO (1910) reported that the Ibukiyama limestone was an overthrust block. Through recent studies of ISOMI (1956), KOBAYASHI (1957) and MORIKAWA and ISOMI (1961), the stratigraphy and paleontology of this area have been clarified.

Among the non-calcareous groups distributed under and around the Ibukiyama limestone [Ht 96], the following formations are referred by SEKI and ISOMI to the zone of *Pseudoschwagerina*; namely, the lower part of the Takayama Formation [Ht 92], the lower division of the Kusanogawa Group, which develops widely northwest of Ibukiyama, and the Oishi Formation [Ht 63] which crops out east of Ibukiyama and northeast of Sekigahara-machi.

The Takayama Formation consists mainly of clayslate and sandstone, intercalating small limestone lenses in two horizons, in the lower one of which the following species were reported by ISOMI (ISOMI's loc. 2, 3, 4):

Pseudofusulina vulgaris (SCHELLWIEN)
Psf. cfr. *fusiformis* (SCHELLWIEN and DYHRENFURTH)
Psf. *ambigua* (DEPRAT)
Psf. *kraffti* (SCHELLWIEN)
Parascwagerina sp.

The above faunal assemblage shows that the lower part of the Takayama Formation is the Sakamotozawan in age and is referable to the P1β subzone of the Akiyoshi limestone Group. However, only *Pseudofusulina vulgaris* has been described by MORIKAWA and ISOMI (1961).

The Oishi Formation [Ht 63] is composed of clayslate and subordinate sandstone, being in contact with fault relation with the Otaki Formation [Ht 62] which is presumably Akiyoshian in age. The species listed below were obtained in the limestone lenses that are intercalated in the lower part of the Oishi Formation and are also regarded as the Sakamotozawan (ISOMI, 1956).

Schwagerina krotowi (SCHELLWIEN)
S. cfr. *gregaria* (LEE)
Pseudofusulina vulgaris globosa (SCHELLWIEN)
Psf. cfr. *ambigua* (DEPRAT)
Triticites sp.
Staffella rotunda SAURIN

With the tectonic relation, the calcareous group is thrusting upon the non-calcareous group from NNW to SSE. ISOMI (1956) referred the non-fossiliferous Kiyotaki Formation [Ht 99] and the conformably overlying Samegai Formation [Ht 100] to the zone of *Pseudoschwagerina*. FUJIMOTO (1941) once described *Pseudoschwagerina schellwieni* HANZAWA from the Manganji limestone of Same-

gai Formation near Ominagaoka, Shiga Prefecture. IGO (1964), who collected further materials from the same locality, illustrated the same species and gave an account of the stratigraphical range of this species.

The Samegai Formation crops out southwest to Ibukiyama, consisting mainly of schalstein and lenticular limestones. ISOMI listed many species from twenty-one localities covering the distributed area, and the important ones are as follows:

* *Pseudofusulina kraffti* (SCHELLWIEN)
* *Psf. fusiformis* (SCHELLWIEN and DYHRENFURTH)
Psf. vulgaris (SCHELLWIEN) and its subspecies
Psf. ambigua (DEPRAT)
Paraschwagerina oblonga (OZAWA)
Pseudoschwagerina schellwieni HANZAWA
Acervoschwagerina? sp.
Schwagerina tschernyschewi (SCHELLWIEN) and its allied forms
Triticites simplex (SCHELLWIEN) and its allied forms
Misellina aliciae (DEPRAT)
Minojapanella sp.
(* most abundant)

ISOMI regarded the above fauna as probably middle and upper Sakamotozawan in age. Joining with MORIKAWA, ISOMI (1961) studied the same fauna of the Samegai Formation, but the species described by them are considerably different from those listed above.

A short time after ISOMI's work (1956) appeared, KOBAYASHI (1957) published a monograph on the fusulinaceans of the Ibukiyama limestone [Ht 96], the typical member of the calcareous group of this area. According to his zonation, the Sakamotozawan equivalent of Ibukiyama limestone is the *Acervoschwagerina* subzone which conformably covers a non-calcareous formation of about 100 m thickness. The characteristic species of this subzone are as follows:

Schwagerina hawkinsi DUNBAR and SKINNER
Pseudofusulina cfr. *vulgaris* (SCHELLWIEN)
Acervoschwagerina cfr. *kagemoriensis* (FUJIMOTO)
A. spp. A and B
Minojapanella sp.
Schubertella sp.

KOBAYASHI believes that the lowest part of the Permian, such as the *Triticites simplex* subzone of the Akiyoshi limestone Group, is missing or represented by the underlying unfossiliferous zone. It is also emphasized that no species of *Triticites* nor of *Pseudoschwagerina* has been found in this subzone.

3. Yoro massif

To the south-southeast of the Ibuki massif is there the Yoro massif which consists exclusively of Permian rocks called the Yoro Group. Recent study of KANUMA and IRIE (1962) has clarified the stratigraphy of this massif in some detail. The Yoro Group [Ht 67] is divided into two subgroups, the lower of calcareous facies (1500 m) and the upper of non-calcareous facies (1700 m). In the middle part of the lower subgroup the following species have been found:

Acervoschwagerina cfr. *endoi* HANZAWA
Pseudofusulina kraffti (SCHELLWIEN)
Psf. *santyuensis* FUJIMOTO
Schwagerina krotowi (SCHELLWIEN)
Rugosofusulina sp.

The above assemblage dates the lower subgroup as the Sakamotozawan, but the lowest part of the Sakamotozawan is seemingly not present in this massif. The geologic structure of this massif is complicated, making up an inclined anticline in the northern part and an inclined syncline in the southern one.

4. Fujiwaradake area

The Fujiwaradake area, located in the northern part of the Suzuka massif, was studied by MURATA (1960). The Fujiwaradake Formation [Ht 105] (about 500 m) developed in the central part of this area and the Ibaragawa Formation [Ht 103] (900 m) in the southern part are referred to the Sakamotozawan. The former, consisting mainly of limestone and schalstein with thin intercalations of lenticular chert and slate, yields the following fossils:

In the lowest limestone:

Pseudoschwagerina fusulinoides (SCHELLWIEN)
Acervoschwagerina endoi HANZAWA
Schwagerina sp.

In the middle limestone:

Acervoschwagerina endoi HANZAWA
Pseudofusulina vulgaris globosa (SCHELLWIEN)
Psf. *vulgaris* (SCHELLWIEN)

In the upper limestone:

Pseudofusulina japonica (GÜMBEL)
Psf. *ambigua* (DEPRAT)
Michelinia sp.
Waagenophyllum sp.

MURATA is of the opinion that the Fujiwaradake Formation ranges from Sakmarian to Artinskian.

The Ibaragawa Formation is the representative of the non-calcareous facies in the southern part of this area. This formation comprises mostly schalstein in the basal part, chert and slate in the lower part with thin lenticular sandstone, and sandstone in the upper part. The Ibaragawa Formaion is very complex in geologic structure, being mosaic due to faults and metamorphosed by the intrusion of the Gozaishoyama granite. Only available fossil evidence is the occurrence of *Pseudofusulina vulgaris* (SCHELLWIEN) from a small limestone lense interbedded in the schalstein of the basal part. Because the middle and upper parts of the Ibaragawa Formation are similar in lithology with the Tokiyama Formation of the probable Nabeyaman in the northern part of this area, MURATA dated the Ibaragawa Formation to the upper Sakmarian to Artinskian.

Although the geologic structure of this area is very complicated, MURATA considers that the formations of the calcareous facies (the Fujiwaradake and

Kurakaketoge Formations of the central part) are not the thrusting mass on the formation of the non-calcareous facies (the Ibaragawa Formation of the southern part and the Tokiyama Formation of the northern part) as once considered, but both are autochthonous but heteropic deposits.

5. Suzuka massif

The Paleozoic Suzuka massif runs in NNE direction to the south of the Ibuki massif with very complex structure. The stratigraphy of the northern part of this massif was studied by TAKIMOTO (1936), SEKI (1939) and FUJIWARA (1940), and it is known that the Lower and Middle Permian rocks are developed. The lower and middle parts of the Ryozen Formation [Ht 101] and the Inugami Formation [Ht 102] in this area are referable to the zone of *Pseudoschwagerina*. Both the formations consist mainly of schalstein and limestone.

With a discussion on the geological age of the *Pseudoschwagerina* zone, FUJIMOTO (1941) described *Pseudoschwagerina* cfr. *fusulinoides* (SCHELLWIEN) and *P. samegaiensis* FUJIMOTO from the limestone of the middle part of Ryozen Formation in Shimonyu [Ht 100′], Maibara-machi, Sakata-gun, Shiga Prefecture.

In the Inugami Formation *Pseudofusulina vulgaris* (SCHELLWIEN) and its allied forms and other schwagerinids are known to occur. This faunule shows that the Inugami and Ryozen Formations are correlated with the P1β subzone of the Akiyoshi limestone Group. It is noted that in the basal part of the Ryozen Formation species of "*Paleofusulina*" and *Fusulinella* were once found with *Mizzia velebitana* SCHUBERT (TAKIMOTO, 1936). Restudy of this faunule is seemingly necessary.

KOIKE (1963) also studied the Ryozen area and tentatively proposed the name "Ryozensan limestone" for the calcareous deposits of this area. He divided the Ryozensan limestone [Ht 101] into three facies; white limestone (ca 250 m), black muddy limestone (ca 250 m), and dark grey limestone (ca 600–700 m). Though mutual stratigraphical relationship between these limestones is not clear, he presumed that the first two are nearly contemporaneous in age but heteropic in facies, above which the last one is overlying.

The white limestone is characterized by the prolificacy of *Schubertella kingi* DUNBAR and SKINNER, *S. giraudi* (DEPRAT) and *Schwagerina chihsiaensis* (LEE) with rare occurrence of *Pseudoschwagerina* cfr. *subsphaerica* NOGAMI and *Paraschwagerina* sp. A. The black muddy limestone contains an abundance of two species of *Schubertella* mentioned above, *Pseudoschwagerina subsphaerica* NOGAMI, *Ps. samegaiensis* FUJIMOTO and *Paraschwagerina kawachiensis* KOIKE (MS). The dark grey limestone contains species of *Pseudofusulina* such as *P. complicata* (SCHELLWIEN), *P. annamitica* (DEPRAT), *P. dugontensis* ROSS with *Pseudoschwagerina* cfr. *schellwieni* HANZAWA and *Schwagerina cervicalis* (LEE). *Pseudofusulina vulgaris* (SCHELLWIEN) occurs throughout the limestones of the three facies but is very large in size of the shell and differs from those associated with species of *Triticites* in the lower Sakamotozawan rocks of other areas.

Thus KOIKE correlated the Ryozensan limestone with the upper Sakamotozawan of P1β to P1γ subzones of the Akiyoshi limestone Group.

C. Southern part of Tamba zone

In the southern part of the Tamba zone, the Upper Paleozoic rocks named the Tamba Group (SAKAGUCHI, 1962) are widely developed, and are composed mostly of shale, slate, sandstone, chert, and schalstein. Although extreme scarcity of limestone in this part of Tamba zone has made the detailed stratigraphy and correlation of the Tamba Group difficult to determine, SAKAGUCHI (1962) has been successful in establishing zonation of this group by means of fusulinaceans and corals. His zonation is as follows in descending order:

IV.	Coral zone	6.	*Waagenophyllum indicum* subzone
III.	*Neoschwagerina* zone	5.	*Neoschwagerina craticulifera* subzone
II.	*Parafusulina* zone	4.	*Parafusulina kaerimizensis* zone
		3.	*Misellina* sp. subzone
I.	*Pseudoschwagerina* zone	2.	*Pseudofusulina vulgaris* subzone
		1.	*Triticites montiparus* subzone

1. Nishiyama area

In the Nishiyama (western hill) area [Ht 112] a Formation, probably of the Moscovian age, is overlaid by the Sakamotozawan b (1500–1600 m) and c (1450–1600 m) Formations (MATSUSHITA, 1950–51). *Triticites subobsoleta* (OZAWA) and *Pseudofusulina* cfr. *vulgaris* (SCHELLWIEN) have been reported from the b Formation, and *Rugosofusulina prisca* [EHRENBERG (MÖLLER)] and its varieties and other schwagerinids from c. None of them, however, have been described.

According to SAKAGUCHI (1962) the Tano Formation [Ht 116], the lower half of the middle Subgroup of the Tamba Group, yields fusulinaceans and corals in the limestone lens intercalated in the schalstein of the lower part. Fusulinaceans and corals found in several localities indicate that the lower part of the Tano Formation is at least referred to the Sakamotozawan. SAKAGUCHI regarded all the species of Akiyoshian, such as *Fusulinella itoi, F. biconica,* etc. as the derived fossils. It may be possible that the Tano Formation contains a part of the Akiyoshian which is sandwiched in the Permian. It should be noted that the Tano Formation is very complex in structure and the limestone lens at Oshioyama yields only species of *Fusulinella.* The exact relationship between the Tano Formation and the b and c Formations of MATSUSHITA is not clear.

2. Nosé area

The Nosé area [Ht 115] in the southern part of the Tamba zone has been studied by SAKAGUCHI (1955, 1956, 1962) who proposed to call the Sakamotozawan rocks in the northern part of this area the Osakatoge Formation [Ht 114′] (700–1200 m). He states that the Osakatoge Formation contains two fossil horizons, the lower is probably referred to the *Triticites montiparus* and the upper to the *Pseudofusulina vulgaris* subzone. The equivalent of the Osakatoge Formation in the southern part of this area is the lower part of the Mino Formation in which *Schwagerina krotowi* (SCHELLWIEN) was reported by FUJIMOTO (1950) from Tada [Ht 120].

3. Sasayama area

The Paleozoic rocks developed in the marginal area of the Sasayama basin [Ht 122], located to the northwest of the Nosé area mentioned above, were collectively called the Taki Group by ARAI and SAKAGUCHI (1955). They divided it into several formations which were later redefined by SAKAGUCHI (1962) and included into his Tamba Group. The Manajo Formation [Ht 123], the second lower of the group of this area, yields *Pseudofusulina kraffti* (SCHELLWIEN), *Acervoschwagerina* sp. and *Schwagerina kawkinsi* (DUNBAR and SKINNER), and is correlated with the zone of *Pseudoschwagerian.* None of the species found in this area have been described.

4. Sonobe area

The Sonobe area is the eastward extension of the Sasayama basin. The Sakamotozawan of this area is called the Sonobe Formation [Ht 110] and consists mostly of shale with intercalation of chert. The fossiliferous limestone lenses are found in the basal part of the schalstein, in which three new species of *Triticites* and one of *Pseudofusulina* are found with *Pseudofusulina* cfr. *santyuensis* FUJIMOTO and *Acervoschwagerina* sp. *Fusulinella itoi* OZAWA and *F. matsushitai* SAKAGUCHI are also found at KUMASAKI, north of SONOBE, but SAKAGUCHI has regarded them as derived fossils.

IV. Chugoku massif

The Chugoku massif belongs geotectonically to the Inner zone of Southwest Japan where the Upper Paleozoic rocks are widely developed. The most characteristic feature of them is a contrast between the calcareous facies (Akiyoshi or para-Akiyoshi facies of KOBAYASHI) and the non-calcareous facies (Yamaguchi facies of KOBAYASHI).

The boundary area between Okayama and Hiroshima Prefectures is one of the well known Paleozoic terrains in Chugoku region which belongs to the para-Akiyoshi facies, consisting of alternation of thick limestone and other kinds of rocks. The terrain is divided morphologically into several hilly plateax—the Atetsu plateau, about 40 km northwest of Okayama city, the Oga plateau, southwest of the former, and the Taishaku plateau, northwest of the second.

1. Atetsu plateau

The Paleozoic of the Atetsu plateau was studied in some detail by MOCHIZUKI (in KOBAYASHI, 1950) who divided it into the Ishiga Formation [Swi 42], the Toyonaga limestone [Swi 39] and the Terauchi black sandstone and shale [Swi 37] in ascending order. Five fossil zones were distinguished in the Toyonaga limestone. The zone of *Pseudoschwagerina,* the second lower of the five zones, yields species of *Schwagerina* and *Staffella,* and directly overlies the zone of *Fusulinella.*

IMAMURA (1959) proposed the Sabushi Group [Swi 36] for the Lower and Middle Permian rocks of the Atetsu area. It unconformably overlies the Car-

boniferous Kodani Group and is overlaid by the limestone conglomerate of the Yukawa Group with a distinct unconformity. The Iwamoto Formation [Swi 39], the lower division of the Sabushi Group, was referred to the zone of *Pseudoschwagerina,* and consists of greyish-white conglomeratic limestone at the type locality of IWAMOTO, Toyonaga-machi, but the lateral change of facies is rather remarkable. The Iwamoto Formation was later studied by SADA (1964, 1965) who divided the *Pseudoschwagerina* zone of IMAMURA into two subzones, the lower *Rugosofusulina arctica* and the upper *Pseudoschwagerina kanmerai* subzone.

The *Rugosofusulina arctica* subzone comprises the following species:

Triticites kawanoboriensis FUJIMOTO
T. obai TORIYAMA
**T. ozawai* TORIYAMA
**T. montiparus* [EHRENBERG (MÖLLER)]
T. cfr. *pseudosimplex* CHEN
T. aff. *subventricosus* DUNBAR and SKINNER
Rugosofusulina arctica (SCHELLWIEN)
Chusenella? atetsuensis SADA
**Quasifusulina longissima ultima* KANMERA

The *Pseudoschwagerina kanmerai* subzone contains the following species:

Triticites kawanoboriensis FUJIMOTO
Pseudoschwagerina kanmerai SADA
Ps. pavlovi (RAUSER-CHERNOUSSOVA)
Ps. saigusai NOGAMI
Ps. muongthensis (DEPRAT)
**Pseudofusulina vulgaris vulgaris* (SCHELLWIEN)
**Psf. vulgaris globosa* (SCHELLWIEN)
Psf. regularis (SCHELLWIEN)
**Schwagerina primigena* NOGAMI
**S. okafujii* TORIYAMA
Chusenella aff. *schwagerinaeformis* SHENG
(Species with an asterisk were not described by SADA in 1964)

As seen in the above lists, the lower subzone is characterized by the *Triticites* assemblage but is devoid of species of *Pseudoschwagerina* and its allied genera, whereas the upper subzone is dominated by the *Pseudoschwagerina* assemblage but contains no representative of *Triticites* except *T. kawanoboriensis* which is a long ranging species. The assemblage of species shows that the lower and the upper subzone are referable respectively to the *Triticites simplex* and the *Pseudofusulina vulgaris* subzone of the Akiyoshi limestone Group. Thus the Iwamoto Formation can certainly be dated to the lower-middle Sakamotozawan.

Independently from IMAMURA and his collaborators, NOGAMI (1961) who dealt mainly with the central part of the same plateau divided the Permian Atetsu limestone Group and the Terauchi Formation into five fusulinacean zones, four of which are subdivided into two subzones respectively. The lower two zones, *Pseudoschwagerina subsphaerica–Quasifusulina longissima ultima* and *Pseudofusulina vulgaris* zones are referred to the Sakamotozawan, of which the former is further divided into the *Quasifusulina longissima ultima* subzone ($_{u}P_{1-\alpha}$) and

Pseudoschwagerina subsphaerica subzone ($_{\text{II}}P_{1-\beta}$). All the component species of these zones and subzones have been described by him in great detail.

It is unfortunate that the results obtained by IMAMURA and his collaborators and those by NOGAMI do not necessarily in agreement with each other in the interpretation of geologic structure of the Atetsu limestone Group and the faunal contents of the fusulinacean zones.

2. Oga plateau

The stratigraphy of the Oga plateau [Swi 47] was first studied by CHANG (in KOBAYASHI, 1950). He found that the zone of *Pseudoschwagerina* is in the Nakamura limestone [Swi 45] of south and in the Koyama limestone [Swi 49] of north. In the former, the zone of *Pseudoschwagerina* occupies the basal part of the limestone, yielding *Pseudofusulina vulgaris* (SCHELLWIEN), *Psf. japonica* (GÜMBEL) and *Rugosofusulina prisca* [EHRENBERG (MÖLLER)] with association of species of *Quasifusulina* and *Triticites*.

The Koyama limestone contains the *Pseudofusulina vulgaris* zone in the middle part where a few thin layers of schalstein and conglomeratic limestone are developed. *Triticites* sp., *Pseudoschwagerina* spp. and *Pseudofusulina vulgaris* have been obtained in the conglomeratic limestone. Besides, the *Pseudofusulina vulgaris* zone directly overlies the zone of *Fusulinella*. YOSHIMURA (1961) thus assumed the absence of the "Uralian" in the Koyama limestone.

3. Taishaku plateau

The Taishaku plateau was studied by many pioneer geologists, such as OGURA (1921), YOSHINO (1937), HANZAWA (1942), and FUJIMOTO (1944). Recent studies of YOKOYAMA (1957, 1959) and AKAGI (1958) have added some knowledge to the stratigraphy and paleontology of this plateau. According to YOKOYAMA the Unada Formation [Swi 61] and Idaniyama Formation [Swi 58] of Higashiuyama Group are referable to the Sakamotozawan. Both are different in facies. YOKOYAMA listed the following species in the Unada Formation:

Triticites simplex (SCHELLWIEN)
T. montiparus [EHRENBERG (MÖLLER)]
Pseudofusulina kraffti (SCHELLWIEN)
Psf. vulgaris (SCHELLWIEN)
Pseudoschwagerina spp.

And in the Idaniyama Formation:

Triticites minimus (SCHELLWIEN)
T. sp.
Pseudofusulina sp.

It is noted that YOKOYAMA confirmed an unconformable relation between the Unada Formation and Carboniferous Eimyoji Formation although HANZAWA and FUJIMOTO once presumed the same relationship.

Independently of YOKOYAMA, AKAGI (1958) divided the Permian rocks developed in the eastern part of the Taishaku area into four formations, each of which represents one fusulinacean zone. The Miharano Formation [Swi 57],

the zone of *Pseudoschwagerina,* is further divided into the *Triticites nishikawai, Pseudoschwagerina miharanoensis,* and *Schwagerina krotowi* subzones in ascending order. Although AKAGI listed *Triticites nishikawai* AKAGI (MS), *Pseudoschwagerina uddeni* (BEEDE and KNIKER), *Paraschwagerina fosteri* THOMPSON and MILLER, *Pseudofusulina nelsoni opima* THOMPSON, *Psf. pseudosimplex* (CHEN), and *Psf. tenuis* CHEN as the associated species of *Pseudoschwagerina miharanoensis* AKAGI. It should be noted that he described only *P. miharanoensis* and based his description from the statistical standpoint of the growth and form of fusulinacean shell.

4. Jinseki-Yuki area

The Permian rocks of calcareous facies of the Taishaku area appear southward in the Jinseki-Yuki area where they are represented by white, massive limestone with a small amount of black shale and tuff. Indeterminable species of *Triticites, Schwagerina* and *Pseudofusulina* have been reported by HASE (1965) from fine calcirudite-calcarenite of the lower part of HASE's e Formation at the south of Nagao [Swi 67A′], Jinseki-cho. HASE correlated this part of the formation with the Unada Formation of Taishaku area.

5. Middle and Upper valley of Ota-gawa

The Paleozoic rocks of non-calcareous facies occur along the middle and upper valley of Ota-gawa in the western part of Hiroshima Prefecture. According to HASE (1964) and IMAMURA, NUREKI and OKIMURA (1966) they consist mainly of black slate associated with sandstone and chert (about 2000 m in thickness) and belong to the northern and middle zones of the Paleozoics of Hiroshima Prefecture. A remarkable sheared zone exist between two zones. OKIMURA discovered indeterminable species of *Schubertella, Triticites, Schwagerina,* and *Pseudoschwagerina* from a limestone lens exposed in Hosomidani [Swi 71], which is however found in the sheared zone. The rock facies shows that the Paleozoic of this area is probably correlative with the lower formation of the Yoshii Group in the eastern part of Hiroshima Prefecture.

6. Akiyoshi area

Since the Akiyoshi limestone [Swi 100] displays a good succession of the fusulinacean zone, it has been regarded as the standard of the Inner zone of Southwest Japan and studied by many pioneer workers such as OZAWA, KOBAYASHI, HANZAWA, etc. TORIYAMA (1954, 1957, 1958) divided the Sakamotozawan zone of *Pseudoschwagerina* of Akiyoshi limestone into the lower *Triticites simplex* and the upper *Pseudofusulina vulgaris* subzone. MURATA (1961) followed TORIYAMA in the zonation of this part of limestone with a little emendation. Because the basal part of the former subzone comprises only species of *Triticites* there is a diverse opinion concerning the correlation of this subzone. The prolific fusulinacean fauna found in the zone of *Pseudoschwagerina* was described by TORIYAMA (1958) in detail.

The Sakamotozawan formations of the non-calcareous facies are developed

around the Akiyoshi limestone. The Katada Formation [Swi 86] of Beppu Group, the Aigyo Formation [Swi 95] of Tsunemori Group and a part of Yaegahara Formation [Swi 99] of Oda Group have been referred to the Sakamotozawan. However, on the stratigraphical interpretation, geologic structure, and correlation of these formations, opinions differ among TORIYAMA (1954), MURATA (1961), KAWANO *et al.* (1963), and KAWAI (1963).

The northern part of Yamaguchi Prefecture is known to have a rather wide distribution of the Upper Paleozoic rocks which also cover the western part of Shimane Prefecture and are collectively called the Kanoashi Group by KAWANO *et al.* (1956). The lowest division of this group, the Kane Formation [Swi 76] of about 3000 m thickness consists mainly of alternation of sandstone and clay-slate, with limestone lenses in two horizons. One is the Koda limestone which is found in the top of the lower part of this formation and the other is the Izuto limestone in the upper part. The Koda limestone yields *Pseudofusulina vulgaris* (SCHELLWIEN) and its allies and other schwagerinids, and the Izuto limestone yields *Neoschwagerina margaritae* DEPRAT and indeterminable species of *Schubertella* and *Schwagerina* along with corals. It is therefore certain that the lower part of the Kane Formation is of the Sakamotozawan, being referred by KAWANO to the P1β and/or P1γ subzone of the Akiyoshi limestone Group. The non-calcareous basal part of the Kane Formation may be referable to the earliest part of the Permian.

7. Abugawa area

Along the tributary of Abugawa in the central northern part of Yamaguchi Prefecture, the Upper Paleozoic rocks are also well developed and, as in the Akiyoshi area, they display a marked contrast of two facies, calcareous and non-calcareous.

The calcareous facies is represented by the Handa limestone (300–400 m) [Swi 79] and the Zomeki limestone (500–600 m) [Swi 77], in the latter the Sakamotozawan has not been found. In the Handa limestone KAWANO (1961) set up five zonules of which *Triticites ozawai* and *Pseudofusulina vulgaris* zonules are Sakamotozawan. The *Triticites ozawai* zonule comprises *T. ozawai* TORIYAMA, *T. biconica* TORIYAMA, *T. simplex* (SCHELLWIEN), and *Quasifusulina*? sp., all of which are the representatives of the *T. simplex* subzone of the Akiyoshi limestone Group. The *Pseudofusulina vulgaris* zonule, which is directly overlying the *T. ozawai* zonule, is very prolific in fusulinaceans, yielding many species of *Pseudofusulina, Triticites, Schwagerina, Rugosofusulna, Dunbarinella, Paraschwagerna,* and *Schubertella.* The faunal assemblage shows that this zonule is definitely correlative with the *Pseudofusulina vulgaris* subzone of the Akiyoshi limestone Group. Since all the species have been described in detail by KAWANO, the specific names are omitted here.

It is noticeable that the *Triticites ozawai* zonule is apparently conformable with the underlying *Fusulinella eopulchra* zonule of the Akiyoshian.

The representative of the non-calcareous facies in the Abugawa area is the Ikadaba Formation [Swi 80] which occurs along the lower valley of Abugawa

with the type locality at Aihara and Ikadaba. It consists of sandstone, clayslate, and limestone, attaining a thickness of 500 to 650 m. As *Pseudofusulina vulgaris* is found in the limestone lens intercalated in the sandstone of the lowest part, the Ikadaba Formation is dated as the upper Sakamotozawan (KAWANO, *op. cit.*).

8. North Kyushu

The Paleozoic rocks developed in the northeastern part of North Kyushu is structually the southwestern extension of the non-calcareous rocks of Yamaguchi area. FUJIMOTO (1935) once reported *Pseudofusulina kraffti* (SCHELLWIEN) and *Quasifusulina* cfr. *longissima* (MÖLLER) from schalstein intercalated in the limestone lens exposed at Tokuriki [Swi 105] located near the neck of the Kiku peninsula. FUJIMOTO, YOSHINAKA and TAJIMA (1961) restudied the Upper Paleozoic of the Kiku peninsula and found *Schwagerina krotowi* (SCHELLWIEN) and *Pseudofusulina vulgaris* (SCHELLWIEN) along with smaller foraminifers in the Aohama Formation [Swi 104] which consists of schalstein, limestone, sandstone, shale, chert, and accompanying conglomerate in the uppermost horizon.

Although the Paleozoic limestones are rather widely distributed in the northeastern part of North Kyushu almost all of them are completely crystalline and they are almost devoid of fossils.

V. Outer zone of Southwest Japan

The Outer zone of Southwest Japan crosses the southern parts of Akaishi massif, Kii peninsula, Shikoku, and Kyushu. The Paleozoic rocks including the Silurian formations are developed in the Outer zone and referred to the Chichibu facies of the KOBAYASHI's classification. They are composed mainly of various kinds of clastic rocks and a considerable amount of limestones. Although many geologists have made efforts to clarify the geology of these Paleozoic rocks, its complexity has left many problems unsolved.

A. Akaishi massif

Hamanako area

The Paleozoic rocks found extensively along the west side of the lower valley of Tenryugawa extending westwardly to the Atsumi peninsula belong geologically to the Outer zone of Southwest Japan. Although little is known of these Paleozoics because of their complicated structure and scarcity of fossil content, those developed to the north of Lake Hamana, Shizuoka Prefecture have been studied by ISOMI (1958). Based on the facies differentiation he classified the Upper Paleozoic of this area into the Iinoya [Swo 2] and Miyakoda [Swo 1] Formations. The Iinoya Formation occupies the northern half of the area, consisting of chert, clayslate and schalstein, with lenticular limestone in which *Pseudofusulina* sp. (probably of *Psf. vulgaris*) and *Schwagerina* spp. have been found. The Miyakoda Formation occurs in the southern part and consists of sandstone, clayslate and chert, apparently grading into the Iinoya Formation. ISOMI referred the Iinoya Formation to the upper Lower Permian, and the Miyakoda Formation—although it is barren of fossils—to the Middle Permian.

B. Kii peninsula

1. Eastern part of Kii peninsula

a. Shima area

It has long been known that fusulinacean-bearing Paleozoic rocks are developed to the southwest of Toba city in the extreme east of the Kii peninsula. As in the southern parts of Shikoku and Kyushu, the Paleozoic is arranged in several belts of NEE–SWW trend. Recent studies of YAMAGIWA (1957) in the central part of Shima peninsula and of KUSAKABE and MIYAMURA (1958) in the southern part of Ise city (formerly Uji-Yamada) [Swo 4] clarified that the Sakamotozawan rocks are well developed in these parallel blocks. Although KUSAKABE and MIYAMURA did not give formation names, they divided the Upper Paleozoic into five fossil zones by means of fusulinaceans. The third, *Triticites* and *Pseudofusulina* zone, yields fourteen species of *Pseudofusulina,* three species of *Schwagerina, Paraschwagerina oblonga* (OZAWA), *Pseudoschwagerina* sp., and *Acervoschwagerina* sp. The fourth, *Pseudofusulina* zone, contains the same species of *Pseudofusulina* and *Schwagerina* as those of the third, but is deficient in species of *Triticites.* As two zones always appear in company with each other in the field, it seems better to unify them into one fossil zone dividing it into lower and upper parts and referring this zone to the Sakamotozawan.

b. Aso-Gokasho area

Stressing the relationship between tectonics and sedimentary facies, KIMURA (1957) clarified the geology of the Aso-Gokasho area located southwest-west of the Shima area.

As well as in other parts of the Outer zone of Southwest Japan, the Chichibu terrain of this area is divided into three belts, northern, central, and southern, each of which is, according to KIMURA, composed of different *Decke* that has characteristic facies. The facies name, Ogawago, Ichinosé, and Nomisaka were proposed by him for these three belts.

The formation of Ogawago facies is characterized by the great thickness of schalstein and ranges from the Upper Carboniferous to Lower Permian. The Sakamotozawan fusulinaceans reported by KIMURA are as follows: *Pseudofusulina* sp. from Ogawago area [Swo 14]; *Psf. santyuensis* FUJIMOTO, *Psf. verneuili solida* (SCHELLWIEN), *Psf.* cfr. *ambigua* (DEPRAT), *Paraschwagerina* sp., and *Schwagerina* sp. from Ryusenzan area [Swo 13].

The Ichinosé facies is the representative of the central belt and characterized by frequently alternating thin beds of sandstone, shale, chert, schalstein, and limestone. Most of the formation of this facies is referred to the Sakamotozawan. *Pseudoschwagerina* sp., *Pseudofusulina vulgaris* (SCHELLWIEN), *Psf. vulgaris globosa* (SCHELLWIEN) and *Schwagerina tschernyschewi* (SCHELLWIEN) were reported from Ichinosé area [Swo 15], *Pseudofusulina santyuensis* FUJIMOTO, *Schwagerina tschernyschewi* (SCHELLWIEN) and *Paraschwagerina* (?) sp. from Yokowa area [Swo 12], and *Parafusulina* sp. from Kirihara area [Swo 10]. It should not be neglected that *Wedekindellina* (?) sp. and *Fusulinella* sp. are also

found in the Kirihara area as mentioned in Chapter V.

The formation of Nomisaka facies which is developed in Aso-Nakamura [Swo 18] and Izumimura [Swo 11] areas is barren of fossil content, though its equivalent in the Izumimura area is dated as the Middle Carboniferous to Middle Permian (YAMAGIWA, 1957).

The formations of the above three facies are different from one another in geologic structure, and many horizontal Decken composed of competent rocks are developed.

None of fusulinaceans listed above have been described.

2. Central part of Kii peninsula

SHIIDA (1962) has brought a light on the stratigraphy and geotectonics of the central part of the Kii massif (Omine and Odaigahara area). The zonal arrangement of the Paleozoic and Mesozoic strata is recognized in this part of the massif though not seen as distinctly as seen in Shikoku. According to SHIIDA the Chichibu terrain is divisible into the northern zone and the main zone, the former of which thrusts upon the latter.

HIRAYAMA and KAMBE (1959) also contributed to the clarification of the geology in the Koyasan area [Swo 25] which is the southwestward extension of the northern zone mentioned above. However, no paleontological information is presently available for this part of the Chichibu terrain. The Hosokawa zone is a part of the northern zone and is in contact with the Shiga zone of Nagatoro metamorphic rocks. It is seemingly a transitional zone from non-metamorphic to metamorphic Paleozoic rocks, being an alternation of both of them.

The Kawakami Group developed in the eastern part of the main zone is, as a whole, referred to the Permian, and divided into three formations. The lower, Gyojagaeri Formation [Swo 23], consists of thick alternation of chert and sandstone with lenticular massive limestone and schalstein, and is presumed to be the Sakamotozawan, though it is barren of fossil content.

3. Western part of Kii peninsula

In Yuasa-machi and its environs, the western part of the peninsula, the Upper Paleozoic rocks, most of which consist of sandstone, clayslate and chert, are distributed in two belts, northern or main and southern, attaining a total thickness of about 2800 m. Besides, phyllitic rocks characterize the basal part, schalstein the middle, and coarse clastic rocks the uppermost part. HIRAYAMA and TANAKA (1956) divided the Chichibu System of this area into four divisions, A, B, C, and D in ascendng order, of which A and B are referable to the Sakamotozawan.

The division A, which consists of phyllitic rocks, being barren of fossils, whereas B (1200 m) is composed mainly of sandstone and clayslate, with lenticular limestone lenses in lower (B_1) and upper (B_3) parts. HIRAYAMA and TANAKA listed the following fossils.

In B_1 (Semuiji, about 2 km NW of Yuasa-machi; Myooji, Kibi-machi (about 4 km NNW of Yuasa-machi)) [Swo 32]

Pseudofusulina cfr. *vulgaris globosa* (SCHELLWIEN)
Psf. sp.

Schwagerina cfr. *kagemoriensis* (FUJIMOTO)
S. sp.

In B_3 (Furuemi, Minoshima-cho) [Swo 30]

Pseudofusulina sp.
Calcareous algae, bryozoan, stromatoporoid, brachiopod

It is clear that the subdivision B_1 is of the upper Sakamotozawan, and B_3 is referable either to the same age or to a part of the Nabeyaman.

The division A and B occur far eastward, but palentological datum available so far is only *Schwagerina* sp. obtained at Onishi, Sashiki-mura (about 14 km NEE of Yuasa).

Besides the above, the following species were reported from Hokaji, near Yura [Swo 36] (SUGIYAMA, 1932), though stratigraphy of the Yura area is not exactly known:

Pseudoschwagerina glomerosa (SCHWAGER)
Rugosofusulina prisca [EHRENBERG (MÖLLER)]
Schwagerina incisa (SCHELLWIEN)
Fusulinella bocki MÖLLER

Fusulinella bocki MÖLLER seems to be derived fossil.

C. Shikoku

The southern half of the Shikoku Island is the typical representative of the Outer zone of Southwest Japan where the Chichibu terrain is divided into three belts or zones. Description of each belt or zone has already been stated in the preceding chapter.

1. Eastern part of Tokushima Prefecture

The middle zone of Chichibu terrain located in the eastern part of Tokushima Prefecture contains Permian rocks collectively called the Hisone Group and this group is divided into the lower Kusune and the upper Hisone Formation.

The Kusune Formation [Swo 39] (300 m) with the type locality at the east of Kusune, Anan city, consists of the alternation of phyllitic mudstone and sandstone, with dark purple to green schalstein. The limestone interbedded in schalstein of the lower part yields the following species:

Quasifusulina longissima (MÖLLER)
Triticites kawanoboriensis FUJIMOTO
Pseudoschwagerina aff. *geyeri* KAHLER and KAHLER
Pseudofusulina regularis (SCHELLWIEN)

The above assemblage shows that the lower part of the Kusune Formation is certainly Sakamotozawan in age.

The Ottate Formation [Swo 55] (HIRAYAMA *et al.*, 1956) is limited in distribution being sporadical small lenses in the northern part of the central zone of Chichibu terrain. It is composed of sandstone with conglomerates and tuffs. Since *Pseudofusulina fusiformis* has been obtained in the small limestone lens exposed near Ottate, HIRAYAMA *et al.* referred this formation to the upper Lower Permian.

2. Central part of Shikoku

The Kameiwa Formation [Swo 66], the representative of the Sakamotozawan in the northern belt, is the lower division of the Shirakidani Group. It is composed of alternation of sandstone and mudstone with intercalations of thick schalstein, limestone and thin chert. According to SUYARI (1961, 1962) the Kameiwa Formation comprises the zones of *Pseudoschwagerina, Schwagerina* and *Misellina* in ascending order. Judging from the faunal assemblages the lower two zones are referable to the Sakamotozawan. It is noted that the constituent species of SUYARI's *Pseudoschwagerina* zone are mixed fauna of the Tethysian and American elements. The existence of species of *Millerella* in the *Pseudoschwagerina* zone is also noteworthy, though their true natures are not exactly known because of incompleteness of his illustrations.

The Kameiwa Formation is perhaps one of the most prolific stratigraphical units in Shikoku, and SUYARI reported many species of fusulinaceans from twenty-nine localities, of which at least eighteen are referable to the Sakamotozawan. He (1962) has recently described most of these species.

The Shimoyakawa Formation [Swo 73] is developed in the central part of the northern belt with a nearly east-west trend. It is not known that whether this formation is partly or wholly synchronous with the Kameiwa Formation described above. According to ISHII *et al.* (1957) the Shimoyakawa Formation is extremely rich in chert, but barren of fossils and is presumed to be the Lower Permian in age.

3. Western part of Shikoku

The western extension of the Shirakidani Group appears in the central southern part of Ehime Prefecture where it is called the Omodani Formation [Swo 95] (ISHIZAKI, 1962). In the lower part of this formation indeterminable species of *Triticites* and primitive form of *Schwagerina* have been reported with *Huangia hashimotoi* (NAGAO and MINATO) which is a well known species in the Sakamotozawan rocks of Japan. According to ISHIZAKI, the Omodani Formation ranges up to the Akasakan, but the stratigraphical relationship with sub- or superjacent formations is not known because of its tectonic contact with them.

The Onogahara Formation [Swo 100], which is regarded by ISHIZAKI (1962) as being equivalent in part with the Shirakidani Group of SUYARI, contains the Sakamotozawan in the lower part. However, ISHIZAKI reported only indeterminable species of *Triticites* and *Pseudoschwagerina,* and their faunal characteristic are not known. The formation is in tectonic contact with the Omodani Formation mentioned above.

KOBAYASHI (1950) listed a number of fusulinacean species which were collected from 49 localities in the western part of Shikoku and identified by TORIYAMA. About one-third of them is of Early Permian, but stratigraphy and paleontological features of some of formations from which these species were collected are not exactly known.

The westernmost representative of the Chichibu terrain of Shikoku is found in the Yawatahama area [Swo 112] of Ehime Prefecture where the name Futaiwa

Formation is given to the phyllitic facies, Iwaki Formation to the alternation of clayslate, sandstone and chert, and the Tawarazu Formation to the clastic facies comprising clayslate, sandstone, chert, conglomerate, and limestone. The former two are partly in fault contact but conformable with each other in general (HIRAYAMA and KAMBE, 1956). The third, Tawarazu Formation is regarded as a correlative with a part of the Sambosan Group (undifferentiated strata including the Permian, the Triassic and the Jurassic) in Kochi Prefecture, owing to the similarity of rock facies and to the tectonic position. No guide fossils for dating have been found in these formations.

D. Kyushu

The Outer zone of Southwest Japan continues from Shikoku to South Kyushu as seen by the similarity of the geological framework. In South Kyushu the Usuki area of the east, the Kuraoka area of the central and the Kumagawa area of the west have been studied in detail.

1. Usuki area

The Paleozoic rocks of Usuki area are developed in several tectonic belts with about NEE-SWW trend. According to FUJII (1954) the Chin'nanzan zone [Swo 116] of the north and the lowest part of the Tsukumi limestone [Swo 114] of the south are referable to the zone of *Pseudoschwagerina*. The *Pseudofusulina* faunule obtained from the latter contains *Psf. vulgaris fusiformis* (SCHELLWIEN), *Triticites kagaharensis* FUJIMOTO, *Rugosofusulina* sp., *Pseudoschwagerina* sp., and *Schubertella* sp. The fusulinacean species described by FUJIMOTO (1937) from Kawanobori [Swo 117] are regarded by FUJII to be equivalent in age. The component species show that both the lowermost parts of the Tsukumi and Kawanobori limestones are correlative with P1α-P1β subzone of the Akiyoshi limestone Group. It should be noted that in the Usuki area the limestone containing *Pseudofusulina* is covered obliquely by rocks which yield *Neoschwagerina craticulifera* faunule.

2. Kuraoka area

The Yurugidake Formation [Swo 124] (SAITO and KAMBE, 1954; KAMBE 1957) occurs in the Kuraoka area located in the northwestern part of Miyazaki Prefecture. This formation consists mainly of sandstone, clayslate, chert, limestone, and schalstein with rare intercalation of conglomerate. Limestone ranging from several to tens of meters in thickness yield mostly fusulinacean fossils. According to KAMBE (1957) fusulinaceans are reported from sixteen localities and corals from two. Three fusulinacean localities are referred to the Sakamotozawan; namely, *Pseudofusulina* sp. and *Paraschwagerina* sp. from his loc. 1 (north of Tenshuyama, Yabe-machi), *Pseudofusulina* cfr. *kraffti* (SCHELLWIEN) from loc. 2 (Hirokawaradani, Yabe-machi), and *Pseudofusulina* cfr. *kraffti* (SCHELLWIEN), *Psf.* sp., *Schwagerina alpina communis* (SCHELLWIEN), and *Schw.* sp. from loc. 3 (south of Ogawa, Gokase-machi) [Swo 126]. KAMBE correlated them with the upper part of the zone of *Pseudoschwagerina* and with the upper subzone of the upper formation of Tobiishi Group in Kuma massif.

3. Kuma area

The Kuma massif located in the western-most part of the Outer zone in Southwest Japan was studied by KANMERA (1955, 1958) who clarified the stratigraphy of the massif in great detail and published a series of papers on fusulinaceans. The Paleozoic of the Kuma massif is also developed in several belts with a general trend of NEE–SWW. The Yayamadake limestone Subgroup [Swo 136] of the Tobiishi Group in the Odao zone was extensively studied, being ranging from Kurikian to Sakamotozawan in age. KANMERA divided the zone of *Pseudoschwagerina* into the lower and upper subzones without giving a subzone name. The lower subzone is characterized by the first appearance of *Pseudoschwagerina* cfr. *muongthensis* (DEPRAT) and by several species of *Triticites*, such as *T. parvulus* (SCHELLWIEN), *T. montiparus* [EHRENBERG (MÖLLER)], *T. subobsoletus* (OZAWA), and *T.* aff. *kagaharensis* FUJIMOTO. The faunal assemblage of this subzone is similar to the P1α subzone of the Akiyoshi limestone Group, and may have the same stratigraphical position. It should be noted, as emphasized by KANMERA, that there is still a stratigraphical hiatus between the lower subzone stated above and the underlying *Triticites matsumotoi* subzone of the Hikawan age.

The upper subzone (about 55 m) of the zone of *Pseudoschwagerina* in the Yayamadake limestone comprises larger, more advanced members of schwagerinids—*Pseudoschwagerina minatoi* KANMERA, *Paraschwagerina shimodakensis* KANMERA, *Triticites samaricus* RAUSER-CHERNOUSSOVA, *T. fornicatus* KANMERA, *Rugosofusulina serrata* RAUSER-CHERNOUSSOVA, *R. pristina* KANMERA, *Pseudofusulina regularis* (SCHELLWIEN), *Psf.* aff. *dongvanensis* (COLANI), *Psf. santyuensis* FUJIMOTO, *Psf. sokensis* RAUSER-CHERNOUSSOVA, *Psf. horrida* KANMERA, *Psf. kumasoana* KANMERA, *Schwagerina stabilis* (RAUSER-CHERNOUSSOVA), *S. krotowi* (SCHELLWIEN), *S. grandensis* THOMPSON—, although some of these species are limited in occurrence to the upper or to the lower part of this subzone. KANMERA has correlated this subzone with the P1β subzone of the Akiyoshi limestone Group.

Besides the Yayamadake Subgroup described above, the Kozaki Formation [Swo 142] contains the upper Sakamotozawan in the basal part; namely, the *Misellina claudiae* zonule of the lower Subformation of the Kozaki Formation is correlated with the *Pseudofusulina ambigua* subzone of the Akiyoshi and Ibuki limestones, etc. (KANMERA, 1961, 1963). The diagnostic species of the *Misellina claudiae* zonule are *M. claudiae* (DEPRAT), *Nankinella kozakiensis* KANMERA, *Sphaerulina crassispira japonica* KANMERA, *Minojapanella* sp., *Toriyamaia laxiseptata* KANMERA, *Nagatoella* sp., *Parafusulina* (*Skinnerella*) *gruperaensis* THOMPSON and MILLER, *P.* (*S.*) *figueroai* THOMPSON and MILLER, *P.* (*S.*) *nakamigawai* MORIKAWA and HORIGUCHI and *Monodiexodina kumensis* KANMERA. The stratigraphical significance of the *Misellina claudiae* zone as well as that of the overlying *Neoschwagerina simplex* zone has been discussed by KANMERA at length. (See also p. 139)

Chapter VIII. The Zone of *Parafusulina*

I. Kitakami and Abukuma massifs

A. Southern part of Kitakami massif

1. Setamai area

As well as the "*Neoschwagerina* zone", the "*Parafusulina* zone" is difficult to define with certainty in the Setamai area which is the standard area of the massif. With his collaborators, MINATO (1954) divided the Sakamotozawa limestone (their IX formation of calcareous facies) by the upper limit of *Pseudoschwagerina* into the Kawaguchi Member of *Pseudoschwagerina* zone below and the Kabayama Member of *Parafusulina* zone above. The same division was also supported by ONUKI (1956) who listed *Nankinella discoides* (LEE), *Pseudofusulina vulgaris globosa* (SCHELLWIEN), *P. kraffti* (SCHELLWIEN), *Parafusulina* cfr. *gigantea* (DEPRAT), *Monodiexodina matsubaishi* (FUJIMOTO), and *Eoverbeekina cheni* THOMPSON as the characteristic species of the "*Parafusulina* zone" of the Hikoroichi-Setamai area.

Later, based on the additional research, MINATO *et al.* (1959) presumed that the Kabayama Member is correlative with the lower half of the "*Parafusulina* zone" and the Katchizawa Member (the lower division of the Kanokura Formation) with the upper half. MINATO *et al.* (1965) then divided the Sakamotozawa Formation into the Kawaguchi Member of the *Pseudoschwagerina* zone and the Kabayama Member of the *Pseudofusulina* zone, and they referred the Katchizawa Member only to the *Parafusulina* zone. As shown above, the fusulinacean zonation in the Sakamotozawa and Kanokura Formations has often been modified and still is not settled by concrete paleontological evidence. This is due to the fact that all these discussions on the zonation and correlation were based not on the species zone, but on the genus zone which often resulted in a considerable dispute on the stratigraphic position of the formations under consideration.

The Katchizawa Member of the Kanokura Formation, which overlies unconformably the Sakamotozawa Formation, is very poor in fusulinacean fossils except for *Monodiexodina matsubaishi* (FUJIMOTO) which has a rather long stratigraphic occurrence, ranging from the I_2 horizon ("*Pseudoschwagerina* zone" of MINATO *et al.*) to the L_0 horizon ("*Yabeina* zone"). Since this species has not been found in other Nabeyaman rocks in this country, the true stratigraphic range is not exactly known. Moreover, it occurs with *Michelinia* (*Protomichelinia*) *multitabulata* YABE et HAYASAKA and *Yatsengia kabayamensis* MINATO which are also known only from this area. These facts suggest that the Nabeyaman of the Kitakami massif differs paleogeographically from that of Southwest Japan.

Besides the Kanokura Formation in the standard area, the Nabeyaman is known in several localities of the Kitakami massif, most of which contain an abundance of brachiopod fauna instead of fusulinaceans.

2. Yonezato area

The Omoriyama Formation (200 m) [Ka 19], consisting of conglomerate and

sandstone, is distributed narrowly in the environs of Otomo, Otomo-mura and to the west of Omoriyama. According to HIROKAWA and YOSHIDA (1954), the brachiopod fauna occurs 700 m south of Otomo primary school and comprises *Productus horridus* SOWERBY, *Pr.* sp., *Spiriferina cristata* SCHELLWIEN, and *Rhynchonella* sp., with coral species, *Amplexus* sp. This fauna is identical with that described by HAYASAKA (1922, 1923, 1925) from Yahagi [Ka 33], Kesen-gun. The joint authors correlated the Omoriyama Formation with the Kanokura Formation in the standard area.

3. Kesennuma area

As already mentioned in the preceding chapter, the Kesennuma area [Ka 41] is one of the classical localities in the studying of the Paleozoic stratigraphy and paleontology of Japan. The area has been studied in detail by KAMBE and SHIMAZU (1961) who reported many species of *Pseudofusulina, Parafusulina* and *Schwagerina* from several localities in their Sakamotozawa Formation*, most of which, however, have not been determined except for *Pseudofusulina kraffti* (SCHELLWIEN). They correlated the above fauna of the Kesennuma area with the upper part of the *Pseudoschwagerina* zone to the *Parafusulina* zone. No representatives of neoschwagerinid are associated with the above schwagerinid fauna.

The Kanokura Formation in the Kesennuma area was also studied by many other workers including YABE (1900), HAYASAKA (1922), SHIIDA (1940), MINATO (1955), etc. Like in the standard area, the fusulinaceans do not play the leading rôle in the Kanokura Formation of the Kesennuma area; viz., brachiopods and corals are the main constituents of the fauna. *Leptodus* (*Lyttonia*) *richthofeni* KAYSER, *Productus flemingi* (SOWERBY) de KONINCK, *Dielasma* cfr. *biplex* WAAGEN, etc. are the characteristic representatives together with *Waagenophyllum polyseptata* MINATO and *Monodiexodina matsubaishi* (FUJIMOTO). Besides KAMBE and SHIMAZU (1961) reported indeterminable species of *Neoschwagerina, Pseudodoliolina, Parafusulina, Pseudofusulina,* and *Schwagerina* and bryozoans, and they assigned the Kanokura Formation of Kesennuma area to the Middle Permian ranging from the zone of *Neoschwagerina* to that of *Yabeina.* Since the brachiopod faunas have been found mostly in sandstone and fusulinaceans in limestone, finer observation on the stratigraphical relationship between them seems necessary.

MURATA (1964) recently described 8 species, of which 6 are new, of aviculopectinidids from the Kanokura Formation and its equivalent Hiryuyama Formation [Ka 8]. Because the fauna shows close affinity either with Eurasian or with certain North American forms, MURATA correlated the Kanokura and the Hiryuyama Formation with the Word Formation of North America.

4. Maiya area

Conformably overlying the Nishikori Formation [Ka 43] of the Sakamotozawan, the Rodai Formation [Ka 47] is the representative of the Nabeyaman in

* KAMBE and SHIMIZU (1961) followed MINATO *et al.* (1954) in the division of the Permian.

this area and is developed in several separated localities. This formation (210 m) consists of the upper limestone member and the lower member of alternation of sandstone and slate. *Michelinia* (*Protomichelinia*) *multitabulata* (YABE and HAYASAKA) represents a useful guide species in the upper limestone in which numerous species of fusulinaceans occur such as *Eoverbeekina cheni* THOMPSON and FOSTER, *Pseudofusulina kraffti* (SCHELLWIEN), *Parafusulina* cfr. *kaerimizensis* (OZAWA), etc. It is rather strange that there are only two common species between the species listed by ONUKI *et al.* (1960) and those* by CHISAKA (1962). Nevertheless it seems safe to correlate the Rodai Formation with the Nabeyaman.

It is noted that in the black shale interbedded in marine sediments of the lower member of the Rodai Formation is found a rich flora named the "Maiya flora" by ASAMA (1956). According to him the "Maiya flora" consists mainly of Euramerican Permo-Carboniferous elements in which *Gigantopteris Whitei*, and species of *Taeniopteris*, *Odontopteris* and *Sphenophyllum* are contained. The first named species, which is one of the characteristic species of the Cathaysian flora, has been found in the Shansi Formation of North China which is of non-marine facies. Besides, the occurrences of *Cordaites principalis* is also common in the Arcto-Carboniferous flora and *Cordaites* (*Noeggerathiopsis*) *Arakawae* belongs to the Gondowana (*Glossopteris*) flora. Thus the facts imply a very significant problem concerning the paleogeography during the Middle Permian time.

B. Northern part of Kitakami massif

1. Kamiarisu—Ohashi area

This area [Ka 13–16] is located to the south of the Kamaishi mine and is a representative of the schalstein facies of northern Kitakami type of ONUKI. The Kasshi Formation [Ka 15] is the representative of the Nabeyaman in this area, though it partly grades into the lower Tsuchikura and the upper Daido Formation. This formation develops as the eastern and western wings of a syncline with the Tsuchikura green rock Formation in the axis. The eastern wing consists mainly of cherty clayslate and chert with limestone. *Misellina* sp. has been reported from a limestone east of Ohashi [Ka 13]. The western wing contains thick limestone with a maximum thickness of 180 m, yielding species of *Parafusulina* and coral along with numerous crinoid fossils. Since indeterminable species of *Neoschwagerina* has also been found in the upper part of the Kasshi Formation (ONUKI, 1956), it is not improbable that this formation may comprise the Akasakan in its upper part and the Sakamotozawan in its lower part as well.

2. Omatsu-Dosen-Ogawa mine area

According to ONUKI's division, the Permian of this area is a representative of the schalstein-dominated area in which limestones are found as thin beds

* CHISAKA described four new species of schwagerinid from the Rodai Formation, most of which are poorly preserved and somewhat deformed and they seem to be not enough to establish new species.

or lens. Although the occurrence of *Parafusulina* sp. in the limestone at Omatsu [Ka 15] is the only available paleontological evidence, a part of the Permian in this area is regarded to be Nabeyaman (ONUKI, 1956).

3. Toyomane-Hanawa area

Conformably overlying the Toyomane Formation [Ka 5] of the Sakamotozawan, the Hanawa Formation [Ka 4] (1700 m) is a representative of ONUKI's chert-dominated area in the northern Kitakami massif. Since indeterminable species of *Parafusulina* and *Neoschwagerina* have been found in this formation, ONUKI correlated the Hanawa Formation with the Kanokura Formation of the southern Kitakami massif. It is noted that *Neoschwagerina* has been found abundantly at Kitakawame of Hanawa-mura without any trace of *Yabeina*.

In the present definition the upper part of the Toyomane Formation and the lower part of the Hanawa Formation are possibly referable to the Nabeyaman.

4. Iwaizumi-Akka area

A large mass of limestone called the Akka limestone [Ka 1] is developed near the eastern margin of the northern Kitakami massif with a length of about 50 km (NNW direction) and a maximum width of about 4 km. Its center is at Akka, Akka-mura. An occurrence of *Parafusulina* sp. and *Michelinia multitabulata* YABE and HAYASAKA is, according to ONUKI (1956), the only available paleontological evidence for the age determination of this huge limestone mass. Although ONUKI referred the Akka limestone to the zone of *Parafusulina*, the true stratigraphical range of the limestone is not known.

C. Abukuma massif

Takakurayama area

Takakurayama and its environs have the best exposures for studying the Abukuma metamorphics, because they consist of schists, phyllites, and clayslates of various grades of metamorphism, with occasional intercalations of limestone lenses and calcareous conglomerate. The name "Yakuki Series" [Ka 55] has been given to the rock unit which has a considerable high grade of metamorphism whereas the Takakurayama Group [Ka 56] of low grade metamorphism keeps its original rock structure (IWAO and MATSUI, 1961). The geology of the area has been investigated at some length by YANAGISAWA and NEMOTO (in HAYASAKA, 1965) who divided the Takakurayama Group into three formations; the lower Iriishikura Formation of slate facies (100 m), the middle Motomura Formation of conglomerate facies (70–170 m), and the upper Kashiwadaira Formation of slate facies (420–530 m). According to HAYASAKA (1957, 1965), *Parafusulina* sp. occurs in the middle formation with *Wentzelella minor* EGUCHI (MS), *Lophophyllum* aff. *pendulum* GRABAU, *Liebea* sp., and *Waagenophyllum*? sp. In addition, he described three species of nautiloids and eight species of ammonoids including species of *Tainoceras, Agathiceras, Waageno-ceras, Stacheoceras*, etc. Although, without exception they are poorly preserved, HAYASAKA is of an opinion that the ammonoid faunule, and in all probability the Takakurayama Group as a whole, corresponds to the Sosio Stage of Middle

Permian, and that the group was deposited rather rapidly in an area not far from shore, possibly in a lagoon. Mention should be made of the fact that the terrestrial plants are rather frequently found in the slate beds of the Kashiwadaira Formation. They are identified by KON'NO (in HAYASAKA, *op. cit.*) as *Calamites* sp., *Pecopteris* sp. and *Taeniopteris* sp.

II. Inner zone of Northeast Japan

Taishaku mountain range

Little is known of the stratigraphy of this wide area. As will be mentioned in the following chapter, FUJIMOTO and KOBAYASHI (1961) reported indeterminable species of neoschwagerinids from the environs of Hanawa [Nei 10], Kuriyama-mura, Shioya-gun, Tochigi Prefecture. Some contributions have been made to the stratigraphy of this area by KOIWAI (1965) who reported *Parafusulina gigantojaponica* KOBAYASHI from Yunishigawa, and *Parafusulina yabei* HANZAWA, *Pseudofusulina japonica* (GÜMBEL), *Psf.* cfr. *crassa* (DEPRAT), and *Neoschwagerina colaniae* OZAWA from limestone boulders of unknown origin in this area. This suggests that the Nabeyaman is developed in this area as well as the Akasakan. Further detailed stratigraphic study of these Upper Paleozoic rocks is necessary.

III. Kwanto massif

1. Nabeyama area

The Paleozoic rocks are widely developed in the Ashio massif located in the northern part of the Kwanto province. The Nabeyama limestone [Kw 4], located in the southern part of the massif, has long been known for its fossil content of brachiopods and fusulinaceans. However, HAYASAKA (1926, 1944), NAGAO and MINATO (1943), and FUJIMOTO (1938, 1961) expressed conflicting opinions concerning the stratigraphical age of the Nabeyama limestone.

YOSHIDA (1956, 1957) studied the stratigraphy of this area at some length and divided the Nabeyama limestone into three divisions, the upper and lower limestones and the middle dolomite. He found many fusulinaceans in the lower and upper limestones, the former of which was referred to the *Parafusulina–Pseudodoliolina* zone and the latter to the *Verbeekima–Neoschwagerina* zone. However, his new species have been left as *nomina nuda.*

In cooperation with SATO, IGO, AKAGI, and ISHII, FUJIMOTO (1961) studied the stratigraphy of the area in detail. He divided the Nabeyama Formation [Kw 4], the lowest division of the Aso Group*, into three members: the lower Yamasuge limestone, the middle Hanetsuru dolomite, and the upper Karasawa limestone which correspond to the three divisions of YOSHIDA, respectively.

The Yamasuge limestone Member consists mainly of black or dark grey limestone, with intercalations of dolomitic limestone, dolomite, tuff, and shale. The well stratified limestone contains an abundance of fusulinaceans, corals, crinoids, brachiopods, and scaphopods. FUJIMOTO identified the following species in this limestone member:

---

* YOSHIDA's (1956) Nabeyama Group.

Schubertella kingi DUNBAR and SKINNER
Minojapanella elongata FUJIMOTO and KANUMA
Schwagerina krotowi (SCHELLWIEN)
S. guembeli DUNBAR and SKINNER
Pseudofusulina granum-avenae (ROEMER)
Ps. ambigua (DEPRAT)
Parafusulina yabei HANZAWA
P. kattaensis (SCHWAGER)
P. kaerimizensis (OZAWA)
P. splendens DUNBAR and SKINNER
Pseudodoliolina ozawai YABE and HANZAWA

IGO (1964), a collaborator of FUJIMOTO, carried out detailed micropaleontological studies on some of fusulinaceans collected from the Yamasuge limestone Member. He redefined *Parafusulina yabei* HANZAWA with a detailed discussion on the intraspecific variation in this species and proposed many subspecies. He included *Parafusulina nabeyamensis* MORIKAWA and TAKAOKA and *P. tomuroensis* MORIKAWA and TAKAOKA into *P. yabei* (*s.l.*) as subspecies together with a new subspecies *P. yabei hanzawae* IGO. In addition, *Schwagerina kinosakii* MORIKAWA (1958) from the Akasaka limestone and *Parafusulina parakinosakii* MORIKAWA and ISOMI (1961) from Iwasayama and Iwakurayama, east of Lake Biwa, Shiga Prefecture are regarded as synonymous with *Parafusulina yabei yabei* and *P. yabei nabeyamensis*, respectively. *P. kaerimizensis* (OZAWA) and *P. nakamigawai* MORIKAWA and HORIGUCHI were also described. However, fine biostratigraphic zonation throughout the Yamasuge limestone Member has not been settled.

Although most of the species reported by FUJIMOTO have not been described, the faunal assemblage shown above suggests that the Yamasuge limestone Member is referable at least to the Pm_{α} subzone of the Akiyoshi limestone Group with a possibility of having a part of the Pl_{γ} subzone in the lower part. The existence of *Schwagerina guembeli* DUNBAR and SKINNER and *Parafusulina splendens* DUNBAR and SKINNER is noticeable. Both of them are known to occur in the zone of *Parafusulina* of Texas. If the species of Nabeyama are exactly conspecific with those of Texas, their occurrence implies a problem concerning the paleogeography in the Middle Permian time.

2. Shomaru-toge area

In the standard area of the Kwanto massif, a part of the III zone of *Neoschwagerina craticulifera* or *Pseudofusulina ambigua* may be referable to a part of the Nabeyaman. Having studied the Shomaru-toge area [Kw 31], MORIKAWA (1955) correlated the zone of *Neoschwagerina* of Japan with the zone of *Parafusulina* of North America without comparing the faunas of both regions. He set up a *Schwagerina* zone between the *Neoschwagerina* and the *Pseudoschwagerina* zone, and named the Shimokuzu Stage. The constituent species of this zone are:

Codonofusiella sp.
Pseudofusulina tenuis CHEN
Psf. modica (THOMPSON and HAZZARD)
Psf. japonica (GÜMBEL)

Psf. *kraffti* (SCHELLWIEN)
Schwagerina paraguembeli MORIKAWA
Parafusulina kaerimizensis (OZAWA)
Nagatoella fujimotoi MORIKAWA
N. *terazawensis* MORIKAWA (MS)
Misellina claudiae (DEPRAT)

Of the species listed above, *Pseudofusulina modica* (THOMPSON and HAZZARD) is known from the zone of *Pseudoschwagerina* in Providence Mountain Range of California. Judging from the faunal assemblage, the Shimokuzu Stage may be correlative with the P1γ subzone of the Akiyoshi limestone Group.

IV. Hida massif and Tamba zone

A. Hida massif

1. Omi limestone

According to KAWADA (1954), the P2 Formation of the Omi limestone [Ht 1], which is referred to the zone of *Neoschwagerina,* directly overlies the P1 Formation of the zone of *Pseudoschwagerina-Pseudofusulina.* He divided the *Neoschwagerina* zone into two parts; the lower part is equivalent to the zone of *Parafusulina s. str.,* though he did not set up the *Parafusulina* zone in the Omi limestone because of the scarcity of species of that genus. The lower part contains *Pseudofusulina kraffti* (SCHELLWIEN), *Psf. japonica* (GÜMBEL), *Schwagerina krotowi* (SCHELLWIEN), and indeterminable species of *Pseudofusulina, Parafusulina* and *Schwagerina,* but no species of neoschwagerinids. The above faunal assemblage shows that the lower part of the P2 Formation is referable to the P1γ subzone of the Akiyoshi limestone Group. A part of the P2 zone defined by FUJITA (1958) is referable to the Nabeyaman.

2. Azusagawa area

The widely developed Permian rocks in the Azusagawa valley in the western part of Nagano Prefecture were named the Azusagawa Group [Ht 8] by TANAKA, KOBAYASHI and KAMEI (1952), the type locality of which is seen from Shimajima to Kamikochi along the Shimajimadani valley, a tributary of Azusagawa. The joint authors divided this group (more than 7000 m) into three formations, naming G.1, the Shimajima [Ht 7] (1500 m), G.2, the Ichinosawa [Ht 4] (3500 m), and G.3, the Tokugotoge [Ht 6] (2000 m+) Formation in ascending order. Although the lower two formations are barren of fossils, the Tokugotoge Formation yields fusulinaceans and other fossils in the limestone (Iwanadome limestone [Ht 5]) intercalated in the upper part. They are:

Pseudofusulina japonica (GÜMBEL)
Psf. *ambigua* (DEPRAT)
Parafusulina kaerimizensis (OZAWA)
Pseudodoliolina ozawai YABE and HANZAWA
Neoschwagerina craticulifera (SCHWAGER)
Schubertella sp.
Mizzia velebitana SCHUBERT

This faunal assemblage indicates that the Tokugotoge Formation is of the Nabeyama age.

Above the Iwanadome limestone, a characteristic conglomerate called the Sawando conglomerate [Ht 9] occurs, in which are contained various kinds of sedimentary pebbles including clayslate, sandstone, chert, and limestone in addition to igneous pebbles of aplite, quartz-porphyry and granitic rocks. The Sawando conglomerate is regarded as intraformational, being a subject concerning the source area of pebbles, especially that of igneous ones.

The joint authors emphasized the occurrence of brecciated slate fragments of irregularly angular shape either in conglomerate or in sandstone or slate which appear as the lateral extension of the conglomerate. These brecciated slates are considered to be produced by contemporaneous erosion. The Sawando conglomerate was correlated by the joint authors with the Katchizawa Member of the Kanokura Formation of the Kitakami massif and to the upper part of the Ichinotani Formation of the Hida massif.

3. Kiso massif

The wide area covering the northern part of the Kiso massif is occupied by the Paleozoic rocks which have similar lithology to that of the Azusagawa Group and are transitional between the non-metamorphic Paleozoic and the Ryoke metamorphics. These Paleozoic rocks have been studied by ISOMI and KATADA (1959) who classified the non-metamorphic Paleozoic into three facies, chert, fine-clastic and coarse clastic. ISOMI and KURODA have stated that the Upper Paleozoic rocks of this area are Flysch-type sediments with submarine volcanics. Stratigraphical dating of these rocks is very difficult because of the extreme scarcity of fossils.

4. Fukuji area

In the Fukuji area the Sorayama Group overlies the Lower Permian Mizuyagatani Formation, the upper division of the Ichinotani Group, with a presumable unconformity. In the lower part of the Sorayama Group is found a conglomerate bed named the Osobudani conglomerate [Ht 28] by IGO (1956). This conglomerate contains a heterogenous assemblage of pebbles of limestone, shale, chert, tuff, tuff breccia, "schalstein", granite, porphyritic granite, porphry, andesite, and spilitic basalt. Various fossils were found in the limestone pebbles ranging in age from Slurian to Permian. Because the upper division of the Mizuyagatani Formation yields no species of *Pseudofusulina* nor any other Permian fusulinaceans, IGO regarded the Osobudani conglomerate as early Middle Permian age.

The species found in the limestone pebbles of the Osobudani conglomerate are as follows:

Hayasakaina kotakiensis FUJIMOTO and IGO
H. ? *kawadai* IGO
Schubertella sp.
Pseudofusulina duplithecata IGO

Psf. spp. A and B
Misellina minor (DEPRAT)

Of these species *Pseudofusulina duplithecata* and two species of *Hayasakaina* were described and illustrated by IGO. Although he considers *Hayasakaina* as a derivative of *Nankinella* or of *Staffella* rather than of *Ozawainella,* it seems that there is no fundamental difference between *Hayasakaina* and *Nankinella,* and the two genera are probably synonymous with each other.

5. Hirayu area

The Hirayu Group is developed in the environs of Hirayu and Nyukawa-mura (south of Fukuji area) and is partly Nabeyaman in its middle portion. According to IGO (1959) the zone of *Parafusulina* of the Hirayu Group [Ht 30] is divisible into two subzones, the upper *Parafusulina hirayuensis* and the lower *Schwagerina yabei* subzone. All the species of these subzones have been described by IGO along with a discussion on the correlation, and there is no reason for further discussion at this time. Although *Pseudoschwagerina* sp. was left unnamed in his paper (1959), it has been restudied on further material and described (1964) as *Pseudoschwagerina* (*Robustoschwagerina*) *schellwieni* HANZAWA with a discussion on the stratigraphical range of that species.

6. Hachiman area

A wide area covering the southern part of the Hida massif and the northeastern part of the Mino massif has been studied by KANUMA (1949–1958) at some length. In this area the followings are referable to the Nabeyaman: (1) the lower part of the Okuzumi Formation [Ht 41] in the northern part, (2) the Kuchibora Formation [Ht 44] in the central part, and (3) the middle division of the Tominoho Group [Ht 46] in the southern part.

Through his paleontological studies of fusulinacean faunas obtained from these formations KANUMA set up three fusulinacean zones in the Permian section in the area under consideration. The middle, zone of *Parafusulina,* is further divided into two; namely the lower part is characterized by *Pseudofusulina paratschernyschewi* KANUMA, *Psf. karaffti* (SCHELLWIEN), and *Psf. japonica truncata* (OZAWA), and the upper part by *Cancellina nipponica* (OZAWA), *Neoschwagerina simplex* OZAWA, *Misellina claudiae* (DEPRAT), and *Parafusulina kaerimizensis* (OZAWA). Since all the fusulinaceans except for the neoschwagerinids have been described by KANUMA, further discussion seems unnecessary.

7. Funafuseyama area

It has long been known that the Upper Paleozoic rocks are widely distributed in the Funafuseyama area [Ht 48] but little work has been published. Recent study by OGAWA and IGO (in FUJIMOTO *et al.*, 1962) has added some knowledge to the stratigraphy and paleontology of this area. According to them the Funafuseyama limestone has the Nabeyaman zone of *Parafusulina* in the lower part, which is divided into the lower *Pseudofusulina japonica* and the upper *Parafusulina iisakai* subzone. Although the faunal characteristics of these subzones

are not known, four species of *Parafusulina* including *P. iisakai* have been described by IGO and OGAWA (1958). The lower *P. iisakai* subzone rests conformably on the *Pseudofusulina vulgaris* zone of the Sakamotozawan.

8. Neogawa and Ibigawa areas

The Uoganeyama Formation [Ht 57] extends westward from the Neo area to the Yokokura and Kuze-mura areas. The lithology is similar in both areas, but the fossil content in the limestone is not the same and species of *Pseudofusulina* and *Parafusulina* and *Cancellina nipponica* have been found in the Yokokura and Kuze-mura area (IGO in FUJIMOTO *et al.*, 1962). This indicates that the Uoganeyama Formation in this area is dated as the Nabeyaman. The thick formation (about 5000 m) of similar lithology occurs further northwestward in the upper valley of Ibigawa, and is named the Tenguyama Formation [Ht 55] (YOKOO in FUJIMOTO *et al.*, 1962) which rests on the Yokoyama Formation [Ht 54] (3000 m) and is overlaid by the Oya Formation [Ht 53] (4000 m).

The Tenguyama Formation yields species of *Pseudofusulina, Parafusulina, Neoschwagerina,* and *Verbeekina,* but further information on their faunal characteristics is not available. The Tenguyama Formation seems to be referable to the Akasakan rather than the Nabeyaman.

The Ibigawa area was also studied by KAJITA (1963) who proposed the Sakauchi Formation [Ht 56] for the Paleozoic of the Nyukawa facies of this area, the main component of which is basic tuff and slate with chert and limestone. KAJITA reported indeterminable species of *Pseudofusulina, Parafusulina* and *Neoschwagerina.* Thus, a part of the Sakauchi Formation is probably referable to the Nabeyaman.

MIYAMURA (1965) studied at some length the biostratigraphy of the Yokoyama area along the middle and upper parts of Ibigawa valley. He correlated the lower part of his *Parafusulina* and *Neoschwagerina* zone with the zone of *Parafusulina* of Ibukiyama limestone (the lower *Pseudofusulina ambigua* and the upper *Parafusulina sapperi* subzone) and of the Akiyoshi limestone (the lower *Pseudofusulina ambigua* and the upper *Parafusulina kaerimizensis* subzone). MIYAMURA (*op. cit.*) listed 4 species of *Neoschwagerina,* 1 species of *Cancellina,* 5 species of *Parafusulina,* 1 species of *Pseudodoliolina,* 7 species of *Schwagerina,* 19 species of *Pseudofusulina,* 1 species of *Acervoschwagerina,* and 4 species of *Schubertella* in the lower part of the *Parafusulina* and *Neoschwagerina* zone. Among them *Parafusulina kaerimizensis* (OZAWA) and *P. takeyamai* MORIKAWA and ISOMI are characteristic to this part.

The exact relationship between the Sakauchi Formation of KAJITA and the stratigraphic divisions of MIYAMURA, most of which have been left unnamed, is not known, and none of the species reported by KAJITA and MIMAMURA have been described.

9. Kuzuryu area

In the northern marginal area of the non-metamorphic Paleozoic terrain of the Hida massif (the upper valley of Kuzuryu-gawa) are found Middle Permian

rocks called the Nojiri Group (FUJIMOTO *et al.*, 1962). The Otani Formation (or Otani conglomerate) [Ht 72], the lowest of the Nojiri Group, consists of red-brown to red-purple conglomerate with various kinds of pebbles, including granodiorite, schalstein, serpentine, gabbro, phyllite, sandstone, chert, and limestone. Because various kinds of fossils* ranging from Silurian to Lower Permian were found in the limestone pebbles, the Otani Formation was dated to the Middle Permian (KAWAI, HIRAYAMA and YAMADA, 1957; FUJIMOTO *et al.*, 1962). In the limestone conglomerate of the Otani Formation, *Lepidolina kumaensis* KANMERA has recently been found by YAMAGUCHI and OHTA (1965) and described by HASEGAWA (1965), which led them to the conclusion that at least a part of the Otani Formation is dated to the Upper Permian. It must be noted that the fossils were found only in the pebbles of conglomerate and not in matrices.

However, OSHIMA** has found that the Otani conglomerate covers the Tomedoro Formation*** of the Lower Permian age unconformably, and is correlative with the Konogidani Formation of presumable Cretaceous age by the similarity in lithofacies. The latter (Konogidani Formation) which yields *Rugosofusulna* cfr. *alpina* (SCHEEWIEN) in the limestone pebbles of conglomerate was also referred to the Middle Permian (FUJIMOTO *et al.*, 1962), but it is also transferred to the Cretaceous.

It seems necessary to restudy the similar conglomerates developed in the Hida massif. They are Nojiri, Kamihirose, Sorayama, Wadano, Shimizukura, and Suzuka conglomerates, and they were all referred by KANUMA *et al.* (1956) to the zone of *Parafusulina*.

10. Akasaka area

As discussed in Chapter I, OZAWA's Nn zone is one of the representatives of the *Neoschwagerina simplex* biofacies, comprising several species of *Schubertella*, many species of *Pseudofusulina* including *Psf. japonca* (GÜMBEL), a primitive member of *Verbeekina*; *V. sphaera* OZAWA, *Pseudodoliolina lepida* (SCHWAGER), two species of *Cancellina*; *C. nipponica* (OZAWA) and *C. schellwieni* (DEPRAT); and a most primitive representative of *Neoschwagerina*, *N. simplex* OZAWA. In the uppermost part of the Nn zone OZAWA listed *N. craticulifera* (SCHWAGER) and *N. multicircumvoluta* (DEPRAT).

In the joint study of MORIKAWA *et al.* (Akasaka Research Group, 1956), the Akasaka limestone was divided into seventeen horizons in which they listed 46 species including 18 new species and varieties. All these new species and varieties have been left as *nomina nuda*. Based on the materials collected by the Akasaka Research Group, MORIKAWA (1958) later described several schwagerinid species including ten new species and varieties, but he did not designate which of the

---

* Among them the Silurian corals were first found, and the Otani conglomerate was first thought to be the Silurian by KAMEI (1949, 1950).

** OSHIMA, H.: Paleozoic and Mesozoic Formations in the central part of Izumi-mura, Fukui Prefecture. Graduation thesis (No. 189), Kyushu University, 1965.

*** The Tomedoro Formation is equivalent to the Konogidani Formation of OZAKI (1954) and FUJIMOTO *et al.* (1962).

new species of the Akasaka Research Group his new species were identified with. Most of MORIKAWA's new specific names are different from those proposed by the Akasaka Research Group in spite of the fact that they dealt with the same materials. Such being the case, their range-chart is not available for the critical discussion for correlation. However their lower formation, which ranges from the horizon a to g, is perhaps referable to the Nabeyaman.

The Umetani Formation [Ht 60], developed to the west of the Akasaka limestone, covers conformably the Oishi Formation [Ht 63] of the Sakamotozawan age. It is not known whether the Umetani Formation is of the Nabeyaman or not, because no fusulinaceans have been detected in the formation.

B. Tamba zone

1. Ibukiyama area

The Ibuki area is the boundary area between Shiga and Gifu Prefectures and has a wide distribution of the Permian rocks in which a contrast between the calcareous and non-calcareous facies is rather remarkable.

In the northernmost part of this area, namely in the environment of the Tsuchikura mine, the Permian is widely exposed. According to KANUMA (in FUJIMOTO *et al.*, 1962) it is divided into the upper Tsuchikura [Ht 91′] and the lower Deguchi [Ht 91] Formation, the latter of which contains *Pseudoschwagerina* sp., *Parafusulina* sp. and *Cancellina nipponica*. Therefore the Deguchi Formation is dated as the Nabeyaman with a possibility of having a part of the Sakamotozawan in the lower part.

The Otaniyama Formation [Ht 93], the upper division of the Kusanokawa Group, is developed northwest of Ibukiyama and composed of chert with intercalation of limestone which contains the following species referable to the Nabeyaman (ISOMI, 1956):

Neoschwagerina cfr. *simplex* OZAWA
Pseudofusulina cfr. *japonica* (GÜMBEL)
Pseudodoliolina ozawai YABE and HANZAWA
Misellina sp.

The Ibukiyama limestone [Ht 96] has the zone of *Cancellina nipponica* and *Pseudofusulina kraffti* in its lower part in which the following species were reported by SEKI (1938):

Cancellina nipponica (OZAWA)
Neoschwagerina craticulifera (SCHWAGER)
Misellina aliciae (DEPRAT)
M. cfr. *ovalis* (DEPRAT)
Pseudofusulina kraffti (SCHELLWIEN)
Psf. *multiseptata* (SCHELLWIEN)
Psf. *granum-avenae* (ROEMER)
Schwagerina tschernyschewi (SCHELLWIEN)
Schubertella giraudi (DEPRAT)
S. *simplex* (LANGE)

Similar fusulinacean fauna is known in the limestones exposed on small hills

to the south of Ibukiyama, which are the southern extension of the Ibukiyama limestone. According to ISOMI (1956), species of *Neoschwagerina* are rare in occurrence in the lower part of these limestones and become abundant in the upper part. Accordingly he referred the lower part of the lower division of the Ibukiyama limestone to the upper part of the zone of *Parafusulina* and the upper part to the lowermost of the zone of *Neoschwagerina*. However, excepting for *N. craticulifera,* all the species of *Neoschwagerina* bear primitive aspect and the associated species of *Pseudofusulina* indicate that the lower division of Ibukiyama limestone is as a whole referable to the Nabeyaman rather than the Akasakan.

Accordng to M. KOBAYASHI (1957) the *Parafusulina* zone of the Ibukiyama limestone is divisible into the lower *Pseudofusulina ambigua* subzone of about 170 m thickness and the upper *Parafusulina sapperi* subzone of about 50 m thickness. The uppermost part of the former, which is characterized by *Cancellina* sp. and *Pseudofusulina japonica* faunule, and the whole of the latter are referable to the Nabeyaman. All of the species of the Ibukiyama limestone were adequately described by KOBAYASHI.

MORIKAWA and ISOMI (1961) described several species of fusulinaceans from the Iwasayama [Ht 97′] and Iwakurayama [Ht 68] limestones, located to the south of Ibukiyama. They are:

Yangchienia sp.
Codonofusiella sp.
Biwaella omiensis MORIKAWA and ISOMI
Pseudofusulina lepida (DEPRAT)
Parafusulina exilis (SCHWAGER)
P. parakinosakii MORIKAWA and ISOMI [=*P. yabei nabeyamensis*]
P. takeyamai MORIKAWA and ISOMI
P. iwasensis MORIKAWA and ISOMI
Verbeekina sp.
Pseudodoliolina ozawai YABE and HANZAWA
Cancellina nipponica OZAWA
Neoschwagerina cfr. *colaniae* OZAWA

MORIKAWA and ISOMI correlated the Iwasayama and Iwakurayama limestones to the lower part of the Ibukiyama limestone Formation. However, the above faunal assemblage indicates that both limestones are undoubtedly of the Nabeyaman and referred to the middle part of the Ibukiyama limestone, though they have few common species. Moreover, it is rather strange that the species described by MORIKAWA and ISOMI (1961) are considerably different from those reported by ISOMI (1956) from the same limestones.

The Matsuoyama Formation [Ht 66], being in fault contact with the Iwakurayama limestone, is developed in the Sekigahara area (southeast of Ibukiyama). This formation consists of massive sandstone and slate with a few intercalations of chert. Except *Pseudofusulina* cfr. *japonica* reported by TAKIMOTO (1936), no other fossils have been found in this formation. ISOMI (1956) and FUJIMOTO *et al.* (1962) dated this formation as the Middle Permian.

Other Nabeyaman rocks in this area are included in the Onogi Formation

[Ht 98] which consist mainly of clayslate with intercalations of limestone and, like the contemporaneous Ibukiyama limestone, thrusts upon the Samegai Formation of the Sakamotozawan age. In the limestone of the Onogi Formation a prolific fusulinacean fauna has been described by MORIKAWA and ISOMI (1961):

Yangchienia sp.
Pseudofusulina aff. *valida* (LEE)
Psf. aff. *subtilis* (SCHELLWIEN)
Psf. *okafujii* TORIYAMA
Psf. *bacca* MORIOKA and ISOMI
Psf. *vulgaris* (SCHELLWIEN)
Psf. *cushmani* CHEN
Psf. *fusiformis* (SCHELLWIEN)
Psf. *kraffti* (SCHELLWIEN)
Psf. *norikurensis* IGO
Misellina ibukiensis KOBAYASHI
Neoschwagerina rotunda (DEPRAT)

The faunal assemblage indicates that the Onogi Formation is certainly Nabeyaman though the joint authors regarded it as ranging from their *Pseudoschwagerina* zone to the *Parafusulina–Neoschwagerina* zone.

Among the rocks which constitute the basement of Ibukiyama district, the Takayama Formation [Ht 92], the lower division of the Kusanogawa Group, is also referable to the Nabeyaman. This formation is distributed in several blocks and yields species of *Nagatoella* and *Parafusulina* cfr. *pusilla* (SCHELLWIEN) from the limestone 150–200 m below the top of the formation (ISOMI, 1956). In the limestone intercalated in the uppermost horizon of this formation are reported the following species: *Neoschwagerina simplex* OZAWA, *N. craticulifera* (SCHWAGER), species of *Cancellina* and *Misellia*, and species of *Pseudofusulina* including *Psf. japonica* (GÜMBEL). The assemblage of species indicates a possibility of referring the upper part of the Takayama Formation to the Nabeyaman also. MORIKAWA and ISOMI (1961) described several species of fusulinaceans from the same limestones previously studied by ISOMI in 1956. However, it is rather strange that the results obtained by the joint authors are very different in specific and even generic determinations from ISOMI's previous results.

2. Suzuka massif

The Suzuka massif, with a nearly N-S trend, is geologically the southward extension of the Ibuki massif in which the Paleozoic rocks are developed widely. The upper part of the Ryozen Formation [Ht 101] is the representative of the calcareous facies in this massif in which only *Paraschwagerina oblonga* (OZAWA) and *Mizzia velebitana* (SCHUBERT) were reported by FUJIHARA (in MATSUSHITA, 1953). In the non-calcareous rocks developed in the east side of the Suzuka massif, *Pseudofusulina* cfr. *japonica* (GÜMBEL) was also reported, suggesting a possibility of existence of the Nabeyaman in this area.

3. Fujiwaradake area

The middle and upper parts of the Fujiwaradake Formation [Ht 105] are

referred by MURATA (1960) to the zone of *Parafusulina* in the Fujiwaradake area located to the south of Ryozen area. According to him, *Acervoschwagerina endoi* HANZAWA and *Pseudofusulina vulgaris* (SCHELLWIEN) with its subspecies *globosa* occur in the limestone of the middle part and *Psf. japonica* (GÜMBEL) along with *Psf. ambigua* (DEPRAT) in the upper part. The Fujiwaradake Formation is conformably overlaid by the Kurakaketoge Formation of the Akasakan.

The Ibaragawa Formation [Ht 103] (900 m) is a representative of the non-calcareous facies in the southern part of this area, consisting of chert and slate in the lower part and of graywack in the upper part. *Pseudofusulina vulgaris* (SCHELLWIEN) has been reported by MURATA (1960) in the limestone interbedded in the schalstein of the lowest part. The formation is extremely complex in geologic structure, being traversed by numerous faults.

MURATA differs from KOBAYASHI (1941, 1951) in geotectonic interpretation of the Permian in this area; namely, he stated that the Fujiwaradake Formation of calcareous facies is not exotic mass, but is synchronous with the Ibaragawa [Ht 103] and the Tokiyama Formation [Ht 69] of the non-calcareous facies in this area. Having studied the eastern part of Ibukiyama, MIZUTANI (1965) pointed out that the calcareous and the non-calcareous facies of Ibuki-Suzuka massif are deposits formed in remarkably different environments which were separated far from each other.

4. Wakasa area

The Wakasa area, located in the northern marginal part of the Tamba zone, is structurally divided into the northern and southern areas (HIROKAWA, ISOMI and KURODA, 1957 and ISOMI and KURODA, 1958). ISOMI and KURODA's Formation III* of the southern area consists of clayslate and chert with a prominent schalstein bed (maximum thickness 1000 m) and yields *Pseudofusulina japonica* (GÜMBEL), *Verbeekina* sp., *Misellina* sp., *Cancellina* sp., and *Neoschwagerina simplex* OZAWA. On the other hand, the Miyakawa Formation [Ht 87] of the northern area is composed mostly of a fine alternation of clayslate and chert with lenses of schalsteins and limestones. Three faunules of fusulinaceans have been distinguished in this formation, one of which comprises *Parafusulina kaerimizensis* (OZAWA), *Misellina* sp., *Cancellina* sp., and *Neoschwagerina simplex* OZAWA. Hence the Formation III of the south and at least a part of the Miyakawa Formation of the north are referable to the Nabeyaman with a possibility of having a lower part of the Akasakan. No species of these faunas have been described at present.

5. Nishiyama area (Western hill of Kyoto)

Parafusulina cfr. *edoensis* (OZAWA) was reported from MATSUSHITA's (1951) d Formation in the Nishiyama area [Ht 112], suggesting the existence of the Nabeyaman. According to a recent study by SAKAGUCHI (1962), the Tano Formation [Ht 116] (2300 m) of the Nishiyama area consists mainly of black shale

* The formation division by HIROKAWA, ISOMI and KURODA and that by ISOMI and KURODA are reverse in order. See also footnote of p. 97.

and yields species of *Schwagerina, Pseudofusulina, Parafusulina, Pseudodoliolina, Neoschwagerina,* and *Waagenophyllum*—including two new schwagerinid species—in the limestone lens 500 m above the lower fossil horizon dated as the lower Sakamotozawan. As SAKAGUCHI referred the upper part of the Tano Formation to the *Neoschwagerina craticulifera* subzone, the Nabeyaman may exist in an unfossiliferous part in the middle of the formation. The relationship between the Tano Formation and MATSUSHITA's d Formation is not clearly understood.

6. Nosé and Sasayama area

The Meigetsutoge Formation [Ht 114] of the Nosé area and a part of the Manajo Formation [Ht 123] of Sasayama basin may be referable to the Nabeyaman. Although they are barren of fossils, they are underlaid by the Sakamotozawan.

7. Sonobe area

The Tamba Group developed in the Sonobe area forms a synclinorium. The Shinmito [Ht 111] and the Sonobe [Ht 110] Formation on both limbs of the synclinorium are referred by SAKAGUCHI (1962) to the Lower and Middle Permian. However, the Shinmito Formation is barren of fossils, whereas the Sonobe Formation yields a *Triticites* fauna of the Lower Permian aspect in the basal part. Moreover, *Fusulinella itoi* OZAWA and *F. matsushitai* SAKAGUCHI with *Dibunophyllum omorii* SAKAGUCHI and YAMAGIWA occur in the Sonobe Formation. It is therefore possible that the Sonobe Formation ranges down even to the Carboniferous. Restudying the stratigraphical relationship between the Sonobe Formation and the unfossiliferous Shinmito Formation seems necessary.

8. Kitayama area (Northern hill of Kyoto)

The Kurama Formation (3200 m) [Ht 106], consisting mostly of schalstein with shale intercalation, is the only formation in the Tamba district which is proved to be Nabeyaman by concrete paleontological evidence. SAKAGUCHI (1962) set up the two fusulinacean subzones in this formation, the lower *Misellina* sp. and the upper *Parafusulina kuramensis* subzone. The former comprises only *Misellina* sp. and *Ozawainella waageni* (SCHWAGER), while the latter contains abundant specimens of *Parafusulina kuramensis* SAKAGUCHI with *P. nakamigawai* MORIKAWA and HORIGUCHI, *P. hayashii* IGO and *Schwagerina* sp. According to SAKAGUCHI (1962), *P. kuramensis* is a synonym of "*P kaerimizensis*" from Tomuro, Tochigi Prefecture.

V. Chugoku massif

1. Boundary area between Hyogo and Okayama Prefectures

In the eastern part of the Chugoku zone, the San'yo branch of the Sangun metamorphic zone runs nearly parallel to the Maizuru zone. The weakly metamorphosed or non-metamorphic Paleozoic formations are found in several places associated with the Sangun metamorphic rocks.

The Hijima Formation [Swi 23] develops in the boundary area between Hyogo and Okayama Prefectures and consists mainly of black clayslate with sandy

clayslate, sandstone conglomerate, chert, limestone, schalstein, and diabase. KAMBE and HIROKAWA (1963) found indeterminable species of *Schwagerina, Pseudofusulina* and *Parafusulina* in the limestone, and referred this formation to the lower Middle Permian. The Hijima Formation is presumed to be in fault contact with the Sangun metamorphic rocks.

The Paleozoic rocks developed in the western part of Okayama Prefecture and the eastern part of Hiroshima Prefecture contain a relatively rich amount of calcareous rocks (the para-Akiyoshi facies of KOBAYASHI). The representatives are the Toyonaga Formation [Swi 39] of Atetsu plateau, the Nakamura limestone [Swi 45] of the northern part of the Oga plateau, and the Koyama limestone [Swi 49] of the southern part of the Oga plateau. The Nabeyaman is found in these formation and limestones.

2. Atetsu plateau

MOCHIZUKI (1938) set up the *Pseudofusulina* cfr. *vulgaris* zone between the *Neoschwagerina craticulifera* and the *Pseudoschwagerina* zone in the Toyonaga Formation [Swi 39]. IMAMURA, SADA and OKIMURA (in IMAMURA, 1959) restudied the Atetsu area, and set up the *Pseudofusulina* zone in the Shoyama Formation (940–110 m) [Swi 40] of the Sabushi Group. This formation is composed of milky white to greyish-white massive limestone and, since *Pseudofusulina kraffti* (SCHELLWIEN) and *P. ambigua* (DERAT) are the leading species, the *Pseudofusulina* zone of this formation is referable to the upper Sakamotozawan.

As stated in the foregoing chapter, NOGAMI (1961) also restudied the same plateau independently from IMAMURA *et al.* His third zone is divided into two subzones, the lower *Pseudofusulina kraffti magna* ($_{u}P_{3-\alpha}$) and the upper *Parafusulina kaerimizensis* subzone ($_{u}P_{3-\beta}$). The lower subzone is correlative with the *Pseudofusulina ambigua* zone of the Akiyoshi limestone Group and the upper subzone with the *Parafusulina kaerimizensis* zone of the Akiyoshi and other areas. Thus, only the upper subzone of NOGAMI is referred to the Nabeyaman. SADA (1965) followed NOGAMI in the zonation of the Shoyama Formation, though they differ considerably in the interpretation of geologic structure of the plateau.

3. Oga plateau

The Nakamura limestone [Swi 45] in the northern part of the Oga plateau comprises the zone of *Parafusulina* in the middle part, the main constituents of which are *P. kaerimizensis* (OZAWA), *Pseudofusulina* cfr. *japonica* (GÜMBEL) and *Pseudodoliolina ozawai* YABE and HANZAWA (KOBAYASHI, 1950). Having studied the Nakamura limestone at length, YOSHIMURA (1961) set up the *Parafusulina kaerimizensis – Afghanella* spp. – *Neoschwagerina simplex – N.* cfr. *craticulifera* zone in the upper part of the limestone. Although none of the fusulinacean fauna have been described, the zone species suggests that it is referable to the upper Nabeyaman and/or the lower Akasakan.

4. Taishaku plateau

Because of its abundance of fossils, the Taishaku limestone [Swi 59] was studied biostratigraphically by many previous workers, but no species of fusulinacean have been described from this area except for *Pseudoschwagerina miharanoensis* AKAGI.

FUJIMOTO's *Pseudodoliolina* zone and a part of HANZAWA's *Schwagerina* zone are probably referable to the Nabeyaman. YOKOYAMA (1959) also set up *Parafusulina* zone in the Permian Higashi-uyama Group of this area, but he has given no mention to the faunal content of the zone of *Parafusulina*. The zone of *Parafusulina*, so far as his stratigraphical description is concerned, is seemingly hard to be defined in the Taishaku limestone Group. Because of its complex geological structure, it seems rather difficult to clarify the detailed stratigraphical sequence of the Permian rocks of this area.

5. Jinseki-Yuki area

A probable southward extension of the Taishaku limestone appears in the Jinseki-Yuki area. According to recent study by HASE (1965) a part of the limestone mass [Swi 67A′] composed of white massive calcirudite yields *Neoschwagerina simplex* OZAWA, *Cancellina* sp., *Afghanella* sp., *Pseudodoliolina pseudolepida* (DEPRAT), *P. ozawai* YABE and HANZAWA, *Parafusulina* spp., *Pseudofusulina* spp., *Codonofusiella* sp., and *Nankinella* sp. together with fragments of crinoid, algae, and bryozoan. HASE referred this part of limestone to the zone of *Parafusulina* or the Uyamano Formation of AKAGI (1958) in the Taishaku area.

6. Akiyoshi area

The zone of *Parafusulina* in the Akiyoshi limestone [Swi 100] was divided by TORIYAMA (1954, 1957, 1958) into the lower *Pseudofusulina ambigua* and the upper *Parafusulina kaerimizensis* subzones. Since the faunas of these subzones were described in detail, no further discussion is added here.

The non-calcareous representatives of the Nabeyaman in this area are a part of the Futagami Formation [Swi 102] of Oda Group, the Maki Formation [Swi 92] of Ofuku Group, and the upper part of the Katada Formation [Swi 86] and the lower part of the Ryugenji Formation [Swi 89] of Beppu Group. As for the stratigraphic position of these units, there has been no remarkable divergent views among workers, although opinions differ considerably as to their geologic structure and stratigraphic relation to the Akiyoshi limestone.

In the northern part of Yamaguchi Prefecture, the Permian rocks of both calcareous and non-calcareous facies are developed. According to KAWANO (1953, 1961) the Nabeyaman is seen in the Handa limestone [Swi 79] which is characterized by the *Parafusulina kaerimizensis* zonule, comprising the *P. kaerimizensis* (OZAWA), *Pseudodoliolina* cfr. *pseudolepida* (DEPRAT) and *Afghanella ozawai* HANZAWA, and is correlated with the *P. kaerimizensis* subzone of the Akiyoshi limestone Group. The stratigraphical relationship between the *P. kaerimizensis* zonule and the overlying *Neoschwagerina* cfr. *craticulifera* and the underlying

Pseudofusulina vulgaris zonule is unconformable.

In the Zomeki limestone [Swi 77] situated about 5 km east of the Handa limestone, the Nabeyama has not clearly been defined, being characterized by only the occurrence of an indeterminable species of *Parafusulina* or *Pseudofusulina.*

7. Abugawa area

The Ikadaba Formation [Swi 80] (about 500–650 m) of the non-calcareous facies is developed along the lower valley of Abugawa and is composed mainly of sandstone, shale and limestone. It contains the Nabeyaman in its lower part; namely, *Pseudofusulina tschernyschewi* (SCHELLWIEN), *Parafusulina kaerimizensis* (OZAWA) and *P. edoensis* (OZAWA) along with minute fusulinaceans reported in the limestone lens.

8. Mino-Kanoashi massif

In the Mino-Kanoashi massif, the boundary area between Yamaguchi and Shimane Prefectures, the Upper Paleozoic rocks called the Kanoashi Group (KAWANO *et al.*, 1956) are widely distributed. As stated in the preceding chapter, the Kane Formation [Swi 76], the lower division of the Kanoashi Group, comprises *Pseudofusulina vulgaris* zonule in the lower part and *Neoschwagerina margaritae* zonule in the middle part; it is therefore probable that the Nabeyaman is included in a part between the two zonules.

9. Yamaguchi area

To the northeast of Yamaguchi city the Upper Paleozoic rocks are developed widely and were first named by KAWANO *et al.* (1954) as the Miyano Formation [Swi 84] and later divided by KAWANO (1961) into the lower Suzumiyama (1250 m) and the upper Aratani (650 m) Formation. In the limestone lenses, which are intercalated into the lower sandstone member of the Suzumiyama Formation [Swi 83], *Leonardphyllum* sp.* is known to occur, and in the uppermost part indeterminable species of *Neoschwagerina, Pseudodoliolina*?, *Pseudofusulina,* and *Schwagerina* were reported along with *Fistulipora kotoi* and *Waagenophyllum* sp. Because *Neoschwagerina* sp. bears a primitive aspect for this genus the Suzumiyama Formation is mostly referable to the Nabeyaman, although the upper part of it may range up to the Akasakan as KAWANO (1961) considered.

VI. Outer zone of Southwest Japan

The Permian rocks of the Outer zone of Southwest Japan display the characteristic zonal arrangement and are exposed in several tectonic belts. Their complex geologic structure often make it difficult to summarize the complete sequence of a group or a formation and to demonstrate a clear mutual relationship between fossil zones.

---

* *Leonardphyllum* sp. was regarded by HAYASAKA and MINATO (1954) as a component species of the zone of *Parafusulina*, but later MINATO (1955) revised its stratigraphical position as the zone of *Neoschwagerina* or *Yabeina* with uncertainty. The specimens from the Suzumiyama Formation [Swi 83] is very incomplete and its generic identification is not certain. Therefore its stratigraphical age is not exactly known.

A. Kii peninsula

1. Eastern part of Kii peninsula

The non-metamorphic Paleozoic rocks of the southern part of Kii peninsula are developed in several parallel tectonic belts of NEE–SWW trend. Since OGAWA (1904) first studied the eastern part of Shima peninsula, many stratigraphers have made efforts to clarify the geology of the region.

Recent study by YAMAGIWA (1957) has added some contributions to the geology although there are still many problems remaining unsolved. According to him, the Kochi Group [Swo 6′], which exposes to the northern side of the Arashima-Gokasho tectonic line, consists of sandstone, shale, and their alternation, and chert, with intercalation of limestone and schalstein. In the lmestone exposed at Osakatoge, YAMAGIWA reported the occurrence of *Pseudofusulina vulgaris* (SCHELLWIEN), *Schwagerina krotowi* (SCHELLWIEN) and *Waagenophyllum* sp. This limestone is apparently higher in position than another limestone which is exposed at Shiraki-machi and yields *Neoschwagerina* sp., but YAMAGIWA deemed that the apparent inversion of the strata is due to the fault between them. At any rate it is presumed that some part of the Kochi Group is referable to the Nabeyaman.

2. Central part of Kii peninsula

The Kotako Formation [Swo 21] (2300 m), the middle division of the Kawakami Group, consists of schalstein, chert and greyish-white massive limestone. The lower part of the formation is referred by SHIIDA (1962) to the zone of *Schwagerina,* though no fusulinacean fossils have been found in the limestone.

The Nishiyoshino Group [Swo 24], developed in the western part of the main zone of Chichibu terrain in the central Kii massif, is assumed to be correlative with the Kotako Formation of the eastern part from the standpoints of facies resemblance and geotectonics (SHIIDA, *op. cit.*). According to SHIIDA there is little hope of finding fossils in these stratigraphical units.

3. Yuasa area

In the vicinity of Yuasa, the western extremity of the Chichibu terrain of Kii massif, the Nabeyaman has been known for long time. *Pseudofusulina japonica* (GÜMBEL) was reported by INOUE (1933) from the Itogawa Formation [Swo 29] in which *Fusulina cylindrica* FISCHER de WALDHEIM was also once reported by NEGA (1896) although it has never been described. More detailed study is necessary to clarify the stratigraphy of this area.

B. Shikoku

As mentioned in the preceding chapter, SUYARI (1961) set up five fusulinacean zones for the Permian of Shikoku; the *Pseudoschwagerina, Schwagerina, Misellina, Neoschwagerina-Yabeina,* and *Lepidolina* zones in ascending order. SUYARI correlated his second, *Schwagerina* zone, with the lower part of the Leonardian of North America and the third, *Misellina* zone, with the upper part.

However, if his specific identification is correct, the faunal contents as seen below give rise to a paleogeographical problem during the Leonardian time because most species of *Triticites* found in his *Schwagerina* zone bear Asiatic aspect whereas those of *Schwagerina* are of the mixture of Asiatic and North American elements. Moreover, there is no definite basis in his correlation of the *Misellina* zone with the upper part of the Leonardian, because the former comprises only *Misellina* and *Pseudodoliolina* of typical Japanese element and no species of *Parafusulina,* except for a doubtful one. In this paper SUYARI's *Misellina* zone and the lower part of *Neoschwagerina* zone are referred to the Nabeyaman.

1. Eastern part of Shikoku

a. Kusune area

The Kusune Formation [Swo 39] of the Hisone Group has the Nabeyaman in its upper half (SUYARI, 1954, 1961). Small muddy limestone lenses intercalated in the tuffaceous shale yield the following species:

Triticites rossicus (SCHELLWIEN)
T. campus THOMPSON
Schwagerina gruperaensis THOMPSON and MILLER
Parafusulina fukaensis SUYARI
Eoverbeekina? sp.
Toriyamaia sp.

b. Kenzan area

The Kenzan Formation [Swo 56] named by HIRAYAMA *et al.* (1956) is widely developed in the central part of Tokushima Prefecture, occupying the northern half of the northern zone of the Chichibu terrain. It consists mainly of sandstone and mudstone with a large amount of chert. Although the fossil occurrence is very rare in this formation, *Pseudofusulina* has been reported by HIRAYAMA *et al.* from the grey limestone exposed to the south of Kenzan. The joint authors referred this formation to the middle part of the Lower–Middle Permian.

c. Miyahama area

The Miyahama Formation [Swo 51] was the name given also by HIRAYAMA *et al.* (1956) to the lower Middle Permian rocks developed in the southern zone of the Chichibu terrain in the central part of Tokushima Prefecture. Although mudstones are the main constituent, chert and limestone predominate in some parts. Since *Pseudofusulina* cfr. *japonica* (GÜMBEL) has been abundantly obtained with *Neoschwagerina* sp. in the limestone, HIRAYAMA *et al.* correlated the Miyahama Formation with the *Parafusulina kaerimizensis* subzone of the Akiyoshi limestone Group.

d. Sakashu area

The name of Ottate Formation [Swo 55] was given by SUYARI (1961) to the Permian rocks developed in Sakashu, Sakashu-mura, Naka-gun, Tokushima Prefecture. The occurrences of *Nagatoella kobayashii* THOMPSON (ICHIKAWA

et al., 1953) and *Pseudofusulina fusiformis* (SCHELLWIEN) (SUYARI, 1961) are the only available paleontological information on this formation.

2. Central part of Shikoku

a. Kameiwa area

The Kameiwa Formation [Swo 66], the lower division of the Shirakidani Group, is referred to the Nabeyaman. The following species were found by KOBAYASHI (1945) in this formation:

Fusulinella sp.
Triticites cfr. *montiparus* [EHRENBERG (MÖLLER)]
Schwagerina incisa (SCHELLWIEN)
Rugosofusulina prisca [EHRENBERG (MÖLLER)]
Misellina sp.

Fusulinella sp. is perhaps a derived fossil. According to SUYARI (1961) the Kameiwa Formation ranges from the zone of *Pseudoschwagerina* to that of *Misellina*. He listed the following species in the *Misellina* zone:

Brevaxina sp. A
Misellina iisakai (TORIYAMA)
M. cfr. *termieri* (DEPRAT)
M. *tosensis* (TORIYAMA)
M. sp. A
Parafusulina? sp.

A discussion on the fusulinacean faunas of the Kameiwa Formation has already been given on page 112. The specific assemblage of the faunas is worthy of discussions concerning the paleogeographical problem in the Sakamotozawan-Nabeyaman times.

b. Shirakidani area

ISHIZAKI (1960) set up many formational names for the Permian rocks developed in the Shirakidani area without designating the type locality, and he (1963) described the *Misellina* faunule from his Shingai Formation [Swo 65]. Because the faunule is comprised almost exclusively of species of *Misellina* without any trace of *Parafusulina*, he referred this faunule to the Upper Wolfcampian age. However, SUYARI (1961) reported the *Misellina* faunule with *Parafusulina*? sp. from the Kameiwa Formation [Swo 66] of the Shirakidani Group. Judging from the geological maps made by ISHIZAKI (1960) and SUYARI (1961), the Kameiwa Formation includes ISHIZAKI's Shingai Formation as a part of it. Moreover, there is no positive evidence to verify the upper Wolfcampian age of the *Misellina* faunule of "the Shingai Formation". Thus, both of the *Misellina* faunule of ISHIZAKI and the *Misellina* zone of SUYARI are probably referable to the Nabeyaman with a possibility of having the upper Sakamotozawan. ISHIZAKI's *Misellina* faunule comprises *M. aliciae* (DEPRAT), *M. cylindrica* ISHIZAKI, *M.* aff. *ibukiensis* KOBAYASHI, *M. subelliptica* (DEPRAT), and *Brevaxina hataii* ISHIZAKI, but his new species are not well preserved and not sufficient for establishing new species. *M. cylindrica* is seemingly an immature form of some allied species.

c. Tosayama area

The Tosayama Formation [Swo 68], the upper division of the Shirakidani Group, was studied by TORIYAMA (1947) who described *Parafusulina lutugini* (SCHELLWIEN) and primitive species of verbeekinids and neoschwagerinids. Recently SUYARI (1962) described *Parafusulina edoensis* (OZAWA), *Pseudofusulina japonica* (GÜMBEL), *Misellina tosensis* (TORIYAMA), *M.* sp., and *Neoschwagerina craticulifera* (SCHWAGER) in the limestone lenses interbedded in the schalstein. SUYARI (1961) correlated the Tosayama Formation with his *Neoschwagerina-Yabeina* zone, but it may be possible that the lower part of this formation is referable to the Nabeyaman.

d. Sakawa area

From several localities in the Sakawa basin [Swo 82] and its environs *Pseudofusulina japonica* (GÜMBEL) has been reported, without any information about the associated species.

The Yamamba limestone [Swo 81′], located 1.6 km north of Sakawa, was studied by many previous workers and the "Yamamba fauna" had long been discussed from various sides of paleontology for its stratigraphical position. However, through the studies of NONAKA (1946), KOBAYASHI (1951), MINATO (1955) and SAKAGAMI (1963), the Yamamba limestone is now referred to the zone of *Parafusulina* and the "Yamamba fauna" bears a close similarity with the Iwaizaki fauna of the southern Kitakami massif. SAKAGAMI (1963) reported *Chusenella* cfr. *conicocylindrica* CHEN which was originally described from the Chinghsichung limestone, Hunan, China and also reported from the c Member of the Iwaizaki limestone (MORIKAWA, 1960).

3. Western part of Shikoku

a. Onogahara area

The Nakakubo Formation [Swo 99], named by ISHIZAKI (1962), is presumed to be equivalent in part with the Kamiyakawa Formation [Swo 69] of ISHII *et al.* It consists mainly of massive limestone and schalstein, though the facies changes considerably at places. Although ISHIZAKI found many fusulinaceans of various ages ranging from the Akiyoshian to the Sakamotozawan in the limestone breccia in the middle part of the formation, he has been unsuccessful in finding any fossil in the massive limestone. KASHIMA (1960) also reported many species of fusulinaceans from the limestone in the Onogahara area [Swo 100], but it is not known whether the limestone is brecciated or not. Judging from the faunal assemblage he listed, some of the limestones are at least limestone conglomerate or breccia. ISHIZAKI is of an opinion that the Nakakubo Formation is of the Artinskian or of a slightly younger age since the limestone breccia is common in the zone of *Neoschwagerina* in Shikoku.

b. Nomura area

The Nomura Group, developed in Nomura [Swo 108] and its environs in Ehime Prefecture, yields species of fusulinaceans which are probably referable

to the Nabeyaman. *Schwagerina* cfr. *ominesis* (OZAWA), *Pseudofusulina* cfr. *ambigua* (DEPRAT), and *Psf. granum-avenae* (ROEMER) were found in Nizashi [Swo 109] and *Neoschwagerina simplex* OZAWA in Shirodani [Swo 110] (IKEBE, 1936).

C. Kyushu

1. Usuki area

The Nabeyaman was found by FUJII (1954) in the Tsukumi [Swo 114] and Meiji zones [Swo 115] of the Usuki area, Oita Prefecture. In the Tsukumi zone five fusulinacean zones were distinguished. According to FUJII, the first limestone, which yields *Pseudofusulina* faunule of the Sakamotozawan, is overlain by the second limestone. In the lower part of the second limestone *Misellina iisakai* (TORIYAMA), *Neoschwagerina kobayashii* (TORIYAMA) and *Cancellina neoschwagerinoides* (DEPRAT) are found, without any association of species of *Parafusulina* of elongate form. This faunule may be regarded as the later stage of the Nabeyaman. The upper part of the second limestone contains the *Neoschwagerina craticulifera* faunule which is definitely of the Akasakan.

FUJII found *Parafusulina* sp. in Hodojima [Swo 113] which belongs to the Meiji zone developed to the south of the Tsukumi zone. Judging from the developmental stage in evolution of this species, he regarded it as an element of the zone of *Parafusulina*. The upper part of the Meiji zone is referred to the zone of *Yabeina*.

2. Kuraoka area

This area covers the northwestern part of the Nishiusuki-gun, Miyazaki Prefecture and the southeastern part of Kamimasuki-gun, Kumamoto Prefecture where the thick Permian rocks, called the Yurugidake Formation [Swo 124] (SAITO and KAMBE, 1954; KAMBE, 1957), are developed. As mentioned in the preceding chapter, the Yurugidake Formation is comprised of limestone beds in various horizons, many of which are prolific in fossils. KAMBE (1957) listed many species of schwagerinids and neoschwagerinids in sixteen localities (his localities 1–11, 14–18). *Parafusulina*? sp. and *Misellina* cfr. *claudiae* (DEPRAT) are respectively found in southwest of Kiaiya [Swo 127] and west of Yurugidake, both in Gokase-machi, whereas *Neoschwagerina simplex* (OZAWA) and/or *N. craticulifera* are reported in four other localities (KAMBE's loc. 8–11) in Gokase-machi, together with *Pseudofusulina* cfr. *japonica* (GÜMBEL) or indeterminable species of *Cancellina*. The former two are referred by KAMBE to the zone of *Parafusulina* or to the Shizo Formation of Kuma area, while the latter two are referred to the zone of *Neoschwagerina*. However, the faunal association in the latter localities, namely, the coexistence of *Neoschwagerina simplex* (OZAWA) with *Cancellina* sp. or *Pseudofusulina japonica* (GÜMBEL) suggests the later Nabeyaman for this part of the Yurugidake Formation rather than the Akasakan.

3. Kuma massif

KANMERA's continuous efforts have brought very much light on the strati-

graphy and paleontology of the western part of South Kyushu which is the western extremity of the Outer zone of Southwest Japan. Among the Permian rocks developed in the Kuma massif, the Shizo Formation of about 300 m thickness [Swo 146] is referable to the Nabeyaman which occurs in the southernmost tectonic belt of this area. The Shizo Formation consists mainly of chert with intercalations of clayslate. In the middle part of this formation a tuffaceous bed occurs in which limestone lenses are intercalated. MATSUMOTO and KANMERA (1964) reported the following species in the dolomitic limestone exposed at the north of Shizo:

Parafusulina gigatojaponica KOBAYASHI*
Pseudofusulina japonica (GÜMBEL)
Nagatoella cfr. *kobayashii* THOMPSON
Pseudodoliolina ozawai YABE and HANZAWA

Although the fauna listed above is certainly referable to the Nabeyaman, the Shizo formation is in tectonic contact with the under- or over-lying formations. Hence the stratigraphical relationship between the zone of *Parafusulina* of the Shizo Formation and the zones of *Pseudoschwagerina* and *Neoschwagerina* known in other tectonic belts is not clear.

The Kozaki Formation [Swo 142] is found in narrow belts along several tectonic lines in the lower valley of Kumagawa. KANMERA (1961, 1963) divided the Kozaki Formation into two subformations. The lower Subformation (180 m) consisting mainly of thick conglomerate with intercalation of sandstone and black mudstone; and the upper Subformation of thick conglomerate in the basal part and predominantly mudstone with thin siltstone and chert in the main part.

KANMERA distinguished two characteristic faunules in the lower Subformation, the lower *Misellina claudiae* and the upper *Neoschwagerina simplex* faunule. Of them the *Misellina claudiae* faunule is, as already mentioned in the preceding chapter (p. 114), of the upper Sakamotozawan age, and the *Neoschwagerina simplex* faunule is referable to the Nabeyaman, the diagnostic species of which are *Neoschwagerina simplex* (OZAWA), *Cancellina tenuitesta* KANMERA, *Verbeekina sphaera* OZAWA, *V.* sp., *Pseudodoliolina pseudolepida pseudolepida* (DEPRAT), *Yangchienia compressa* (OZAWA), *Parafusulina* (*Parafusulina*) *kaerimizensis* (OZAWA), and *P.* (*Skinnerella*) cfr. *sapperi* (STAFF).

As pointed out by KANMERA the *Neoschwagerina simplex* zone, as well as the *Misellina claudiae* zone, is very important in that it serves as a widely applicable index for the correlation of the lower Middle Permian not only in Japan, but also in the Tethysian realm. KANMERA has also made a correlation of this zone with other known fusulinacean zones in Japan. The *Neoschwagerina simplex* zone is correlated with the typical Nabeyaman zone such as the *Parafusulina kaerimizensis* zone of Akiyoshi, Atetsu, etc. Since all the species have been described by KANMERA (1963) in detail and an implicative account on the biostratigraphic significance of the fauna has been given by him, further discussion is not necessary here.

* The joint authors listed this species as *P. kaerimizensis* (OZAWA) in their first report (1952).

Recently MIYACHI (1966) studied the granite fragments in the Kozaki Formation and came to a conclusion that the granite fragments were derived in very short distance from Yatsushiro granite or its equivalents, and that a part of the secondary metamorphism in the source granite bodies was caused prior to the sedimentation of the Kozaki Formation.

Chapter IX. The Zone of *Neoschwagerina*

I. Kitakami and Abukuma massifs

A. Southern part of Kitakami massif

1. Hikoroichi-Setamai area

The typical *Neoschwagerina* fauna has not been found in the standard area of the Kitakami massif (Hikoroichi-Setamai area [Ka 23–27]) where the Sakamotozawan is overlaid by the thick coarse grained sandstone formation of about 500 m thickness* with a conglomerate bed of about 10 m thickness at the base. This is the Katchizawa member of the Kanokura Formation or the XI Group of MINATO *et al.* (1954), or the Katchizawa sandstone Member of the Kanokura Formation of ONUKI (1956).

Fossils characterizing the Katchizawa Member are brachiopods species of *Camarophoria humbletoensis* HOWSE, *Lyttonia* (*Leptodus*) *richthofeni* (KAYSER) HAYASAKA and others reported by the joint authors. As for the fusulinaceans *Monodiexodina matsubaishi* (FUJIMOTO)** occurs throughout the Katchizawa Member, although it begins to appear from much lower horizon in the IX Group of MINATO *et al.*

According to ONUKI (1956) species of *Parafusulina, Verbeekina* and *Neoschwagerina* are found in the formation developed in the Kamiyase-Kesennuma area [Ka 39′] which is presently regarded as being equivalent to the Katchizawa Member of the standard area from the lithological similarity. Thus ONUKI believes that the Katchizawa Member belongs to the zone of *Neoschwagerina*. However, it is not known whether the Katchizawa Member is equivalent to the whole or a part of the Akasakan.

2. Maiya area

The Tenjinnoki Formation [Ka 46] (ONUKI, 1956) is a representative of the Akasakan in the Maiya area, but, likewise in the standard area mentioned above, the brachiopod and pelecypod fauna is dominant in this formation and no fusulinacean faunas are known except *Monodiexodina matsubaishi* (FUJIMOTO) which occurs abundantly in thin limestone interbedded in several horizons. The Tenjinnoki Formation consists of alternation of sandstone and slate, attaining a thickness of about 280–330 m (ONUKI *et al.*, 1960). It is conformable in stratigraphical relation with the underlying Rodai and the overlying Yamazaki conglomerate Formation.

---

* According to ONUKI (1956) it is measures 180–200 m.

** This species has long been known as *Parafusulina wanneri* (SCHUBERT) (see also footnote of p. 88).

3. Iwaizaki area

The Iwaizaki peninsula [Ka 42], which occupies the southernmost part of the Kitakami massif, is composed mostly of the thick Permian rocks. The stratigraphy of this area has been studied by many workers such as MABUCHI (1935), INAI (1939), HANZAWA (1954), ONUKI (1956) and MORIKAWA *et al.* (1958). Although there is some discrepancies between the results of these workers, MABUCHI's and HANZAWA's zonation is cited here in descending order:

Zonation of HANZAWA	Zonation by MABUCHI
(1) black clayslate: *Richthofenia* zone	V. *Richthofenia japonica* zone
(2) dark grey limestone: *Yabeina* zone	IV. *Yabeina hayasakai* zone
(3) grey massive limestone:	
a. *Neoschwagerina-Verbeekina* zone	III. *Verbeekina verbeeki* zone
b. *Waagenophyllum* zone	II. *Waagenophyllum indicum* zone
c. *Parafusulina* zone	I. *Monodiexodina matsubaishi* zone
(4) Sandstone and conglomerate	

The constituent fusulinacean species of the above are as follows:

From (2) *Yabeina* sp., *Verbeekina sphaera* OZAWA, *Parafusulina* sp.
(3) a, b *Neoschwagarina* sp., *Verbeekina verbeeki* (GEINITZ), *Parafusulina* sp.
c *Parafusulina* sp.
[no fusulinaceans in (1)]

The results of recent study by MORIKAWA *et al.* (1958) are considerably different from those of the previous workers. They divided the Iwaizaki limestone into three zonules in descending order:

Yabeina shiraiwensis zonule
Pseudofusulina paramotohashii zonule
Monodiexodiua matsubaishi zonule

MORIKAWA (1960) described all the species contained in the above mentioned three zonules, although his species have little in common with those identified by HANZAWA or with those known from the Middle Permian of other parts of Japan.

B. Northern part of Kitakami massif

Enough information for a complete detailed summary of a stratigraphical and paleontological nature in this wide Paleozoic area is not available, but the following formations have been referred to the Akasakan by fossil evidences.*

1. Kamiarisu-Ohashi area

The upper part of the Kasshi Formation [Ka 15] consists mainly of black slate with thin intercalations of calcareous slate, lenticular limestone and limestone breccia and yields *Neoschwagerina* (ONUKI, 1956). The overlying Daido Formation [Ka 17] (MORIAI, 1955), which consists of black slate, argillaceous slate, sandstone, and conglomerate, also yields *Yabeina* sp., *Parafusulina wanneri* (SCHUBERT)** and *P.* sp. It is therefore presumed that the upper part of the

* As for the lithological division of the northern part of Kitakami massif see p. 88.
** See footnote of p. 88.

Kasshi Formation and a part of the Daido Formation are referable to the Akasakan. According to ONUKI both formations are somewhat contemporaneous and transitional with each other.

2. Toyomane-Hanawa area

As already mentioned in the preceding chapter (p. 118), *Neoschwagerina* has been abundantly found in the Hanawa Formation [Ka 4] which consists of alternation of sandstone, slate and chert along with lenticular limestone and conglomerate of the Usuginu type (ONUKI, 1956). However, no further paleontological information is presently available.

C. Abukuma massif

The Soma area, northeastern part of the Abukuma massif, is well known to have the Upper Paleozoic though they are partly metamorphosed and complicated in structure. The Oashi Formation [Ka 54] is the representative of the Akasakan in this area and conformably overlies the Uwano Formation of the Sakamotozawan age. In the upper part of the formation are found species of *Neoschwagerina* and *Pseudodoliolina* in the limestone and species of *Yabeina* and *Parafusulina* and *Waagenophyllum indicum* (WAAGEN and WENTZEL) along with other corals in the pebbles of the conglomerate.

Although the Oashi Formation was correlated by MINATO (1955) with the Kanokura Formation of the southern part of the Kitakami massif, and by HANZAWA (1954) with what ranging from Artinskian to Basleoian, the paleontological evidence is not enough to decide whether the Oashi Formation includes the Nabeyaman in its lower part and the Kuman in its upper part.

II. Inner zone of Northeast Japan

The Upper Paleozoic basement complex crops out in several limited areas of the Inner zone of Northeast Japan. Although little is known of the stratigraphy and paleontology of these Paleozoic rocks, recent studies by FUJIMOTO and KOBAYASHI (1961) have made some contributions to the stratigraphy of these rocks. According to them the Upper Paleozoic rocks of the Inner zone of Northeast Japan are found in ten areas although half of which are not dated because they are barren of fossils. The other areas, so far as they have been determined by the paleontological evidence, are mostly of the Akasakan.

1. Yatsumori area

This area covers the northeastern corner of Akita Prefecture and the northwestern corner of Iwate Prefecture. Main distribution is seen around Yatsumoriyama [Nei 1] and at the Ohirayama mine [Nei 2] and its environs, with a general trend of E-W and N-S respectively. The Permian of this area consists mainly of clayslate, quartzite and schalstein. The limestone lens found in the gallery of the Ohirayama mine yields *Neoschwagerina craticulifera* (SCHWAGER) and *Verbeekina verbeeki* (GEINITZ). FUJIMOTO and KOBAYASHI referred these rocks to the Middle Permian.

2. Shin-yu area

Shin-yu area [Nei 3], located west of Ichinoseki city, Iwate Prefecture, was surveyed by KITAMURA and TANI (1953) who found *Waagenophyllum* cfr. *indicum* in the limestone intercalated in the Paleozoic formation consisting of clayslate, schalstein and mica-schist. This formation was dated by them only as Permian.

3. Awagatake area

Little is known of the Paleozoic rocks of the Awagatake area [Nei 5] in Niigata Prefecture, but according to personal communications of Dr. CHIHARA to Dr. FUJIMOTO (in FUJIMOTO and KOBAYASHI, 1961) *Neoschwagerina* sp. and corals were found in the limestone.

4. Taishaku mountain range

The Taishaku mountain range [Nei 11], occupying the boundary area between Fukushima and Tochigi Prefectures, consists mainly of Chichibu Paleozoic rocks with granite intruded by granite-porphyry. According to FUJIMOTO (1953) indeterminable species of *Neoschwagerina, Yabeina, Verbeekina,* and *Schwagerina* occur in the limestone exposed at Hanawa [Kw 10], Kuriyama-mura, Tochigi Prefecture. Although the detailed stratigraphy has not been clarified due to the inadequate state of preservation of these fossils it is almost certain that the Akasakan is present in this mountain range.

5. Komagatake area

This is the boundary area between Niigata, Gumma, and Fukushima Prefectures where two main distributions of Upper Paleozoic rocks are seen, one in Keizuruyama [Nei 8] and its environs and the other in Inami mine [Nei 6] area.

In the former a *Lepidolina* fauna is known whereas in the latter *Neoschwagerina* cfr. *craticulifera* (SCHWAGER) has been obtained from a boulder which was probably derived from the limestone lens exposed near the Inami mine. Further information is presently not available.

III. Kwanto massif

1. Nabeyama area

The Aso Group was proposed by FUJIMOTO (1961) for the Permian developed mainly in Kuzu-machi and Tanuma-machi. The Nabeyama Formation [Kw 4], the second lowest of the Aso Group, is further divided into three members, Yamasuge limestone, Hanetsuru dolomite and Karasawa limestone. As already mentioned in the Chapter VIII (p. 120), the Yamasuge limestone Member is a typical representative of the Nabeyaman. The middle Hanetsuru dolomite (130–180 m) is almost barren of any fossils except in the lower part where fusulinaceans are abundantly found. However, according to FUJIMOTO their internal characteristics are not known because of the secondary dolomitization.

The upper Karasawa limestone Member, consisting of massive light grey or grey limestone, contains a rich fauna of fusulinaceans, and the following species are identified by FUJIMOTO:

Rauserella elatica DUNBAR
Schubertella simplex LANGE
Yangchienia sp.
Codonofusiella paradoxica DUNBAR and SKINNER
**Schwagerina krotowi* (SCHELLWIEN)
S. ominensis (OZAWA)
**S. gnembeli* DUNBAR and SKINNER
S. gnembeli pseudoregularis DUNBAR and SKINNER
S. margheritii DEPRAT
Rugosofusuliua prisca [EHRENBERG (MÖLLER)]
Pseudofusulina vulgaris (SCHELLWIEN)
Ps. vulgaris watanabei LEE
**Ps. granum-avenae* (ROEMER)
**Ps. ambigua* (DEPRAT)
Ps. cfr. *tenuissima* (SCHELLWIEN)
Ps. japonica (GÜMBEL)
**Parafusulina yabei* HANZAWA
**P. kattaensis* (SCHWAGER)
**P. kaerimizensis* (OZAWA)
**Pseudodoliolina ozawai* YABE and HANZAWA
Neoschwagerina colaniae OZAWA
N. margaritae DEPRAT
Yabeina columbiana (DAWSON)
(Species with asterisks are also found in the lower Yamasuge Member)

Since none of these species has been described nor a detailed stratigraphical relationship has been found between fossil localities throughout the member, critical biostratigraphical discussion cannot be given here even though FUJIMOTO inferred that the Karasawa limestone Member ranges from the *Parafusulina* zone up to the *Neoschwagerina* zone and even partly up to the *Yabeina* zone.

The upper three formations of the Aso Group, *viz.* the Adoyama, Maki and Mikagura Formations are still ambiguous in stratigraphical position, because of being almost barren of fossils except for the occurrence of *Parafusulina nakamigawai* MORIKAWA and HORIGUCHI in the Adoyama Formation [Kw 6] and the radiolarian remains in the Mikagura Formation. YOSHIDA (1956, 1957) also reported *Pseudodoliolina ozawai* YABE and HANZAWA, *Parafusulina* sp. and *Schwagerina* sp. in the Maki Formation [Kw 8]*. He inferred that the Adoyama and the Maki Formations are contemporaneous in age with the upper part of the Nabeyama Formation. However, FUJIMOTO (1961) regards the Nabeyama, Adoyama, Maki, and Mikagura Formations as being supperposed in order, though there are no remarkable difference in geological age between them.

2. Mamba and other areas

In FUJIMOTO's division (1936) the upper part of the III zone of *Neoschwagerina craticulifera* or *Pseudofusulina ambigua* and the IV zone of *Neoschwagerina margaritae,* which are developed in his Mamba [Kw 12] and Shomarutoge [Kw 31] Groups and Raidenyama [Kw 39] and Katsuboyama [Kw 43] zones, are probably referable to the lower and upper part of the Akasakan, respectively.

* According to FUJIMOTO (1961) the Maki Formation yields no fossils.

TAKAOKA (1966) described *N. margaritae* DEPRAT from Kanosan [Kw 13], together with *Misellina claudiae* (DEPRAT) from Futagoyama [Kw 21], but his illustrated specimens are too insufficient to make a critical discussion of zonation and detailed paleontological comparison. In MORIKAWA's study (1955) on the Permian of Shomarutoge [Kw 31], the eastern part of the massif, the zone of *Neoschwagerina* is called the Asakaido Stage, the constituent species of which are *N. margaritae* DEPRAT, *N. minoensis* OZAWA, *N. craticulifera* (SCHWAGER), *Misellina claudiae* (DEPRAT), *Pseudofusulina vulgaris* (SCHELLWIEN), *P. tenuis* CHEN, and *P. modica* (THOMPSON and HAZZARD).

Although MORIKAWA followed OZAWA in his division of zone of *Neoschwagerina*, there is still a doubt about the fossil contents of each locality. For example, the limestone of MORIKAWA's locality 25 and 28 were both correlated with the Nm zone but yields only *Pseudofusulina* sp. and *P. japonica* (GÜMBEL), respectively. Moreover, as already pointed out by KANMERA (1957), the fusulinaceans found at MORIKAWA's locality 31 (Asakaido) are clearly found in the pebbles of the limestone conglomerate, and it is not known whether they are referable to the zone of *Neoschwagerina*. Such being the case, more exact and detailed study is needed for the zone of *Neoschwagerina* of the Kwanto massif.

IV. Hida massif and Tamba zone

A. Hida massif

1. Omi limestone

The uppermost P2 Formation of about 100 m thickness is referred by KAWADA (1954) to the zone of *Neoschwagerina*. However, as he mentioned, the lower half of the P2 is of the zone of *Parafusulina s. str.* and the upper half is of the zone of *Neoschwagerina*. FUJITA (1958) followed KAWADA in his biostratigraphic zonation, though the fossil contents in his P2 zone are little different from those listed by KAWADA. The constituent species of KAWADA's zone of *Neoschwagerina* are as follows:

Pseudodoliolina ozawai YABE and HANZAWA
Cancellina sp.
Neoschwagerina craticulifera (SCHWAGER)
N. douvillei OZAWA
N. margaritae DEPRAT
N. minoensis OZAWA
Yabeina cfr. *globosa* (YABE)
Sumatrina cfr. *annae* VOLZ

Although the exact stratigraphical range of each species is a little different according to parts of the Omi limestone, it is noted that *Cancellina* sp.—if KAWADA's identification is correct—and *Yabeina* cfr. *globosa* occur together. None of the species have been described yet.

2. Hirayu area

In the eastern part of the Hida massif, the Akasakan is found in the Hirayu Group [Ht 30] and consists mainly of clayslate, sandstone, limestone, and schal-

stein. Having found *Neoschwagerina margaritae* DEPRAT and *Parafusulina* sp. from the lower part of this group, KAMEI (1952) referred it to the middle Upper Permian. However, IGO (1956) has stated that the Sakamotozawan and the Nabeyaman are found respectively in the lower and middle divisions of the Hirayu Group and he (1959) also described many fusulinacean species. Thus IGO correlated the Hirayu Group with the upper part of the Ichinotani Group [Ht 27] and the Sorayama Group [Ht 25] in the Fukuji area, although there is a considerable difference in facies between the Hirayu Group and latter two groups.

According to IGO (1959) the upper division (200 m+) of the Hirayu Group consists of clayslate and white to grey limestone and is referred to the Akasakan. This division is very narrow in distribution and found only within a shattered tectonic zone. It is also very poor in fossil occurrence and only *Neoschwagerina margaritae* DEPRAT, *N.* sp. and *Schwagerina* sp. were reported but not described.

3. Nyukawa area

The Upper Paleozoic of Nyukawa area, east of Takayama city, was named the Nyukawa Group by TAKANO (1952) and divided into three formations. The upper division was named the Shioya Formation [Ht 38] and was referred to the zone of *Pseudofusulina.* However, ISOMI and NOZAWA (1957) revised the definition of the Nyukawa Group and limited it to the Permian section only, excluding the Nakahata Formation, the lower division of TAKANO's Nyukawa Group. The N_2 Formation of ISOMI and NOZAWA yields *Neoschwagerina craticulifera* (SCHWAGER), *Pseudodoliolina ozawai* YABE and HANZAWA and *Parafusulina* cfr. *kaerimizensis* (OZAWA), and the Junigatake Formation [Ht 33] developed north of the Nyukawa Group also has *Neoschwagerina* cfr. *margaritae* DEPRAT, *Verbeekina verbeeki* (GEINITZ) and other schwagerinids. These two formations were referred by them to the zone of *Neoschwagerina.*

The Nyukawa Group was also studied in detail by IGO (1960, 1964). The Kono Formation [Ht 37] (400 m) in the Gombo area consists mainly of volcanic rocks and chert with intercalations of limestone lenses. The limestones bear two faunules of different ages; one is of the Akasakan in which *Pseudodoliolina ozawai* YABE and HANZAWA, *Misellina claudiae* (DEPRAT), *Cancellina nipponica* (OZAWA), and *Parafusulina* spp. are found at Nishinotani valley and *Pseudofusulina horadaniensis* IGO, *Misellina claudiae* (DEPRAT), *M.* sp., and *Neoschwagerina* sp. at Horadani valley, and the other one is of possibly Kuman age, comprising *Yabeina kanmerae* IGO and others. Thus, the Kono Formation is dated to the Akasakan to the Kuman, although the stratigraphical relationship between the fusulinacean-bearing limestones stated above is not exactly known. Mutual relationship between the division of the Nyukawa Group of ISOMI and NOZAWA and that of IGO is not known.

4. Southern part of the Hida massif

In this part of the massif the followings are referred to the zone of *Neoschwagerina,* and their stratigraphy and paleontology have been described by KANUMA (1958, 1960) in detail.

(1) The Okuzumi Formation [Ht 41] of Oppara and Akiyama in the northern part; *Neoschwagerina margaritae* DEPRAT, *N. craticulifera* (SCHWAGER), *Verbeekina verbeeki* (GEINITZ), and *Pseudofusulina aganoensis* FUJIMOTO.

(2) The Shimadani Formation [Ht 43′] and the Kayugawa Formation of Kuchibora [Ht 44] of central part; *Neoschwagerina schellwieni* (DEPRAT) and *Verbeekina verbeeki* (GEINITZ) from the former and *N. douvillei* OZAWA from the latter.

(3) The upper Formation of the Tominoho Group [Ht 46] of southern part: no fossils have been found in this formation which overlies the middle Formation of the Nabeyaman age, hence it may be referable to the Akasakan.

5. Shiojiri area, Kiso massif

To the southeast of Shiojiri, Nagano Prefecture there are thick Permian rocks which consist of sandstone (greywacke), clayslate, chert, and their alternation. They are tectonically divisible into three, the northern, central and southern terrains, all separated from each other by major fault zones (ISOMI and KATADA, 1959; KAMEI *et al.*, 1962; KATADA and ISOMI, 1962, 1964). KATADA and ISOMI (1964) also distinguished nine zones* by means of the difference of lithofacies or the combination of lithofacies, to each of which the formational names were given. The Kurokawa, Hata, Nomata and Hario Formations in the northern terrain (from NW to SE), the Misogawa Formation [Ht 15] in the central terrain, and the Yabuhara [Ht 14], Narai [Ht 13] and Yokokawa [Ht 11] Formations in the southern terrain.

Fossils are extremely rare and complicated geologic structure make the exact correlation between the three terrains difficult, though *Helminthoidea*, a representative of the "flysch-type" of fossil trails, is abundantly found at many places throughout the formations. The only available paleontological evidences for these wide Permian terrains are the occurrence of *Spiriferina* sp. and *Waagenophyllum indicum* in the Utoyama limestone [Ht 10] of Yabuhara Formation, and of *Yabeina katoi* (OZAWA)** in the limestone lens (Nojiri limestone) exposed 2 km north of Nojiri-machi of Agematsu area [Ht 16] which is presumed to be the southwestern extension of the Yabuhara Formation (MORITA, 1952).

6. Upper valley of Hinokawa (Imajo area)

Little is known of the Paleozoic occupying the vast area including the western part of Gifu and the southeastern part of Fukui Prefecture. ISOMI's report (1955) described the stratigraphy of a part of this wide area. Along the upper reaches of Hinokawa, the Permian Takura [Ht 81] and the Carboniferous Nanjo Group are developed. The former consists mainly of sandstone and clayslate with limestone lenses. As already stated in Chapter VII, *Pseudofusulina vulgaris* and other schwagerinids were found in the limestone lens intercalated

* In their paper of 1959, ISOMI and KATADA discriminated five zones (Ia, Ib, IIa, IIb, and III) without giving zone or formation names.

** This species was first reported by MORITA (1952) as *Yabeina globosa* (YABE), but changed to *Y. katoi* by KATADA and ISOMI who also reported the occurrence of small forms of neoschwagerinids.

in the lower part of the Takura Group whereas *Neoschwagerina douvillei* OZAWA and *Pseudofusulina* cfr. *japonica* (GÜMBEL) were found in the limestone of upper part. Thus ISOMI referred the lower part of the Takura Group to the upper part of the zone of *Pseudoschwagerina* or to the lower part of the zone of *Parafusulina* and the upper part to the Middle Permian.

7. Kuzuryu area

In the upper valley of Kuzuryu-gawa, the Akasakan is represented by the Komukudani [Ht 73′] and the Makatoji [Ht 76′] Formations, the upper two divisions of the Nojiri Group. The former (450 m) consists mainly of clayslate and sandstone with an intercalation of limestone which yields *Lyttonia richthofeni* and other brachiopods and *Parafusulina* cfr. *wanneri* (SCHUBERT) (HAYASAKA and OZAKI, 1955). The Makatoji Formation has not been studied well, but, according to FUJIMOTO *et al.* (1962) *Yabeina globosa* (YABE), *Y. katoi* (OZAWA), *Neoschwagerina craticulifera* (SCHWAGER), and *N. minoensis* OZAWA have been found in the greyish-white limestone. Thus, the Makatoji Formation is referable to the upper Akasakan, with a possibility of its upper part being the Kuman.

8. Wakasa area

The Miyakawa Formation* [Ht 87] of the northern part of the Wakasa area comprises the Nabeyaman and Akasakan fusulinaceans, of which the former has already been mentioned in the preceding chapter (p. 129). According to ISOMI and KURODA (1958), the Akasakan fusulinaceans of the Miyakawa Formation contain two assemblages: one comprises *Parafusulina kaerimizensis* (OZAWA), *Misellina* sp., *Cancellina* sp., *Neoschwagerina craticulifera* (SCHWAGER), and *N. simplex* OZAWA; and the other contains *Parafusulina kaerimizensis* (OZAWA), *Verbeekina* sp., *Neoschwagerina craticulifera* (SCHWAGER), and *N. margaritae* DEPRAT. Although the former is older in age than the latter, they are seemingly not in normal order in stratigraphical superposition in the field.

The Kochi Formation** [Ht 86], which occurs mainly along the Obama Bay, consists of chert and clayslate in the lower part, sandstone with intraformational conglomerate in the middle, and thick schalstein in the upper. *Neoschwagerina* sp., *N. margaritae* DEPRAT, *Yabeina katoi* (OZAWA), and *Y. globosa* (YABE) have been reported in the brecciated limestone. Although the stratigraphical relationship between the Kochi Formation and other formations in the Obama area are not known, it is clear that the Kochi Formation is the uppermost stratigraphical unit of the Upper Paleozoic Tamba Group in this area and belongs to the upper Akasakan to the Kuman.

The Oura Formation [Swi 2′] (3000 m), named by IGI, KURODA and HATTORI (1961), is developed along Yuragawa valley and along the Maizuru Bay. It is

* The Oi Formation [Ht 90] and the Aoi Formation [Ht 88] (HIROKAWA. ISOMI and KURODA, 1957), both have phyllitic facies in the Wakasa area and are included in the Miyakawa Formation of ISOMI and KURODA (1958).

** The Kochi Formation includes the Kato Formation [Ht 89] defined by HIROKAWA, ISOMI and KURODA (1957).

composed mainly of dark greyish clayslate with intercalation of thick beds of schalstein and thin beds of chert but contains no fossils, so the stratigraphical age of this formation is not exactly known. So based on the lithological characters, the joint authors regard the Oura Formation as the upper Middle Permian of the Tamba zone proper, being correlative with the lower Member of the Maizuru Group.

The western extension of the Oura Formation appears in the western part of Maizuru city and northern part of Oé-machi where it is called the Shimomitani Formation [Swi 3′] (IGI and KURODA, 1965). Although the Shimomitani Formation contains no fossils it is presumed to be Middle Permian by IGI and KURODA from the lithological point of view.

9. Upper valley of Ibigawa—Tokuyama and Sakauchi area

The Sakauchi Formation [Ht 56] (600 m) consists mainly of basic tuff and slate and is presumed to be the Middle Permian (KAJITA, 1963) by the fossil evidence. KAJITA reported indeterminable species of *Pseudofusulina, Parafusulina* and *Neoschwagerina* from the limestone lenses interbedded in the basic tuff, none of which have been described. The Sakauchi Formation is also presumed to be equivalent to the Middle Permian of the Nyukawa facies in the Hida massif.

The Upper Paleozoic rocks of the middle and upper parts of Ibigawa valley have also been studied by MIYAMURA (1965). The upper part of his *Parafusulina–Neoschwagerina* zone is certainly referable to the Akasakan in which the following species are determined by him:

Neoschwagerina cfr. *margaritae* DEPRAT
N. *craticulifera* (SCHWAGER)
N. *rotunda* DEPRAT em. MORIKAWA
Cancellina nipponica OZAWA
Parafusulina kaerimizensis (OZAWA)
P. *edoensis* (OZAWA)
P. *takeyamai* MORIKAWA and ISOMI
P. *iwasensis* MORIKAWA and ISOMI
Pseudodoliolina sp.
Pseudofusulina lepida (DEPRAT)
Psf. *ambigua* (DEPRAT)

It should be noted that all the species listed above are also found in the lower part of the *Parafusulina–Neoschwagerina* zone in this area.

Although KAJITA (1963) and MIYAMURA (1965) studied nearly the same area, their results differ considerably in the stratigraphical division and geological structure.

10. Funafuseyama area

The upper part of the Funafuseyama limestone [Ht 48] is referred to the Akasakan in which OGAWA and IGO (in FUJIMOTO *et al.*, 1962) set up the following fusulinacean zones in descending order:

Yabeina sp. zone
Neoschwagerina zone { *N. margaritae* subzone; *N. craticulifera* subzone; *Cancellina nipponica* subzone }

Although these zones and subzones are distinguished lithologically from one another, their faunal contents are not as yet known.

11. Akasaka area

As already stated, the Akasaka limestone [Ht 65] is the type of the Akasakan Stage in Japan and is also a classical locality for the study of the Paleozoic stratigraphy and paleontology of Japan. OZAWA (1927) was the first who set up the fusulinacean zones in this limestone from the evolutional standpoint of neoschwagerinids. OZAWA's zonation is so prominent that it has been still accepted by many of paleontologists and stratigraphers.

MORIKAWA *et al.* (Akasaka Research Group) recently restudied the Akasaka limestone and divided it into three formations: the lower with the guide genus of *Schwagerina*, the middle with *Neoschwagerina*, and the upper with *Yabeina*. Although they listed a number of species of neoschwagerinids including one new genus and several new species, their range chart and explanation are, as already stated in the preceding chapter, not available for a critical discussion.

HONJO (1959) and MINATO and HONJO (1959) also restudied the Akasaka limestone and presented considerably different results from those having been made by previous workers. However, HONJO's observation was based on only a single route along the southeastern slope of Kinshozan, Akasaka, and MINATO and HONJO's scheme of phylogeny of Neoschwagerininae put too much stress on the nature of axial septula and it seems applicable to the phylogeny within specific rank rather than generic one. Such being the situation, most of MINATO and HONJO's new genera are not accepted here, being synonymous with other known genera.

In this paper OZAWA's biostratigraphical zonation of the Akasaka limestone has been followed and further discussion seems unnecessary.

B. Tamba zone

1. Ishiyama limestone

The Ishiyama limestone [Ht 58] is exposed about 15 km northwest of Ogaki city where the Mino massif decreases in height, forming hilly land. The limestone attains a thickness of about 100 m and yields the following species (ISOMI, 1955):

Schubertella giraudi (DEPRAT)
Neoschwagerina craticulifera (SCHWAGER)
N. margaritae DEPRAT
Yabeina katoi (OZAWA)
Cancellina nipponica OZAWA
Verbeekina verbeeki (GEINITZ)
Pseudofusulina japonica (GÜMBEL)

ISOMI referred the Ishiyama limestone to the Nn, Nc, Nm, and Ng zones of Akasaka limestone. However, it is not known whether all the species listed above occur in a single horizon or not. Stratigraphical relationship between this limestone and the surrounding non-calcareous formations is also not clear because it is in fault contact with the latters.

2. Ibukiyama area

The Akasakan is widely distributed in the Ibuki massif and its adjacent area. The typical representative is the Ibukiyama limestone which constitutes the thrusting mass on the non-calcareous formations of nearly the same age.

The Ibukiyama limestone [Ht 96] (450 m) was studied by SEKI (1938, 1939) at some length who reported several species of neoschwagerinids and schwagerinids. Recent KOBAYASHI's study (1957) has thrown light on the paleontology of this limestone. He divided the zone of *Neoschwagerina* into two subzones, the lower *N. craticulifera* (about 400 m thick) and the upper *N. margaritae* (about 500 m thick) which are correlated with the Nc and Nm zone of the Akasaka limestone, respectively. The assemblage of the Ibukiyama fauna has much in common with other Akasakan fauna of Southwest Japan, such as Akasaka, Akiyoshi, etc. and also with some of the American Tethys fauna. All the constituent species of the zone of *Neoschwagerina* of Ibukiyama have been described by KOBAYASHI.

The Middle Permian of the non-calcareous facies developed below and around the Ibukiyama limestone was also surveyed by ISOMI and others.

The Tsuchikura Formation [Ht 91′] is developed to the north of the Ibuki massif, namely, in the boundary area between Shiga, Gifu, and Fukui Prefectures. It consists of chert, with clayslate, schalstein and limestone. *Neoschwagerina margaritae* DEPRAT is the only available evidence for an age determination of this formation (KANUMA in FUJIMOTO *et al.*, 1962). The Tsuchikura Formation is underlaid by the Deguchi Formation [Ht 91] of probable Nabeyaman.

The Kasuga Group exposes in the easterly adjacent area of the Ibukiyama limestone and is divided into the upper Noharadani, the middle Kasuga, and the lower Sasamata Formation. The Kasuga Group contains no fossils, but based on the lithological similarity, it is correlated with the Kasukawa Formation and the overlying unnamed formation which are developed further to the east. According to ISOMI (1956) the Kasukawa Formation [Ht 64′] yields *Pseudofusulina japonica* (GÜMBEL) and *Neoschwagerina craticulifera* (SCHWAGER) in the lower part (clayslate, sandstone and limestone) and *Codonofusiella paradoxica* DUNBAR and SKINNER and *Neoschwagerina margaritae* DEPRAT in the upper part (alternation of sandstone and clayslate with limestone lenses). The lower part of the Kasukawa Formation is probably correlated with the Nc zone and the upper part with the Nm zone of the Akasaka limestone.

The Itanami Group [Ht 95] and the Ashimatagawa Group [Ht 95], developed west and northwest of the Ibukiyama limestone, are presumably regarded as the Akasakan, though they are barren of fossils. The former is lithologically referred to the Kasukawa Formation and the latter to the Kasuga Group. More study in the future is necessary on these non-calcareous groups.

3. Yoro massif

The upper Subgroup of Yoro Group [Ht 67] has been referred by KANUMA and IRIÉ (1962) to the Middle Permian ranging from the zone of *Parafusulina*

to the zone of *Yabeina* although this is not verified by the paleontological evidence except a problematical occurrence of *Yabeina globosa* (YABE) in the limestone lens of the chert member. The joint authors pointed out the stratigraphical importance for the occurrence of granitic pebbles in the conglomerate of the lowest part of the Subgroup.

4. Fujiwaradake area

The Kurakaketoge Formation [Ht 104] in this area consists of the alternation of chert and clayslate in the lower part, thick sandstone in the upper part, and attains about 800 m in thickness. The basal part consists of brecciated limestones of about 20 m and the limestone matrix of which yields *Neoschwagerina craticulifera* (SCHWAGER). MURATA (1960) referred the Kurakaketoge Formation to the zone of *Neoschwagerina.*

The Tokiyama Formation [Ht 69] (400 m) developed in the northern part of the Fujiwaradake area is, according to MURATA, probably correlative with the Kurakaketoge Formation of the south because of the similarity in facies.

KOBAYASHI (1941, 1951) and MURATA (1961) differs in their geotectonical interpretation of the Suzuka massif as already mentioned in the preceding chapter (p. 129).

5. Kitayama area (Northern hill of Kyoto)

The Kurama Formation [Ht 106] (SAKAGUCHI, 1962), the lowest division of the Tamba Group in the Kitayama area, has the *Neoschwagerina craticulifera* subzone in the upper part in which *N. craticulifera* (SCHWAGER) and *Parafusulina* sp. have been reported from the north of Kurama station. The overlying Ichihara (2400 m) and the Kumogahata (1300 m) Formations are barren of fossils, though they are presumed to be of the Upper Permian age.

6. Nishiyama area (Western hill of Kyoto)

The stratigraphy of Nishiyama area was studied by MATSUSHITA (1950, 1951), and more recently by SAKAGUCHI (1958, 1962). According to SAKAGUCHI, the upper part of the Tano Formation [Ht 116] belongs to the *Neoschwagerina craticulifera* subzone in which the following species have been found:

Pseudofusulina tanbensis SAKAGUCHI (abundant)
Psf. japonica (GÜMBEL)
Psf. gigantojaponica KOBAYASHI
Parafusulina edoensis (OZAWA)
P. takatsukiensis SAKAGUCHI
Pseudodoliolina ozawai YABE and HANZAWA
Cancellina sp.
Neoschwagerina craticulifera (SCHWAGER)
Waagenophyllum izuruhense SAKAGUCHI and YAMAGIWA

Fossiliferous limestones occur only in the Tano Formation but not in the Izuruha [Ht 116′] and the Takatsuki Formation [Ht 117] which are the middle and upper divisions of the Tamba Group of this area. The whole Permian strata of this area attain 6800 m in thickness.

7. Western part of the Tamba zone

Due to the scarcity of fossils, our knowledge of the Permian stratigraphy and paleontology of this part is still very meager, for which only the following results are available:

FUJIMOTO (1938) once reported a *Neoschwagerina* fauna from Kametsubo [Ht 125], Ichikawa-machi, Hyogo Prefecture. The fauna indicates the upper Akasakan age rather than the Kuman. It comprises the following species:

Endothyra sp.
Pseudofusulina sp.
Verbeekina cfr. *verbeeki* (GEINITZ)
Neoschwagerina craticulifera tenuis DEPRAT (abundant)
Yabeina cfr. *globosa* (YABE)

NAKADA and GOTO (1958) reported the following species in two limestone lenses found north by west of that of Kametsubo:

Neoschwagerina sp.
N. cfr. *margaritae* DEPRAT
Schwagerina sp.
Hayasakaina sp.

The stratigraphical horizon of these limestones is certainly of the upper Akasakan. NAKADA and GOTO considered the former as a little higher than the latter. Detailed stratigraphic study is necessary on this area.

V. Chugoku massif

1. West central part of Hyogo Prefecture

Upper Paleozoic rocks of uncertain age have been found in several separated areas in the west central part of Hyogo Prefecture. These Paleozoics rocks were considered to belong to the Yamaguchi facies of KOBAYASHI in which limestone is extremely rare. Some of them are metamorphosed thus complicating in structure.

The Akenobe Formation [Swi 18] and its metamorphic equivalent, the Surugamine Formation [Swi 17], and the Oya Formation [Swi 15] with its presumable equivalent the Chihara Formation in the easterly adjacent Takeda area have been studied by HIROKAWA, TOGO and KAMBE (1954) who regard them only as Permo-Carboniferous. However, since MATSUSHITA (1953) reported *Neoschwagerina craticulifera* (SCHWAGER) and "*Pseudofusulina*" sp. from the limestone lens intercalated in the black slate of the Akenobe Formation exposed to the east of Iwai, Minamitani-mura, Yabu-gun, Hyogo Prefecture, it is certain that a part of the Akenobe Formation is at least referred to the Akasakan.

It is noted that conglomerate beds are found in the Akenobe, Surugamine, Oya, and Chihara Formations, though they are very thin and not continuous in distribution. Stratigraphical implication of these conglomerate beds has not been determined yet.

Meanwhile, NAKAZAWA and his collaborators have made effort to clarify the Maizuru zone from the stratigraphical, paleontological and geotectonical stand-

points. And, it has been proved that the Akenobe and Oya Formations have the same characteristics as the Maizuru Group of the Maizuru area, and also that a part of the Akenobe Formation is Early-Middle Triassic in age according to the paleontologic evidence. Thus, SHIMIZU (1962) rejected the Akenobe and Oya Formations and combined them into the Maizuru Group. Stratigraphy of the Maizuru Group will be mentioned in the following chapter.

The Akasakan *Neoschwagerina* faunule reported by NAKADA and GOTO (1961) from Yokozeki [Swi 26], Himeji city is considered to be the easterly extension of the Kamigori branch of the Maizuru zone (SHIMIZU *et al.*, 1962). It comprises the following species:

Neoschwagerina sp.
N. cfr. *margaritae* DEPRAT
N. cfr. *iisakai* TORIYAMA
N. *craticulifera* (SCHWAGER)
Pseudofusulina sp.

2. Atetsu plateau

The stratigraphy and paleontology of the Atetsu limestone have recently been much clarified by IMAMURA and his collaborators and also by NOGAMI. IMAMURA (1958, 1959) divided the Permian of the Atetsu limestone into two groups, the lower Sabushi and the upper Yukawa. The Kanikawa Formation [Swi 35], the upper division of the Sabushi Group, and the Maki Formation [Swi 34], the lower division of the Yukawa Group were referable to the zone of *Neoschwagerina*. According to later studies by SADA* (1960, 1961, 1964, 1965) only the Maki Formation can be referred to the zone of *Neoschwagerina*. The Maki Formation consists mostly of limestone conglomerate which is conformably overlain by the Terauchi Formation. The fusulinaceans found in the Maki Formation are *Neoschwagerina craticulifera* (SCHWAGER), *N. minoensis* OZAWA, *N. margaritae* DEPRAT, *N. megasphaerica* DEPRAT, *N. douvillei* OZAWA, *N. toriyamai* SADA, *Yabeina katoi* (OZAWA), *Afghanella* sp., *Sumatrina annae* VOLZ, *S. longissima* DEPRAT, *Verbeekina verbeeki* (GEINITZ), *Pseudodoliolina pseudolepida* (DEPRAT), and *Parafusulina armstrongi* THOMPSON.

SADA believes that the *Neoschwagerina* faunule of the Maki Formation is certainly the uppermost of the zone of *Neoschwagerina*, and the *Neoschwagerina–Yabeina* faunule of the Terauchi Formation, which was first (1960) designated *Yabeina globosa* zone and later (1961) redefined as the *Yabeina shiraiwensis* zone, is older than the *Yabeina–Lepidolina* faunule.

---

* As the uppermost division of the Sabushi Group, the Kanikawa Formation was proposed by IMAMURA, OKIMURA and SADA (in IMAMURA, 1959). It comprises *Pseudofusulina kraffti* (SCHELLWIEN), *Psedodoliolina ozawai* YABE and HANZAWA and *Afghanella*? sp. in the lower part, and *Verbeekina verbeeki* (GEINITZ), *Neoschwagerina craticulifera* (SCHWAGER), *Pseudodoliolina ozawai* YABE and HANZAWA and *Ozawainella* sp. in the upper part. IMAMURA referred the lower part of the Kanikawa Formation to the *Parafusulina kaerimizensis* or the *Neoschwagerina craticulifera* subzone, and the upper part to the *Verbeekina verbeeki* subzone. However, SADA (1961) later revised the definition of the Sabushi Group and included the Kanikawa Formation in his Shoyama Formation [Swi 40].

IMAMURA emphasized the stratigraphical significance of the unconformity between the Kanikawa and Maki Formations and proposed the "pre-Maki unconformity". He also pointed out that further study is needed to ascertain whether the pre-Maki unconformity implies only epeirogenic movement or a more profound geotectonic movement which might have an important bearing on the geologic history of Southwest Japan.

Independently of IMAMURA and his collaborators, NOGAMI studied the central part of the Atetsu plateau and regarded the Permian section of the Atetsu limestone Group as conformably successive sequence. His *Neoschwagerina douvillei – N. margaritae* subzone is certainly correlative with SADA's *N. douvillei* zone, though their faunal contents are not necessarily the same. All the species found in the *N. douvillei – N. margaritae* subzone have been described by NOGAMI (1961) in detail.

3. Oga plateau

In the Nakamura limestone [Swi 45′] which is developed in the northern part of the Oga plateau, CHANG (in KOBAYASHI, 1950) recognized the zone of *Yabeina* which is directly underlaid by the zone of *Parafusulina*. The zone of *Yabeina* comprises *Y.* cfr. *katoi* (OZAWA), *Neoschwagerina* cfr. *douvillei* OZAWA, and *Sumatrina* sp. However, the zone of *Neoschwagerina* is said to be present (IMAMURA, 1959) and, in fact, YOSHIMURA (1961) stated that the *Neoschwagerina douvillei* subzone is developed in the uppermost part of the Nakamura limestone which is conformably overlaid by the *Yabeina shiraiwensis* subzone of the Uji Formation.

In the Koyama limestone [Swi 49] of the southern part of the Oga plateau, the *Pseudofusulina* cfr. *japonica* zone with *Neoschwagerina craticulifera* was recognized (CHANG in KOBAYASHI, 1950) and is overlain by the *Lepidolina multiseptata* zone of the Uji Formation of conglomeratic facies. Through recent study by YOSHIMURA (1961) the *Parafusulina–Neoschwagerina* zone has also been found in the uppermost part of the Koyama limestone, though its faunal contents is not clear. Under the modern knowledge of micropaleontology, detailed biostratigraphical study is needed on the Upper Paleozoic of the Oga plateau.

4. Taishaku plateau

FUJIMOTO (1944) stated that the Middle Permian fusulinacean zones are not exposed as well in the Taishaku plateau as the Upper Permian fusulinacean zones. The following species were listed by him as the constituent species of the zone of *Neoschwagerina*:

Ozawainella delawarensis DUNBAR and SKINNER
Pseudofusulina ambigua (DEPRAT)
P. kraffti (SCHELLWIEN)
P. japonica hayasakai (LEE)
Verbeekina verbeeki (GEINITZ)
Neoschwagerina craticulifera (SCHWAGER)
N. margaritae DEPRAT

In a recent study by YOKOYAMA (1959), the Kiriwake Formation [Swi 54′] of the Higashi-uyama Group is referred to the zone of *Neoschwagerina* in which he found the following species; *Neoschwagerina douvillei* OZAWA, *N. craticulifera* (SCHWAGER), *Sumatrina annae* VOLZ, and *Pseudodoliolina* sp.

It seems certain that the zone of *Neoschwagerina* of the Taishaku plateau is correlated with the Pmγ and/or Pmδ subzone of the Akiyoshi limestone Group.

5. Fuchu area (Eastern part of Hiroshima Prefecture)

Several masses of limestone and weakly metamorphosed Paleozoic rocks of the Upper Permian age display parallel arrangement in the environs of Joé [Swi 66] though they are in tectonic contact (HASE, 1963). Most of these limestones are of the Lower Pennsylvanian age, yielding primitive fusulinaceans and smaller foraminifers, but a limestone conglomerate crops out west of Joé, Sanwa-cho, Jinseki-gun and contains the *Neoschwagerina margaritae* faunule. SADA (1963) described *N. margaritae* and its allies from this limestone in detail.

It is noted that the Joé and the other Pennsylvanian limestones are so closely located that an unconformable relationship between them is presumed (HASE, 1963).

The non-calcareous Paleozoic rocks developed to the south of Taishaku plateau (Jinseki-Yuki area) have been studied recently by HASE (1965) at some length. Because of a similarity in lithofacies he correlated them with the Yoshii Group which has the type locality in Mihara [Swi 51], Yoshii-cho, Shitsuki-gun, Okayama Prefecture (YOSHIMURA, 1961). The Yoshii Group of the Jinseki-Yuki area is divided by HASE into the lower formation (800 m+) of black shale facies and the upper formation (1500–2000 m) of sandstone and shale facies. The lower formation is mostly barren of fossils, and only available paleontological evidence is the occurrence of *Neoschwagerina* sp. (primitive type) and *Pseudofusulina*? sp. in the small limestone lens. HASE referred the lower formation to the Middle Permian and correlated it with the Odake Formation of the Yoshii Group in the type area.

A formation of calcareous facies in this area, which has been left unnamed but is presumed to be the southern extension of the Taishaku limestone, crops out south of Nagano [Swi 67A′], Jinseki-cho. The Akasakan is represented by a limestone conglomerate and yields *Yabeina* sp. (*Y. katoi* type), *Neoschwagerina* cfr. *douvillei* OZAWA and *Parafusulina* sp. in the matrices. It is correlated with the Arito Formation of the Taishaku area.

6. Akiyoshi area

The Akasakan fusulinacean zone in the Akiyoshi limestone [Swi 100] is the zone of *Neoschwagerina* which is divided into three subzones, *N. craticulifera*, *Verbeekina verbeeki* and *N. douvillei* subzones in ascending order. The last named subzone is unconformably overlain by the *Yabeina shiraiwensis* zone. The faunal contents and paleontological characteristics of these subzones were described by TORIYAMA (1954, 58) in detail. HASEGAWA (1958) and MURATA (1961) have different opinions on the zonation of the Akiyoshi limestone.

The non-calcareous formations of the Akasakan are also developed around the Akiyoshi limestone. The Yaegahara Formation [Swi 99] of Oda Group, the Tsunemori Formation [Swi 93] of Tsunemori Group, and the Serita Formation [Swi 88] of Beppu Group were all referred to the Akasakan (TORIYAMA, 1954). MURATA (1961), who restudied the Akiyoshi area, revised the definitions of some of these formations along with different interpretations on the tectonic relation between the non-calcareous formations and the Akiyoshi limestone. KAWANO *et al.* (1963) also differ in their opinions in the interpretations of the geologic structure of the Oda Group.

7. Mino-Kanoashi massif

The Paleozoic rocks developed in the border area of Yamaguchi and Shimane Prefectures consist of alternation of sandstone and slate with intercalation of limestones and cherts. The Kane Formation [Swi 76] contains the Akasakan in its upper part; namely, the Izuto limestone yields *Neoschwagerina margaritae* DEPRAT together with *Schwagerina* sp. and *Schubertella* sp. KAWANO *et al.* (1956) referred the upper part of the Kane Formation to the Pmδ subzone of the Akiyoshi limestone Group. The lower part of this formation ranges from the Sakamotozawan to Nabeyaman and obtains a thickness of about 3000 m.

The Hatagasako Formation [Swi 74] (1000–1500 m) conformably overlies the Kane Formation and consists mainly of coarse sandstone that changes to conglomerate at places. This formation is stratigraphically regarded as the upper part of the zone of *Neoschwagerina* (KAWANO, 1961), although there is no positive paleontological evidence to verify this age.

8. Abugawa area

According to KAWANO (1961), the Ikadaba Formation [Swi 80] developed along the lower valley of Abugawa consists of sandstone and clayslate with intercalations of limestone. The limestone and limestone breccia in the upper part of this formation yield *Neoschwagerina* cfr. *craticulifera* (SCHWAGER), *N.* cfr. *simplex* OZAWA and *N. margaritae* DEPRAT. Therefore the upper part of the Ikadaba Formation is correlated to the Akasakan. It is noted that the Ikadaba Formation is unconformably overlaid by the Kyodoko Formation [Swi 81] which is mostly of the Kuman but also including the uppermost Akasakan in the lower part.

9. Zomeki and Handa limestones

The Handa limestone [Swi 79] also contains a limestone conglomerate above the limestone referred to the Nabeyaman (KAWANO, 1961, 1963). Although *Neoschwagerina* cfr. *craticulifera* was reported from the limestone conglomerate, it is not known whether the specimens of this species do occur in the pebbles of limestone conglomerate or in the matrix. The uppermost of the Handa limestone is probably of the uppermost Akasakan. TAKAHASHI (1963) differs from KAWANO on the structural interpretation of the Handa limestone and the stratigraphical relationship between the Handa limestone and the Kyodoko Formation.

Two zonules of the Akasakan have been recognized in the Zomeki limestone [Swi 77] by KAWANO (1961); the lower *Neoschwagerina megaspherica* and the upper *Sumatrina annae* zonule. As the species of *Neoschwagerina* in the lower zonule are considerably advanced in form for that genus, the upper part of the Zomeki limestone was correlated by KAWANO to the Akasakan, corresponding to that ranging from the *Veerbeekina verbeeki* to the *Neoschwagerina douvillei* subzones of the Akiyoshi limestone Group. It should be remembered that the Zomeki limestone is conformably overlaid by a formation which is considered to be correlative to the Mugitani Formation of the Kuman age.

Between the Handa and Zomeki limestones is developed the Hirawarabi Formation [Swi 78] in which no horizons have been proved paleontologically to be the Akasakan. However, because of its similarity in lithology to that of the Suzumiyama Formation (Nabeyaman to Akasakan) of Miyano area, KAWANO (1961) regarded the Hirawarabi Formation as the Nabeyaman up to the Akasakan.

TAKAHASHI (1963) differs in his opinion concerning the correlation of the Hirawarabi Formation; namely, he correlated the formation to the *Sumatrina annae* zone or to the Kyodoko Formation (the uppermost Akasakan to the lower Kuman) from the structural point of view. He does not share the same opinions concerning the geological structure of the Zomeki limestone, assuming that the Zomeki limestone and the Mugitani Formation [Swi 79′] are not in structural contact as KAWANO considered, but are conformable with each other, forming an isoclinal folding with the westerly dipping axis.

10. Yamaguchi area

The Aratani Formation [Swi 82] was once regarded by KAWANO (1954) as the middle (Aratani conglomerate) and upper divisions of the Miyano Formation but later redefined (1961) as the upper formation of the Tsunemori Group in the Yamaguchi area. The Aratani Formation is divided into three members: the lower alternation of conglomerate and sandstone (40–50 m), the middle conglomerate and conglomeratic sandstone (350–400 m), and the upper alternation of sandstone and clayslate (700 m). KAWANO identified the following species in the limestone conglomerate of the lower member:

Ozawainella aff. *kueichihensis* (CHEN)
Codonofusiella explicata KAWANO
Pseudofusulina arataniensis KAWANO
Parafusulina sp.
Pseudodoliolina ? sp.
Neoschwagerina cfr. *douvillei* OZAWA
N. megaspherica miyanoensis KAWANO

KAWANO considers that the above fusulinaceans were derived from different horizons and also that some pebbles of limestone conglomerate were derived from an older formation. He correlated the lower member of the Aratani Formation to the upper part of the zone of *Neoschwagerina*.

VI. Outer zone of Southwest Japan

A. Kii peninsula

1. Omura isle

YAMAGIWA and ISHII (1957) described *Yabeina packardi shimensis* and *Y. omurensis* in the unnamed Permian formation developed in the Omura isle [Swo 5] off Toba city. This formation consists of sandstone, shale, chert, schalstein, and limestone and was once correlated by IIZUKA (1928) to the Matsuo Formation of Cretaceous age located in the Shima peninsula with the NE-SW trend.

The above mentioned species of *Yabeina,* judging from the illustrations, are rather primitive for the genus. Hence, the Permian of Omura isle may be referable to the upper Akasakan rather than to the Kuman.

2. Shima area

The Upper Paleozoics, together with Jurassic and Lower Cretaceous formations, are complicated in structure by folding and numerous faultings (KIMURA, 1957; YAMAGIWA, 1956, 1957; KUSAKABE and MIYAMURA, 1958).

Among the Upper Paleozoic rocks, the Aomine [Swo 7] and the Iwakura [Swo 6] Formation of YAMAGIWA and the C block of KUSAKABE and MIYAMURA are referable to the Akasakan by paleontological evidences. The former two formations are developed in two zones to the north and south, separated by structurally intervening Mesozoic rocks.

The fusulinacean fossils reported by YAMAGIWA from the Aomine Formation are as follows:

**Neoschwagerina fujimotoi* YAMAGIWA
**N. sakaguchii* YAMAGIWA
N. sp.
**Cancellina matsushitai* YAMAGIWA
C. ? sp.
Pseudodoliolina sp.
Schubertella sp.

Although YAMAGIWA regarded the above fauna as belonging to the middle part of the Middle Permian, but judging from his description and illustrations of his new species (shown by an asterisk in the above list) each bears rather primitive aspect for the respective genus. Thus, if the stratigraphic position of the allied species of these neoschwagerinids is taken into account, it is not improbable that the Aomine Formation may be referable to the upper Nabeyaman.

The eastward extension of the Aomine Formation is the C block of KUSAKABE and MIYAMURA in which *Neoschwagerina* cfr. *craticulifera* (SCHWAGER) occurs. In this block, however, limestones referred to the zone of *Fusulinella* and the Jurassic Torinosu limestone are inserted.

The Iwakura Formation [Swo 6] yields only *Yabeina* cfr. *katoi* (OZAWA) and an indeterminable species of schwagerinids, the former of which was described by YAMAGIWA who referred this formation to the upper Akasakan.

A part of the Kochi Group [Swo 6′] is developed in the northernmost part of this area and is also referred to the Akasakan based on *Neoschwagerina* sp. in the limestone of apparently the lower horizon.

3. Aso-Gokasho area

The only available information for the Akasakan in the Aso-Gokasho area is the occurrence of *Neoschwagerina* limestone in the Ichinosé area [Swo 15]. Because KIMURA (1957) studied this area, putting stress on the tectonic, further details concerning the *Neoschwagerina* fauna of this area is not known.

4. Central part of Kii peninsula

In the main zone of Chichibu terrain of the central part of Kii peninsula the Kawakami Group* is widely developed, the upper division of which is named by SHIIDA (1962) as the Shiroyadake Formation [Swo 22]. It consists mainly of massive chert with association of clayslate, sandstone and lenticular limestones (about 2500 m). In the greyish white massive limestone intercalated in the sandstone of the lower part yields *Neoschwagerina* sp. and *Schubertella* sp. (Locality, east of Seto, Kawakami-mura). Although enough paleontological information has not been available from this faunule, SHIIDA assumed that the lower part of the Shiroyadake Formation can be correlated with the zone of *Yabeina* and a part of zone of *Lepidolina*.

Neoschwagerina sp. and *Yabeina* sp. were found in the Osugi area [Swo 19] of Mié Prefecture by ARAKI *et al.* (1956) in the lower limestone of unnamed Paleozoic formation of about 850 m thickness. It has been shown, however, that these species are not referable to the Akasakan but to the Kuman as will be stated later. (See p. 189)

5. Western part of Kii peninsula

In this part of the peninsula the Upper Paleozoics consisting of sandstone, clayslate, and chert with limestone lenses occur in two narrow belts (several hundreds meters to 1.5 km in width) with nearly E–W or NEE–SWW trend.

The northern belt is well developed in Yuasa [Swo 33] and its environs. As already mentioned in Chapter VII, the Permian of the northern belt is divided by HIRAYAMA and TANAKA (1956) into A, B, C, and D, of which C is the Akasakan. The division C is further divided into C_1 (200–400 m) and C_2 (200–400 m). The C_1 is characterized by a predominance of schalstein whereas the C_2 contains clayslate, chert and sandstone without schalstein. HIRAYAMA and TANAKA reported *Neoschwagerina* cfr. *craticulifera* (SCHWAGER) from Otokoura [Swo 30′], Minoshima-machi and *Yabeina* cfr. *katoi* (OZAWA) from Kirisaki [Swo 32′], Tasukawa-mura.

The southern belt is composed of sandstone, clayslate, and their alternation with a subordinate amount of chert and limestone. A conglomerate bed of about

---

* SHIIDA (1954) proposed the Kashiwagi, Nireo, Seto, and Okuseto Formations in ascending order for the Upper Paleozoic of this area, but, all the formational names have not been used in his later paper (1962).

1 m thick is also found and contains round or subangular pebbles of sandstone, chert and slate. *Neoschwagerina* cfr. *craticulifera* (SCHWAGER) has been found at Awao [Swo 28] of Iwakura-mura and *Pseudofusulina japonica* (GÜMBEL), *Schwagerina* sp., *Neoschwagerina craticulifera* (SCHWAGER) and *Huangia* sp. at Itogawa [Swo 29] of Ishigaki-mura.

Besides the above mentioned, the fossil evidence avalable in this area is as follows (SUGIYAMA, 1932):

Shirasaki limestone [Swo 35] exposed NNW of Yura:

Schubertella phairayensis (COLANI)
Pseudofusulina ambigua (DEPRAT)
Neoschwagerina craticulifera (SCHWAGER)

Ina, north by west of Yura [Swo 36]:

Staffella sp.
Schubertella phairayensis (COLANI)
Pseudofusulina ambigua (DEPRAT)
Neoschwagerina craticulifera (SCHWAGER)
Yabeina? sp.

The above two faunules are probably referable to the Akasakan though no species have been described.

B. Shikoku

1. Eastern part of Tokushima Prefecture

a. Northern zone

(1) Katsuuragawa area

The Cretaceous terrain exists between the northern and the middle zone of the Chichibu terrain. The Kenzan Group, named by YAMASHITA *et al.* (1956), is the representative of the Middle Permian in the northern zone, which consists mainly of sandstone and mudstone, with a large amount of chert and subordinate amount of basic pyroclastics (shalstein) and is almost barren of fossils. The only known available paleontological informations are *Schwagerina bellula* DUNBAR and SKINNER from Yokose* [Swo 38] (fossil list in KOBAYASHI, 1950) and *Pseudofusulina*? sp. from Ten'nodani [Swo 37] (YAMASHITA *et al., op. cit.*).

As pointed out by YAMASHITA *et al.* the Kenzan Group is certainly Lower to Middle Permian in age, though it is difficult to determine the exact stratigraphical lower and upper limits of the group.

(2) Sawadani area

The Sawadani Formation [Swo 49] (HIRAYAMA *et al.*, 1956) is developed with east-west trend in the southern part of Tokushima Prefecture. This formation is a member of the northern zone of the Chichibu terrain, being in a tectonic contact with the Kenzan Formation in the north and thrust upon the Mesozoic and/or Paleozoic formations of the middle or southern zone in the south.

The middle part of the Sawadani Formation is composed of a vast amount of basic volcanics with limestone lenses in which *Neoschwagerina craticulifera*

* TSUKANO (1931) once reported *Depratella* sp., *Fusulina* sp., *Doliolina lepida*, *Neoschwagerina craticulifera*, and *Cancellina* sp. from the same locality.

(SCHWAGER) and *Schwagerna* sp. occur in several localities, Takano [Swo 48], Kisawa-mura; Yaeji [Swo 47], Kamikatsu-machi; Yokose [Swo 38], Katsuura-machi, etc.

The upper part of the Sawadani Formation consists of sandstone and mudstone with a chert bed and yields *Yabeina globosa* (YABE) in the limestone interbedded in the black mudstone. The middle and upper parts of the Sawadani Formation are referable to the Akasakan while there is a possibility that the uppermost part, which consists of an alternation of sandstone and mudstone, ranges up to the Kuman.

b. Central zone

The central zone of the Chichibu terrain in the eastern part of Shikoku is almost exclusively occupied by the Hisone Group which is cut by thrusts and faults and is arranged in several minor belts of nearly east-west direction, to each of which a different name (facies name) is given (YAMASHITA *et al.*, 1958). They are as follows from north to south:

(1) Kaneishi facies (northern facies of the Kusune Group [Swo 39] of SUYARI, 1954): dark purple to green tuff, bedded chert, black shale, sandy shale, and limestone. The following fusulinaceans* are known from two localities:

Pseudofusulina cfr. *ambigua* (DEPRAT)
Pseudoschwagerina? sp.
Pseudodoliolina sp.
Neoschwagerina cfr. *douvillei* OZAWA
N. sp.
Yabeina katoi (OZAWA)
Y. sp.

(2) Kusune facies (southern facies of the Kusune Group [Swo 39] of SUYARI, 1954): alternation of shale and sandstone, green tuffaceous shale, with limestone. The fusulinaceans were found in the limestone exposed at 500 m east of Fukase-tunnel:

Pseudofusulina verneuili solida (SCHELLWIEN)
Psf. cfr. *ambigua* (DEPRAT)
Schwagerina sp.
Neoschwagerina simplex OZAWA

(3) Fukase facies (Fukase Group [Swo 40] of SUYARI, 1954): alternation of sandstone and shale, and chert with conglomeratic limestone. The fossils were found from localities about 700 m west of a shrine located to the south of Fukase:

Neoschwagerina cfr. *craticulifera* (SCHWAGER)
Schwagerina sp.
Pseudofusulina sp.
Fusulinella sp. (found in pebbles of the limestone conglomerate)

(4) Miyauchi facies: alternation of sandstone and shale and conglomeratic sandstone with limestone. No fusulinaceans occur.

(5) Kamodani facies (Kamodani Group [Swo 41] of SUYARI, 1954): alternation of sandstone and shale and coarse sandstone, with dark purple tuff, chert, and limestone. The following fusulinacean fossils were found at Higashi-Kamo, Tomioka-machi.

* The listed species are considerably different from those listed by SUYARI from the same locality.

Fusulinella cfr. *pseudobocki* (LEE et CHEN)
F. sp.
Fusulina sp.

The above three species are found only in pebbles of conglomeratic limestone, whereas *Neoschwagerina* sp. and *Schwagerina* sp. are known from other localities.

The paleontological data obtained from the above five facies indicate that most of the central zone of the eastern part of Shikoku is probably referable to the Akasakan, though some of them also contain a part of the Nabeyaman.

The Hisone Group is divided into two formations according to recent study of SUYARI (1961). They are the lower Kusune Formation [Swo 39] which ranges from the Sakamotozawan to the Nabeyaman in age and the upper Hisone Formation [Swo 52] which is of the Akasakan. The stratigraphical relationship between these two formations and five facies mentioned above is not clearly understood.

The fusulinacean species listed by SUYARI from the Hisone Formation are as follows:

Neoschwagerina craticulifera (SCHWAGER)
N. cfr. *douvillei* OZAWA
N. sp.
Yabeina omurensis YAMAGIWA and ISHII
Pseudodoliolina pseudolepida (DEPRAT)

c. Southern zone

The Daigo and the Wakasugi Formation are the Paleozoic members in the southern zone of Chichibu terrain, the former of which is Pennsylvanian in age as already stated. The Wakasugi Group [Swo 43] shows the largest distribution among the Paleozoic in this area, and occurs in two belts, north and south, in middle of them the Daigo Group is inserted with fault relation. The lower formation of the Wakasugi Group consists mainly of conglomeratic to coarse sandstone, with alternation of sandstone and shale, and thin tuff layers and limestone in the upper part. Fusulinacean fossils were collected from one locality west of Otai and two localities in Wakasugi (YAMASHITA *et al.*, 1958).

From west of Otai [Swo 44]; *Neoschwagerina simplex* OZAWA
From Wakasugi [Swo 43];

Pseudofusulina sp.
Pseudodoliolina sp.
Verbeekina sp.
Neoschwagerina craticulifera (SCHWAGER)
Yabeina globosa (YABE)
Y. sp.

Thus the lower formation of the Wakasugi Group is referred by YAMASHITA *et al.* to the Middle Permian and ranges from the *Neoschwagerina simplex* zone (or *Parafusulina kaerimizensis* zone) to the *Yabeina globosa* zone. The middle and upper formations of the Wakasugi Group (about 1000 m) contain no fossils, although from the lithological standpoint they are probably referable to the

Upper Permian. It is regretable that no species have been described from the Katsuuragawa basin.

2. Central part of Tokushima Prefecture

The Hisone area [Swo 52] is located about 20 km southwest of the Katsuuragawa area, along the valley of Nakagawa. KOBAYASHI and IWAYA (1941) reported the complicated structure in the Paleozoic and Mesozoic rocks in this area, but YAMASHITA (1950) insisted that this is not an imbricated structure but the Paleozoic and Mesozoic rocks are forming sandwich structure such as seen in other parts of the Chichibu terrain in the Outer zone of Southwest Japan. Although it is an interesting problem, discussion on the structural analysis is beyond the scope of this paper. In the Hisone area, like the Katsuuragawa area stated above, the Paleozoic and Mesozoic rocks expose in three zones, northern, central, and southern, bordered by remarkable tectonic line or zone.

a. Northern zone

The representatives of Permian in the northern zone are the Kenzan Group of the north and the Sawadani Group of the south. Both are partly metamorphosed and very poor in fossil contents. HIRAYAMA *et al.* (1956) reported indeterminable species of *Pseudofusulina* and *Parafusulina* from the Kenzan Group [Swo 56], referring it to Lower to Middle Permian. The Sawadani Group [Swo 49] is comprised mainly of sandstone and shale with a considerable amount of basic volcanic tuff and yields *Parafusulina*? sp. in the lower part, *Neoschwagerina craticulifera* (SCHWAGER) and *Schwagerina* sp. in the middle, and *Yabeina globosa* (YABE) in the upper. Thus the joint authors referred the Sawadani Group to the Middle Permian with a possibility of being the Upper Permian toward the uppermost part.

b. Central zone

The Hisone Group [Swo 52] of the central zone is most prolific in fusulinacean fossils, and consists mainly of an alternation of shale and sandstone with intercalations of chert, basic tuffite and conglomeratic limestone (about 300 m in thickness). HIRAYAMA *et al.* (1956) listed many fusulinacean species from eleven localities ranging from Pennsylvanian to Middle Permian in age, most of which however have been left undescribed. Because species of *Neoschwagerina* are found in the matrices of conglomerate and those of *Eoschubertella, Fusulinella, Schwagerina,* and *Pseudofusulina* are in the pebbles of conglomerate, the age of limestone conglomerate is roughly referable to the Akasakan. HIRAYAMA *et al.* believes that all the limestone conglomerates are Middle Permian in age even though some of them do not comprise any Permian species but Pennsylvanian species only in the pebbles. They deem that this does not mean a difference in age, but it is due to a difference in the condition of deposition and also to the incompleteness in sampling.

The Pennsylvanian species found in the "Middle Permian" limestone conglomerates may be interpreted to show that the limestone conglomerates are Pennsylvanian in age and is sandwiched between the Permian strata.

c. Southern zone

The Wakasugi Group extends westward from the Sawadani area into the southern zone of the Hisone area. The paleontological evidence for the stratigraphic dating is available only in the lower formation of the Wakasugi Group as already stated on page 163. Like the Sawadani Group in the northern zone, the Wakasugi Group has a good possibility of having the Upper Permian in the upper formation.

3. Central and western parts of Shikoku

a. Northern zone

The Permian rocks occupy the widest area in the northern zone as well as in the Katsuuragawa basin and Hisone area. The Kamiyakawa Formation* [Swo 69] (ISHII *et al.*, 1957) of northern side and the Tosayama Formation [Swo 68] of the Shirakidani Group are referable to the Akasakan. The former is almost barren of fossils, and *Neoschwagerina* sp., discovered by HASHIMOTO, is the only available information for an age determination. The Tosayama Formation, on the contrary, abounds with fusulinaceans. TORIYAMA (1947) described fifteen species including species of *Misellina* and primitive members of *Neoschwagerina* in the lower part of the Tosayama limestone and five species including advanced species of *Neoschwagerina* in the upper part. Thus the upper part of the Tosayama Formation is referred with certainity to the upper Akasakan.

Besides the above, a number of species of *Neoschwagerina,* mostly of *N. craticulifera* (SCHWAGER), *N. douvillei* OZAWA and *N. margaritae* DEPRAT, have been reported from several localities (KOBAYASHI, FUJITA and KIMURA, 1945; KOBAYASHI, 1950; HIRATA, 1958).

In the northern zone and in the northern half of the central zone of the Chichibu terrain are developed "the schistosed Paleozoic formations" most of which are presumed to be the metamorphosed facies of the Lower and Middle Permian rocks. According to a recent study of ISHIZAKI (1962), the metamorphosed rocks developed in the environs of Ochimen [Swo 92] are divided into the Shimoyakawa [Swo 73] and Rokucho [Swo 96] Formations based on the grade of mylonitization and development of "gefüge". The former is, according to SUYARI (1960), an unit of relatively striking "schistose rocks", while the latter is of weak schistosity. Although no paleontological evidences have been available for the age determination, ISHIZAKI is of an opinion that the Shimoyakawa Formation is seemingly correlative with the Rokucho Formation. In the equivalent formations of the Kurosegawa area [Swo 102] NAKAGAWA *et al.* (1959) once reported the following fusulinaceans:

Schwagerina sp.
Verbeekina sp.

---

* There is a considerable degree of confusion concerning the nomenclature of Group or Formation. Since Group or Formation names have been often changed by the authors, it is rather difficult even to the Japanese geologists to understand the exact definition of a Group or a Formation. The law of priority should be adopted to the nomenclature of the individual Group or Formation.

Neoschwagerina cfr. *margaritae* DEPRAT
Yabeina cfr. *katoi* (OZAWA)
Y. aff. *shimensis* YAMAGIWA and ISHII

b. Central zone

(1) Sakawa area

In the central zone of the Chichibu terrain special attention is given to the Sakawa basin [Swo 82] and its environs which are one of the most important localities in the study of geotectonics of Southwest Japan. The Sakawa basin, most of which belongs to the central zone, is composed of the Upper Paleozoic ranging from Pennsylvanian to Upper Permian, along with the Mesozoic rocks including the Triassic Zohoin and Kochigatani Groups, the Jurassic Torinosu Group, and the Cretaceous Ryoseki Group. Although KOBAYASHI and many geologists have tried to describe the extremely complicated geological structure of the basin, there still remains many problems to be solved. KOBAYASHI inferred a number of *Klippen* to explain the complex structure, but KATTO *et al.* (1956) and ISHII *et al.* (1958) believe that they are not *Klippen* but are regarded as complicated sandwich structure as seen in other parts of the Chichibu terrain.

The representative of the Akasakan in the central zone is the Takaoka Formation [Swo 79] (SUYARI, 1961) which is exposed in several tectonic belts and is bordered by faults in the north and south. Although this formation is considerably disturbed and complicated in structure, it has a fairly prolific fossil content and yields the following species of fusulinaceans:

Neoschwagerina craticulifera (SCHWAGER)
N. *simplex* OZAWA
N. *margaritae* DEPRAT
Cancellina tosayamensis TORIYAMA

Of these species, the first one is reported in eight of the nineteen localities (SUZUKI, 1933; KOBAYASHI, 1950; HIRATA, 1958). ISHIZAKI (1962) also studied the Takaoka Formation and found *Misellina claudiae* (DEPRAT), *Neoschwagerina margaritae* DEPRAT and *N.* sp. all of which he described in detail.

Besides the above, the Akiyoshian (Middle Pennsylvanian) species of *Fusulinella* and *Eoschubertella* are known in the pebbles of the limestone conglomerate (SUYARI, 1961), some of which were found in Inomine [Swo 78] and already described by TORIYAMA (1945). Although SUYARI regarded the Takaoka Formation as the Akasakan, it is possible that a part of this formation may not be younger than Permian. The Takaoka Formation is correlated with the Hisone Group of the Katsuuragawa and Hisone areas and also with the Nomura Group of Ehime Prefecture.

Akasakan fusulinaceans are known to occur in several localities (fossil locality and list in KOBAYASHI, 1950) which are perhaps referable to the central zone of the Chichibu terrain, though none of them have been described.

(2) Yokokurayama area

The central zone extends westward and is exposed extensively in the Yokokurayama area, northwest of Ochi. The Permian rocks in this area are in fault

contact with the Mori Formation, the lower division of the Silurian Yokokurayama Group in the north and with the Ryoseki and Monobegawa Groups of Cretaceous in the south. The Permian of this area was divided by NODA (1955) into two formations: the upper Matsuo Formation [Swo 89] of thick chert and the lower Kuki Formation [Swo 88] of greyish-white sandstone, black slate and chert. NODA reported *Parafusulina* cfr. *richthofeni* (SCHWAGER) from the Kuki Formation and *Neoschwagerina margaritae* DEPRAT and *Yabeina katoi* (OZAWA) from the Matsuo Formation, referring the former to the P1β to Pmγ and the latter to the Pmδ subzone of the Akiyoshi limestone Group.

(3) Kurosegawa area

The Kurosegawa area [Swo 102] is a westward extension of the central zone of the Chichibu terrain and was studied by IKEBE (1936) who divided the Upper Paleozoic into the Kaibuki, Nomura and Itagatani Formations.

The Nomura Formation* [Swo 108] consists of sandstone and shale with intercalation of limestone and crops out in two zones. IKEBE reported the following species of this formation:

Nizashi, Nomura-machi [Swo 109];
Pseudofusulina granum-avenae (ROEMER)
Psf. cfr. *ambigua* (DEPRAT)
Wentzelella cfr. *timorica* (GERTH)

Shirodani [Swo 110];
Neoschwagerina simplex OZAWA

Takenouchi, Nomura-machi [Swo 108′];
Neoschwagerina craticulifera (SCHWAGER)
Verbeekina verbeeki (GEINITZ)
Mizzia velebitana (SCHUBERT)

Uonashi, Kurosegawa-mura [Swo 107];
Neoschwagerina craticulifera (SCHWAGER)

The above species show that the Nomura Formation is of the Akasakan age, though its lower part may range down to the Nabeyaman. In a recent study, SUYARI correlated the Nomura Formation with the Takaoka Formation mentioned above.

The geology of the eastern part of the Kurosegawa area is very important in any analysis of geotectonics of Southwest Japan. It was studied in detail by ICHIKAWA *et al.* (1956) from the tectonical standpoint. Although they proposed many group or formation names for the Pennsylvanian and Permian rocks, no paleontological information is available except from the Itadorigawa Group.

c. Southern zone

In the southern zone, the lower and middle parts of the Kokuzosan Group [Swo 85] (about 2000 m) (SUYARI, 1961; ISHIZAKI**, 1962) were referred to the Akasakan, which show extensive distribution in the southern part of this zone.

* The Nomura Formation was originally named by IKEBE (1936), but was revised by NAKAGAWA *et al.* (1959) who limited the formation to the Middle Permian rocks.

** ISHIZAKI redefined the Kokuzosan Group and divided it into the lower Ozodani [Swo 93′] and the upper Uwanaro [Swo 94] Formation. The former and the lower part of the latter are referred to the Akasakan.

It forms a synclinorium with the axis of east-west trend and the facies are not the same in both of the wings. The equivalent formation in the Otochi area (eastern part of Kochi Prefecture) yields the following species in the limestone which is intercalated in the middle part of the formation: *Schwagerina* sp., *Parafusulina* sp., *Neoschwagerina douvillei* OZAWA, *N. margaritae* DEPRAT, *Yabeina katoi* (OZAWA), and *Y.* sp. from Donooka and Nurui [Swo 57], Monobe-mura, Kami-gun (FUJITA, 1943). Besides the above, some Pennsylvanian species were reported from the same formation (SUZUKI, 1931; KOBAYASHI, 1950), although they are regarded as derived fossils in the limestone conglomerate.

The Takagawa Group [Swo 105], with the type locality in the Takagawa area, Kurosegawa-mura, Ehime Prefecture (NAKAGAWA *et al.*, 1959), is presumed to be correlative with the Kokuzosan Group of Kochi Prefecture and also with the Wakasugi Group of Tokushima Prefecture. It consists mainly of coarse sandstone with chert and alternation of sandstone and mudstone. The Takagawa Group is almost barren of fossils except for the occurrence of *Pseudofusulina japonica* (GÜMBEL) at Miyanoura (SUZUKI, 1935) which is the only available paleontological evidence. However, the remarkable similarity in lithology leads to the correlation mentioned above.

C. Kyushu

The characteristics of the Chichibu terrain of the Outer zone of Southwest Japan are well observable in South Kyushu which covers the southern part of Oita, the northern part of Miyazaki, and the central part of Kumamoto Prefectures.

1. Usuki area

Bordered by the Usuki-Yatsushiro line of north and the Itogawa-Butsuzo line of south, the Usuki area is divided into five tectonic belts, of which the Tsukumi and Meiji belts are referred to the Akasakan. FUJII (1950) distinguished the following faunules in the Tsukumi limestone [Swo 114] of the Tsukumi belt.

(1) *Yabeina globosa* faunule: *Y. globosa* (YABE), *Y. katoi* (OZAWA)
(2) *Neoschwagerina margaritae* faunule: *N. margaritae* DEPRAT (abundant), *N. minoensis* OZAWA, *N. craticulifera* (SCHWAGER), *Pseudodoliolina* sp. *Verbeekina* sp., and *Schwagerina* sp.
(3) *Neoschwagerina craticulifera* faunule: *N. craticulifera rotunda* DEPRAT, *Verbeekina* sp., *Schwagerina* sp.
(4) *Neoschwagerina iisakai* or *N. kobayashii* faunule: *N. kobayashii* TOIRYAMA, *N. iisakai* TORIYAMA, *Cancellina neoschwagerinoides* TORIYAMA
(5) *Pseudofusulina* faunule: *Pseudofusulina vulgaris fusuformis* (SCHELLWIEN), *Psf.* sp., *Triticites* aff. *kagaharensis* FUJIMOTO, *Rugosofusulina* sp., *Pseudoschwagerina* sp., *Schubertella* sp.

Of the above five faunules, (1), (2) and (3) are of the Akasakan. It is noted that a part of (2) is conglomerate and that the horizon containing faunule of (4) covers that of (5). The former, (4), is correlated with the lower part of the Tosayama Formation of South Shikoku.

The Meiji belt [Swo 115] comprises a remarkably abundant chert in the lower and coarse sandstone in the upper part, being almost barren of any fossils. The

only available information is *Parafusulina* sp. from Hodojima [Swo 113] and *Yabeina* sp. in the limestone lenses in the upper part of this zone. FUJII referred the Meiji belt to the *Parafusulina* to *Yabeina* zone. Since no species have been described, paleontological features of fusulinaceans of the Meiji belt are not understood. Although FUJII correlated this belt with the *Parafusulina* to *Yabeina* zone, it is not known whether it is equivalent to the whole or a part of the Akasakan or whether it contains even a part of the Nabeyaman.

2. Northern part of Miyazaki Prefecture

Paleozoic rocks, mostly of Permian, are developed in several tectonic belts of NEE–SWW trend, being sandwiched by Silurian (Gion'yama Formation) and Mesozoic rocks. General characteristics and geological structure of these rocks are closely related to those in the Kuma massif to the southwest where the Paleozoic and Mesozoic stratigraphy is understood better.

The representative of the Akasakan in this area is the Yurugidake Formation [Swo 124] which is most extensive in distribution. According to SAITO and KAMBE (1954) and KAMBE (1957) it is composed mainly of sandstone, slate, chert, limestone, and schalstein, with rare intercalations of conglomerate. In the northern half of this formation is found limestone lens of between 2 to 10 m thickness in which species of fusulinaceans and corals occur. SAITO and KAMBE listed six fossil localities and later KAMBE added twelve more, of which three (KAMBE's locality 1, 2, and 3) are referable to the upper Sakamotozawan, eight (KAMBE's locality 4 to 11) to the Nabeyaman, and four (KAMBE's locality 15 to 18) to the Akasakan. Among the Akasakan species *Neoschwagerina craticulifera* (SCHWAGER) and *N. margaritae* DEPRAT are common. It should be noted that the Akasakan species occur in the limestone lenses interbedded in an apparently lower horizon of the Yurugidake Formation.

As pointed out by KAMBE, the extreme abundance of limestone and schalstein in the southern peripheral part of the Yurugidake Formation suggests that a part of this formation may be correlated to the Sambosan Group of Shikoku.

The Kagamiyama Formation [Swo 122], developed in the northwestern part of this area, is composed of clayslate, sandstone, conglomerate, schalstein, and chert, and is frequently intruded by diabase and serpentine. Although this formation is barren of any fossils, KAMBE questionably referred it to the Middle Permian because a formation of its probable northeastern extension in Toroku [Swo 119] yields Middle Permian fusulinaceans (IISAKA, 1933; SAITO and KAMBE, 1954).

3. Kuma massif

The western extremity of the Outer zone of Southwest Japan is in the Kuma massif which is a typical area for the Paleozoic stratigraphy. As well as in other areas of the Outer zone, the Paleozoic rocks of Kuma massif are developed in several tectonic belts which are bordered by faults. The tectonic relation between Paleozoic and Mesozoic groups has been studied by MATSUMOTO and KANMERA (1952, 1964).

The Paleozoic rocks developed in each tectonic belt represent a definite rock

facies of an eugeosynclinal type, consisting of slate, sandstone of a feldspathic greywacke type, and chert along with subordinate limestone, and pyroclastic rock, lava flow and conglomerate in certain parts. The following group and formations are referred to the Akasakan by the fossil evidences (MATSUMOTO and KANMERA, *op. cit.*).

(1) Ryuhozan Group [Swo 140]: It is composed of an alternation of black phyllite and crystalline limestone. *Verbeekina* sp. found in an argillaceous limestone exposed at south of Inokawa, Miyaji of Yatsushiro city is the only paleontological evidence for an age determination of this group.

(2) Hashirimizu Formation [Swo 141]: It occupies the Hashirimizu tectonic belt, the northern half (probably the lower part) of which consists of phyllite or phyllitic slate with frequent intervention of chert, and the southern one of alternation of quartzite and phyllite (or siliceous phyllite) and phyllite. In an impure limestone in the central part which occurs to the southeast of Také the following fusulinaceans occur:

Neoschwagerina margaritae DEPRAT
N. craticulifera (SCHWAGER)
Verbeekina verbeeki (GEINITZ)
Schwagerina sp.

The Hashirimizu Formation is referred to the *Neoschwagerina margaritae* zone.

(3) Yonagu Formation [Swo 143]: This shows a considerably wide distribution between the Haki and Setoishi tectonic lines. According to MATSUMOTO and KANMERA (1952, 1964) the lower Member (about 500 m) of the formation consists of phyllitic slate and a very fine grained calcareous sandstone, the middle Member (400–500 m) consists of chert and slate, and the upper Member (about 200 m) consists of slate, fine-grained feldspathic sandstone, chert and green pyroclastic rocks. The small lenticular limestone lens interbedded in the upper part of the lower Member yields *Neoschwagerina simplex* OZAWA and *Brevaxina compressa* (DEPRAT), and that in the upper part of the middle Member contains *Yabeina globosa* (YABE), *Y. katoi* (OZAWA), *Neoschwagerina minoensis* DEPRAT, and *Verbeekina verbeeki* (GEINITZ). Thus the Yonagu Formation ranges from the *Neoschwagerina simplex* zone of the Nabeyaman up to the *Yabeina globosa* zone of the Kuman.

(4) Yoshio Formation [Swo 149]: It is characterized by the predominance of thick-bedded, medium-grained sandstone with intercalation of slate and chert. A lenticular limestone lens in the upper part yields *Neoschwagerina* cf. *craticulifera haydeni* DOUTKEVITCH and KHABAKOV and *Schwagerina* sp. The Yoshio Formation is thus referred to the *Neoschwagerina craticulifera* zone.

Chapter X. The Zone of *Yabeina-Lepidolina*

I. Kitakami and Abukuma massifs

Since the Upper Permian of the Kitakami massif is not necessarily defined

paleontologically with great accuracy, many problems have been still left unsolved. The Permian stratigraphy in the standard area of Setamai [Ka 27] was generalized by MINATO *et al.* (1954). They divided the Permian of this massif into two Subsystems: the lower Yukisawa and the upper Toyoma, the former of which was further divided into the lower Sakamotozawa and the upper Kanokura Series. The Sakamotozawa Series is correlated with the *Pseudoschwagerina* zone plus *Parafusulina* zone, while the Kanokura Series may possibly be divided into the K_0–K_1 zone characterized by the *Lyttonia* fauna and the L_0–L_1 zone represented by the *Lepidolina* fauna although paleontological evidence is not sufficient to give a final decision. However, they pointed out that the four following cases are possible in the correlation between the fusulinacean zones and their fossil beds K_0 to L_1:

a) (K_0–K_1) zone=zone of *Neoschwagerina*
   (L_0–L_1) zone=zone of *Yabeina*
b) (K_0–K_1) zone+(L_0–L_1) zone=zone of *Yabeina*
c) (K_0–K_1) zone=zone of *Yabeina*
   (L_0–L_1) zone=zone of *Lepidolina*
d) L_0=zone of *Yabeina*
   L_1=zone of *Lepidolina*

To avoid future confusion they temporarily defined the lower half of the Kanokura Series, represented by the K_0–K_1 zones, as the Katchizawa Stage and the upper half represented by the L_0–L_1 zone as the Iwaizaki Stage.

Such being the case and since the fusulinacean fossils found in this area are poorly preserved and not suitable for detailed observation, the Setamai area is not preferable to the standard area of the Middle–Upper Permian at least from the biostratigraphical point of view.

Within the present knowledge concerning the zone of *Lepidolina* in the Setamai area, the genus *Lepidolina* ranges from the horizon L_0, the base of the XII Group, to the horizon L_1 which is represented by the conglomerate in the lower part of the XIII Group. Based on the specimens collected by MINATO, TORIYAMA (1952, 1954) described *Lepidolina gigantea* and *L.*? spp. A, B, C, and D, together with schwagerinid species and small fusulinaceans from the L_0 horizon. Although MINATO's materials are deformed and very poor in preservation, KANMERA (1953) pointed out that *L.*? sp. C is closely related to *L. toriyamai* KANMERA and *L.*? sp. D to *L. kumaensis* KANMERA. Therefore KANMERA strongly suggested that the *Lepidolina* fauna of the Kitakami massif and that of the Kuma massif are closely related with each other and that both faunas are almost the same in age. Moreover, the XIII Group resembles the Kuma Formation in lithology and there is no great difference in their thickness. Since the lowest stratigraphical limit of the *Lepidolina* fauna is the L_0 horizon, it is most probable that the XII and XIII Groups are referable to the Kuman.

ONUKI (1956) who summarized the whole Paleozoic stratigraphy in the Kitakami massif, divided the Kanokura Formation of the type locality (Hikoroichi-Setamai area) [Ka 23–27] into the lower Katchizawa sandstone Member and the upper Iwahara limestone Member, referring the former to the zone of

Neoschwagerina and the latter to the zone of *Yabeina** including the *Lepidolina* fauna. However, it must be noted that the Iwahara limestone Member is contemporaneous but heteropic with the underlying member, and that the *Neoschwagerina* limestone is continuous in deposition to the *Yabeina* limestone, forming the same limestone mass. The same is the case in the Iwaizaki limestone which will be discussed below and the limestone exposed at Iwahata, Yukizawa [Ka 31] being the examples. ONUKI (1956) regards the *Neoschwagerina-Yabeina* limestone as abnormal deposition with bioherm condition.

The Toyoma Group [Ka 48], in which the Usuginu conglomerate is interbedded, is one of the most characteristic features in the Permian stratigraphy of the Kitakami massif. As already discussed by MINATO (1950, 1954) and many other workers, the Usuginu conglomerate is not limited in occurrence to the definite horizon, but ranges from the upper Nabeyaman up to the Kuman. A part of the Usuginu conglomerate [Ka 37] is contemporaneous but heteropic with the Kanokura Formation (Akasakan) and it is not improbable that the lowest part is still lower in stratigraphical position. Several species of neoschwagerinids including *Yabeina hayasakai* OZAWA, *Neoschwagerina douvillei* OZAWA and *Verbeekina verbeeki* (GEINITZ) and species of corals including *Waagenophyllum indicum* (WAAGEN and WENTZEL) have been found in the matrices of conglomerate and conglomeratic limestone.

A. Southern part of Kitakami massif

1. Iwaizaki area

Iwaizaki limestone [Ka 42], located about 8 km south of Kesennuma city, has been studied by MABUCHI (1935), INAI (1939), HANZAWA (1954), and MORIKAWA *et al.* (1958) (Refer also p. 141). HANZAWA's second zone, *Yabeina* zone (=MABUCHI's *Y. hayasakai* zone) comprises *Yabeina* sp., *Verbeekina sphaera* OZAWA, *Parafusulina* spp., and coral species including *Wentzelella iwaisakiensis* YABE and MINATO, *W. kitakamiensis* YABE and MINATO, *Waagenophyllum indicum* (WAAGEN and WENTZEL). The last named species is known from the lower and middle parts of the Kuma Formation, and *W. kitakamiensis*** is known from the lower part of the XII Group (about 100 m above the L_0 horizon) of the type locality. According to MORIKAWA *et al.* (Iwaizaki Research Group, 1958)*** and MORIKAWA (1960), their e–g horizons are characterized by *Yabeina shiraiwensis* OZAWA, *Verbeekina* sp., and several species of *Pseudofusulina* without any species of *Neoschwagerina*. Thus it is almost safe to correlate the upper part of the Iwaizaki limestone with the Kuma Formation. ISHIZAKI (1964) described 22

* ONUKI divided the Permian into four fusulinacean zones in ascending order: zones of *Pseudoschwagerina*, *Parafusulina*, *Neoschwagerina*, and *Yabeina*. Hence his zone of *Yabeina* denotes that used in the broad sense.

** According to MINATO the lower limit of this species ranges down to the zone of *Pseudoschwagerina*.

*** The results of the joint authors and those of MORIKAWA do not coincide with each other in specific association and the range of each species, although they dealt with exactly the same limestone and fauna.

species of ostracods from the g horizon six of which were previously known in the stratigraphically lower horizons of North America and South China.

ONUKI (1956) pointed out that there is a possibility that the HANZAWA's uppermost zone, *Richthofenia* zone, may be representative of different facies of the lower part of the *Yabeina* zone and the *Neoschwagerina–Waagenophyllum* zone.

Besides those mentioned above, species of *Yabeina, Neoschwagerina* and *Parafusulina* have been reported from several localities in the Toyoma Formation. For example, *Yabeina hayasakai* OZAWA, *Neoschwagerina douvillei* OZAWA, *Verbeekina verbeeki* (GEINITZ), and other fusulinaceans are known to occur in the Toyoma Group extensively developed in the southwestern and southern parts of Nagasaka area [Ka 34]. However, the fusulinaceans mostly have not been described and their faunal characteristics are not exactly known.

2. Maiya area

The Yamazaki conglomerate Formation [Ka 45], named by MABUCHI, correlates with the Usuginu conglomerate in the standard area. As clarified by ONUKI *et al.* (1960) and CHISAKA (1962), the conglomerate of this formation displays a rather remarkable change in development vertically and laterally, interfingering with or merging into slate of the Toyoma Group. In the conglomeratic or bedded limestone found in several horizons of this formation the following fusulinaceans have been reported with corals by ONUKI *et al.* (1960): *Codonofusiella cuniculata* KANMERA, *C. paradoxica* DUNBAR and SKINNER, *Parafusulina wanneri* (SCHUBERT), *Pseudodoliolina ozawai* YABE and HANZAWA, *P. pseudolepida* (DEPRAT), *Yabeina katoi* (OZAWA), *Y. hayasakai* OZAWA, and *Y. shiraiwensis* OZAWA.

CHISAKA (1962) also described eight species from the same formation, but strangely only two species are in common with those listed by ONUKI *et al.* Since most of CHISAKA's specimens are badly preserved and not well illustrated, one cannot be free from doubt as to the specific identification. Nevertheless, it is almost certain that the Yamazaki conglomerate Formation is correlated at least to the lower part of the Kuman.

B. Northern part of Kitakami massif

In the northern part of the Kitakami massif, HANZAWA (1954) reported *Yabeina* sp. and *Parafusulina* sp. from east of Ohazama-machi [Ka 6]. MORIAI (1957) also reported species of *Neoschwagerina* and *Yabeina* from the Daido Formation [Ka 17] and the underlying Kasshi Formation [Ka 15′] which are partly contemporaneous but heteropic with each other. No species of *Lepidolina* have been found in this area, however. It is not known for certain whether the Daido and Kasshi Formations are referable to the Kuman.

C. Choshi peninsula

It is well known that the Permian and Cretaceous rocks are developed in the Choshi peninsula [Ka 59], forming the basement of the overlying Cenozoic for-

mation. YAMANE (1924) first reported *Neofusulinella giraudi* DEPRAT from a limestone exposed near the southern tip of the peninsula. Later HANZAWA (1950) described *Sphaerulina crassispira* (LEE) from a green chert near Kurohae, east coast of the peninsula. This was the first discovery of the genus *Sphaerulina* in this country.

Near the middle of the peninsula, about 2 km south of Choshi city, a limestone conglomerate called the Takagami conglomerate [Ka 60] is developed in which pebbles of sandstone, shale, chert, limestone and less commonly of granitic and metamorphic rocks are found. Having studied the fusulinaceans found in the limestone pebbles, CHISAKA (1960) described fourteen species* including one each of the species *Reichelina, Rauserella, Paraboultonia, Chusenella, Pseudodoliolina,* and *Neoschwagerina,* three species of *Pseudofusulina,* and five species of *Yabeina.* Because all of the species have been found in the pebbles of conglomerate the stratigraphical age of the conglomerate is not exactly known. In fact, it was first referred to the basal conglomerate of the Cretaceous rocks, and KANO (1958), from the petrographical point of view, pointed out that the granitic and metamorphic pebbles of the Takagami conglomerate bear a close similarity to those of the Usuginu conglomerate (Akasakan and Kuman) and the Ojima conglomerate (early Triassic) in the southern part of the Kitakami massif. While OZAKI (1959) has regarded the Takagami conglomerate as contemporaneous conglomerate formed during the deposition. SAKAGAMI (1965), who described three species of bryozoans, considered that all the limestone pebbles of conglomerate are of exotic origin, and he correlated the Takagami conglomerate with the Toyoma Group. In short, we know only that the Takagami conglomerate is not older than the early Kuman age.

II. Inner zone of Northeast Japan

The Middle and Upper Permian occurs sporadically in the Inner zone of Northeast Japan, most of which, as mentioned in the preceding chapter, are the Akasakan, and the Kuman formations have been known only in the Komagatake area.

Komagatake area is the boundary area between Gumma, Fukushima and Niigata Prefectures and has two main distributions of the Upper Paleozoic, one of which occurs in Keizuruyama and its environs, northwest of Ozegahara in Gumma Prefecture. The Keizuruyama area [Nei 8] was surveyed by KOBAYASHI (in FUJIMOTO and KOBAYASHI, 1962) who found the following fossils in the limestones intercalated in shale or in the alternation of shale and sandstone (Zensakuzawa valley) [Nei 9]:

Yabeina multiseptata DEPRAT
Lepidolina keizuruensis n. sp. (MS)
L. sp. n. sp. (MS)
Schwagerina incisa (SCHELLWIEN)
Texutularia sp.
Cribrogenerina sp.

* Prior to CHISAKA, OZAKI (1959) reported twenty-two species from the same conglomerate. However, there is no common species between those determined by OZAKI and those described by CHISAKA, excepting three species of *Yabeina.*

Thus the Permian of Keizuruyama area is certainly referable to the Kuman age, though future study of the stratigraphy of the area is necessary.

III. Kwanto massif

The uppermost fusulinacean zone in the Kwanto massif is the V zone of *Yabeina globosa* set up by FUJIMOTO (1936) who listed *Y. globosa* (YABE), *Y. katoi* (OZAWA), *Y. shiraiwensis* OZAWA, and *Neoschwagerina minoensis* OZAWA as the characteristic species of this zone. However, judging from the faunal assemblage at Katsuboyama [Kw 43] and Shomarutoge [Kw 31] from which *Y. shiraiwensis* was collected, limestones in these localities seem to be limestone conglomerate in which many species that came from the lower zones are associated.

MORIKAWA (1955) proposed the zone of *Yabeina* (Kamikuzu stage) as the uppermost fusulinacean zone in the Kwanto massif. He listed *Y. globosa* (YABE), *Y. shiraiwensis* OZAWA, *Neoschwagerina margaritae* DEPRAT, and *Codonofusiella* sp. as the constituent species of this zone (MORIKAWA's locality 17 and 29). Although the limestone of his locality 17* [Yoshinobe (1)] is correlated with the Kamikuzu conglomerate [Kw 33], *Neoschwagerina margaritae* DEPRAT is found in the pebbles of this conglomerate and not in matrices. It is not certain whether the limestone of loc. 17 is limestone conglomerate or not; nor is it understood whether the Kamikuzu conglomerate and its equivalent formations are of the Akasakan or of the Kuman age.

The Kamiyoshida Group, the uppermost division of the Chichibu System in the type locality, has long been regarded as being barren of fossils, although thin limestone beds are intercalated in this group. MORIKAWA (1956) described six species of Upper Permian aspect from the black limestone boulders in the Onagata area [Kw 20] which are presumed to have been derived from the Kamiyoshida Group. The fusulinaceans described by MORIKAWA comprise one each of the species of the following: *Reichelina, Dunbarula, Rauserella,* and two species of *Yabeina.* Although MORIKAWA established a new species of *Yabeina, Y. akiyamai,* his illustrated specimens are more or less deformed, cut excentrically, and far from the completeness necessary for establishing a new species.

In several localities of the Kwanto massif, limestone conglomerate-bearing formations are known to occur.

1. Okuchichibu area

ISHII and TAKAHASHI (1960) described several species of various ages obtained from the pebbles of limestone conglomerate intercalated in the Ogamata Formation [Kw 22A] of about 2000 m thickness. The Ogamata Formation had long been referred to the Upper Jurassic Otaki Formation which is extensively developed in the southern part of this area.

The limestone conglomerate found in the Ogamata Formation contains two

---

* Although MORIKAWA stated that the Kamikuzu conglomerate is also found at Yoshinobe (his locality 18), Loc. 18 in his map is not in Yoshinobe, but in Sakaishi, Agano-gun.

kinds of limestone pebbles. One is white to pale grey in color and the other is black and weathers to brown. In the former, fusulinaceans of Carboniferous to Permian occur, while in the latter only Upper Permian fusulinaceans are found. The fauna described by the joint authors comprises species of *Ozawainella, Reichelina, Rauserella, Schubertella, Dunbarula, Codonofusiella, Paradoxiella, Fusulinella, Fusulina, Schwagerina, Pseudofusulina, Verbeekina, Misellina, Pseudodoliolina, Cancellina, Neoschwagerina,* and *Yabeina.* Among this fauna, as pointed out by the authors, the first occurrence of *Paradoxiella* in Japan is noteworthy. *Paradoxiella japonica* ISHII and TAKAHASHI closely resembles *P. pratti* SKINNER and WILDE from the Upper Permian Beil Canyon Formation of West Texas.

ISHII and TAKAHASHI are of an opinion that the Ogamata conglomerate is nearly equivalent in age to the Hinode Formation discussed below, and is slightly older than the Kuma Formation of South Kyushu.

2. Itsukaichi and Ome area

The Paleozoic and Mesozoic terrain of NW–SE trend, which is widely distributed to the north of Itsukaichi, was divided by FUJIMOTO (1932, 1936) into many Paleozoic (mostly Permian) and Mesozoic (Triassic to Upper Jurassic) zones, bordered by faults with one another.

YAMADA (in FUJIMOTO, 1951) found Upper Permian limestone conglomerate and breccia in the several hundred meters thick formation which overlies the zone of *Yabeina* in Hosoo [Kw 43′] and east of Kan'yo [Kw 42] in Omé city, southeastern corner of FUJIMOTO's Katsuboyama zone. This thick formation was later named the Hinode Formation by SAKAGAMI (1958) who discriminated two kinds of conglomerate. One is the Tamanouchi conglomerate [Kw 41] with matrix of dark grey arenaceous limestone containing abundant fusulinaceans, and the other is the Nishinoiri conglomerate [Kw 42′] with matrix of black to dark green sandstone, containing fusulinaceans in pebbles but not in the matrix.

Accordng to SAKAGAMI (1956, 1958), verbeekinids and neoschwagerinids are found only in the matrix of the Tamanouchi conglomerate, whereas species of minute fusulinellids, fusulinids, and schwagerinids are found in pebbles of both kinds of conglomerates. It should be noted that in spite of the lithological difference in matrix several species are common to the Tamanouchi and Nishinoiri conglomerates. SAKAGAMI presumed that most of the fusulinaceans found in the matrix of the Tamanouchi conglomerate are secondary in origin, because they are considerably eroded out. Furthermore, based on the fact that the Hinode Formation is overlying the Katsuboyama Formation (Sakamotozawan to Akasakan), he correlated the Hinode Formation with the Kuma Formation although there are rather striking lithological and paleontological difference between them. More than thirty species obtained from the Tamanouchi and Nishinoiri conglomerates have been described by SAKAGAMI in his two papers (1956, 1958).

IV. Hida massif and Tamba zone

In the extensive area of the Hida massif and Tamba zone there are no

formations* referable to the Kuman with certainly except the upper part of the Kono Formation and the Kasuga and Anegawa Formations of Ibuki area.

The Kono Formation [Ht 37] (400 m) is the upper division of the Nyukawa Group defined by IGO (1960, 1964) who reported the occurrence of *Codonofusiella* sp., *Rauserella* sp., *Reichelina* sp., *Dunbarula* sp., and *Yabeina kanmerai* IGO in the pale-grey partly silified limestone cropping out in the upper course of Tochiyamadani valley in the Gombo area. The faunal assemblage as a whole is typical of the Kuman fauna in Southwest Japan, although most of the fusulinaceans mentioned above have not been specifically determined with the exception of *Yabeina kanmerai* which is, according to IGO, most closely allied to *Y. columbiana* (DAWSON). The latter is also one of the typical representative of the Kuman fusulinacean fauna. There is no doubt that the upper part of the Kono Formation should be correlated with the Kuman.

The Kasuga Formation [Ht 64] and the Anegawa Formation [Ht 94′] developed around Ibukiyama have no concrete evidence for dating, but ISOMI (1955, 1956) pointed out that there is a possibility of referring both of them to the Kuman from the stratigraphical point of view.

V. Maizuru zone

The Paleozoic and Mesozoic terrain mainly developed in the northern part of the Kinki province and the eastern part of the Chugoku province with NEE–SWW trend is the Maizuru zone named by MATSUSHITA (1950, 1951). It occupies an area from the northwestern part of Kyoto Prefecture through the central part of Hyogo Prefecture to the northeastern part of Okayama Prefecture, with about 10 to 30 km width and about 130 km prolongation. The Maizuru zone is very complex in geologic structure, consisting of Permian and Triassic rocks and the Yakuno intrusive rocks.

To the northwest of this zone, dioritic rocks and Cenozoic deposits are seen in Kyoto Prefecture but further to the northwest semi-schist and Paleozoic rocks rich in limestone appear, whereas to the south the Paleozoic formations of the Maizuru zone stand out in striking contrast to those of both sides and are important to the study of the geologic history in the Permian and Triassic times.

The Permian rocks developed in the Maizuru zone were named the Maizuru Group by NAKAZAWA and OKADA (1949). It consists of shale, sandstone and conglomerate with rare intercalations of small limestone lenses. The thickness of this group measures more than 1000 m.

The relationship between the sedimentary facies and the faunules of the Maizuru Group has been well documentated by recent studies of SHIMIZU *et al.* (1962) and SHIMIZU (1962, 1963). They have also dealt with the sedimentary environment, paleogeography and tectonics of this zone (1962). They consider

* Since *Fusulinella* spp. and *Yabeina* sp. were found in the pebbles of conglomerate of the Motodo Formation [Ht 79] it was regarded by FUJIMOTO *et al.* (1962) as the Upper Permian, but OSHIMA (1965; see p. 125) clarified that the Motodo Formation overlies unconformably the Jurassic Tetori Group and is lithologically referable to the Kwanmon Group of Cretaceous.

the Maizuru Group to be divided into four (or five) lithologic facies—schalstein facies, slate with limestone facies [=graded facies and slaty facies of SHIMIZU (1962)], sandstone-shale-conglomerate facies, and deltaic Gujo facies. And the fossils of the Maizuru Group are classified into five faunules—the *Lepidolina toriyamai* and the *Paleofusulina–Reichelina* faunule of fusulinaceans and the Takauchi-, the Kawahigashi- and the Gujo-faunule of brachiopod-molluscan assemblage. Of these, the lower schalstein facies is barren of fossils. The middle, slate with limestone facies, contains the *Paleofusulina-Reichelina* and the Takauchi faunule. The upper, sandstone-shale-conglomerate facies, has the *Lepidolina toriyamai* and the Kawahigashi faunule. The uppermost Gujo facies contains the Gujo faunule without fusulinaceans.

ISOMI (1965) who studied sole marks observed in the sandstone-shale-conglomerate facies came to a conclusion that the sole marks represent the "axial current", and his interpretation is in agreement with the paleogeographical analysis of SHIMIZU *et al.*

1. Wakasa and Maizuru areas

The Wakasa area occupies the northeastern margin of the Maizuru zone. The Takarao Formation [Swi 1] named by HIROKAWA, ISOMI and KURODA (1957) is presumed to be a correlative with the Maizuru Group based on the lithology and structural pattern although it is barren of fossils.

The southwestern extension of the Takarao Formation is seen in the Maizuru area where the mudstone is the main constituent of the formation and is combined with the Yakuno intrusive rocks, both of which show interfingering at places. IGI, KURODA and HATTORI (1961) proposed the name Ichinose Group for this combination of rocks.

In the type area of the Maizuru [Swi 2], the Maizuru Group is widely developed with a general trend of NE–SW and a width of few kilometers. Lithologically the Maizuru Group is divided into three unnamed formatons (SHIMIZU *et al.*, 1962). The lower formaton (700 m+) consists of the schalstein facies—the alternation of slate, schalstein, and green and black phyllite in which no fossils have been found. The middle formation (550 m) is of the slate with limestone facies, with thin fine conglomerate. The fossils found in this formation are *Waagenophyllum* ? sp., *Fenestella* and *Batostomella* at Shinjo, and *Bellorophon, Nuculites,* and indeterminable species of brachiopod and bryozoan at Matsuodera, east of Maizuru. The upper formation (800 m+) consists of the sandstone-shale-conglomerate facies which is presumed to be a sedimentary product formed in the axial part of the sinking basin. The matrices of conglomerate contain the *Lepidolina toriyamai* faunule which is very characteristic in assemblage and composed of the following species:

Lepidolina toriyamai KANMERA
L. toriyamai maizuruensis NOGAMI
L. kumaensis KANMERA
Yabeina shiraiwensis OZAWA
Neoschwagerina cfr. *margaritae* DEPRAT

"Pseudodoliolina" gravitesta KANMERA
Parafusulina? sp.
Schwagerina pseudocrassa KANMERA
Codonofusiella cuniculata KANMERA
Rauserella sp.
Nankinella sp.

2. Shidaka area

The Permian of this area [Swi 2] was studied by KAMBE (1950) and KURODA (1960). The *Lepidolina toriyamai* faunule is found in the upper formation of Kuroda which consists of alternation of sandstone and shale along with fine conglomerate and overlies conformably the lower formation of the schalstein facies (the Shimomitani Formation of KURODA).

3. Kawahigashi area

NAKAZAWA, SHIKI and SHIMIZU (1958) stated that the brachiopod and fusulinacean faunas are found in sandstone or conglomeratic sandstone of the Maizuru Group developed in Oé-machi [Swi 7] and Komori-machi [Swi 5] of Kasa-gun. Since these two faunas do not occur in the same rock, the exact relationship is not understood. The following species have been reported by them from Katsuradani [Swi 6′], west of Okuyama, Kawahigashi-mura:

**Lepidolina kumaensis* KANMERA
L. sp.
**Yabeina* cfr. *columbiana* (DAWSON)
**Y. yasubaensis* TORIYAMA
**Y. gubleri* KANMERA
Y. cfr. *minuta* THOMPSON and WHEELER
Pseudodoliolina cfr. *pseudolepida gravitesta* KANMERA
P. sp.
Schwagerina aff. *acris* THOMPSON
S. sp.
Parafusulina sp.
**Codonofusiella* cfr. *cuniculata* KANMERA
(Species with * are described by NOGAMI)

In this fossil assemblage, the percentage of number of individuals is more than 70 percent in the *Yabeina* group and 6 percent in the *Lepidolina* group.

4. Kawanishi area

In this area the Maizuru Group is almost the same in lithology as in the Kawahigashi area stated above, and the same *Lepidolina–Yabeina* faunule occurs in the matrices of calcareous fine conglomerate or fine conglomeratic sandstone. The Gujo Formation [Swi 8], which was once regarded as being of the Triassic age, is also nearly the same in lithology as the Maizuru Group, and yields *Costatoria kobayashii* (KAMBE) and other pelecypods but none of fusulinacean and brachiopod.

5. Yakuno area

The representative of the Maizuru Group in this area is the Nukada For-

mation [Swi 10] which is composed mainly of black silt to mudstone with dark grey sandstones, fusulinacean-bearing calcareous fine conglomerates and limestones. NAKAZAWA, SHIKI and SHIMIZU (1957) reported the following species from fine conglomeratic sandstone:

Yabeina yasubaensis TORIYAMA
Y. cfr. *gubleri* KANMERA
Y. sp.
Lepidolina toriyamai KANMERA
Pseudodoliolina pseudolepida gravitesta KANMERA
Schwagerina aff. *acris* THOMPSON

In the limestone, whose horizon is regarded as being equivalent to that which yields the above listed species, brachiopod fauna including *Lyttonia nobilis* WAAGEN has been found. It is worthy to note that this brachiopod fauna bears a close resemblance to the brachiopod fauna from the lower part of the Kanokura Formation in the Kitakami massif and has been referred by many workers to the zone of *Neoschwagerina* (Akasakan). The joint authors assert that the horizon in which the *Lepidolina–Yabeina* faunule is found is at least partly contemporaneous with the horizon in which the brachiopod fauna is obtained, because there is no great difference in stratigraphical position between both of the horizons.

6. Miharaiyama area

The southwestern prolongation of the Maizuru zone appears in the vicinity of Miharaiyama [Swi 14], Minamitani-mura, Yabu-gun, central part of Hyogo Prefecture. It was called the Minamitani Group [Swi 16] (NAKAZAWA and SHIKI, 1954), but later referred by SHIMIZU *et al.* (1962) to the Maizuru Group because of the similarity in the lithology and faunal contents. According to SHIMIZU *et al.*, there are two kinds of the faunal association in the fossil contents of this area: one is comprised of *Lepidolina* sp. and *Codonofusiella cuniculata* and referable to the *Lepidolina toriyamai* faunule, and the other of *Paleofusulina* cfr. *sinensis* which is comparable to that of the Mikata area mentioned below. It is noted that the Maizuru Group of this area is unconformably overlain by the Miharaiyama Group of the Early Triassic age.

7. Mikata area

The Maizuru Group developed in this area [Swi 22] was once called the "Akenobe Formation" (HIROKAWA *et al.*, 1954) in which the Kamikishida Formation of the Lower-Middle Triassic was also included. According to recent study of SHIMIZU (NAKAZAWA in IKEBE *et al.*, 1961; SHIMIZU, 1962), the Maizuru Group of this area forms a synclinal structure having the Kamikishida Formation as its axial zone. The lithofacies is somewhat different between the northern and southern wings of the syncline. SHIMIZU divided the Maizuru Group of this area into the Yokoyama [Swi 21], Mikata [Swi 22] and Iuchi [Swi 20] Formations in descending order. In addition, the Kuratoko Formaton was proposed to be probably equivalent partly to the Yokoyama and partly to the Mikata Forma-

tion, although its stratigraphical age is not exactly known because of being barren of fossils.

The lower Iuchi Formation (350–500 m) is of the schalstein facies consisting mainly of meta-diabase and schalstein with black slate. Since no fossils have been found in this formation, the age of the formation is not exactly known, though SHIMIZU correlated it with the Akasakan based on the stratigraphical relation. The middle Mikata Formation (500 m+) is a representative of the slate with limestone facies in which *Paleofusulina* cfr. *sinensis, Codonofusiella* sp. and *Rauserella*? sp. are found along with *Spiriferina* aff. *cristata, Hustedia*? sp., *Aviculopecten* sp., etc. The Mikata Formation is dated by SHIMIZU (1961) from the upper Akasakan to the lower Kuman.

The upper Yokoyama Formation (500 m+), which overlies the middle Mikata Formation partly conformably and partly with a fault relation, is of the sandstone-shale-conglomerate facies of SHIMIZU *et al.* (1962). The *Lepidolina toriyamai* faunule is found in the muddy matrices of conglomerate.

In the Maizuru Group of the Mikata area one fact must not be neglected; namely, that the *Paleofusulina-Reichelina* faunule occurs in stratigraphically lower horizon than the *Lepidolina toriyamai* faunule.

8. Fukumoto area

The Kosé Group [Swi 27], named by NAKAZAWA (1954), is a representative of the Maizuru Group in the Fukumoto area which is located 30 km NNE of Okayama city. It consists mainly of black shale or sandy shale, with rare intercalations of lenticular limestone conglomerate. According to NAKAZAWA, SHIKI and SHIMIZU (1954), *Codonofusiella* sp. is found in the pebbles of limestone conglomerate and indeterminable species of *Yabeina, Nankinella* and *Schwagerina,* together with stems of crinoid and bryozoans in the coarse sandstone. The lithological and paleontological characteristics indicate that the Kosé Group is probably referable to the Kuman. According to the joint authors the Kosé Group is in fault contact with the Fukumoto Group of Early and Middle Triassic, although they are presumed to have been conformable with each other originally.

However, MITSUNO and OMORI (1963) are of a different opinion in the stratigraphical correlation of the Kosé Group. Having found *Waagenophyllum indicum* (WAAGEN and WENTZEL) (?) in the limestone lens intercalated in the slate at Shimoyama, Aida-machi, they regarded the Kosé Group as Middle Permian, it being stratigraphically lower than the Dodo Group of the typical Kuman and higher than the Yanahara Group. The last named group is, as are the upper two, composed mainly of thick clayslate but is characterized by acid pyroclastic rocks in which the ore bodies of the Yanahara mine were formed. The stratigraphical relationship among the three groups mentioned above is not known due to their being in fault contact with one another.

9. Dodo area

The Dodo Group [Swi 29] is developed in the northwestern part of Yanahara-machi, Okayama Prefecture near the westernmost margin of the Maizuru zone.

According to MITSUNO and OMORI (1963) it consists of alternations of sandstone and slate with intercalations of limestones and conglomerate beds. The conglomerate is comprised of pebbles of various kinds of igneous rocks together with limestone pebbles. The following species were described by KONISHI (1952):

In matrix: *Schwagerina pseudochihsiaensis* (CHEN)
S. sp.
Yabeina sp.

In pebbles: *Staffella* or *Nankinella* sp.
Schwagerina pseudochihsiaensis (CHEN)
Neoschwagerina craticulifera (SCHWAGER)
N. minoensis OZAWA
Sumatrina cfr. *annae* VOLZ
S. longissima DEPRAT
Yabeina sp.

KANMERA (1953, 1954) restudied the above fusulinaceans, resulting in two species of *Sumatrina* and *Yabeina* sp. being referred to the genus *Lepidolina*, probably to *L. toriyamai* KANMERA. Accordingly the Dodo Group is referred to the Kuman without doubt.

10. Mitsu area

The Mitsu area [Swi 30′] is located to the north of Okayama city and is the southewstern extension of the Maizuru zone. The Maizuru Group of this area, according to NAKAZAWA and SHIMIZU (1962), has two distributions, one occurs in the west of Kanagawa and the other in the east of Nonokuchi. The former is of the alternation of shale-sandstone-conglomerate facies in which SHIMIZU (1963) found the *Lepidolina toriyamai* faunule. The brachiopod faunule including *Wellerella saxatilis* (REED), *W. nucula* (SCHELLWIEN), *Dielasma nummulus* WAAGEN, *D.* cfr. *biplex* WAAGEN, *Athyris subtriangularis* (REED), etc., has also been described by SHIMIZU (1963). NAKAZAWA and SHIMIZU (1962) and SHIMIZU (1963) are of the opinion that this assemblage is not similar to Japanese fauna but is referable either to the brachiopod fauna of the Loping Series of South China or to the Middle Productus limestone of Salt Range. Thus they dated this part of the Maizuru Group to the Middle Permian.

11. Fuchu area (Eastern part of Hiroshima Prefecture)

The so-called San'yo branch of the Sangun metamorphic zone extends to the eastern part of Hiroshima Prefecture where the weakly metamorphosed Paleozoic rocks appear. The stratigraphy of this Paleozoic has recently been clarified by HASE (1963) who divided the weakly metamorphosed Paleozoic into three Subgroups: A (700 m), B (2500–3000 m) and C (1500–2000 m) in ascending order. Although no fossil evidences have been obtained in A and B Subgroups, the following fusulinaceans have been found in the conglomerate of the C-3 member of C Subgroup:

From Kotohara [Swi 63]:
Neoschwagerina cfr. *toriyamai* SADA
Yabeina shiraiwensis OZAWA

Y. cfr. *yasubaensis* TORIYAMA
Y. cfr. *shimensis* YAMAGIWA and ISHII

From Yakawa [Swi 64]:
Yabeina shiraiwensis OZAWA
Y. cfr. *gubleri* KANMERA
Y. (*Lepidolina*?) sp.
Sumatrina annae VOLZ

Since the above fossil assemblage is most closely allied to the *Lepidolina imamurai – Yabeina shiraiwensis* assemblage of the Terauchi Formation, the C Subgroup of the weakly metamorphosed Paleozoic of Fuchu area is probably correlative with the main part of the Maizuru Group, ranging up to the Kuman.

It is noted that the Pennsylvanian (partly Middle Permian) limestone crops out nearly parallel to the C Subgroup, but both are in tectonic relationship (HASE, *op. cit.*).

12. *Lyttonia* fanua in Karita

Worthy of note is that the *Lyttonia* fauna was found by IMAMURA (1953) from Karita [Swi 69], about 30 km NNE of Hiroshima city. The *Lyttonia* fauna was found in the Karita Formation (+1000 m) which consists of sandstone, black shale, and their alternation, with intercalations of thin conglomerate in several horizons and a few limestone lenses in the lower part. The fauna identified by IMAMURA contains *L. richthofeni* (KAYSER) HAYASAKA and various forms of brachiopods, pelecypods, gastropods, and crinoids. The first mentioned species, which is only illustrated by IMAMURA, is a well known species in the Middle Permian of Japan, and its bearing on the paleogeographical consideration must not be neglected. According to SHIMIZU *et al.* (1962), the *Lepidolina toriyamai* faunule is found in the Karita Formation which bears the same lithological characteristics as that of the Maizuru Group. Hence they regard the Karita Formation as the westward extension of the Maizuru zone. HASE (1964) also reported *Lepidolina toriyamai* KANMERA, *Yabeina* cfr. *shiraiwensis* OZAWA, *Codonofusiella* sp., and *Pseudodoliolina* sp. from the characteristic conglomerate which is probably stratigraphically higher than the *Lyttonia*-bearing horizon mentoned above.

VI. Chugoku massif

In the central part of the Chugoku massif—western part of Okayama Prefecture and eastern part of Hiroshima Prefecture—Permian rocks are known in several places. During the last decade our knowledge of the stratigraphical aspect has greatly increased, but many problems remain to be solved on the paleontological side.

1. Atetsu plateau

As already stated in the preceding chapter, the Terauchi Formation [Swi 37], which conformably overlies the *Neoschwagerina douvillei* zone of the Maki Formation, is divided into two parts. The lower part consists of black shale and fine sandstone and the upper part consists mainly of coarse sandstone. In the

former, lenticular limestone conglomerates are intercalated in four horizons.

The Terauchi Formation is comprised of two fusulinacean zones in the lower part. The lower and upper zones were assigned by SADA (1960, 1961, 1965) the *Yabeina shiraiwensis* [H_1 horizon] and the *Lepidolina imamurai* [H_2 and H_3 horizons] zone, respectively, and by NOGAMI (1961) the *Y. shiraiwensis* – *Y.* sp. A (350 m) and the *Y. shiraiwensis* (100 m) subzone, respectively. According to SADA, many species of neoschwagerinids are common to both zones: *Neoschwagerina craticulifera* (SCHWAGER), *N. douvillei* OZAWA, *N. megasphaerica* DEPRAT, *N. minoensis* OZAWA, *N. margaritae* DEPRAT, *Yabeina katoi* (OZAWA), *Y. globosa* (YABE), *Y. shiraiwensis* OZAWA, *Y. columbiana* (DAWSON), *Sumatrina annae* VOLZ, and *S. longissima* DEPRAT, and only *Codonofusiella* sp., *Yabeina yasubaensis* TORIYAMA* and *Lepidolina imamurai* SADA are confined to the *L. imamurai* zone. In the upper subzone of Nogami, *Yabeina shiraiwensis* is almost exclusively found, and *Neochwagerina* and *Sumatrina* rarely, if ever, occur.

Although it is clear that the upper zone of SADA or the upper subzone of NOGAMI is stratigraphically higher than the lower zone or subzone, the two zones or subzones are rather close to each other, if not of the same, in stratigraphical age. [Actually the vertical distance between SADA's H_1 and H_3 horizons is less than 100 m in field.] It is noted however that *Yabeina shiraiwensis* and its allied species occur together with *Y. globosa* in SADA's *Lepidolina imamurai* zone. SADA, therefore, insisted that the faunal assemblage of the *Lepidolina imamurai* zone is a new type assemblage. If SADA's specific identification is correct, the mixed fauna of *Y. globosa* and *Y. shiraiwensis* is very important to the discussion of the stratigraphical position of the Upper Permian fusulinacean zones. It will be a clue in the controversy concerning the *Y. globosa* zone and the *Y. shiraiwensis* zone: is one higher than the other, or are they contemporaneous in stratigraphical position but heteropic in biofacies? SADA is of the opinion that the *Lepidolina imamurai* fauna of the Terauchi Formation is correlated with the *Yabeina-Lepidolina* fauna of the Kuma Formation and its equivalents despite its coexistence with many species of *Neoschwagerina* and *Yabeina* which are also characteristic to the lower fusulinacean zones.

2. Oga plateau

The Uji Group [Swi 44] (about 1400 m) in the southern part of the Oga plateau is mostly referable to the Kuman. It consists mainly of calcareous shale with thin beds of schalstein and chert. According to IMAMURA (1959), limestone conglomerate is found in seven horizons, the lower four of which contain an abundance of fusulinaceans. *Yabeina* faunule including *Y. shiraiwensis* OZAWA, *Y. yasubaensis* TORIYAMA and *Y.* spp. is found in matrices of limestone conglomerate, while many species of various ages ranging from the zone of *Millerella* to that of *Neoschwagerina-Verbeekina* occur in pebbles of conglomerate. Thus, IMAMURA (1959) is of an opinion that the limestone mass ranging from the *Millerella* to the *Neoschwagerina-Verbeekina* zone might have been above sea

* NOGAMI regards *Y. yasubaensis* as the junior synonym of *Y. shiraiwensis* (ISHII and NOGAMI, 1962).

level as a source area during the deposition of the Uji Formation. Although the Uji Formation yields no species of *Lepidolina,* it may perhaps be referable to the Kuman (IMAMURA, 1959).

YOSHIMURA (1961) restudied the Uji Formation developed in the Oga, Fukiya [Swi 43] and Hane [Swi 45] areas, and set up three fusulinacean subzones, the *Yabeina-Lepidolina,* the *Y. shiraiwensis,* and the *Y.* aff. *cascadensis* subzone in descending order. The last subzone is, however, correlated with the *Neoschwagerina douvillei* subzone (H_1 horizon) of the Yukawa Group. YOSHIMURA regards the Uji Formation and its equivalent formations in these areas as deposits formed under annaerotic condition and all the faunas in the limestone conglomerates as the derived fossils in the strict sense.

3. Taishaku plateau

HANZAWA (1941) was the first to find the zone of *Yabeina* in this plateau. He stated as follows: "The *Yabeina*-limestones are almost always brecciated in texture, even though they sometimes appear compact and homogeneous, and contain remains of *Yabeina, Sumatrina* and *Parafusulina,* besides *Trticites* and *Fusulinella* in fragmental state and limestone block with the formainifera of the last named two genera. This fact suggests that *Triticites* and *Fusulinella* in the limestone breccias are not primary in origin but secondary, obviously reworked from the older rocks when the Perman limestones with *Yabeina, Sumatrina* and *Parafusulina* were formed." Since HANZAWA did not make any comment on the specific assemblage of the *Yabeina*-limestone, the paleontologic characteristics of this limestone was not clear.

Three years after the HANZAWA's study, FUJIMOTO (1944)* reported the occurrence of *Yabeina shiraiwensis* OZAWA in his eleven localities which were referred to his *Yabeina-Sumatrina* zone, in three of these localities (Loc. 9, 12, 15), with *Lepidolina multiseptata* (DEPRAT) and in four others (Loc. 15, 26, 37, 40) with *Y. shiraiwensis* and *Y. globosa.*

According to YOKOYAMA (1959) the Nishiuyama Group and the Yasumoto Formation are referred to the Kuman. The former is divided into two, the lower Maedani [Swi 55] and the upper Notabiyama [Swi 59′] Formation. The Maedani Formation consists mainly of black shale and sandstone, with intercalations of limestone conglomerates and limestone lenses in several horizons, and yields the following species:

Yabeina shiraiwensis OZAWA
Y. spp.
Sumatrina annae VOLZ
Neoschwagerina margaritae DEPRAT
N. spp.
Pseudodoliolina sp.
Schwagerina sp.
Pseudofusulina sp.

* Since all the thin sections used in FUJIMOTO's study were raided and lost during the last War, it is impossible to restudy them.

The Notabiyama Formation conformably overlies the Maedani Formation and it also is composed of black shale and sandstone with chert and meta-diabase, but is barren of fossil content.

On the other hand the Yasumoto Formation [Swi 58] whose stratigraphical relationship with the Maedani Formation and Notabiyama Formation is not clear, contains thick limestone bed (about 50 m) in which the following *Lepidolina* faunule is known (YOKOYAMA, 1959):

Lepidolina sp. nov.
L. sp.
Yabeina shiraiwenis OZAWA
Y. spp.
Neoschwagerina spp.
Parafusulina sp.
Codonofusiella sp.
Waagenophyllum cfr. *akasakensis* (YABE)
W. *longiseptatum* YOKOYAMA (MS)

Although none of the species from Taishaku plateau have been described except *Pseudoschwagerina miharanoensis* AKAGI mentioned in Chapter VII, the Maedani Formation of YOKOYAMA is probably equivalent to SADA's *Yabeina shiraiwensis* zone or to NOGAMI's *Yabeina shiraiwensis*—*Y.* sp. A subzone of Atetsu limestone Group, and the Yasumoto Formation is almost certainly correlative with SADA's *Lepidolina* zone or with NOGAMI's *Yabeina shiraiwensis* subzone.

4. Jinseki-Yuki area

To the south of the Taishaku plateau an unnamed non-calcareous group occurs in the Jinseki-Yuki area. Although no fusulinaceans have been found in the upper formation of this group except *Eostaffella* sp., *Millerella* sp., *Schwagerina* sp., and *Sumatrina* sp. which were found in the limestone pebbles of conglomerate in the upper part of this formation, HASE (1965) correlated it with the Mihara Formation of the Yoshii Group in the Oga area because of a lithological similarity and stratigraphical relationshp to the lower formaton.

Limestone and schalstein bodies, which are presumed to be in tectonic contact with the non-calcareous formation mentioned above, occur to the north of Kuregatoge [Swi 67A] and yield *Yabeina shiraiwensis* OZAWA, *Neoschwagerina* cfr. *douvillei* OZAWA, *N.* cfr. *margaritae* DEPRAT, *Pseudodoliolina* cfr. *pseudolepida* (DEPRAT), and *Schwagerina* sp. in the limestone conglomerate. HASE (1965) referred this limestone mass to the upper Middle to Upper Permian.

5. Akiyoshi area

In the Akiyoshi limestone Group [Swi 100], whose stratigraphy and paleontology have been studied by TORIYAMA (1954, 1957, 1958) at length, the uppermost fusulinacean zone (*Yabeina shiraiwensis* zone) is mostly referable to the Kuman, although, as in the Uji Formation in the Oga plateau, no species of *Lepidolina* have been found in that zone.

Among the Permian rocks of the non-calcareous facies developed around the Akiyoshi limestone, the Yaegahara Formation [Swi 99] of the Oda Group, the

Sanbonmatsu Formation [Swi 88′] of the Beppu Group and the Shiraiwa Formation [Swi 94] of the Tsunemori Group were referred to the Kuman (TORIYAMA, 1954).

MURATA (1961) holds a slightly different opinion as to the division of these non-calcareous groups and their geologic structures. The upper part of the Yaegahara Formation and the Tsutsumi [Swi 92′] and Kawarakami [Swi 87] Formations of Murata is referred to the Kuman. KAWANO *et al.* (1963) also differ in their interpretation of the geologic structure of the Oda Group.

KAWAI (1963) expressed a different opinion on the geotectonic history of the Akiyoshi area. Although he proposed many new group or formation names and geotectonic terms, his interpretation is sometimes not based on concrete field evidences. His interpretation is therefore not accepted here. TAKAHASHI (1965) also does not agree with KAWAI in the geotectonic interpretation of the Tsunemori Group.

6. Mino-Kanoashi massif

The Nichihara Formation (1500 m) [Swi 72], the uppermost division of the Kanoashi Group, consists of grey black clayslate and chert with intercalations of limestone and schalstein. KAWANO (1961) referred the Kuman to this formation in which an indeterminable species of *Yabeina* was found. However, it is not improbable that the Nichihara Formation is referable to the upper Akasakan. *Neocalamites* sp. was once reported from the lenticular limestone exposed near the Sasagatani mine [Swi 73] in the northwestern part of this area (YABE and ENDO, 1920). A trunk of *Calamites* (*Arthropitys*) sp. was formerly found in the limestone at this mine.

7. Mugitani area

The Mugitani Formation [Swi 79′] (750–800 m) developed in the area between Handa and Zomeki limestone plateaux is composed of sandstone, conglomeratic at some horizons, and black clayslate, with conglomerate at the base. Since indeterminable species of *Sumatrina, Yabeina* and *Parafusulina* have been obtained in the middle part, the Mugitani Formation* is dated by KAWANO (1961) as the uppermost of the zone of *Neoschwagerna* to the zone of *Yabeina-Lepidolina* zone.

8. Ikadaba area

Along the lower valley of Abugawa is distributed the Kyodoko Formation [Swi 81] which consists mainly of chert and sandstone with remarkable conglomerate or limestone conglomerate at the base. KAWANO (1961) described *Yabeina shiraiwensis* OZAWA, *Y.* sp. A, *Sumatrina* cfr. *longissima* DEPRAT, *Neoschwagerina* cfr. *douvillei* OZAWA, *Pseudodoliolina* sp., *Verbeekina* sp., and several species of schwagerinids, including *Schwagerina* cfr. *acris* THOMPSON and WHEELER. Although no species of *Lepidolina* have been found, the Kyodoko Formation is dated as the uppermost Akasakan to the Kuman (KAWANO, 1961). The stratigraphical relationship between the Kyodoko and the underlying Ikadaba

* Mugitanigawa Formation of KAWANO (1953).

Formation is not conformable, and at some places, for example at Totani, southwest of Ikadaba, the basal conglomerate of the former covers the erosion surface of the latter.

9. Yamaguchi area

Covering an area of about 10 km from east to west and about 2 km from north to south, the Permian rocks called the Miyano Formation [Swi 84] (KAWANO, KAWAMURA and KAWAMURA, 1954) is developed to the northeast of Yamaguchi city. KAWANO (1960, 1961) revised the stratigraphical division and divided the Permian rocks of this area into two formations, the lower Suzumiyama [Swi 83] (about 650 m) and the upper Aratani [Swi 82] (about 1250 m) Formation. The Aratani Formation conformably overlies the Suzumiyama Formation and is characterized by conspicuous conglomerate in the lower part and by clayslate in the upper. KAWANO reported the following species from the limestone conglomerate, called the Aratani conglomerate, in the basal part:

Ozawainella aff. *kueichihensis* (CHEN)
**Codonofusiella explicata* KAWANO
Schwagerina sp.
**Pseudofusulina arataniensis* KAWANO
Parafusulina sp.
Pseudodoliolina? sp.
Neoschwagerina cfr. *douvillei* OZAWA
N. megaspherica miyanoensis KAWANO
(Species with an asterisk were found in the pebbles of limestone conglomerate)

KAWANO (1960, 1961) described all the species listed above excepting the indeterminable ones, and he correlated the lower part of the Aratani Formation with the upper Akasakan age and the upper part with the Kuman age. However, it is probable that the Aratani Formation is as a whole equivalent to the Akasakan as no species of *Yabeina* nor of *Lepidolina* have been found.

10. Izumiyama, Yamaguchi city

SUGIYAMA (1939) reported *Yabeina shiraiwensis* OZAWA, *Sumatrina annae* VOLZ and *Parafusulina* cfr. *kattaensis* (SCHWAGER) in the limestone exposed at Izumiyama in the west of Yamaguchi city. SUGIYAMA regarded the limestone as a *Klippe* resting on the non-calcareous Paleozoic rocks (sandstone). However, according to KAWANO, KAWAMURA and KAWAMURA (1954) and KAWANO (1961), the limestone is a limestone conglomerate and the underlying sandstone is lithologically correlative with the Aratani Formation. KAWANO stated that the limestone mass and the underlying sandstone are not in the relation of "*Klippe*" as SUGIYAMA considered, but both of them, together with the non-metamorphic Paleozoic rocks exposed at Akazuma, about 2 km east of Izumiyama, are forming *Klippen* resting on the Sangun-Motoyama metamorphic Group.

VII. Outer zone of Southwest Japan

A. Kii peninsula

The zonal arrangements of the Paleozoic and Mesozoic strata are well shown

in the southern half of Kii peninsula in which Kuman formations are known in several places.

1. Osugi area

The Osugi area is along the upper valley of Miyagawa in the central part of the peninsula [Swo 19]. According to ARAKI, YAMADA, KOBAYASHI, and MURATA (1956), the Paleozoic formation of more than 850 m thickness, which has been left unnamed, consists mainly of sandstone with intercalation of limestone in the middle and lower parts. According to personal information from MURATA, the lower limestone is conglomeratic, yielding *Yabeina* cfr. *yasubaensis* TORIYAMA, *Y. shiraiwensis* OZAWA, and *Y.* sp. together with *Neoschwagerina* sp. which seems to be a derived fossil. This Permian formation is probably correlated with the Yasuba Formation of Shikoku which will be described below.

2. Kawakami-mura area

Kawakami-mura area [Swo 20–22] along the upper valley of Yoshinogawa, Mié Prefecture, was studied by SHIIDA (1951) who divided the Chichibu terrain of this area into several belts of nearly east-west trend. In one of these, called the Takahara-Nakaoku belt, schalstein, limestone and chert are predominant with intercalation of conglomerates. Since the conglomerates are comprised of granitic pebbles, and fusulinacean fossils are known in the beds close to the conglomerate, they may be equivalent to the Yasuba conglomerate of Shikoku. Paleontological information related to this extensive area is not available.

3. Yuasa-machi and its environs (Western part of Kii peninsula)

The division D of HIRAYAMA and TANAKA (1956, see Chapter VII) (Ukiishi Formation [Swo 32]—700 m) is referred to the Kuman. The division D overlies C of the Akasakan with a presumable unconformity. The division D is also distinguished lithologically from the underlying C, B and A in that the basal part of the division D is characterized by conglomerate and the upper by sandstone with a subordinate conglomerate. The pebbles of limestone in the conglomerate contain various kinds of fusulinaceans (undetermined) whose range is from the Sakamotozawan to the Kuman. HIRAYAMA and TANAKA are of the opinion that the Ukiishi Formation (D_1+D_2) is correlative with the Kuma Formation of South Kyushu.

Besides the above mentioned localities, the fusulinacean-bearing limestone conglomerates have long been known to occur in the following localities in the environs of Yuasa-machi, although no paleontological information has been available on them: a) Hota [Swo 31], Arita city to the environs of Suhara, Yuasa-machi (YABE, 1906; NAGAO, 1926); and b) Shirosaki and Kuroyama [Swo 35], northwest of Yura-machi (NAKAMURA, 1926).

B. Shikoku

As many stratigraphers have stated, the Chichibu terrain of Shikoku is divisible into three zones or belts, northern, central and southern. Between the northern and central zones the Kurosegawa tectonic zone (or Sakashu thrust

zone or Kuroiwa tectonic line of KOBAYASHI), Otaru-Suita tectonic lines (SUYARI), etc. exist.

1. Northern zone

Since KOBAYASHI found the characteristic conglomerate, called the Yasuba conglomerate, in the vicinity of Yasuba [Swo 64], 4 km north of Tosa-Yamada-machi and emphasized its geological significance, similar types of conglomerate have been found in several places not only in Southwest Japan but also in Kwanto massif and other places. Hence the Yasuba-type conglomerate has been regarded as the most typical characteristic feature of the Upper Permian Kuman age. At the type locality the Yasuba conglomerate contains round pebbles of several to fifteen centimeters in diameter in the limy matrix. Pebbles are various in kind, comprised of chert, limestone, mudstone, sandstone, and tuff, and several kinds of igneous rocks. The fusulinacean fossils are found both in limestone pebbles and in matrices of the conglomerate. Although TORIYAMA (1942) already described the fusulinaceans obtained from the type locality, KANMERA (1953) restudied the same material and added several species characteristic of the Kuman age.

The species in the matrices are as follows (those with an astrisk were described by TORIYAMA):

Codonofusiella sp.
Pseudodolina pseudolepida (DEPRAT)
**Yabeina shiraiwensis* OZAWA
**Y. yasubaensis* TORIYAMA
Y. cfr. *gubleri* KANMERA
Lepidolina cfr. *kumaensis* KANMERA
L. sp.

HASHIMOTO (1955) proposed to give the name Yasuba Formation to the stratigraphical unit in which the Yasuba conglomerate is included, although it was revised by NAKAGAWA *et al.* (1959) to the Yasuba Group and by SUYARI (1961) again to the Yasuba Formation. In their definitions, the Yasuba conglomerate occurs in the middle part of the formation.

2. Central zone

The Haigyu Formation is the representative of the Kuman in the central zone of the Chichibu terrain in Tokushima Prefecture, with the type locality in the vicinity of Haigyu [Swo 53], Kaminako-cho. It consists mainly of sandstone and mudstone, with intercalations of conglomerate and limestone. In the limestone lenses interbedded in the conglomerate or mudstone in the middle part of the formation, the following species have been found by YAMASHITA *et al.* (1956) (Locality; south of Sakashu [Swo 54], Kisawa-mura, and north of Haigyuguchi, Kaminaka-cho):

Codonofusiella cuniculata KANMERA
Schwagerina aff. *acris* THOMPSON and WHEELER
Parafusulina? sp.

Pseudodoliolina pseudolepida gravitesta KANMERA
P. sp.
Yabeina columbiana (DAWSON)
Y. *yasubaensis* TORIYAMA
Y. *gubleri* KANMERA
Lepidolina kumaensis KANMERA
L. *toriyamai* KANMERA

The Ichinose Formation [Swo 81′] is the equivalent of the Haigyu Formation in Kochi Prefecture. It consists of massive mudstone, coarse sandstone and conglomerate and is developed from north of Kochigatani to Shimoyama in Sakawa-cho. In several horizons conglomerates are found, in whose matrices the following species were reported by YAMASHITA (1958) (Locality; north of Shimoyama [Swo 81]):

Rauserella? sp.
Codonofusiella cfr. *cuniculata* KANMERA
Schwagerina aff. *acris* THOMPSON and WHEELER
S. sp.
Verbeekina sp.
Yabeina cfr. *columbiana* (DAWSON)
Y. *yasubaensis* TORIYAMA
Y. sp.
Lepidolina sp.

The faunal assemblage in the conglomerate and the lithological characteristics of the Haigyu and Ichinose Formations indicate that without doubt both the formations are correlated with the Kuma Formation of South Kyushu.

The limestone exposed at Yamamba and Shimoyama [Swo 81] in Sakawa-cho, which are regarded by SUYARI *et al.* as a part of the Ichinose Formation, contain a wealth* of brachiopod, coral, sponge, bryozoa, and other fossils, but only a scant supply of fusulinaceans.

Since this fauna is exotic to the Chichibu terrain while the fossil assemblage is remarkably similar to the fauna of the Iwaizaki limestone, KOBAYASHI (1941, 1951) regarded the Shimoyama and Yamamba limestones as the *Klippen* on his para-Kitakami facies which came from the Sambagawa terrain of the north to the present position by the Sakawa orogenesis. However, KATTO *et al.* (1956) insisted that the Ichinose Formation, including the Shimoyama and Yamamba limestones, is not *Klippe* but is of autochthonous deposits.

The Uwanaro Formation [Swo 94], the upper division of the Kokuzosan Group (ISHIZAKI, 1962), is presumed to have the Kuman in the upper part, though there is no positive paleontological evidence to verify this presumption. This formation occurs to the south of Ochimen [Swo 92] and consists of chert, coarse sandstone and siliceous mudstone, attaining a thickness of about 1400 m. The correlation of this formation by ISHIZAKI was based on the great thickness of the deposits and the stratigraphical relationship with the subjacent Ozodani

* As for the specific names of these fossils see YABE and SUGIYAMA (1933, 1943), MINATO (1955) and SUYARI (1961).

Formation [Swo 93′] in which species of *Neoschwagerina* and *Yabeina* occur, but further study seems to be necessary to find concrete paleontological evidence.

The Doi Formation [Swo 104] of Kurosegawa area consists of sandstone and black mudstone with a lenticular conglomerate which comprises the same kinds of igneous rocks as those found in the Yasuba conglomerate in the Yasuba Formation (ICHIKAWA *et al.*, 1956). Although little information is available concerning the faunal contents, the Doi Formation has been referred by ICHIKAWA *et al.* to the Upper Permian.

C. Kyushu

The Kuma Formation [Swo 139] developed in the upper valley of Hikawa in the Kuma massif is the standard of the Upper Permian in Southwest Japan. Since KANMERA (1953, 1954) has given a detailed account of the geology and paleontology of the Kuma formation, it seems unnecessary to add further discussion.

Mizukoshi area

The Mizukoshi Formation [Swo 133] named and studied by MATSUMOTO and FUJIMOTO (1939) is distributed in an area about 10 km southeast of Kumamoto city. FUJIMOTO reported several species of *Schwagerina, Pseudodoliolina, Neoschwagerina,* and *Yabeina,* referring this formation to the Artinskian to Saxonian in age. In his study of the Kuma Formation, KANMERA (1953) made a reference to the Mizukoshi Formation suggesting that there is a possibility of refering it to the Kuman.

According to YANAGIDA (1958), who has restudied the Mizukoshi Formation in detail, it is undoubtedly a correlative of the Kuma Formation in lithology and faunal contents. It consists of alternation of black shale and sandstone frequently with graded bedding in the lower part (900 m), and of shale, sandstone and conglomerate in the upper part (500 m). The following fusulinaceans have been identified in the limestone 130 m above the base of the upper part:

Yabeina cfr. *gubleri* KANMERA
Y. cfr. *yasubaensis* TORIYAMA
Lepidolina cfr. *toriyamai* KANMERA
Pseudodoliolina cfr. *pseudolepida* (DEPRAT)
Schwagerina sp.
Parafusulina sp.

All the species listed above, with the exception of the indeterminable ones, are main constituents of the zone of *Lepidolina* of the Kuma Formation. Besides the above, YANAGIDA found the following brachiopods, pelecypods and gastropods in the shale about 100 m below the top of the formation:

Neospirifer cfr. *fasciger* (KAYSERLING)
Spiriferella sp.
Productus sp.
Acanthopecten aff. *spinosus* HAYASAKA
Pleurotomaria sp.

Generally speaking, the brachiopod faunas are rather rare in occurrence in Southwest Japan, the exception being the Omi limestone of Hida massif and the Akiyoshi limestone Group. However, they are rich in Northeast Japan, especially in the Kanokura Formation of the southern part of the Kitakami massif. Comparing the brachiopod faunas of the Mizukoshi Formation with those of the Kanokura Formaton, there is nothing in common with both in generic comparison except for *Spiriferella*. However, it is worthy to note that the spiriferids occur in the horizon clearly higher than that characterized by the *Lepidolina* fauna.

Postscript

After the manuscript was completed several reports concerning the Carboniferous and Permian stratigraphy and paleontology have come to hand, some of which are considerably important to the subject dealt with in this paper, and their results are added here as the postscript.

1. The Permian formations developed in the Ibukiyama area have recently been studied by MIYAMURA (1966) whose conclusion is different in the tectonic interpretation from those of the previous workers. He divided the calcareous formation of this area into two, the Ibukiyama limestone [Ht 96] and the Itanamiyama limestone [Ht 95′], both of which are tectonically separated into several blocks. These calcareous formations have long been regarded as *"Klippen"* upon the non-calcareous formations developed under or around the formers, but MIYAMURA inferred that they are not "exotic" mass but are "autochthonous", that is to say, the calcareous formations are assumed to have been deposited *in situ* simultaneously with the non-calcareous formations. He considers that the Itanamiyama limestone is faulted into imbricated structure and the Ibukiyama limestone is flexed into overturned folding. The former is assumed to be earlier in the tectonic developmental stage than the latter. As for the fusulinacean fossil, no new information has been given by MIYAMURA. (Refer; page 98–99, 126–128, and 151).

2. SADA and YOKOYAMA (1966) have described well preserved specimens of *Lepidolina multiseptata multiseptata* (DEPRAT), *L. multiseptata shiraiwensis* (OZAWA), *L. elongata* (GUBLER), *Yabeina minuta* THOMPSON and WHEELER, and *Chusenella* sp. A from the Yasumoto Formation [Swi 58] of the Taishaku limestone. The fauna is quite similar to that of Cambodia described by GUBLER (1935) and recently redescribed by ISHII and NOGAMI (1964). Because the Yasumoto fauna is unique in having *L. elongata*, the joint authors set up the *Lepidolina elongata* zone for the Yasumoto Formation. However it is not known which part of the Kuman Stage is referable to the *L. elongata* zone. The occurrence of the Yasumoto fauna implies the paleogeographical problem in its relation to the *Lepidolina toriyamai* fauna in Southwest Japan.

3. A series of papers have been presented by HAYASAKA, HAYASAKA and MINATO, and HAYASAKA and KATO on the Upper Palaeozoic fauna from Miharanoro [=Miharano] [Swi 57], Tojo-machi, Hiroshima Prefecture. The biostrati-

graphical significance of the fauna has been given by HAYASAKA. HAYASAKA and KATO (1st Note of 1966) revised the zonation of the Miharanoro Formation —the zone of *Pseudoschwagerina* as follows: namely, *Pseudofusulina krotowi* subzone, *Pseudoschwagerina miharanoensis* subzone and *Triticites nishikawai* (MS) subzone in descending order. They mentioned that *Pseudoschwagerina miharanoensis* AKAGI occurs abundantly in the lower part of the *Pseudofusulina* limestone together with *Pseudofusulina vulgaris* (SCHELLWIEN), but does not seem to occur in the *Triticites* limestone nor in the upper part of the *Pseudofusulina* limestone.

Although faunal assemblage of these subzones is not known, the following correlation may be plausible: the lower subzone with the *Triticites simplex* subzone, the middle subzone with the *Pseudofusulina vulgaris* subzone, and the upper subzone wth the upper part of the *Pseudofusulina vulgaris* subzone and/or the lower part of the *P. ambigua* subzone of the Akiyoshi limestone Group.

Supplement to Chapter VII (pp. 89–90)

The results of SAKAGAMI and OMATA's study (1957) have been left out in the original manuscript. Having studied the Raidenyama Paleozoic zone of FUJIMOTO they described the Sakamotozawan fusulinaceans which were contained in the boulders found at the foot of the Shiraiwa limestone, about 1.5 km NNW of Raidenyama [Kw 39]. This fauna comprises *Schubertella kingi* DUNBAR and SKINNER, *S. cylindrica* SAKAGAMI and OMATA, *Kwantoella fujimotoi* SAKAGAMI and OMATA, *Triticites thalmanni* SAKAGAMI and OMATA, *T. fujinoi* SAKAGAMI and OMATA, *T.* cfr. *simplex* (SCHELLWIEN), *T. kawanoboriensis* FUJIMOTO, *T.* spp., *Pseudoschwagerina* cfr. *orientale* FUJIMOTO, *Schwagerina modica* THOMPSON and HAZZARD, *S. guembeli omensis* SAKAGAMI and OMATA, *S. guembeli pseudoregularis* DUNBAR and SKINNER, *S.* cfr. *verneuili levidensis* (LEE), and *S.* spp., all of them have been described except for the indeterminable species. The Shiraiwa limestone was correlated by SAKAGAMI and OMATA with the middle to upper Wolfcampian of North America, but it is more likely referable to the lower to middle Sakamotozawan. Although they divided the Raidenyama Paleozoic zone into three formations, Kitaosogi, Raidenyama and Naruki, further information on stratigraphy of this area is presently not available.

List of locality names

Kitakami and Abukuma massifs [Ka]

Iwate Prefecture (岩手県)

1. Akka (安家); Iwaizumi-machi, Shimohei-gun (Akka-mura) 下閉伊郡岩泉町 (安家村)
2. Kogawa (小川); Iwaizumi-machi, Shimohei-gun (Kogawa-mura) 〃 〃 (小川村)
3. Iwaizumi (岩泉); Iwaizumi-machi, Shimohei-gun 〃 〃
4. Hanawa (花輪); Miyako-shi (Hanawa-mura, Shimohei-gun) 宮古市 (下閉伊郡花輪村)
5. Toyomane (豊間根); Yamada-machi, Shimohei-gun (Toyomane-mura) 下閉伊郡山田町 (豊間根村)
6. Ohazama (大迫); Ohazama-machi, Hienuki-gun 稗貫郡大迫町
7. Tassobe (達曽部); Miyamori-mura, Kamihei-gun (Tassobe-mura) 上閉伊郡宮守村 (達曽部村)
8. Hiryuyama (飛竜山); Miyamori-mura, Kamihei-gun (Tassobe-mura) 〃 〃 (〃)
9. Kuribayashi (栗林); Kamaishi-shi (Kurihashi-mura, Kamihei-gun) 釜石市 (上閉伊郡栗橋村)
10. Kamaishi-kozan (mine) (釜石鉱山); Kamaishi-shi (Kasshi-mura, Kamihei-gun) 釜石市 (上閉伊郡甲子村)
11. Kamaishi (釜石); Kamaishi-shi 釜石市
12. Kogawa (小川); Kamaishi-shi (Kasshi-mura, Kamihei-gun) 釜石市 (上閉伊郡甲子村)
13. Ohashi (大橋); Kamaishi-shi (Kassi-mura, Kamihei-gun) 〃 (〃 〃)
14. Tsuchikura (土倉); Sumita-machi, Kesen-gun (Kamiarisu-mura) 気仙郡住田町 (上有住村)
15. Omatsu (大松); Kamaishi-shi (Kasshi-mura, Kamihei-gun) [Kasshi (甲子)] 釜石市 (上閉伊郡甲子村)
16. Kamiarisu (上有住); Sumita-machi, Kesen-gun (Kamiarisu-mura) 気仙郡住田町 (上有住村)
17. Daido (大洞); Sumita-machi, Kesen-gun (Kamiarisu-mura) 〃 〃 (〃)
18. Shimoarisu (下有住); Sumita-machi, Kesen-gun (Shimoarisu-mura) 〃 〃 (下有住村)
19. Omoriyama (大森山); Esashi-shi (Yonezata-mura, Esashi-gun) 江刺市 (江刺郡米里村)
20. Shiba (芝); Esashi-shi (Yonezato-mura, Esashi-gun) [Tochu (戸中)] 〃 (〃 〃)
21. Hitokabe (人首); Esashi-shi (Yonezato-mura, Esashi-gun) 〃 (〃 〃)
22. Yonezato (米里); Esashi-shi (Yonezato-mura, Esashi-gun) 〃 (〃 〃)
23. Hikoroichi (日頃市); Ofunato-shi (Hikoroichi-mura, Kesen-gun) 大船渡市 (気仙郡日頃市村)
24. Nagaiwa (長岩); Ofunato-shi (Hikoroichi-mura, Kesen-gun) 〃 (〃 〃)
25. Sakamotozawa (坂本沢); Ofunato-shi (Hikoroichi-mura, Kesen-gun) 〃 (〃 〃)
26. Onimaru (鬼丸); Ofunato-shi (Hikoroichi-mura, Kesen-gun) 〃 (〃 〃)

---

shi=city; *gun*=county; *machi* or *cho*=town; *mura* or *son*=village

As the results of the law of promotion of unification of township and village taken effect several years ago, many of *machi* or *cho* (town) and *mura* or *son* (village) were combined together to make a new *shi* (city) or a new larger *machi* or *cho* (town). The former name of *machi* or *cho* and *mura* or *son* is indicated in the parentheses immediately after the present name in the list.

27. Setamai (世田米); Sumita-machi, Kesen-gun (Setamai-machi) 気仙郡住田町 (世田米町)
28. Katchizawa (合地沢); Sumita-machi, Kesen-gun (Setamai-machi) 〃 〃 (〃)
29. Kanokura (叶倉); Sumita-machi, Kesen-gun (Setamai-machi) 〃 〃 (〃)
30. Yokota (横田); Rikuzen-Takata-shi (Yokota-mura, Kesen-gun) 陸前高田市 (気仙郡横田村)
31. Yukisawa (雪沢); Rikuzen-Takata-shi (Yahagi-mura, Kesen-gun) [Iwahata (岩畑)] 陸前高田市 (気仙郡矢作村)
32. Takata (高田); Rikuzen-Takata-shi (Takata-machi, Kesen-gun) 陸前高田市 (気仙郡高田町)
33. Yahagi (矢作); Rikuzen-Takata-shi (Yahagi-mura, Kesen-gun) 陸前高田市 (気仙郡矢作村)
34. Nagasaka (長坂); Higashiyama-cho, Higashiiwai-gun (Nagasaka-mura) 東磐井郡東山町 (長坂村)
35. Matsukawa (松川); Higashiyama-cho, Higashiiwai-gun (Matsukawa-mura) 〃 〃 (松川村)
36. Ichinoseki (一の関); Ichinoseki-shi (Ichinoseki-machi, Nishiiwai-gun) 一関市 (西磐井郡一関町)
37. Usuginu (薄衣); Kawasaki-mura, Higashiiwai-gun (Usuginu-mura) 東磐井郡川崎村 (薄衣村)

Miyagi Prefecture (宮城県)

38. Matsukawa (松川); Kesennuma-shi (Niitsuki-mura, Motoyoshi-gun) 気仙沼市 (本吉郡新月村)
39. Tsukidachi (月立); Kesennuma-shi (Niitsuki-mura, Motoyoshi-gun) 〃 (〃 〃)
40. Karakuwa (唐桑); Karakuwa-cho, Motoyoshi-gun (Karakuwa-mura) 本吉郡唐桑町 (唐桑村)
41. Kesennuma (気仙沼); Kesennuma-shi (Kesnnuma-machi, Motoyoshi-gun) 気仙沼市 (本吉郡気仙沼町)
42. Iwaizaki (岩井崎); Kesennuma-shi (Hashikami-mura, Motoyoshi-gun) 気仙沼市 (本吉郡階上村)
43. Nishikori (西郡); Towa-machi, Tome-gun (Nishikori-mura) 登米郡東和町 (錦織村)
44. Maiya (米谷); Towa-machi, Tome-gun (Maiya-machi) 登米郡東和町 (米谷町)
45. Yamazaki (山崎); Towa-machi, Tome-gun (Maiya-machi) 〃 〃 (〃)
46. Tenjin'noki (天神の木); Towa-machi, Tome-gun (Maiya-machi) 〃 〃 (〃)
47. Rodai (楼台); Towa-machi, Tome-gun (Maiya-machi) 〃 〃 (〃)
48. Toyoma (登米); Toyoma-machi, Tome-gun 登米郡登米町
49. Jusanhama (十三浜); Kitakami-machi, Monoo-gun (Jusanhama-mura) 桃生郡北上町 (十三浜村)
50. Ogatsu (雄勝); Ogatsu-machi, Monoo-gun (Jugohama-mura) 桃生郡雄勝町 (十五浜村)

Fukushima Prefecture (福島県)

51. Tateishi (立石); Kashima-machi, Soma-gun (Kamimano-mura) 相馬郡鹿島町 (上真野村)
52. Uenohata (植の畑); Kashima-machi, Soma-gun (Kamimano-mura) 〃 〃 (〃)
53. Uwano (上野); Kashima-machi, Soma-gun (Kamimano-mura) 〃 〃 (〃)
54. Oashi (大芦); Haranomachi-shi (Ishikami-mura, Soma-gun) 原町市 (相馬郡石神村)
55. Yakuki (八茎); Yotsukura-machi, Iwaki-gun (Ono-mura) 石城郡四倉町 (大野村)
56. Takakurayama (高倉山); Yotsukura-machi, Iwaki-gun (Ono-mura) 〃 〃 (〃)

Ibaragi Prefecture (茨城県)

57. Sugimoto (杉本); Hitachi-shi [Hitachi mine (日立鉱山)]; 日立市
58. Ayukawa (鮎川); Hitachi-shi (Taga-machi, Taga-gun) 日立市 (多賀郡多賀町)

Chiba Prefectue (千葉県)
59. Choshi (銚子); Choshi-shi 銚子市
60. Takagami (高神); Choshi-shi 〃

Inner zone of Northeast Japan [Ni]

Akita Prefecture (秋田県)
1. Yatsumori (八森); Hachimantai-mura, Kazuno-gun 鹿角郡八幡平村

Iwate Prefecture (岩手県)
2. Ohirasawa Kozan (mine)(大平沢鉱山); Ashiro-machi, Ninohe-gun (Tayama-mura) 二戸郡安代町 (田山村)
3. Shin'yu (真湯); Ichinoseki-shi (Kebi-mura, Nishiiwai-gun) 一関市 (西磐井郡厳美村)

Niigata Prefecture (新潟県)
4. Mizutani Kozan (mine) (水谷鉱山); Tsugawa-machi, Higashikambara-gun 東蒲原郡津川町
5. Awagatake (粟ケ岳); Kamo-shi (Nanatako-mura, Nakakambara-gun) 加茂市 (中蒲原郡七谷村)

Fukushima Prefecture (福島県)
6. Inami Kozan (mine) (伊南鉱山); Inami-mura, Minamiaizu-gun 南会津郡伊南村
7. Komagatake (駒ケ岳); Hinoemata-mura, Minamiaizu-gun 南会津郡桧枝岐村

Gumma Prefecture (群馬県)
8. Keizuruyama (景鶴山); Katashina-mura, Tone-gun 利根郡片品村
9. Zensakuzawa (善作沢); Katashina-mura, Tone-gun 〃 〃

Tochigi Prefecture (栃木県)
10. Hanawa (花輪); Kuriyama-mura, Shioya-gun 塩谷郡栗山村
11. Taishakusan (帝釈山); Kuriyama-mura, Shioya-gun 〃 〃

Kwanto massif [Kw]

Ibaragi Prefecture (茨城県)
1. Nanaai (七合); Nanaai-mura, Nishiibaragi-gun 西茨城郡七合村
2. Kasama (笠間); Kasama-shi (Kasama-machi, Nishiibaragi-gun) 笠間市 (西茨城郡笠間町)
3. Oizumi (大泉); Iwase-machi, Nishiibaragi-gun 西茨城郡岩瀬町

Tochigi Prefecture (栃木県)
4. Nabeyama (鍋山); Tochigi-shi (Terao-mura, Shimotsuga-gun) 栃木市 (下都賀郡寺尾村)
5. Izuru (出流); Tochigi-shi (Terao-mura, Shimotsuga-gun) 〃 (〃 〃)
6. Adoyama (アド山); Kuzuu-machi, Aso-gun 安蘇郡葛生町
7. Aizawa (会沢); Kuzuu-machi, Aso-gun 〃 〃
8. Maki (牧); Kuzuu-machi, Aso-gun 〃 〃
9. Kuzuu (葛生); Kuzuu-machi, Aso-gun 〃 〃
10. Mikagura (御神楽); Tanuma-machi, Aso-gun 〃 田沼町

Gumma Prefecture (群馬県)
11. Kawamo (川面); Omama-machi, Yamada-gun (Fukuoka-mura) 山田郡大間々町 (福岡村)

12. Mamba (万場); Mamba-machi, Tano-gun 多野郡万場町
13. Kanosan (叶山); Nakazato-mura, Tano-gun 〃 中里村
14. Kagahara (神ケ原); Nakazato-mura, Tano-gun 〃 〃
15. Okura (大倉); Nanmoku-cho, Kanra-gun (Iwato-mura, Kitakanra-gun) 甘楽郡南牧町 (北甘楽郡磐戸村)
16. Mutsuguruma (六車); Nanmoku-cho, Kanra-gun (Tsukigata-mura, Kitakanra-gun) 〃 〃 (北甘楽郡月形村)
17. Tsukigata (月形); Nanmoku-cho, Kanra-gun (Tsukigata-mura, Kitakanra-gun) 〃 〃 (〃 〃)
18. Shiroi (白井); Ueno-mura, Tano-gun 多野郡上野村

Saitama Prefecture (埼玉県)

19. Kamiyoshida (上吉田); Yoshida-machi, Chichibu-gun (Kamiyoshida-mura) 秩父郡吉田町 (上吉田村)
20. Onagata (女形); Yoshida-machi, Chichibu-gun (Kamiyoshida-mura) 〃 〃 (〃)
21. Futagoyama (双子山); Ogano-machi, Chichibu-gun (Kurao-mura) 〃 小鹿野町 (倉尾村)

22A. Ogamata (大ガマタ); Otaki-mura, Chichibu-gun 〃 大滝村

22. Mujinazawa (ムジナ沢); Otaki-mura, Chichibu-gun 〃 〃
23. Rokusuke (六助); Otaki-mura, Chichibu-gun [Maemonkura (前門倉)] 〃 〃
24. Nakatsugawa (中津川); Otaki-mura, Chichibu-gun 〃 〃
25. Otaki (大滝); Otaki-mura, Chichibu-gun 〃 〃
26. Ryokami (両神); Ryokami-mura, Chichibu-gun 〃 両神村
27. Kagemori (影森); Chichibu-shi (Kagemori-mura, Chichibu-gun) 秩父市 (秩父郡影森村)
28. Kamikagemori (上影森); Chichibu-shi (Kagemori-mura, Chichibu-gun) 〃 (〃 〃)
29. Hinoda (日野田); Chichibu-shi (Chichibu-machi, Chichibu-gun 〃 (〃 秩父町)
30. Bukosan (武甲山); Yokose-mura, Chichibu-gun 秩父郡横瀬村
31. Shomarutoge (正丸峠); Hanno-shi (Agano-mura, Iruma-gun) 飯能市 (入間郡吾野村)
32. Shimokuzu (下久通); Hanno-shi (Agano-mura, Iruma-gun) 〃 (〃 〃)
33. Kamikuzu (上久通); Hanno-shi (Agano-mura, Iruma-gun) 〃 (〃 〃)
34. Asakaido (浅海道); Naguri-mura, Iruma-gun 入間郡名栗村

Tokyo Prefecture (東京都)

35. Hikawa (氷川); Okutama-machi, Nishitama-gun (Hikawa-machi) 西多摩郡奥多摩町 (氷川町)
36. Unazawa (梅沢); Okutama-machi, Nishitama-gun (Hikawa-machi) 〃 〃 (〃)
37. Shiromaru (白丸); Okutama-machi, Nishitama-gun (Furusato-mura) 〃 〃 (古里村)
38. Shozawa (正沢); Ome-shi (Naruki-mura, Nishitama-gun) [Zengosasu (前後指)] 青梅市 (西多摩郡成木村)
39. Raidenyama (雷電山); Ome-shi (Naruki-mura, Nishitama-gun) 〃 (〃 〃)
40. Hinatawada (日向和田); Ome-shi (Ome-machi, Nishitama-gun) 〃 (〃 青梅町)
41. Tamanouchi (玉の内); Hinode-mura, Nishitama-gun (Okuno-mura) 西多摩郡日出村 (大久野村)
42. Kan'yo (肝要); Hinode-mura, Nishitama-gun (Okuno-mura) [Nishinoiri (西の入)] 〃 〃 (〃)
43. Katsuboyama (勝峯山); Ome-shi (Okuno-mura, Nishitama-gun) [Hosoo (細尾)] 青梅市 (西多摩郡大久野村)
44. Itsukaichi (五日市); Itsukaichi-machi, Nishitama-gun 西多摩郡五日市町

Hida massif and Tamba zone [Ht]

Niigata Prefecture (新潟県)

1. Omi (青海); Omi-machi, Nishikubiki-gun 西頸城郡青海町
2. Myojodake (明星岳); Itoigawa-shi (Kotaki-mura, Nishikubiki-gun) 糸魚川市 (西頸城郡小滝村)
3. Kotakigawa (小滝川); Itoigawa-shi (Kotaki-mura, Nishikubiki-gun) 〃 (〃 〃)

Nagano Prefecture (長野県)

4. Ichinosawa (一の沢); Azumi-mura, Minamiazumi-gun 南安曇郡安曇村
5. Iwanadome (常留); Azumi-mura, Minamiazumi-gun 〃 〃
6. Tokugotoge (徳本峠); Azumi-mura, Minamiazumi-gun 〃 〃
7. Shimajima (島々); Azumi-mura, Minamiazumi-gun 〃 〃
8. Azusagawa (梓川); Azumi-mura-Azusagawa-mura, Minamiazumi-gun 〃 安曇村-梓川村
9. Sawando (沢渡); Azumi-mura, Minamiazumi-gun 〃 〃
10. Utoyama (善知鳥山); Shiojiri-shi (Chikuma-mura, Higashichikuma-gun) 塩尻市 (東筑摩郡筑摩村)
11. Yokokawa (横川); Tatsuno-machi, Kamiina-gun (Kawashima-mura) 上伊那郡辰野町 (川島村)
12. Kuwazawa (桑沢); Tatsuno-machi, Kamiina-gun (Inatomi-mura) 〃 〃 (伊那富村)
13. Narai (奈良井); Narakawa-mura, Nishichikuma-gun 西筑摩郡楢川村
14. Misogawa (味噌川); Kiso-mura, Nishichikuma-gun 〃 木祖村
15. Yabuhara (藪原); Kiso-mura, Nishichikuma-gun 〃 〃
16. Agematsu (上松); Agematsu-machi, Nishichikuma-gun 〃 上松町

Gifu Prefecture (岐阜県)

17. Kamitakara (上宝); Kamitakara-mura, Yoshiki-gun 吉城郡上宝村
18. Hongo (本郷); Kamitakara-mura, Yoshiki-gun 〃 〃
19. Kunimiyama (国見山); Kamitakara-mura, Yoshiki-gun 〃 〃
20. Kurahashira (蔵柱); Kamitakara-mura, Yoshiki-gun 〃 〃
21. Moribu (森部); Nyukawa-mura, Ono-gun 大野郡丹生川村
22. Arakigawa (荒城川); Nyukawa-mura, Ono-gun 〃 〃
23. Kamihirose (上広瀬); Takayama-shi (Kokufu-mura, Yoshiki-gun) 高山市 (吉城郡国府村)
24. Kansaka (神坂); Kamitakara-mura, Yoshiki-gun 吉城郡上宝村
25. Sorayama (空山); Kamitakara-mura, Yoshiki-gun 〃 〃
26. Fukuji (福地); Kamitakara-mura, Yoshiki-gun 〃 〃
27. Ichinotani (一の谷); Kamitakara-mura, Yoshiki-gun 〃 〃
28. Osobudani (尾添谷); Kamitakara-mura, Yoshiki-gun 〃 〃
29. Mizuyagadani (水屋ケ谷); Kamitakara-mura, Yoshiki-gun 〃 〃
30. Hirayu (平湯); Kamitakara-mura, Yoshiki-gun 〃 〃
31. Ozu (大洲); Nyukawa-mura, Ono-gun [Kute (久手)] 大野郡丹生川村
32. Sote (曽手); Nyukawa-mura, Ono-gun 〃 〃
33. Junigatake (十二ケ岳); Nyukawa-mura, Ono-gun 〃 〃
34. Nakahata (中畑); Nyukawa-mura, Ono-gun 〃 〃
35. Shiroi (白井); Nyukawa-mura, Ono-gun 〃 〃
36. Gombo (根方); Nyukawa-mura, Ono-gun 〃 〃
37. Kono (小野); Nyukawa-mura, Ono-gun [Urita (瓜田)] 〃 〃
38. Shioya (塩屋); Takayama-shi (Ohachiga-mura, Ono-gun) 高山市 (大野郡大八賀村)
39. Kiyomi (清見); Kiyomi-mura, Ono-gun 大野郡清見村
40. Oppara (大原); Kiyomi-mura, Ono-gun 〃 〃
41. Okuzumi (奥住); Okumyogata-mura, Gujo-gun [Akiyama (明山)] 郡上郡奥明方村

42. Okumyogata (奥明方); Okumyogata-mura, Gujo-gun 郡上郡奥明方村
43. Hachiman (八幡); Hachiman-cho, Gujo-gun [Shimadani (島谷)] 〃 八幡町
44. Kuchibora (口洞); Hachiman-cho, Gujo-gun (Nishiwara-mura) 〃 〃 (西和良村)
45. Akuda (安久田); Hachiman-cho, Gujo-gun 〃 〃
46. Tominoho (富之保); Mugi-mura, Mugi-gun (Tominoho-mura) 武儀郡武儀村 (富之保村)
47. Mandokoro (万所); Miyama-mura, Yamagata-gun (Kitayama-mura) 山県郡美山村 (北山村)
48. Funafuseyama (船伏山); Miyama-mura, Yamagata-gun (Kitayama-mura) 〃 〃 (〃)
49. Kanzaki (神崎); Miyama-mura, Yamagata-gun (Kitayama-mura) 〃 〃 (〃)
50. Taniai (谷合); Miyama-mura, Yamagata-gun (Taniai-mura) 〃 〃 (谷合村)
51. Samondake (左門岳); Neo-mura, Motosu-gun 本巣郡根尾村
52. Tokuyama (徳山); Tokuyama-mura. Ibi-gun 揖斐郡徳山村
53. Oya (親); Fujihashi-mura, Ibi-gun 揖斐郡藤橋村
54. Yokoyama (横山); Fujihashi-mura, Ibi-gun 〃 〃
55. Tenguyama (天狗山); Sakauchi-mura, Ibi-gun 〃 坂内村
56. Sakauchi (坂内); Sakauchi-mura, Ibi-gnn 〃 〃
57. Uoganeyama (魚金山); Neo-mura, Motosu-gun 本巣郡根尾村
58. Ishiyama (石山); Ono-machi, Ibi-gun 揖斐郡大野町
59. Noharadani (野原谷); Kasuga-mura, Ibi-gun 〃 春日村
60. Umetani (梅谷); Tarui-machi, Fuwa-gun (Fuchu-mura) 不破郡垂井町 (府中村)
61. Sasamata (笹又); Kasuga-mura, Ibi-gun 揖斐郡春日村
62. Otaki (大滝); Tarui-machi, Fuwa-gun (Iwate-mura) 不破郡垂井町 (岩手村)
63. Oishi (大石); Tarui-machi, Fuwa-gun (Iwate-mura) 〃 〃 (〃)
64. Kasuga (春日); Kasuga-mura, Ibi-gun [Kasukawa (粕川)] 揖斐郡春日村
65. Akasaka (赤坂); Akasaka-machi, Fuwa-gun 不破郡赤坂町
66. Matsuoyama (松尾山); Sekigahara-machi, Fuwa-gun 〃 関ヶ原町
67. Yoro (養老); Yoro-cho, Yoro-gun 養老郡養老町
68. Iwakurayama (岩倉山); Sekigahara-machi, Fuwa-gun 不破郡関ヶ原町
69. Tokiyama (時山); Kamiishizu-mura, Yoro-gun (Toki-mura) 養老郡上石津村 (時村)
70. Itoshiro (石徹白); Shiratori-machi, Gujo-gun (Itoshiro-mura, Ono-gun, Fukui Prefecture) 郡上郡白鳥町 (福井県大野郡石徹白村)
71. Shimozaisho (下在所); Shiratori-machi, Gujo-gun (Itoshiro-mura, Ono-gun, Fukui Prefecture) 〃 〃 (〃 〃 〃)

Fukui Prefecture (福井県)

72. Otani (大谷); Izumi-mura, Ono-gun (Kamianama-mura) 大野郡和泉村 (上穴馬村)
73. Nojiri (野尻); Izumi-mura, Ono-gun (Kamianama-mura) [Komukudani (小椋谷)] 〃 〃 (〃)
74. Ashidani (芦谷); Izumi-mura, Ono-gun (Kamianama-mura) 〃 〃 (〃)
75. Kamianama (上穴馬); Izumi-mura, Ono-gun (Kamianama-mura) 〃 〃 (〃)
76. Isetoge (伊勢峠); Izumi-mura, Ono-gun (Kamiana-mura) [Makatoji (マカトジ)] 〃 〃 (〃)
77. Fujikuradani (藤倉谷); Izumi-mura, Ono-gun (Nishinotani-mura) 〃 〃 (西谷村)
78. Akyu (秋生); Nishitani-mura, Ono-gun 大野郡西谷村
79. Motodo (本戸); Nishitani-mura, Ono-gun 〃 〃
80. Nishitani (西谷); Nishitani-mura, Ono-gun [Ananori (穴乗), Kumokawa (雲川)] 〃 〃
81. Takura (宅良); Imajo-machi, Nanjo-gun (Takura-mura) 南条郡今庄町 (宅良村)
82. Yunoo (湯尾); Imajo-machi, Nanjo-gun (Yunoo-mura) 〃 〃 (湯尾村)
83. Takakura (高倉); Imajo-machi, Nanjo-gun (Takura-mura) 〃 〃 (宅良村)
84. Nanjo (南条); Nanjo-gun 〃

85. Imajo (今庄); Imajo-machi, Nanjo-gun (Imajo-mura) 南条郡今庄町 (今庄村)
86. Kochi (河内); Mikata-machi, Mikata-gun (Nishida-mura) 三方郡三方町 (西田村)
87. Miyakawa (宮川); Obama-shi (Miyakawa-mura, Onyu-gun) 小浜市 (遠敷郡宮川村)
88. Aoi (青井); Obama-shi (Obama-machi, Onyu-gun) 〃 (〃 小浜町)
89. Kato (加斗); Obama-shi (Kato-mura, Oi-gun) 〃 (大飯郡加斗村)
90. Oi (大飯); Oi-machi, Oi-gun 大飯郡大飯町

Shiga Prefecture (滋加県)

91. Deguchi (出口); Kinomoto-cho, Ika-gun (Sugino-mura) [Tsuchikura (土倉)] 伊香郡木之本町 (杉野村)
92. Takayama (高山); Asai-machi, Higashiasai-gun (Kamikusano-mura) 東浅井郡浅井町 (上草野村)
93. Otaniyama (小谷山); Kohoku-cho, Higashiasai-gun (Otani-mura) 〃 湖北町 (小谷村)
94. Ashimatagawa (足俣川); Ibuki-mura, Sakata-gun (Higashikusano-mura, Higashiasai-gun) [Anegawa (姉川)] 坂田郡伊吹村 (東浅井郡東草野村)
95. Itanami (板並); Ibuki-mura, Sakata-gun (Higashikusano-mura, Higashiasai-gun) 〃 〃 (〃 〃)
96. Ibukiyama (伊吹山); Ibuki-mura, Sakata-gun 〃 〃
97. Yataka (弥高); Ibuki-mura, Sakata-gun (Suisho-mura) [Iwasayama (岩佐山)] 〃 〃 (春照村)
98. Onogi (大野木); Santo-cho, Sakata-gun (Kashiwabara-mura) 〃 山東町 (柏原村)
99. Kiyotaki (清滝); Santo-cho, Sakata-gun (Kashiwabara-mura) [Manganji (満願寺)] 〃 〃 (〃)
100. Samegai (醒井); Maibara-machi, Sakata-gun (Samegai-mura) 〃 米原町 (醒井村)
101. Ryozen (霊仙); Taga-machi, Inukami-gun (Wakigahata-mura) 犬上郡多賀町 (脇ヶ畑村)
102. Inukami (犬上); Inukami-gun 〃
103. Ibaragawa (茨川); Eigenji-mura, Kanzaki-gun (Higashiogura-mura, Echi-gun) 神崎郡永源寺村 (愛知郡東小椋村)

Mié Prefecture (三重県)

104. Kurakaketoge (鞍掛峠); Fujiwara-mura, Inabe-gun (Nishifujiwara-mura) 員弁郡藤原村 (西藤原村)
105. Fujiwaradake (藤原岳); Fujiwara-mura, Inabe-gun (Higashifujiwara-mura) 〃 〃 (東藤原村)

Kyoto Prefecture (京都府)

106. Kurama (鞍馬); Kita-ku, Kyoto-shi (Kurama-mura, Otagi-gun) 京都市北区 (愛宕郡鞍馬村)
107. Kumogahata (雲ヶ畑); Kita-ku, Kyoto-shi (Kumogahatake-mura, Otagi-gun) 〃 〃 (愛宕郡雲ヶ畑村)
108. Iwakura (岩倉); Kita-ku, Kyoto-shi (Iwakura-mura, Otagi-gun) 〃 〃 (愛宕郡岩倉村)
109. Ichihara (市原); Kita-ku, Kyoto-shi (Shizuichino-mura, Otagi-gun) 〃 〃 (愛宕郡静市野村)
110. Sonobe (園部); Sonobe-machi, Funai-gun 船井郡園部町
111. Shinmito (新水戸); Tamba-machi, Funai-gun (Takeno-mura) 〃 丹波町 (竹野村)
112. Nishiyama (西山); Ukyo-ku, Kyoto-shi 京都市右京区
113. Nishibetsuin (西別院); Kameoka-shi (Nishibetsuin-mura, Minamikuwada-gun) 亀岡市 (南桑田郡西別院村)

Osaka Prefecture (大阪府)

114. Meigetsutoge (名月峠); Nose-machi, Toyono-gun (Nishinose-mura) [Osakatoge (逢坂峠)] 豊能郡能勢町 (西能勢村)
115. Nosé (能勢); Nose-machi, Toyono-gun (Nishinose-mura) 〃 〃 (〃)
116. Tano (田能); Takatsuki-shi (Takatsuki-machi, Mishima-gun) [Izuruha (出灰)] 高槻市 (三島郡高槻町)
117. Takatsuki (高槻); Takatsuki-shi (Takatsuki-machi, Mishima-gun) 〃 (〃 〃)
118. Mino (箕面); Mino-shi (Mino-mura, Toyono-gun) 箕面市 (豊能郡箕面村)

Hyogo Prefecture (兵庫県)

119. Furue (古江); Kawanishi-shi (Tada-mura, Kawabe-gun) 川西市 (川辺郡多田村)
120. Tada (多田); Kawanishi-shi (Tada-mura, Kawabe-gnn) 〃 (〃 〃)
121. Taki (多紀); Taki-machi, Taki-gun 多紀郡多紀町
122. Sasayama (篠山); Sasayama-machi, Taki-gun 〃 篠山町
123. Manajo (真南条); Tannan-cho, Taki-gun (Jonan-mura) 〃 丹南町 (城南村)
124. Ikuno (生野); Ikuno-machi, Asako-gun 朝来郡生野町
125. Kametsubo (亀坪); Fukuzaki-machi, Kanzaki-gun (Tahara-mura) 神崎郡福崎町 (田原村)

Inner zone of Southwest Japan [Swi]

Maizuru zone

Fukui Prefecture (福井県)

1. Takarao (宝尾); Takahama-machi, Oi-gun 大飯郡高浜町

Kyoto Prefecture (京都府)

2. Maizuru (舞鶴); Maizuru-shi [Oura (大浦半島)] 舞鶴市
3. Shidaka (志高); Maizuru-shi (Okadashimo-mura, Kasa-gun) [Shimomitani (下見谷)] 鶴舞市 (加佐郡岡田下村)
4. Hatta (八田); Ayabe-shi (Nishihatta-mura, Ikaruga-gun) 綾部市 (何鹿郡西八田村)
5. Komori (河守); Oe-machi, Kasa-gun (Komori-machi) 加佐郡大江町 (河守町)
6. Kawahigashi (河東); Oe-machi, Kasa-gun (Kawahigashi-mura) [Katsuradani (桂谷)] 〃 〃 (河東村)
7. Oe (大江); Oe-machi, Kasa-gun 〃 〃
8. Gujo (公庄); Oe-machi, Kasa-gun (Kawanishi-mura) 〃 〃 (河西村)
9. Kawanishi (河西); Oe-machi, Kasa-gun (Kawanishi-mura) 〃 〃 (〃)
10. Nukada (額田); Yakuno-machi, Amada-gun (Shimoyakuno-mura) 天田郡夜久野町 (下夜久野村)
11. Chihara (千原); Yakuno-machi, Amada-gun (Shimoyakuno-mura) 〃 〃 (〃)

Hyogo Prefecture (兵庫県)

12. Hikami (氷上); Hikami-machi, Hikami-gun 氷上郡氷上町
13. Nakayashiro (中八代); Asako-machi, Asako-gun (Yamaguchi-mura) 朝来郡朝来町 (山口村)
14. Miharaiyama (御抜山); Oya-machi. Yabu-gun (Kuchioya-mura) 養父郡大屋町 (口大屋村)
15. Oya (大屋); Oya-machi, Yabu-gun (Oya-mura) 〃 〃 (大屋村)
16. Minamitani (南谷); Oya-machi, Yabu-gun (Minamitani-mura) 〃 〃 (南谷村)
17. Surugamine (須留峯); Oya-machi, Yabu-gun (Minamitani-mura) 〃 〃 (〃)
18. Akenobe (明延); Oya-machi, Yabu-gun (Minamitani-mura) 〃 〃 (〃)
19. Kuratoko (倉床); Ichinomiya-machi, Shiso-gun (Hansei-mura) 宍粟郡一宮町 (繁盛村)

20. Iuchi (井内); Ichinomiya-machi, Shiso-gun (Hansei-mura) 宍栗郡一宮町 (繁盛村)
21. Yokoyama (横山); Ichinomiya-machi, Shiso-gun (Hansei-mura) 〃 〃 (〃)
22. Mikata (三方); Ichinomiya-machi, Shiso-gun (Mikata-mura) 〃 〃 (三方村)
23. Hijima (土万); Yamazaki-machi, Shiso-gun (Hijima-mura) 〃 山崎町 (土万村)
24. Yamazaki (山崎); Yamazaki-machi, Shiso-gun 〃 〃
25. Mikazuki (三日月); Mikazuki-machi, Sayo-gun 佐用郡三日月町
26. Yokozeki (横関); Himeji-shi 姫路市

Okayama Prefecture (岡山県)

27. Kose (巨勢); Mimasaka-machi, Aida-gun (Kose-mura) 英田郡美作町 (巨勢村)
28. Fukumoto (福本); Aida-machi, Aida-gun (Fukumoto-mura) 〃 英田町 (福本村)
29. Dodo (百々); Yanahara-machi, Kume-gun (Kitawake-mura, Katsuta-gun) 久米郡柵原町 (勝田郡北和気村)
30. Kanagawa (金川); Mitsu-machi, Mitsu-gun (Kanagawa-machi) 御津郡御津町 (金川町)

Chugoku massif

Okayama Prefecture (岡山県)

31. Azai (砦部); Hokubo-cho, Jobo-gun (Azai-machi) 上房郡北房町 (砦部町)
32. Nagoe (名越); Niimi-shi (Toyonaga-mura, Atetsu-gun) 新見市 (阿哲郡豊永村)
33. Mitsudo (光遠); Niimi-shi (Toyonaga-mura, Atetsu-gun) 〃 (〃 〃)
34. Maki (槇); Niimi-shi (Toyonaga-mura, Atetsu-gun) 〃 (〃 〃)
35. Kanikawa (蟹川); Hokubo-cho, Jobo-gun (Nakatsui-mura) 上房郡北房町 (中津井村)
36. Sabushi (佐伏); Niimi-shi (Toyonaga-mura, Atetsu-gun) 新見市 (阿哲郡豊永村)
37. Terauchi (寺内); Niimi-shi (Toyonaga-mura, Atetsu-gun 〃 (〃 〃)
38. Kodani (小谷); Niimi-shi (Toyonaga-mura, Atetsu-gun) 〃 (〃 〃)
39. Toyonaga (豊永); Niimi-shi (Toyonaga-mura, Atetsu-gun) [Iwamoto (岩本)] 〃 (〃 〃)
40. Shoyama (正山); Niimi-shi (Toyonaga-mura, Atetsu-gun) 〃 (〃 〃)
41. Yukawa (湯川); Niimi-shi (Kusama-mura, Atetsu-gun) 〃 (〃 草間村)
42. Ishiga (石蟹); Niimi-shi (Ishigasato-mura, Atetsu-gun) 〃 (〃 石蟹郷村)
43. Fukiya (吹屋); Nariwa-machi, Kawakami-gun (Fukiya-machi) 川上郡成羽町 (吹屋町)
44. Uji (宇治); Takahashi-shi (Uji-mura, Kawakami-gun) 高梁市 (川上郡宇治村)
45. Hane (羽根); Nariwa-machi, Kawakami-gun (Naka-mura) [Nakamura (中村)] 川上郡成羽町 (中村)
46. Nariwa (成羽); Nariwa-machi, Kawakami-gun 川上郡成羽町
47. Oga (大賀); Kawakami-machi, Kawakami-gun (Oga-mura) 川上郡川上町 (大賀村)
48. Fuka (富家); Bitchu-machi, Kawakami-gun (Fuka-mura) 川上郡備中町 (富家村)
49. Koyama (高山); Kawakami-machi, Kawakami-gun (Koyama-mura) 川上郡川上町 (高山村)
50. Kurohagi (黒萩); Bisei-cho, Oda-gun (Hinosato-mura, Kawakami-gun) 小田郡美星町 (川上郡日里村)
51. Mihara (三原); Yoshii-machi, Shitsuki-gun (Mihara-mura) 後月郡芳井町 (三原村)
52. Hina (日南); Yoshii-machi, Shitsuki-gun (Kyowa-mura) 〃 〃 (共和村)
53. Yoshii (芳井); Yoshii-machi, Shitsuki-gun 〃 〃

Hiroshima Prefecture (広島県)

54. Uyama (宇山); Tojo-machi, Hiba-gun (Taishaku-mura) [Higashiuyama (東宇山), Nishiuyama (西宇山)] 比婆郡東城町 (帝釈村)
55. Maedani (前谷); Tojo-machi, Hiba-gun (Taishaku-mura) 比婆郡東城町 (帝釈村)
56. Tameshige (為重); Tojo-machi, Hiba-gun (Kushiro-mura) 〃 〃 (久代村)
57. Miharano (三原野) [=Miharanoro]; Tojo-machi, Hiba-gun (Kushiro-mura) 〃 〃 (〃)

58. Yasumoto (保元); Tojo-machi, Hiba-gun (Taishaku-mura) [Idaniyama (猪谷山)] 比婆郡東城町 (帝釈村)
59. Taishaku (帝釈); Tojo-machi, Hiba-gun (Taishaku-mura) [Eimyoji (永明寺), Notabiyama (野旅山)] 〃 〃 (〃)
60. Dangyokei (断魚溪); Tojo-machi, Hiba-gun (Taishaku-mura) 〃 〃 (〃)
61. Unada (宇那田); Tojo-machi, Hiba-gun (Shinsaka-mura, Jinseki-gun) 〃 〃 (神石郡新坂村)
62. Yamano (山野); Kamo-machi, Fukayasu-gun (Yamano-mura) 深安郡加茂町 (山野村)
63. Kotohara (琴原); Kamo-machi, Fukayasu-gun (Yamano-mura) 〃 〃 (〃)
64. Yakawa (矢川); Kamo-machi, Fukayasu-gun (Yamano-mura) 〃 〃 (〃)
65. Kobatake (小畠); Sanwa-machi, Jinseki-gun (Kobatake-mura) 神石郡三和町 (小畠村)
66. Joé (城江); Sanwa-machi, Jinseki-gun (Kami-mura) 〃 〃 (上村)
66A. Yuki (油木); Yuki-machi, Jinseki-gun 〃 油木町
67. Kurome (黒目); Soryo-machi, Konu-gun (Ryoke-mura) 甲奴郡総領町 (領家村)
67A. Kuregatoge (呉ケ峠); Jinseki-cho, Jinseki-gun (Fukunaga-mura) 神石郡神石町 (福永村)
68. Fuchu (府中); Fuchu-shi (Fuchu-machi, Ashina-gun) 府中市 (芦品郡府中町)
69. Karita (刈田); Yachiyo-machi, Takata-gun (Karita-mura) 高田郡八千代町 (刈田村)
70. Yoshiwa (吉和); Yoshiwa-mura, Saiki-gun 佐伯郡吉和村
71. Hosomidani (細見谷); Yoshiwa-mura, Saiki-gun 〃 〃

Shimane Prefecture (島根県)

72. Nichihara (日原); Nichihara-machi, Kanoashi-gun (Nichihara-mura) 鹿足郡日原町 (日原村)
73. Sasagatani (笹谷); Tsuwano-machi, Kanoashi-gun (Hatasako-mura) 〃 津和野町 (畑迫村)
74. Hatagasako (畑迫); Tsuwano-machi, Kanoashi-gun (Hatasako-mura) 〃 〃 (〃)

Yamaguchi Prefecture (山口県)

75. Koda (神田); Ato-cho, Abu-gun (Kane-mura) [Izuto (出戸)] 阿武郡阿東町 (嘉年村)
76. Kane (嘉年); Ato-cho, Abu-gun (Kane-mura) 〃 〃 (〃)
77. Zomeki (蔵目喜); Ato-cho, Abu-gun (Ikumo-mura) 〃 〃 (生雲村)
78. Hirawarabi (平蕨); Fukue-mura, Abu-gun (Fukugawa-mura) 〃 福栄村 (福川村)
79. Handa (半田); Fukue-mura, Abu-gun (Fukugawa-mura) [Mugitani (麦谷)] 〃 〃 (〃)
80. Ikadaba (筏場); Kawakami-mura, Abu-gun 〃 川上村
81. Kyodoko (京床); Kawakami-mura, Abu-gun 〃 〃
82. Aratani (荒谷); Yamaguchi-shi (Miyano-mura, Yoshiki-gun) 山口市 (吉敷郡宮野村)
83. Suzumiyama (涼山); Yamaguchi-shi (Miyano-mura, Yoshiki-gun) 〃 (〃 〃)
84. Miyano (宮野); Yamaguchi-shi (Miyano-mura, Yoshiki-gun) 〃 (〃 〃)
85. Kaerimizu (帰り水); Mito-cho, Mine-gun (Akago-mura) 美弥郡美東町 (赤郷村)
86. Katada (堅田); Shuho-cho, Mine-gun (Beppu-mura) 〃 秋芳町 (別府村)
87. Kawarakami (河原上); Shuho-cho, Mine-gun (Beppu-mura) 〃 〃 (〃)
88. Serita (芹田); Shuho-cho, Mine-gun (Beppu-mura) [Sambonmatsu (三本松)] 〃 〃 (〃)
89. Ryugenji (竜現寺); Miné-shi (Ofuku-mura, Mine-gun) 美弥市 (美弥郡於福村)
90. Ofuku (於福); Miné-shi (Ofuku-mura, Mine-gun) 〃 (〃 〃)
91. Dai (台); Toyoda-machi, Toyora-gun (Nishiichi-machi) 豊浦郡豊田町 (西市町)
92. Maki (真木); Miné-shi (Omine-machi, Mine-gun) [Tsutsumi (堤)] 美弥市 (美弥郡大嶺町)
93. Tsunemori (常森); Miné-shi (Omine-machi, Mine-gun) 〃 (〃 〃)
94. Shiraiwa (白岩); Miné-shi (Omine-machi, Mine-gun) 〃 (〃 〃)

95. Aigyo (相行); Miné-shi (Omine-machi, Mine-gun) 美弥市 (美弥郡大嶺町)
96. Oda [=Ota] (太田); Mito-cho, Mine-gun (Oda-machi) 美弥郡美東町 (太田町)
97. Tobinosu (鳶巣); Mito-cho, Mine-gun (Oda-machi) [Okubo (大久保)] 美弥郡美東町 (太田町)
98. Tsuzumigatake (鼓ケ岳); Mito-cho, Mine-gun (Oda-machi) 〃 〃 (〃)
99. Yaegahara (八重原); Shuho-cho, Mine-gun (Akiyoshi-mura) 〃 秋芳町 (秋吉村)
100. Akiyoshi (秋吉); Shuho-cho, Mine-gun (Akiyoshi-mura) 〃 〃 (〃)
101. Aratakiyama (荒滝山); Kusunoki-cho, Asa-gun (Kibe-mura) 厚狭郡楠町 (吉部村)
102. Futagami (二神); Mine-shi (Isa-machi, Mine-gun) 美弥市 (美弥郡伊佐町)
103. Isa (伊佐); Mine-shi (Isa-machi, Mine-gun) 〃 (〃 〃)

Fukuoka Prefecture (福岡県)
104. Aohama (青浜); Moji-ku, Kitakyushu-shi (Moji-shi) 北九州市門司区 (門司市)
105. Tokuriki (徳力); Kokura-ku, Kitakyushu-shi (Kokura-shi) 〃 小倉区 (小倉市)

Outer zone of Southwest Japan [Swo]

Shizuoka Prefecture (静岡県)
1. Miyakoda (都田); Hamamatsu-shi (Miyakoda-mura, Inasa-gun) 浜松市 (引佐郡都田村)
2. Iinoya (井伊谷); Inasa-machi, Inasa-gun (Iinoya-mura) 引佐郡引佐町 (井伊谷村)

Mié Prefecture (三重県)
3. Kamishima (神島); Toba-shi (Kamishima-mura, Shima-gun) 鳥羽市 (志摩郡神島村)
4. Ise (伊勢); Ise-shi (Ujiyamada-shi) 伊勢市 (宇治山田市)
5. Omurajima (大村島); Toba-shi (Kagamiura-mura, Shima-gun) 鳥羽市 (志摩郡鏡浦村)
6. Iwakura (岩倉); Toba-shi (Kamo-mura, Shima-gun) [Kochi (河内)] 〃 (〃 加茂村)
7. Aomine (青峰); Toba-shi (Kamo-mura, Shima-gun) 〃 (〃 〃)
8. Isobe (磯部); Isobe-machi, Shima-gun (Isobe-mura) 志摩郡磯部町 (磯部村)
9. Koraihiro (高麗広); Ise-shi (Ujiyamada-shi) 伊勢市 (宇治山田市)
10. Kirihara (切原); Nansei-cho, Watarai-gun (Gokasho-mura) 度会郡南勢町 (五ケ所村)
11. Izumimura (泉村); Nansei-cho, Watarai-gun (Kambara-mura) 〃 〃 (神原村)
12. Yokowa (横輪); Ise-shi (Numaki-mura, Watarai-gun) 伊勢市 (度会郡沼木村)
13. Ryusenzan (竜仙山); Nansei-cho, Watarai-gun (Gokasho-mura) 度会郡南勢町 (五ケ所村)
14. Ogawago (小川郷); Watarai-mura, Watarai-gun (Ogawago-mura) 〃 度会村 (小川郷村)
15. Ichinose (一の瀬); Watarai-mura, Watarai-gun (Ichinose-mura) 〃 〃 (一之瀬村)
16. Nakamura (中村); Watarai-mura, Watarai-gun (Ichinose-mura) 〃 〃 (〃)
17. Nomisaka (能見坂); Nanto-cho, Watarai-gun (Nakajima-mura) 〃 南島町 (中島村)
18. Aso (阿曽); Omiya-machi, Watarai-gun (Takihara-mura) 〃 大宮町 (滝原村)
19. Osugidani (大杉谷); Miyagawa-mura, Taki-gun (Osugidani-mura) 多気郡宮川村 (大杉谷村)

Nara Prefecture (奈良県)
20. Seto (瀬戸); Kawakami-mura, Yoshino-gun 吉野郡川上村
21. Kotako (上多古); Kawakami-mura, Yoshino-gun 吉野郡川上村
22. Shiroyadake (白屋岳); Kawakami-mura, Yoshino-gun 〃 〃
23. Gyojagaeri (行者還); Tennokawa-mura, Yoshino-gun 〃 天川村
24. Nishiyoshino (西吉野); Nishiyoshino-mura, Yoshino-gun 〃 西吉野村

Wakayama Prefecture (和歌山県)

25. Koyasan (高野山); Koya-machi, Ito-gun 伊都郡高野町
26. Hosokawa (細川); Koya-machi, Ito-gun 〃 〃
27. Onishi (大西); Kanaya-machi, Arita-gun (Sashiki-mura) 有田郡金屋町 (五西月村)
28. Awao (粟生); Kanaya-machi, Arita-gun (Iwakura-mura) 〃 〃 (岩倉村)
29. Itogawa (糸川); Kanaya-machi, Arita-gun (Ishigaki-mura) 〃 〃 (石垣村)
30. Minoshima (簑島); Arita-shi (Minoshima-machi, Arita-gun) [Otokoura (男浦)] 有田市 (有田郡簑島町)
31. Hota (保田); Arita-shi (Hota-mura, Arita-gun) 有田市 (有田郡保田村)
32. Ukiishi (浮石); Yuasa-machi, Arita-gun (Hota-mura) [Kirisaki (霧崎)] 有田郡湯浅町 (保田村)
33. Yuasa (湯浅); Yuasa-machi, Arita-gun 有田郡湯浅町
34. Ena (衣奈); Yura-machi, Hidaka-gun (Ena-mura) [Hokaji (法華寺)] 日高郡由良町 (衣奈村)
35. Shirasaki (白崎); Yura-machi, Hidaka-gun (Shirasaki-mura) 〃 〃 (白崎村)
36. Yura (由良); Yura-machi, Hidaka-gun (Yura-mura) 〃 〃 (由良村)

Tokushima Prefecture (徳島県)

37. Ten'nodani (天王谷); Komatsushima-shi (Komatsushima-machi, Katsuura-gun) 小松島市 (勝浦郡小松島町)
38. Yokose (横瀬); Katsuura-machi, Katsuura-gun (Yokose-machi) 勝浦郡勝浦町 (横瀬町)
39. Kusune (楠根); Anan-shi (Kamodani-mura, Naka-gun) 阿南市 (那賀郡加茂谷村)
40. Fukase (深瀬); Anan-shi (Kamodani-mura, Naka-gun) 〃 (〃 〃)
41. Kamodani (加茂谷); Anan-shi (Kamodani-mura, Naka-gun) 〃 (〃 〃)
42. Daigo (醍醐); Anan-shi (Kamodani-mura, Naka-gun) 〃 (〃 〃)
43. Wakasugi (若杉); Anan-shi (Kamodani-mura, Naka-gun) 〃 (〃 〃)
44. Otai (大田井); Anan-shi (Kamodani-mura, Naka-gun) 〃 (〃 〃)
45. Umaji (馬路); Aioi-machi, Naka-gun (Aioi-mura) 那賀郡相生町 (相生村)
46. Fukuhara (福原); Kamikatsu-machi, Katsuura-gun (Fukuhara-mura) 勝浦郡上勝町 (福原村)
47. Yaeji (八重地); Kamikatsu-machi, Katsuura-gun (Fukuhara-mura) 〃 〃 (〃)
48. Takano (高野); Kisawa-mura, Naka-gun (Sawadani-mura) 那賀郡木沢村 (沢谷村)
49. Sawadani (沢谷); Kisawa-mura, Naka-gun (Sawadani-mura) 〃 〃 (〃)
50. Sakuradani (桜谷); Kaminaka-cho, Naka-gun (Miyahama-mura) 〃 上那賀町 (宮浜村)
51. Miyahama (宮浜); Kaminaka-cho, Naka-gun (Miyahama-mura) 〃 〃 (〃)
52. Hisone (桧曽根); Kaminaka-cho, Naka-gun (Miyahama-mura) 〃 〃 (〃)
53. Haigyu (拝宮); Kaminaka-cho, Naka-gun (Miyahama-mura) 〃 〃 (〃)
54. Sakashu (坂州); Kisawa-mura, Naka-gun (Sakashukito-mura) 〃 木沢村 (坂州木頭村)
55. Ottate (追立); Kisawa-mura, Naka-gun (Sakashukito-mura) 〃 〃 (〃)
56. Kenzan (剣山); Kisawa-mura, Naka-gun (Sawadani-mura) 〃 〃 (沢谷村)

Kochi Prefecture (高知県)

57. Nurui (沼井); Monobe-mura, Kami-gun (Kaminirao-mura) [Donooka (堂の岡)] 香美郡物部村 (上韮生村)
58. Kambayama (勘場山); Monobe-mura, Kami-gun (Kaminirao-mura) 〃 〃 (〃)
59. Gozaishoyama (御在所山); Monobe-mura, Kami-gun (Zaisho-mura) 香美郡物部村 (在所村)
60. Taniai (谷相); Kahoku-machi, Kami-gun (Zaisho-mura) 〃 香北町 (在所村)
61. Miyanokuchi (宮の口); Tosayamada-machi, Kami-gun (Kataji-mura) 〃 土佐山田町 (片地村)
62. Aritani (有谷); Tosayamada-machi, Kami-gun (Saoka-mura) [Saoka (佐岡)] 〃 〃 (佐岡村)

63. Sambosan (三宝山); Noichi-machi, Kami-gun 香美郡野市町
64. Yasuba (休場); Tosayamada-machi, Kami-gun (Shinkai-mura, Nagaoka-gun) 〃 土佐山田町 (長岡郡新改村)
65. Shinkai (新改) [=Shingai]; Tosayamada-machi, Kami-gun (Shinkai-mura, Nagaoka-gun) 〃 〃 (〃 〃)
66. Kameiwa (亀岩); Nangoku-shi (Kameiwa-mura, Nagaoka-gun) 南国市 (長岡郡亀岩村)
67. Shirakidani (白木谷); Nangoku-shi (Agekura-mura, Nagaoka-gun) 〃 (〃 上倉村)
68. Tosayama (土佐山); Tosayama-mura, Tosa-gun 土佐郡土佐山村
69. Kamiyakawa (上八川); Gohoku-mura, Agawa-gun (Kamiyakawa-mura) 吾川郡吾北村 (上八川村)
70. Shogase (勝賀瀬); Ino-machi, Agawa-gun (Mitsuse-mura) 〃 伊野町 (三瀬村)
71. Ishimi (石見); Ino-machi, Agawa-gun (Mitsuse-mura) 〃 〃 (〃)
72. Kamoike (鴨池); Hitaka-mura, Takaoka-gun (Notsu-mura) 高岡郡日高村 (能津村)
73. Shimoyakawa (下八川); Gohoku-mura, Agawa-gun (Shimoyakawa-mura) 吾川郡吾北村 (下八川村)
74. Asao (浅尾); Sakawa-machi, Takaoka-gun (Kuroiwa-mura) 高岡郡佐川町 (黒岩村)
75. Yokobatake (横畠); Ochi-machi, Takaoka-gun (Yokobatake-mura, Agawa-gun) [Donooka (堂岡)] 〃 越知町 (吾川郡横畠村)
76. Notsu (能津); Hitaka-mura, Takaoka-gun (Notsu-mura) 高岡郡日高村 (能津村)
77. Ishida (石田); Hitaka-mura, Takaoka-gun (Kusaka-mura) 〃 〃 (日下村)
78. Inomine (井の峯); Hitaka-mura, Takaoka-gun (Kusaka-mura) 〃 〃 (〃)
79. Nagatake (長竹); Sakawa-machi, Takaoka-gun (Kamo-mura) [Takaoka (高岡)] 〃 佐川町 (加茂村)
80. Koike (小池); Sakawa-machi, Takaoka-gun 〃 〃
81. Shimoyama (下山); Sakawa-machi, Takaoka-gun [Ichinose (市瀬), Yamamba (山姥)] 〃 〃
82. Sakawa (佐川); Sakawa-machi, Takaoka-gun 〃 〃
83. Katsura (桂); Sakawa-machi, Takaoka-gun 〃 〃
84. Togano (斗賀野); Sakawa-machi, Takaoka-gun (Togano-mura) 〃 〃 (斗賀野村)
85. Kokuzosan (虚空蔵山); Tosa-shi (Heba-mura, Takaoka-gun) 土佐市 (高岡郡戸波村)
86. Yokokurayama (横倉山); Ochi-machi, Takaoka-gun (Ogiri-mura) 高岡郡越知町 (大桐村)
87. Sanokuni (佐の国); Ochi-machi, Takaoka-gun (Ogawa-mura) 〃 〃 (尾川村)
88. Kuki (久喜); Niyodo-mura, Takaoka-gun (Befu-mura) 〃 仁淀村 (別府村)
89. Matsuo (松尾); Niyoda-mura, Takaoka-gun (Befu-mura) 〃 〃 (〃)
90. Kaminogo (上の郷); Higashitsuno-mura, Takaoka-gun 〃 東津野村
91. Otoda (大戸田); Yuzuhara-mura, Takaoka-gun 〃 檮原村
92. Ochimen (越知面); Yuzuhara-mura, Takaoka-gun 〃 〃
93. Yuzuhara (檮原); Yuzuhara-mura, Takaoka-gun [Ozodani (おぞ谷)] 〃 〃
94. Uwanaro (上成); Yuzuhara-mura, Takaoka-gun 〃 〃
95. Omodani (おも谷); Yuzuhara-mura, Takaoka-gun 〃 〃
96. Rokucho (六町); Yuzuhara-mura, Takaoka-gun 〃 〃
97. Tsubonata (坪野田); Yuzuhara-mura, Takaoka-gun 〃 〃

Ehime Prefecture (愛媛県)

98. Yanadani (柳谷); Yanadani-mura, Kamiukena-gun 上浮穴郡柳谷村
99. Nakakubo (中久保); Yanadani-mura, Kamiukena-gun 〃 〃
100. Onogahara (大野原); Shirokawa-machi, Higashiuwa-gun (Ukena-mura, Kamiukena-gun) 東宇和郡城川町 (上浮穴郡浮穴村)
101. Onji (男地); Shirokawa-machi, Higashiuwa-gun (Doi-mura) 〃 〃 (土井村)
102. Kurosegawa (黒瀬川); Shirokawa-machi, Higashiuwa-gun (Doi-mura) 〃 〃 (〃)
103. Itadorigawa (板取川); Shirokawa-machi, Higashiuwa-gun (Doi-mura) 〃 〃 (〃)

104. Doi (土居); Shirokawa-machi, Higashiuwa-gun (Doi-mura) 東宇和郡城川町 (土居村)
105. Takagawa (高川); Shirokawa-machi, Higashiuwa-gun (Takagawa-mura) 〃 〃 (高川村)
106. Kaibuki (貝吹); Nomura-machi, Higashiuwa-gun (Kaibuki-mura) 〃 野村町 (貝吹村)
107. Uonashi (魚成); Shirokawa-machi, Higashiuwa-gun (Uonashi-mura) 〃 城川町 (魚成村)
108. Nomura (野村); Nomura-machi, Higashiuwa-gun [Takenouchi (竹の内)] 〃 野村町
109. Nizashi (荷刺); Nomura-machi, Higashiuwa-gun 〃 〃
110. Shirodani (四郎谷); Nomura-machi, Higashiuwa-gun (Tanosuji-mura) 〃 〃 (田之筋村)
111. Itagatani (板ケ谷); Uwa-machi, Higashiuwa-gun (Shimouwa-mura) 〃 宇和町 (下宇和村)
112. Yawatahama (八幡浜); Yawatahama-shi

Oita Prefecture (大分県)

113. Hodojima (保戸島); Tsukumi-shi (Hodojima-mura, Kitaamabe-gun) 津久見市 (北海部保戸島村)
114. Tsukumi (津久見); Tsukumi-shi (Tsukumi-machi, Kitaamabe-gun) 〃 (〃 津久見町)
115. Meiji (明治); Yayoi-mura, Minamiamabe-gun (Meiji-mura) 南海部郡弥生村 (明治村)
116. Chin'nanzan (鎮南山); Tsukumi-shi (Tsukumi-machi, Minamiamabe-gun) 津久見市 (南海部郡津久見町)
117. Kawanobori (川登); Notsu-machi, Ono-gun (Kawanobori-mura) 大野郡野津町 (川登村)
118. Katauchi (片内); Honjo-mura, Minamiamabe-gun (Imbi-mura) 南海部郡本匠村 (因尾村)

Miyazaki Prefecture (宮崎県)

119. Toroku (土呂久); Takachiho-machi, Nishiusuki-gun (Iwato-mura) 西臼杵郡高千穂町 (岩戸村)
120. Uemura (上村); Takachiho-machi, Nishiusuki-gun (Iwato-mura) 〃 〃 (〃)
121. Sankasho (三ケ所); Gokase-machi, Nishiusuki-gun (Sankasho-mura) 〃 五ケ瀬町 (三ケ所村)
122. Kagamiyama (鏡山); Gokase-machi, Nishiusuki-gun (Sankasho-mura) 〃 〃 (〃)
123. Gion'yama (祇園山); Gokase-machi, Nishiusuki-gun (Kuraoka-mura) 〃 〃 (鞍岡村)
124. Yurugidake (揺岳); Gokase-machi, Nishiusuki-gun (Kuraoka-mura) 〃 〃 (〃)
125. Tonegoyama (戸根川山); Gokase-machi, Nishiusuki-gun (Sankasho-mura) 〃 〃 (三ケ所村)
126. Ogawa (小川); Gokase-machi, Nishiusuki-gun (Kuraoka-mura) 〃 〃 (鞍岡村)
127. Kiaiya (木合屋); Gokase-machi, Nishiusuki-gun (Kuraoka-mura) 〃 〃 (〃)
128. Nakazaki (中崎); Shiiba-mura, Higashiusuki-gun 東臼杵郡椎葉村
129. Namigaeri (波帰り); Gokase-machi, Nishiusuki-gun (Kuraoka-mura) 西臼杵郡五ケ瀬町 (鞍岡村)
130. Shiraiwayama (白岩山); Shiiba-mura, Higashiusuki-gun 東臼杵郡椎葉村
131. Mimikawa (耳川); Shiiba-mura, Higashiusuki-gun 〃 〃

Kumamoto Prefecture (熊本県)

132. Yuzuruha (湯鶴葉); Seiwa-mura, Kamimashiki-gun (Mamihara-machi, Aso-gun) 上益城郡清和村 (阿蘇郡馬見原町)
133. Mizukoshi (水越); Mifune-machi, Kamimashiki-gun 〃 御船町
134. Odao (小田尾); Chuo-son, Shimomashiki-gun (Toshine-mura) 下益城郡中央村 (年弥村)

135. Tobiishi (飛石); Izumi-mura, Yatsushiro-gun (Kakisako-mura) 八代郡泉村 (柿迫村)
136. Yayamadake (矢山岳); Izumi-mura, Yatsushiro-gun (Shimodake-mura) 〃 〃 (下岳村)
137. Shimodake (下岳); Izumi-mura, Yatsushiro-gun (Shimodake-mura) 〃 〃 (〃)
138. Kakisako (柿迫); Izumi-mura, Yatsushiro-gun (Kakisako-mura) 〃 〃 (柿迫村)
139. Kukino (久木野); Toyo-cho, Yatsushiro-gun (Kawamata-mura) 〃 東陽町 (河俣村)
140. Ryuhozan (竜峯山); Yatsushiro-shi (Ryuho-mura, Yatsushiro-gun) 八代市 (八代郡竜峯村)
141. Hashirimizu (走水); Sakamoto-mura, Yatsushiro-gun (Shimomatsukuma-mura) 八代郡坂本村 (下松求麻村)
142. Kozaki (小崎); Sakamoto-mura, Yatsushiro-gun (Shimomatsukuma-mura) 〃 〃 (〃)
143. Yonagu (与奈久); Sakamoto-mura, Yatsushiro-gun (Kudaragi-mura, Ashikita-gun) 〃 〃 (葦北郡百済来村)
144. Futami (二見); Yatsushiro-shi (Futami-mura, Ashikita-gun) 八代市 (葦北郡二見村)
145. Ohira (大平); Yatsushiro-shi (Futami-mura, Ashikita-gun) 〃 (〃 〃)
146. Shizo (四蔵); Kuma-mura, Kuma-gun (Koonose-mura) 球磨郡球磨村 (神瀬村)
147. Ebirase (箙瀬); Kuma-mura, Kuma-gun (Koonose-mura) 〃 〃 (〃)
148. Koonose (神瀬); Kuma-mura, Kuma-gun (Koonose-mura) 〃 〃 (〃)
149. Yoshio (吉尾); Ashikita-machi, Ashikita-gun (Yoshio-mura) 葦北郡葦北町 (吉尾村)
150. Amatsuki (天月); Ashikita-machi, Ashikita-gun (Ono-mura) 〃 〃 (大野村)

Alphabetical index of locality names

A

Adoyama (Kw 6): アド山
Agematsu (Ht 16): 上松
Aigyo (Swi 95): 相行
Aizawa (Kw 7): 会沢
Akasaka (Ht 65): 赤沢
Akenobe (Swi 18): 明延
Akiyoshi (Swi 100): 秋吉
Akka (Ka 1): 安家
Akuda (Ht 45): 安久田
Akyu (Ht 78): 秋生
Amatsuki (Swo 150): 天月
Ananori (Ht 80): 穴乗
Anegawa (Ht 94): 姉川
Aohama (Swi 104): 青浜
Aoi (Ht 88): 青井
Aomine (Swo 7): 青峰
Arakigawa (Ht 22): 荒城川
Aratakiyama (Swi 101): 荒滝山
Aratani Swi 82): 荒谷
Aritani (Swo 62): 有谷
Asakaido (Kw 34): 浅海道
Asao (Swo 74): 浅尾
Ashidani (Ht 74): 芦谷
Ashimata (Ht 94): 足俣
Aso (Swo 18): 阿曽
Awagatake (Nei 5): 粟ケ岳
Awao (Swo 28): 粟生
Ayukawa (Ka 58): 鮎川
Azai (Swi 31): 砦部
Azusagawa (Ht 8): 梓川

B

Bukosan (Kw 30): 武甲山

C

Chihara (Swi 11): 千原
Chin'nanzan (Swo 116): 鎮南山
Choshi (Ka 59): 銚子

D

Dai (Swi 91): 台
Daido (Ka 17): 大洞
Daigo (Swo 42): 醍醐
Dangyokei (Swi 60): 断魚溪
Deguchi (Ht 91): 出口
Dodo (Swi 29): 百々
Doi (Swo 104): 土井
Donooka (Swo 57): 堂の岡
Donooka (Swo 79): 堂の岡

E

Ebirase (Swo 147): 簾瀬
Eimyoji (Swi 59): 永明寺
Ena (Swo 34): 衣奈

F

Fuchu (Swi 68): 府中
Fujikuradani (Ht 77): 藤倉谷
Fujiwaradake (Ht 105): 藤原岳
Fuka (Swi 48): 富家
Fukase (Swo 40): 深瀬
Fukiya (Swi 43): 吹屋
Fukuhara (Swo 46): 福原
Fukuji (Ht 26): 福地
Fukumoto (Swi 28): 福本
Funafuseyama (Ht 48): 船伏山
Furué (Ht 119): 古江
Futagami (Swi 102): 二神
Futagoyama (Kw 21): 双子山
Futami (Swo 144): 二見

G

Gion'yama (Swo 123): 祇園山
Gombo (Ht 36): 根方
Gozaishoyama (swo 59): 御在所山
Gujo (Swi 8): 公庄
Gyojagaeri (Swo 23): 行者還

H

Hachiman (Ht 43): 八幡
Haigyu (Swo 53): 拝宮
Hanawa (Ka 4): 花輪
Hanawa (Nei 10): 花輪
Handa (Swi 79): 半田
Hane (Swi 45): 羽根
Hashirimizu (Swo 141): 走り水
Hatagasako (Swi 74): 畑迫
Hatta (Swi 4): 八田
Higashi-uyama (Swi 54): 東宇山
Hijima (Swi 23): 土万
Hikami (Swi 12): 氷上
Hikawa (Kw 35): 氷川
Hikoroichi (Ka 23): 日頃市
Hina (Swi 52): 日南
Hinatawada (Kw 40): 日向和田
Hinoda (Kw 29): 日野田
Hirawarabi (Swi 78): 平蕨
Hirayu (Ht 30): 平湯
Hiryuyama (Ka 8): 飛竜山
Hisone (Swo 52): 桧曽根
Hitokabe (Ka 21): 人首
Hodojima (Swo 113): 保戸島
Hokaji (Swo 34): 法華寺
Hongo (Ht 18): 本郷
Hosokawa (Swo 26): 細川
Hosomidani (Swi 71): 細見谷
Hosoo (Kw 43): 細尾
Hota (Swo 31): 保田

I

Ibaragawa (Ht 103): 茨川
Ibukiyama (Ht 96): 伊吹山
Ichihara (Ht 109): 市原
Ichinosawa (Ht 4): 一の沢
Ichinose (Swo 15): 一の瀬
Ichinose (Swo 81): 市の瀬
Ichinoseki (Ka 36): 一の関
Ichinotani (Ht 27): 一の谷
Idaniyama (Swi 58): 猪谷山
Iinoya (Swo 2): 井伊谷
Ikadaba (Swi 80): 筏場
Ikuno (Ht 124): 生野
Imajo (Ht 85): 今庄
Inami (mine) (Nei 6): 伊南 (鉱山)
Inomine (Swo 78): 井の峯
Inugami (Ht 102): 犬上
Isa (Swi 103): 伊佐
Ise (Swo 4): 伊勢
Isetoge (Ht 76): 伊勢峠
Ishida (Swo 77): 石田
Ishiga (Swi 42): 石蟹
Ishimi (Swo 71): 石見
Ishiyama (Ht 58): 石山
Isobe (Swo 8): 磯部
Itadorigawa (Swo 103): 板取川
Itagatani (Swo 111): 板ケ谷
Itanami (Ht 95): 板並
Itogawa (Swo 29): 糸川
Itoshiro (Ht 70): 石徹白
Itsukaichi (Kw 44): 五日市
Iuchi (Swi 20): 井内
Iwahata (Ka 31): 岩畑
Iwaizaki (Ka 42): 岩井崎
Iwaizumi (Ka 3): 岩泉
Iwakura (Ht 108): 岩倉
Iwakura (Swo 6): 岩倉
Iwakurayama (Ht 68): 岩倉山
Iwamoto (Swi 39): 岩本
Iwanadome (Ht 5): 鯔留
Iwasayama (Ht 97): 岩佐山
Izumimura (Swo 11): 泉村
Izuru (Kw 5): 出流
Izuruha (Ht 116): 出灰

J

Joé (Swi 66): 城江
Junigatake (Ht 33): 十二ケ岳
Jusanhama (Ka 49): 十三浜

K

Kaerimizu (Swi 85): 帰り水
Kagahara (Kw 14): 神ケ原
Kagamiyama (Swo 122): 鏡山
Kagemori (Kw 27): 影森
Kaibuki (Swo 106): 貝吹
Kakisako (Swo 138): 柿迫
Kamaishi (Ka 11): 釜石
Kamaishi (mine) (Ka 10): 釜石（鉱山）
Kambayama (Swo 58): 勘場山
Kameiwa (Swo 66): 亀岩
Kametsubo (Ht 125): 亀坪
Kamianama (Ht 75): 上穴馬
Kamiarisu (Ka 16): 上有住
Kamihirose (Ht 23): 上広瀬
Kamikagemori (Kw 28): 上影森
Kamikuzu (Kw 33): 上久通
Kaminogo (Swo 90): 上の郷
Kamishima (Swo 3): 神島
Kamitakara (Ht 17): 上宝
Kamiyakawa (Swo 69): 上八川
Kamiyoshida (Kw 19): 上吉田
Kamodani (Swo 41): 加茂谷
Kamoike (Swo 72): 鴨池
Kanagawa (Swi 30): 金川
Kane (Swi 76): 嘉年
Kanikawa (Swi 35): 蟹川
Kanokura (Ka 29): 叶倉
Kanosan (Kw 13): 叶山
Kansaka (Ht 24): 神坂
Kan'yo (Kw 42): 肝要
Kanzaki (Ht 49): 神崎
Karakuwa (Ka 40): 唐桑
Karita (Swi 69): 刈田
Kasama (Kw 2): 笠間
Kasshi (Ka 15): 甲子
Kasuga (Ht 64): 春日
Kasukawa (Ht 64): 粕川
Katada (Swi 86): 堅田
Katauchi (Swo 118): 片内
Katchizawa (Ka 28): 合地沢
Kato (Ht 89): 加斗
Katsuboyama (Kw 43): 勝峯山
Katsura (Swo 83): 桂
Katsuradani (Swi 6): 桂谷
Kawahigashi (Swi 6): 河東
Kawamo (Kw 11): 川面
Kawanishi (Swi 9): 河西
Kawanobori (Swo 117): 川登
Kawarakami (Swi 87): 河原上
Keizuruyama (Nei 8): 景鶴山
Kenzan (Swo 56): 剣山
Kesennuma (Ka 41): 気仙沼
Kiaiya (Swo 127): 木合屋
Kirihara (Swo 10): 切原
Kirisaki (Swo 32): 霧崎
Kiyomi (Ht 39): 清見
Kiyotaki (Ht 99): 清滝
Kobatake (Swi 65): 小畠
Kochi (Ht 86): 河内
Kochi (Swo 6): 河内
Koda (Swi 75): 神田
Kodani (Swi 38): 小谷
Kogawa (Ka 2): 小川
Kogawa (Ka 12): 小川
Koike (Swo 80): 小池
Kokuzosan (Swo 85): 虚空蔵山
Komagatake (Nei 7): 駒ケ岳
Komori (Swi 5): 河守
Komukudani (Ht 73): 小椋谷
Kono (Ht 37): 小野
Konose (Swo 148): 神瀬
Koraihiro (Swo 9): 高麗広
Kose (Swi 27): 巨勢
Kotakigawa (Ht 3): 小滝川
Kotako (Swo 21): 上多古
Kotohara (Swi 63): 琴原
Koyama (Swi 49): 高山
Koyasan (Swo 25): 高野山
Kozaki (Swo 142): 小崎
Kuchibora (Ht 44): 口洞
Kuki (Swo 88): 久喜
Kukino (Swo 139): 久木野
Kumogahata (Ht 107): 雲ケ畑
Kumokawa (Ht 80): 雲川
Kunimiyama (Ht 19): 国見山
Kurahashira (Ht 20): 蔵柱
Kurakaketoge (Ht 104): 鞍掛峠
Kurama (Ht 106): 鞍馬
Kuratoko (Swi 19): 倉床
Kuregatoge (Swi 67A): 呉ケ峠
Kuribayashi (Ka 9): 栗林
Kurohagi (Swi 50): 黒萩
Kurome (Swi 67): 黒目
Kurosegawa (Swo 102): 黒瀬川
Kusune (Swo 39): 楠根
Kuwazawa (Ht 12): 桑沢
Kuzu (Kw 9): 久通
Kyodoko (Swi 81): 京床

M

Maedani (Swi 55): 前谷
Maiya (Ka 44): 米谷
Maizuru (Swi 2): 舞鶴
Maki (Kw 8): 牧
Maki Swi 34): 槇
Maki (Swi 92): 真木
Mamba (Kw 12): 万場
Manajo (Ht 123): 真南条
Mandokoro (Ht 47): 万所
Manganji (Ht 99): 満願寺
Matsukawa (Ka 38): 松川
Matsukawa (Ka 35): 松川
Matsuo (Swo 89): 松尾
Matsuoyama (Ht 66): 松尾山
Meigetsutoge (Ht 114): 名月峠
Meiji (Swo 115): 明治
Mihara (Swi 51): 三原
Miharaiyama (Swi 14): 御抜山
Miharano[=Miharanoro](Swi 57): 三原野
Mikagura (Kw 10): 御神楽
Mikata (Swi 22): 三方
Mikazuki (Swi 25): 三日月
Mimikawa (Swo 131): 耳川
Minamitani (Swi 16): 南谷
Mino (Ht 118): 箕面
Minoshima (Swo 30): 簑島
Misogawa (Ht 14): 味噌川
Mitsudo (Swi 33): 光遠
Miyahama (Swo 51): 宮浜
Miyakawa (Ht 87): 宮川
Miyakoda (Swo 1): 都田
Miyano (Swi 84): 宮野
Miyanokuchi (Swo 61): 宮の口
Mizukoshi (Swo 133): 水越
Mizutani (mine) (Nei 4): 水谷 (鉱山)
Mizuyagadani (Ht 29): 水屋ケ谷
Moribu (Ht 21): 森部
Motodo (Ht 79): 本戸
Mugitani (Swi 79): 麦谷
Mujinazawa (Kw 22): ムジナ沢
Mutsuguruma (Kw 16): 六車
Myojodake (Ht 2): 明星岳

N

Nabeyama (Kw 4): 鍋山
Nagaiwa (Ka 24): 長岩
Nagasaka (Ka 34): 長坂
Nagatake (Swo 79): 長竹
Nagoé (Swi 32): 名越
Nakahata (Ht 34): 中畑
Nakakubo (Swo 99): 中久保
Nakamura (Swo 16): 中村
Nakamura (Swi 45): 中村
Nakatsugawa (Kw 24): 中津川
Nakayashiro (Swi 13): 中八代
Nakazaki (Swo 128): 中崎
Namigaeri (Swo 129): 波帰り
Nanaai (Kw 1): 七合
Nanjo (Ht 84): 南条
Narai (Ht 13): 奈良井
Nariwa (Swi 46): 成羽
Nichihara (Swi 72): 日原
Nishibetsuin (Ht 113): 西別院
Nishikori (Ka 43): 西郡
Nishinoiri (Kw 42): 西の入
Nishitani (Ht 80): 西谷
Nishi-uyama (Swi 54): 西宇山
Nishiyama (Ht 112): 西山
Nishiyoshino (Swo 24): 西吉野
Nizashi (Swo 109): 荷刺
Noharadani (Ht 59): 野原谷
Nojiri (Ht 73): 野尻
Nomisaka (Swo 17): 能見坂
Nomura (Swo 108): 野村
Nosé (Ht 115): 能勢
Notabiyama (Swi 59): 野旅山
Notsu (Swo 76): 能津
Nukada (Swi 10): 額田
Nurui (Swo 57): 沼井

O

Oashi (Ka 54): 大芦
Ochimen (Swo 92): 越知面
Oda[=Ota] (Swi 96): 太田
Odao (Swo 134): 小田尾
Oé (Swi 7): 大江
Ofuku (Swi 90): 於福
Oga (Swi 47): 大賀
Ogamata (Kw 22A): 大ガマタ
Ogatsu (Ka 50): 雄勝
Ogawa (Swo 126): 小川

Ogawago (Swo 14): 小川郷
Ohashi (Ka 13): 大橋
Ohazama (Ka 6): 大迫
Ohira (Swo 145): 大平
Ohirasawa (Nei 2): 大平沢
Oi (Ht 90): 大飯
Oishi (Ht 63): 大石
Oizumi (Kw 3): 大泉
Okubo (Swi 97): 大久保
Okumyogata (Ht 42): 奥明方
Okura (Kw 15): 大倉
Okuzumi (Ht 41): 奥住
Omatsu (Ka 15): 大松
Omi (Ht 1): 青海
Omodani (Swo 95): おも谷
Omoriyama (Ka 19): 大森山
Omurajima (Swo 5): 大村島
Onagata (Kw 20): 女形
Onimaru (Ka 26): 鬼丸
Onishi (Swo 27): 大西
Onji (Swo 101): 男地
Onogahara (Swo 100): 大野原
Onogi (Ht 98): 大野木
Oppara (Ht 40): 大原
Osakatoge (Ht 114): 逢坂峠
Osobudani (Ht 28): 尾添谷
Osugi (Swo 19): 大杉
Ota (Swi 96): 太田
Otai (Swo 44): 大田井
Otaki (Kw 25): 大滝
Otaki (Ht 62): 大滝
Otani (Ht 72): 大谷
Otaniyama (Ht 93): 小谷山
Otoda (Swo 91): 大戸田
Ottate (Swo 55): 追立
Oura (Swi 2): 大浦
Oya (Ht 53): 親
Oya (Swi 15): 大屋
Ozodani (Swo 93): おぞ谷
Ozu (Ht 31): 大洲

R

Raidenyama (Kw 39): 雷電山
Rodai (Ka 47): 桜台
Rokucho (Swo 96): 六町
Rokusuke (Kw 23): 六助
Ryokami (Kw 26): 両神
Ryozen (Ht 101): 霊仙
Ryugenji (Swi 89): 竜現寺
Ryuhozan (Swo 140): 竜峯山
Ryusenzan (Swo 13): 竜仙山

S

Sakamotozawa (Ka 25): 坂本沢
Sakashu (Swo 54): 坂州
Sakauchi (Ht 56): 坂内
Sakawa (Swo 82): 佐川
Sakuradani (Swo 50): 桜谷
Sambonmatsu (Swi 88): 三本松
Sambosan (Swo 63): 三宝山
Samegai (Ht 100): 醒井
Samondake (Ht 51): 左門岳
Sankasho (Swo 121): 三ケ所
Sanokuni (Swo 87): 佐の国
Sasagatani (Swi 73): 笹ケ谷
Sasamata (Ht 61): 笹又
Sasayama (Ht 122): 篠山
Sawando (Ht 9): 沢渡
Sawadani (Swo 49): 沢谷
Serita (Swi 88): 芹田
Setamai (Ka 27): 世田米
Seto (Swo 20): 瀬戸
Shiba (Ka 20): 芝
Shidaka (Swi 3): 志高
Shimadani (Ht 43): 島谷
Shimajima (Ht 7): 島々
Shimoarisu (Ka 18): 下有住
Shimodake (Swo 137): 下岳
Shimokuzu (Kw 32): 下久通
Shimomitani (Swi 3): 下見谷
Shimoyakawa (Swo 73): 下八川
Shimoyama (Swa 81): 下山
Shimozaisho (Ht 71): 下在所
Shinkai [=Shingai] (Swo 65): 新改
Shinmito (Ht 111): 新水戸
Shin'yu (Nei 3): 真湯
Shioya (Ht 38): 塩屋
Shiraiwa (Swi 94): 白岩
Shiraiwayama (Swo 130): 白岩山
Shirakidani (Swo 67): 白木谷
Shirasaki (Swo 35): 白崎
Shirodani (Swo 110): 四郎谷
Shiroi (Kw 18): 白井
Shiroi (Kw 35): 白井
Shiromaru (Kw 37): 白丸
Shiroyadake (Swo 22): 白屋岳
Shizo (Swo 146): 四蔵

Shogase (Swo 70): 勝賀瀬
Shomarutoge (Kw 31): 正丸峠
Shoyama (Swi 40): 正山
Shozawa (Kw 38): 正沢
Sonobe (Ht 110): 園部
Sorayama (Ht 25): 空山
Sote (Ht 32): 曽手
Sugimoto (Ka 57): 杉本
Surugamine (Swi 17): 須留峯
Suzumiyama (Swi 83): 涼山

T

Tada (Ht 120): 多田
Taishaku (Nei 11): 帝釈
Taishaku (Swi 59): 帝釈
Taishakugawa (Swi 59): 帝釈川
Takagami (Ka 60): 高神
Takagawa (Swo 105): 高川
Takakura (Ht 83): 高倉
Takakurayama (Ka 56): 高倉山
Takano (Swo 48): 高野
Takaoka (Swo 79): 高岡
Takarao (Swi 1): 宝尾
Takata (Ka 32): 高田
Takatsuki (Ht 117): 高槻
Takayama (Ht 92): 高山
Takenouchi (Swo 108): 竹の内
Taki (Ht 121): 多紀
Takura (Ht 81): 宅良
Tamanouchi (Kw 41): 玉の内
Tameshige (Swi 56): 為重
Taniai (Ht 50): 谷合
Taniai (Swo 60): 谷相
Tano (Ht 116): 田能
Tassobe (Ka 7): 達曽部
Tateishi (Ka 51): 立石
Tenguyama (Ht 55): 天狗山
Tenjinnoki (Ka 46): 天神の木
Ten'nodani (Swo 37): 天王谷
Terauchi (Swi 37): 寺内
Tobiishi (Swo 135): 飛石
Tobinosu (Swi 97): 鳶の巣
Tochu (Ka 20): 戸中
Togano (Swo 84): 斗賀野
Tokiyama (Ht 69): 時山
Tokugotoge (Ht 6): 徳本峠
Tokuriki (Swi 105): 徳力
Tokuyama (Ht 52): 徳山
Tominoho (Ht 46): 富之保
Tonegoyama (Swo 125): 戸根川山
Toroku (Swo 119): 土呂久
Tosayama (Swo 68): 土佐山
Toyoma (Ka 48): 登米
Toyomane (Ka 5): 豊間根
Toyonaga (Swi 39): 豊永
Tsubonata (Swo 97): 坪野田
Tsuchikura (Ka 14): 土倉
Tsuchikura (Ht 91): 土倉
Tsukidachi (Ka 39): 月立
Tsukigata (Kw 17): 月形
Tsukumi (Swo 114): 津久見
Tsunemori (Swi 93): 常森
Tsutsumi (Swi 92): 堤
Tsuzumigatake (Swi 98): 鼓ケ岳

U

Uemura (Swo 120): 上村
Uenohata (Ka 52): 植の畑
Uji (Swi 44): 宇治
Ukiishi (Swo 32): 浮石
Umaji (Swo 45): 馬路
Umetani (Ht 60): 梅谷
Unada (Swi 61): 宇那田
Unazawa (Kw 36): 梅沢
Uoganeyama (Ht 57): 魚金山
Uonashi (Swo 107): 魚成
Usuginu (Ka 37): 薄衣
Utoyama (Ht 10): 善知鳥山
Uwanaro (Swo 94): 上成
Uwano (Ka 53): 上野

W

Wakasugi (Svo 43): 若杉

Y

Yabuhara (Ht 15): 藪原
Yaegahara (Swi 99): 八重ケ原
Yaeji (Swo 47): 八重地
Yahagi (Ka 33): 矢作

Yakawa (Swi 64): 失川
Yakuki (Ka 55): 八茎
Yamamba (Swo 73): 山姥
Yamano (Swi 62): 山野
Yamazaki (Ka 45): 山崎
Yamazaki (Swi 24): 山崎
Yanadani (Swo 98): 柳谷
Yasuba (Swo 64): 休場
Yasumoto (Swi 58): 保元
Yataka (Ht 97): 弥高
Yatsumori (Nei 1): 八森
Yayamadake (Swo 136): 矢山岳
Yawatahama (Swo 112): 八幡浜
Yokobatake (Swo 75): 横畠
Yokokawa (Ht 11): 横川
Yokokurayama (Swo 86): 横倉山
Yokose (Swo 38): 横瀬
Yokota (Ka 30): 横田
Yokowa (Swo 12): 横輪
Yokoyama (Ht 54): 横山
Yokoyama (Swi 21): 横山
Yokozeki (Swi 26): 横関
Yonagu (Swo 143): 与奈久
Yonezato (Ka 22): 米里
Yoro (Ht 67): 養老
Yoshii (Swi 53): 芳井
Yoshio (Swo 149): 吉尾
Yoshiwa (Swi 70): 吉和
Yuasa (Swo 33): 湯浅
Yukawa (Swi 41): 湯川
Yuki (Swi 66A): 油木
Yukisawa (Ka 31): 雪沢
Yunoo (Ht 82): 湯尾
Yura (Swo 36): 由良
Yurugidake (Swo 124): 揺岳
Yuzuhara (Swo 93): 檮原
Yuzuruha (Swo 132): 湯鶴葉

Z

Zomeki (Swi 77): 蔵目喜
Zengosasu (Kw 38): 前後指
Zensakuzawa (Nei 9): 善作沢

References

*AKAGI, Saburo (1958): *Pseudoschwagerina miharanoensis*, a new Permian fusulinid, and its growth and form. *Sci. Repts. Tokyo Kyoiku Daigaku*, [C], **6**, (54), 147–156, pl. 1.

——— (1958): Morphological development of fusulinids and its paleontological significance. *Chikyu Kagaku* (*Earth Science*), (38), 13–27 (J+E).

ARAI, Fusao *et al.* (1963): On the Atokura conglomerate in the Shimonita district, Gumma Prefecture. *ibid.*, (64), 18–31, pls. 1, 2(J+E).

ARAI, Juzo *et al.* (1952): On the limestone beds of Kanosan, Futagoyama and Shiraishiyama in the northeastern Kwanto mountains. *Jour. Geol. Soc. Japan*, **58**, (682), 319 (J).

ARAI, K. and SAKAGUCHI, S. (1955): Geology of the Sasayama basin. *Jour. Geol. Soc. Japan*, **61**, (718), 345 (J).

ARAKI, Hideo (1961): The Permian Trilobite around Kesennuma city in the Kitakami mountainlands, Japan. *Chigaku Kenkyu* (*Jour. Soc. Earthscientists & Amateures, Japan*), **12**, (6), 224–228 (J+E).

ARAKI, Yoshio *et al.* (1956): Geology of the Osugi district, Mie Prefecture. *Bull. Liberal Arts, Mie Univ.*, (15), 1–4 (J+E).

AKASAKA RESEARCH GROUP (1956): Geological studies of the Akasaka limestone. *Chikyu Kagaku* (*Earth Science*), (26–27), 10–18 (J+E).

ASAMA, Kazuo (1956): Permian plants from Maiya in northern Honshu, Japan (Preliminary note). *Proc. Japan Acad.*, **32**, (7), 469–471.

CARBONIFEROUS RESEARCH SUBCOMMITTEE (Chairman H. YABE) (1960): Carboniferous System of Japan. *Rep. Geol. Surv. Japan*, spec. no. D, 1–65.

CHISAKA, Takeshi (1952): Fusulinid fossils from the Yahagi-mura area, Kesen-gun, Iwate Prefecture. *Jour. Geol. Soc. Japan*, **58**, (682), 312–313 (J).

——— (1953): On the Permian system of the southwestern part of the Kitakami mountainland (Maiya district). *Sci. Repts., Tokyo Bunrika Daigaku*, (2), 1–9 (J+E).

——— (1955): Fusulinid fossils from the Choshi peninsula. *Jour. Geol. Soc. Japan*, **61**, (718), 346 (J).

*——— (1960): On some Permian fusulinids from the Takagami conglomerate, Choshi peninsula, Chiba Prefecture, Japan. *Jour. Coll. Arts & Sci., Chiba Univ., Nat. Sci.*, **3**, (2), 235–254, pls. 1–9.

*——— (1962): Fusulinids from the vicinity of Maiya town, Kitakami mountainland, and Upper Permian fusulinids of Japan. *ibid.*, **3**, (4), 519–551, pls. 1–8.

CHICHIBU RESEARCH GROUP (1961): On the Paleozoic formations and geologic structure of the Kanna-gawa district. *Chikyu Kagaku* (*Earth Science*), (57), 1–11 (J+E).

——— (1963): Outline of the geology of the Chichibu mountains, Central Japan. *ibid.*, (68), 13–18 (J+E).

ENDO, Riuji (1924): The Upper Paleozoic Formations in the Kitakami Mountainland. *Jour. Geol. Soc. Japan*, **31**, 230–249 (J).

——— (1951–1961): Stratigraphical and paleontological studies of the Later Paleozoic calcareous Algae in Japan, I–XVII. I(1951): Several new species from

References with asterisks are those in which the fusulinaceans are described and illustrated.

For convenience each title in the references is followed by letter indices, indicating the language by which the publications are written, as follows:

J—Japanese; G—German; J+E—Japanese with English abstract; J+G—Japanese with German abstract; References without letter indices are written in English.

the Sakamotozawa section, Hikoroichi-mura, Kesen-gun, in the Kitakami mountaineous land. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (4), 121–129, 2 pls.; II (1952): Several species previously described from the Sakamotozawa section. *ibid.*, (5), 139–144, 1 pl.; III (1952): A few species from the Maiya section, Maiya-machi, Tome-gun, Miyagi-ken. *Sci. Rep. Saitama Univ.*, [B], **1**, (1), 23–28, 1 pl.; IV (1952): Note on the calcareous algae of the Omi limestone. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (8), 241–248, 1 pl.; V (1953): Several species from the Iwaizaki limestone, Motoyoshi-gun, in the Kitakami mountaineous land. *Japan. Jour. Geol. Geogr.*, **23**, 117–126, pl. 1; VI (1953): Several interesting species from the Kwanto mountaineous land and a new genus from Kinshozan, Gifu-ken. *Sci. Rep. Saitama Univ.*, [B], **1**, (2), 105–114; VII (1954): Geology of the Mino mountainland and southern part of Hida plateau, with descriptions of the algal remains found in those districts (with M. KANUMA). *ibid.*, **1**, (3), 177–208, 5 pls.; VIII (1954): Several species from Kinshozan Akasaka-machi, Gifu-ken. *ibid.*, **1**, (3), 209–216, 1 pl.; IX (1954): Interesting species from Sakamoto-mura, Taga-gun, Ibaraki-ken. *ibid.*, **1**, (3), 217–221, 1 pl.; X (1956): Fossil algae from the Kwanto and Kitakami mountains. *ibid.*, **2**, (2), 221–248, 10 pls.; XI (1957): Fossil algae from the Taishaku district, Hiroshima-ken, and Kitamino-kuni, Hokkaido. *ibid.*, **2**, (3), 279–305, 8 pls.; XII (1957): Fossil algae from the Fukuji district in the Hida massif (with M. HORIGUCHI). *Japan. Jour. Geol. Geogr.*, **28**, (4), 169–177, 3 pls.; XIII (1958): A restudy of the genus *Physoporella*. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, (31), 265–269, 1 pl.; XIV (1959): Fossil algae from the Nyugawa valley in the Hida massif. *Sci. Rep. Saitama Univ.*, [B], **3**, (2), 177–207, 13 pls.; XV (1960): A restudy of the genus *Epimastopora*. *ibid.*, **3**, (3), 267–270, 1 pl.; XVI (1961): Fossil algae from Ominagahama district. *ibid.*, *Commem. vol.* Prof. R. ENDO, 77–118, 19 pls.; XVII (1961): Fossil algae from the Akiyoshi limestone Group. *ibid.*, 119–142, 7 pls.

——— (1952): Stratigraphical study of the Omi limestone by calcareous algae and foraminifers. *Jour. Geol. Soc. Japan*, **58**, (682), 320–321 (J).

ENDO, R. and HASHIMOTO, W. (1955): Unquestionably Palaeozoic (Permian) fossils found in Hokkaido, Japan. *Proc. Japan Acad.*, **21**, 704–708.

——— and ——— (1956): Unquestionable Permian fossils found in Kitaminokuni, Hokkaido and its significance. *Jour. Geol. Soc. Japan*, **62**, (728), 241–243 (J+E).

ENDO, R. and MATSUMOTO, E. (1962): Permo-Carboniferous Trilobites from Japan. *Sci. Repts., Saitama Univ.* [B], (IV), **2**, 149–172, pls. 8–10.

FUJII, Koji (1954): Stratigraphy and geologic structure of the Usuki district, Oita Prefecture. *Jour. Geol. Soc. Japan*, **60**, (709), 413–427; (710), 494–500 (J+E).

——— (1962): Petrography of the Upper Paleozoic sandstones from the Yatsushiro area, Kyushu. *Mem. Fac. Sci., Kyushu Univ.*, [D], **12**, (3), 179–204, pls. 28–33.

FUJII, K., KANMERA, K. and MATSUMOTO, T. (1962): Notes on the Chichibu geosyncline (Appendix to Petrography of the Upper Paleozoic sandstones from the Yatsushiro area by K. FUJII). *ibid.*, 204–218.

FUJIMOTO, Haruyoshi (1925): Fossil corals in limestone associated with schistose rocks in the vicinity of the Hitachi mine. *Jour. Geogr.* **36**, (428), 559–561 (J).

——— (1935): A new locality for Fusulina-limestone in northern Kyushu. *Jour. Geol. Soc. Japan*, **42**, (496), 36–38, pl. 1 (J).

*——— (1936): Stratigraphical and paleontological studies of the Titibu system of the Kwanto-mountainland pt. 1, Stratigraphy; pt. 2, Paleontology. *Sci. Repts. Tokyo Bunrika Daigaku*, [C], **1**, (4), 157–188, pls. 27–29; **1**, (2), 29–125, pls. 1–26.

*——— (1937): Some Fusulinids from Kawanobori-mura, Kyushu, Japan. *Japan. Jour. Geol. Geogr.*, **14**, 117–125, pls. 7–8.

——— (1938): Fusulinids from Kanzaki-gun, Hyogo Prefecture. *Jour. Geol. Soc. Japan*, **45**, (535), 368 (J).

——— (1938): On the Fusulina-limestone in the Asio mountainland (Preliminary report): *ibid.*, 379–382 (J).

——— (1940): Correlation of Carboniferous and Permian Systems of East Asian continents by fusulinid fossils. *Repts. Takushoku Daigaku Inst.*, **1**, 1–29 (J).

*——— (1941): *Pseudoschwagerina* from Akasaka and its neighbourhood and some considerations on the geological age of the *Pseudoschwagerina* zone of Japan. *Jour. Geol. Soc. Japan*, 48, 88–97, pl. 5 (Specific description in English).

——— (1942): On the geology of the Toba district, Mié Prefecture. *ibid.*, **49**, 262–263 (J).

——— (1944): Palaeontological study of the Chichibu System of the Taishaku district, Hiroshima Prefecture. *Repts. Geol. Mineral. Inst. Tokyo Bunrika Daigaku* (1), 2–19 (J).

——— (1950): Fusulinids from Kuriyama-mura, Tochigi Prefecture and Tada-mura, Hyogo Prefecture. *Jour. Geol. Soc. Japan*, **56**, (657), 330 (J).

——— (1952): The Fusulinid zones in the Japanese Carboniferous. *Compte rendu, 3me Congr. Strat. Geol. Carbon.—Heerlen*, 1951, Tome I, 219–223.

——— (1952): Fossil zones of the Carboniferous-Permian Systems in Japan. *Jour. Geol. Soc. Japan*, 58, (682), 318 (J).

——— (1953): The Carboniferous-Permian boundary in Japan. *Proc. VIII Pacific Sci. Congr., Quezon City*, 429–435.

——— (1953): Regional geology of Japan; Kwanto Province, 1–345. *Asakura Shoten Press* (J).

——— (1953): Stratigraphy of the Paleozoic of Japan; Kwanto and Chubu provinces. *Jour. Geol. Soc. Japan*, **59**, (694), 288–290 (J).

——— (1955): Paleoecology of Fusulinids. *"Yukochu" ("Foraminifera")*, (4), 24–28 (J).

*——— (1956): A new species of *Parafusulina* from the Kitakami massif, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (21), 157–160, pl. 25.

——— (1957): Geological studies of the Hida mountainland (On the age problem of the Hida metamorphic complex). *Jour. Geol. Soc. Japan*, **63**, (742), 388–396 (J).

——— (1957): Stratigraphical consideration of the Hida metamorphics (in Symposium on the basement of the Japanese islands). *Chikyu Kagaku (Earth Science)*, (32), 4–7 (J).

——— (1959): Recent studies on the Paleozoics of Japan (Presidental address). *Jour. Geol. Soc. Japan*, **65**, (766), 406–411 (J).

——— (1961): Geological map with explanatory text; Tochigi, 1 : 50,000. *Geol. Surv. Japan.*

FUJIMOTO, H. and HARA, K. (1951): Upper Paleozoic group in the Taishaku valley district, Hiroshima Prefecture. *Jour. Geol. Soc. Japan*, **57**, (670), 263 (J).

*FUJIMOTO, H. and IGO, H. (1955): *Hidaella*, a new genus of the Pennsylvanian fusulinids from the Fukuji district, eastern part of the Hida mountain-land, central Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (18), 45–48, pl. 7.

——— and ——— (1958): Stratigraphic position of the corals in the Ichinotani formation (Carboniferous), Fukuji district, Hida massif, central Japan. *Proc. Japan Acad.* **34**, (3), 159–163.

——— and ——— (1958): The Fusulinid zones in the Japanese Carboniferous. *Sci. Repts. Tokyo Kyoiku Daigaku*, [C], **6**, (53), 127–146.

*FUJIMOTO, H. and KANUMA, M. (1953): *Minojapanella*, a new genus of Permian fusulinids. *Jour. Paleont.*, **27**, (1), 150–152, pl. 19.

FUJIMOTO, H., KANUMA, M. and MIDORIKAWA, Y. (1953): On the Gotlandian deposits

newly discovered from Kiyomi-mura, Gifu Prefecture. *Sci. Repts. Tokyo Gakugei Univ.*, (2), 11–16 (J+E).

FUJIMOTO, H., KANUMA, M. and IGO, H. (1962): Upper Paleozoic of Hida massif. *Geological Studies of the Hida massif* (H. FUJIMOTO, editor). 44–70 (J).

FUJIMOTO, H., KANUMA, M., INAMORI, J., and MIDORIKAWA, Y. (1962): Geology of the environs of Naradani, Kiyomi-mura, Gifu Prefecture. *ibid.*, 76–82 (J).

FUJIMOTO, H., KANUMA, M., INAMORI, J. and IGO, H. (1962): On the geologic age of the Hida metamorphic rocks. *ibid.*, 88–98 (J).

FUJIMOTO, H. and KAWADA, S. (1951): On the *Triticites* zone found in the Omi limestone, Niigata Prefecture. *Jour. Geol. Soc. Japan*, **57**, (670), 266–267 (J).

*FUJIMOTO, H. and KAWADA, S. (1953): *Hayasakaina*, a new genus of fusulinids from the Omi-limestone, Niigata Prefecture. *Sci. Repts. Tokyo Bunrika Daigaku*, [C], **2**, (13), 207–209, pl. 1.

FUJIMOTO, H. and KOBAYASHI, F. (1961): On the Paleozoic deposits of the Inner zone of the Ou region. *Jour. Geol. Soc. Japan*, **67**, (787), 221–227 (J+E).

FUJIMOTO, H., MORIKAWA, R. and FUJIYAMA, I. (1955): Carboniferous System of the Kwanto massif. *Jour. Geol. Soc. Japan*, **61**, (718), 305–306 (J).

FUJIMOTO, H., OGAWA, K. and HIDA, K. (1957): On the geology of Mt. Buko and its neighbourhood. *Repts. Chichibu Mus. Nat. Hist.*, (7), 1–16 (J+E).

FUJIMOTO, H., YOSHINAKA, R. and TAJIMA, N. (1961): On the Upper Paleozoic deposits of the Kiku peninsula, Fukuoka Prefecture. *Bull. Yamagata Univ.*, (*Nat. Sci.*), **5**, (2), 419–423, 1 pl. (J+E).

FUJIMOTO, H. *et al.* (1957): The basement of the Japanese islands. *Chikyu Kagaku* (*Earth Science*), (32), 1–26 (J).

——— (1957): Geology of the northwestern part of Kwanto massif. *Repts. Chichibu Sci. Museum, Nat. Hist.*, (7), 17–28 (J+E).

——— (1957): Paleozoic rocks of Okuchichibu and Chichibu mine. *Guide book for the geological excursion of the 64th Annual Meeting of the Geological Society of Japan*, 1–28 (J).

FUJITA, Asahi (1943): Geology of the environs of Ototi, Sikoku. *Jour. Geol. Soc. Japan*, **50**, (599), 207–215 (J).

FUJITA, Hiroshi (1958): Geology of the Omi Limestone (Permo-Carboniferous), Niigata Prefecture; *Contrib. Inst. Geol. Palaeont. Tohoku Univ.*, (48), 1–60 (J+E).

HAMADA, Takashi (1959): Gotlandian stratigraphy of the Outer zone of Southwest Japan. *Jour. Geol. Soc. Japan.*, **65**, (770), 688–700 (J+E).

——— (1962): Two Brachiopods from Kyushu: The Silurian shelly fauna from Southwest Japan (II). *Sci. Paper Coll. General Educ. Univ. Tokyo*, **12**, (2), 241–258, pls. 1–2.

*HANZAWA, Shoshiro (1938): An aberrant type of the Fusulinidae from the Kitakami mountainland, Northeastern Japan. *Proc. Imp. Acad. Japan*, **14**, (7), 255–259, figs. 1–16.

*——— (1939): Stratigraphical distribution of the genera *Pseudoschwagerina* and *Paraschwagerina* in Japan with descriptions of two new species of *Pseudoschwagerina* from the Kitakami mountainland, Northeastern Japan. *Japan. Jour. Geol. Geogr.*, **16**, (1–2), 65–73, pl. 4.

——— (1941): The stratigraphical relation between the Carboniferous and Permian formations in Manchuria, Korea, and Japan proper. *ibid.*, **18**, (3), 97–108.

*——— (1942): *Parafusulina yabei* n. sp. from Tomuro, Shimotsuke province, Japan. *ibid.*, **18**, (4), 127–131, pls. 13–14.

——— (1944): Stratigraphic distribution of the Fusulinid Foraminifera found in South Manchuria and Japan. *ibid.*, **19**, 1–10.

*——— (1949): A new type of the fusulinid foraminifera from central Japan. *Jour.*

Paleont. **23**, (2), 205–209, pl. 43, text-figs. 1–3.

*——— (1950): On the occurrence of the Foraminiferal genera, *Eoverbeekina*, *Nankinella*, and *Sphaerulina* from Japan. *Short Papers Inst. Geol. Pal. Tohoku Univ.*, (2), 1–12, pls. 1, 2.

*——— (1954): Notes on *Afghanella* and *Sumatrina* from Japan. *Japan. Jour. Geol. Geogr.*, 24, 1–14, pls. 1–3.

——— (1954): Stratigraphical distribution of the Fusulinid Foraminifera in Japan. *Rep. XIX Internat. Geol. Congr., Alger*, Sec. XIII–III, 129–137.

——— (1954): Regional Geology of Japan; Tohoku Province, 1–344. *Asakura Shoten Press* (J).

——— (1961): Facies and Micro-organisms of the Paleozoic, Mesozoic, and Cenozoic sediments of Japan and her adjacent islands. *Internat. Sediment. Petrogr. series*, **5**, Leiden.

*HANZAWA, S. and MURATA, M. (1963): The paleontologic and stratigraphic consideration on the Neoschwagerininae and Verbeekininae, with description of some fusulinid foraminifera from the Kitakami massif, Japan. *Sci. Repts. Tohoku Univ.*, [2], **35**, (1), 1–31, pls. 1–20.

HANZAWA, S. and YABE, H. (1932): Tentative classification of the Foraminifera of the Fusulinidae: *Proc. Imp. Acad. Japan*, 8, (2), 40–43.

HASE, Akira (1963): Stratigraphy of the weakly metamorphosed Paleozoic rocks in eastern Hiroshima Prefecture, Japan. *Geol. Repts. Hiroshima Univ.*, [12], 277–294 (J+E).

——— (1964): Geologic history of Hiroshima Prefecture. *Explanatory text of Geologic map of Hiroshima Prefecture. Hiroshima Prefecture*, 17–20 (J).

——— (1964): Paleozoic strata of Hiroshima Prefecture. *ibid.*, 31–59 (J).

——— (1965): The Upper Paleozoic strata in the Jinseki-Yuki area of the western Kibi plateau, Chugoku district, Southwest Japan; with special reference to the relation between the calcareous and non-calcareous groups. *Geol. Rep. Hiroshima Univ.*, 14, 277–291, pls. 24–26 (J+E).

HASEGAWA, Yoshiyuki (1958): Note on the geologic structure of Akiyoshi plateau, SW Honshu. *Chikyu Kagaku* (*Earth Science*), (39), 15–18 (J+E).

——— (1963): New find of fossils in the reddish tuffaceous shale in the Akiyoshi province. *ibid.*, (64), 32–37 (J+E).

——— (1964): On phrenotheca on *Pseudofusulina vulgaris globosa*. *ibid.*, (74), 13–16, pls. 1–2 (J+E).

*——— (1965): "*Lepidolina*" from the Ohtani conglomerate, Central Japan. *ibid.*, (76), 25–33, pls. 1–3 (J+E).

——— (1966): On the proloculus size of *Lepidolina shiraiwensis* (Ozawa). *Sci. Rep. Dept. Geol. Min. Fac. Sci. Niigata Univ.*, (1), 21–29, pl. 1 (J+E).

HASHIMOTO, Kiyomi (1955): Geologic study of the Paleozoic formations in Shikoku island. *Rep. Education Board of Education, Kochi Prefecture*, 7, (11), 25–26 (J).

HASHIMOTO, Wataru (1960): Stromatoporoids from the Ainonai limestone, Kitami province, Hokkaido. *Sci. Repts. Tokyo Kyoiku Daigaku*, [C], 7, (65), 195–203, pls. 1–3.

——— (1960): Some problems concerning the older deposits prior to the Middle Yezo Group of Hokkaido. *Sci. Repts. Tohoku Univ.*, [*Geol.*], Spec. no. [4], 437–447 (J+E).

HASHIMOTO, W. *et al.* (1960): Discovery of fusulinid fossil from the Kabato massif, Ishikari province, Hokkaido. *Jour. Geol. Soc. Japan*, **66**, (776), 361 (J).

HASHIMOTO, W. and SHIMADA, T. (1960): Discovery of a Paleozoic coral from the southwestern part of Hokkaido. *ibid.*, **66**, (780), 621 (J).

HATORI, Harufumi (1965): Stratigraphic studies in the southeastern part of the

Ashio massif, Tochigi Prefecture. *ibid.*, **71**, (837), 247–256 (J+E).

HAYASAKA, Ichiro (1918): Some Palaeozoic brachiopods from Omi-mura, Nishikubiki-gun, Niigata Prefecture. *Jour. Geol. Soc. Japan*, **25**, (297), 304–310 (J).

——— (1921): Limestone of Omi-mura, Echigo province. *Jour. Geogr.* **33**, (392), 431–444 (J).

——— (1922): The limestone of Omi-mura. *Japan. Jour. Geol. Geogr.* **1**, (1), 1–7.

——— (1923): Some Permian fossils from the Kitakami mountains. *ibid.*, **2**, (4), 107–116, pl. 15.

——— (1924): On the fauna of the anthracolithic limestone of Omi-mura in the western part of Echigo. *Sci. Repts. Tohoku Imp. Univ.*, [2], 8, 1–83, pls. 1–7.

——— (1932): On three brachiopod species of the Subfamily Orthotetinae in the Fusulina-limestone of Kinshozan, Akasaka-machi, Prov. Mino, Japan. *Mem. Fac. Sci. Agr. Taihoku Imp. Univ.*, 8, (1), 1–7.

——— (1943): On some Permian gastropods from Kinshozan, Akasaka-machi, Gifu Prefecture. *ibid.*, [3], 1, (2), 23–38, 5 pls.

——— (1944): On the geological age of the Brachiopod Beds in the vicinity of Nabeyama, Tochigi Prefecture. *Jour. Geol. Soc. Japan*, **51**, (608), 154–156 (J).

——— (1953): *Hamletella*, a new Permian genus of Brachiopoda, and a new species from the Kitakami mountains, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (12), 89–95, pl. 9.

——— (1953): Revision and Summary of the Palaeozoic fossils in Japan. *Jour. Geol. Soc. Japan*, **59**, (694), 292–293 (J).

——— (1953): Carboniferous and Permian cephalopods in the Kitakami mountains. *ibid.*, **59**, (694), 344–345 (J).

——— (1954): An occurrence of *Koninckioceras* from the Japanese Permian. *Japan. Jour. Geol. Geogr.*, **25**, (1–2), 57–59, pl. 6.

——— (1954): *Euconospira* with color markings from the Permian of Japan. *Jour. Fac. Sci. Hokkaido Univ.*, [4], 8, (4), 349–360, pls. 20–21.

——— (1954): Younger Paleozoic Cephalopods from the Kitakami mountains. *ibid.*, 361–374, pls. 22–23.

——— (1955): A new Permian species of *Porcellia* from Japan. *ibid.*, [4], **9**, (1), 21–24, pl. 1.

——— (1955): Permian Cephalopodos from Japan. *Chigaku-Kenkyu* (*Jour. Soc. Earthscientists & Amateures Japan*), 8, (3), 71–76 (J).

——— (1957): Two Permian Nautiloids from Takakura-yama near Yotsukura-machi, Fukushima Prefecture (Abukuma plateau region), Japan. *Sci. Rep. Yokohama National Univ.*, [2], **6**, 21–30, pls. 8–9.

——— (1960): On the occurrence of *Neospirifer fasicger* (KAYSERLING) in Japan, and a note on some associate Permian Brachiopods from around Kesen-numa city, Northeast Japan. *Collection Essays, Comm. Tenth Anniv. Shimane Univ.* (*Nat. Sci.*), pp. 34–57, pls. 1–3.

——— (1963): Some Permian fossils from southern Kitakami, I–IV. *Proc. Japan Acad.*, **39**, (7, 8, 10), 474–478, 479–483, 594–599, 753–757.

——— (1964): Some Permian Fossils from Southern Kitakami, V. *ibid.*, **40**, (7), 528–532.

——— (1965): Some Cephalopods in the Permian faunule of Takakura-yama, Fukushima Prefecture, Japan (with a note on the geology of the district by Ichiro YANAGISAWA and Mamoru NEMOTO). *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (57), 8–27, pls. 2–3.

——— (1966): An Upper Palaeozoic Fauna from Miharanoro, Hiroshima Prefecture, Japan. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **13**, (3), 261–264.

HAYASAKA, I. and HAYASAKA, S. (1953): Fossil assemblage of Molluscs and Brachiopods of unusually large sizes in the Permian of Japan. *Trans. Proc. Palaeont.*

Soc. Japan, N. S., (10), 37–44, pl. 5.

*HAYASAKA, I. and KATO, M. (1966): On *Pseudoschwagerina miharanoensis* AKAGI. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **13**, (3), 265–272, pls. 31, 32.

——— and ——— (1966): On *Enteletes gibbons* CHRONIC. *ibid.*, 281–286, pls. 34–35.

HAYASAKA, I. and MATSUO, H. (1951): Permian fossils from "Oguradani", Nojiri, Kamianama-mura, Ono-gun, Fukui Prefecture. *Jour. Geol. Soc. Japan*, **57**, (670), 266 (J).

HAYASAKA, I. and MINATO, M. (1952): Carboniferous formation in the Japanese islands. *Compte rendu, 3me Congr. Strat. Geol. Carbon.–Heerlen*, 1951, 267–274.

——— and ——— (1954): The Paleozoic of Japan. *Comptes rendus, dix-neuvième session, Congr. Geol. Intern., Alger*, 1952, Sec. XIII, Fasc. 13, 193–204.

——— and ——— (1954): A *Sinospirifer*-faunule from the Abukuma Plateau, Northeast Japan in comparison with the so-called Upper Devonian Brachiopod faunule of the Kitakami mountains. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (16), 201–211, pl. 26.

——— and ——— (1954): A note on the Carboniferous and Permian faunas of Japan. *Jour. Fac. Sci. Hokkaido Univ.*, [4], 8, (4), 375–379.

——— and ——— (1956): Some Brachiopods from the lower Kanokura series of the Kitakami mountains, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (21), 141–147, pl. 23.

——— and ——— (1966): On *Lonsdaleoides nishikawai* n. sp. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **13**, (3), 273–280, pl. 33.

HAYASAKA, I. and NISHIKAWA, I. (1963): On some Permian macrofossils from Hiroshima Prefecture, Japan (A preliminary report), *Kaseki* (*"Fossil"*), (6), 27 (J).

HAYASAKA, I. and OZAKI, K. (1955): A *Foordiceras* from the Permian formation of Central Japan. *Sci. Repts. Kanazawa Univ.*, **3**, (1), 183–186, pl. 1.

HIRATA, Shigeru (1958): Some important new facts from the Chichibu zone in the central part of Shikoku. *Chikyu Kagaku* (*Earth Science*), (36), 22–24 (J+E).

——— (1958): On the distribution of dolomite-bearing quartzite found in a part of the Chichibu system in the central part of Shikoku. *Chigaku-Kenkyu* (*Jour. Soc. Earthscientists & Amateurs Japan*), **10**, (4), 154–155 (J).

——— (1961): The geology of the mountain districts of Onogahara and Torigata-yama in Shikoku. *ibid.*, **12**, (1), 35–41 (J+E).

——— (1966): On the Upper Devonian Ohira Formation in the Outer zone of Shikoku, Japan. *ibid.*, **17**, (4), 102–105 (J+E).

HIRAYAMA, K. and KAMBE, N. (1956): Geological sheet map with explanatory text; Yawatahama and Iyo-Takayama, 1 : 50,000. *Geol. Surv. Japan.*

——— and ——— (1959): Geological sheet map with explanatory text; Koyasan, 1 : 50,000. *Geol. Surv. Japan.*

HIRAYAMA, K. and TANAKA, K. (1956): Geological sheet map with explanatory text, Kainan, 1 : 50,000, *Geol. Surv. Japan.*

——— and ——— (1956): Geological sheet map with explanatory text, Todoroki, 1 : 50,000. *Geol. Surv. Japan.*

HIRAYAMA, K. *et al.* (1956): Geological sheet map with explanatory text, Kenzan, 1 : 75,000, *Tokushima Prefecture.*

HIROKAWA, O., ISOMI, H. and KURODA, K. (1957): Geology of the western part of Wakasa district. *Jour. Geol. Soc. Japan.*, **63**, (742), 414 (J).

———, ——— and ——— (1957): Geological sheet map with explanatory text, Obama, 1 : 50,000. *Geol. Surv. Japan.*

HIROKAWA, O., TOGO, F. and KAMBE, N. (1954): Geological sheet map with explanatory text, Oyaichiba, 1 : 50,000. *Geol. Surv. Japan.*

———, ——— and ——— (1954): Geological sheet map with explanatory text, Tajima-Takeda, 1 : 50,000. *Geol. Surv. Japan.*

HIROKAWA, O. and YOSHIDA, T. (1959): Geological sheet map with explanatory text, Hitokabe, 1 : 50,000. *Geol. Surv. Japan.*

*HONJO, Susumu (1959): Neoschwagerinids from the Akasaka limestone. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **10**, (1), 111–161, pls. 1–12.

——— (1960): A study of some primitive *Neoschwagerina* by a new serial section technique. *ibid.*, [4], **10**, (3), 458–470, 3 pls.

HORIGUCHI, Mankichi (1958): Some calcareous algae in the central part of the Kitakami mountains, Iwata Prefecture, Northeast Japan. *Sci. Repts. Saitama Univ.*, [B], **3**, 132–139, pls. 27–28.

ICHIKAWA, Koichiro (1951): *Actinodontophora*, nov, and other Permian Mollusca from Katsura in the Sakawa basin, Shikoku, Southwest Japan. *Jour. Fac. Sci. Univ. Tokyo*, [2], **7**, (6), 317–335, pl. 1.

——— (1964): Tectonic status of the Honshu Major Belt in Southwest Japan during the Early Mesozoic. *Jour. Geosciences Osaka City Univ.*, [8], **3**, 71–107.

ICHIKAWA, K., ISHII, K. and KATTO, J. (1955): The northern belt of the Chichibu terrain in the middle part of Kochi Prefecture. *Jour. Geol. Soc. Japan*, **61**, (718), 345 (J).

ICHIKAWA, K. *et al.* (1952): The Kurosegawa tectonic zone. *Jour. Geol. Soc. Japan*, **58**, (682), 287 (J).

——— (1953): On the "Sakashu unconformity"—Group study on the environs of Sakashu-mura, Naka-gun, Tokushima Prefecture—*Jour. Gakugei, Tokushima Univ.*, (*Nat. Sci.*), **3**, 61–74 (J+E).

——— (1956): Die Kurosegawa-Zone (Untersuchung über das Chichibu terrain in Shikoku, III). *Jour. Geol. Soc. Japan*, **62**, (725), 82–103 (J+G).

IGI, S. and KURODA, K. (1965): Geol. sheet map with explanatory text; Oeyama, 1 : 50,000, *Geol. Surv. Japan.*

IGI, S., KURODA, K. and HATTORI, H. (1961): Geological sheet map with explanatory text; Maizuru, 1 : 50,000. *Geol. Surv. Japan.*

*IGO, Hisayoshi (1955): Notes on the Osobudani conglomerate and some Lower Permian fusulinids contained in its limestone pebbles. Pt. 2. (On a new type of the wall structure of Fusulinids). *Sci. Rept. Tokyo Kyoiku Daigaku*, [C], **4**, (40), 293–302, pls. 18–19.

——— (1955): Carboniferous System in the Fukuji district. *Jour. Geol. Soc. Japan*, **61**, (718), 306 (J).

——— (1956): Note on the Osobudani conglomerate of the Fukuji district, Hida mountainland. *ibid.*, **62**, (724), 46 (J).

——— (1956): On the Carboniferous and Permian of the Fukuji district, Hida massif, with special reference to the Fusulinid zones of the Ichinotani Group. *ibid.*, **62**, (728), 217–240 (J+E).

*——— (1956): Notes on the Osobudani conglomerate and some Lower Permian fusulinids contained in its limestone pebbles. Pt. 1. *Trans. Proc. Palaeont. Soc. Japan, N. S.* (22), 169–174, pl. 27.

*——— (1957): Fusulinids of Fukuji, southeastern part of the Hida massif, Central Japan. *Sci. Repts. Tokyo Kyoiku Daigaku*, [C], **5**, (47), 153–246, pls. 1–15.

*——— (1957): On a remarkable *Triticites* from the pebbles of the Sorayama conglomerate, Fukuji, southeastern part of the Hida massif, central Japan. *Japan. Jour. Geol. Geogr.*, **28**, (4), 239–246, pl. 18.

——— (1958): Stratigraphy and depositional environment of the Permian Nyukawa Group. *Jour. Geol. Soc. Japan*, **64**, (759), 690–691 (J).

——— (1958): On the occurrence of *Koninkocaninia* from the Ichinotani formation. *Japan. Jour. Geol. Geogr.*, **29**, (4), 209–222, pls. 15–16.

——— (1959): Note on some Permian corals from Fukuji, Hida massif, central Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (34), 79–85, pl. 8.

*——— (1959): Some Permian fusulinids from the Hirayu district, southeastern part of the Hida massif, Central Japan. *Sci. Repts. Tokyo Kyoiku Daigaku*, [C], **6**, (56), 231–254, pls. 1–4.

——— (1959): On the unconformities found in the Carboniferous Ichinotani Formation. *Jour. Geol. Soc. Japan*, **65**, (766), 457 (J).

——— (1959): Stratigraphic position of the corals in the Ichinotani Formation (Carboniferous)—Reply to KATO's opinion. *ibid.*, **65**, (768), 559–560 (J).

*——— (1960): *Yabeina* from the Omi limestone, Niigata Prefecture, Central Japan. *Sci. Repts. Tohoku Univ.*, [2], Spec. vol. 4, 335–343, pl. 36.

——— (1960): First discovery of the non-marine sediments in the Japanese Carboniferous. *Proc. Japan Acad.*, **36**, (8), 498–502.

——— (1960): Fusulininae from Japan. *"Kaseki"* (*"Fossil"*), (1), 7–11 (J).

——— (1960): On the paleoecology and fusulinids from the Nyukawa Group. *ibid.*, 63–71 (J).

——— (1961): On the disconformity and aluminous shale of the Carboniferous Ichinotani formation, Hida massif. *Jour. Geol. Soc. Japan*, **67**, (788), 261–273 (J+E).

——— (1961): Middle Carboniferous corals from the Ichinotani formation (Upper Paleozoic corals from Fukuji, Southwestern part of the Hida massif, pt. 3). *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (43), 127–137, pls. 18–19.

*——— (1964): On some *Pseudoschwagerina* and *Zellia* from Japan. *Jour. Paleont.* **38**, (2), 281–293, pls. 45–46.

——— (1964): *Diphyphyllum* from Itoshiro, Fukui Prefecture, Central Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (53), 170–172.

——— (1964): On the occurrence of *Goniatites* (*s.s.*) from the Hida massif, Central Japan. *ibid.*, (54), 234–238.

*——— (1964): Permian Fusulinids of Nyukawa, Central Japan, Pt. 1. Some Fusulinids from the Shiroi and Kono Formations. *Jour. Paleont.* **38**, (4), 637–649, pls. 103–106.

*——— (1964): Fusulinids from the Nabeyama formation (Permian) Kuzu, Tochigi Prefecture, Japan. *Mem. Mejiro Gakuen Woman's Junior Coll.* **1**, 1–28, pls. 1–9.

*——— (1965): Permian fusulinids of Nyukawa, Central Japan, pt. 2. Some fusulinids from the lower part of the Sote formation. *Jour. Paleont.*, **39**, (2), 210–223, pls. 29–32.

——— (1965): Carboniferous Conodonts from Yobara, Akiyoshi Limestone, Japan. (Studies of Asiatic Conodonts, Pt. II). *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (59), 83–91, pls. 8–9.

IGO, H. and KOIKE, T. (1964): Carboniferous Conodonts from the Omi limestone, Niigata Prefecture, Central Japan. *Trans. Proc. Placont. Soc. Japan, N. S.*, (53), 179–193, pls. 27–28.

*IGO, H. and OGAWA, K. (1958): Fusulinids from the Funafuseyama limestone, pt. 1 (On some interesting *Parafusulina* from the Funafuseyama limestone). *Jubilee Publ. Comm. Prof. H. Fujimoto*, 50–57, pls. 1–2.

IIZUKA, Yasugoro (1928): Geological sheet map with explanatory text, Toba, 1: 75,000. *Geol. Surv. Japan.*

IKEBE, Nobuo (1936): On the Uonashi thrust. *Chikyu* (*The Globe*), **25**, 399–408 (J).

IKEBE, N. *et al.* (1961): Geology and Mineral Resources map of Hyogo Prefecture with explanatory text. *Hyogo Prefecture.*

IMAMURA, Sotoji (1953): New occurrence of *Lyttonia* from the environs of Hiroshima, Japan. *Jour. Sci. Hiroshima Univ.*, [C], **1**, (3), 11–15, pl. 1.

——— (1959): Outline of geology of the Chugoku massif (Hibasan, Dogosan, and Sentsuzan district). *Sci. Repts. Okayama Prefecture,* 17–28 (J).

——— (1959): Carboniferous and Permian limestones of Okayama Prefecture. *Rept. Natural Resources, Okayama Pref.,* 1–2 (J).

IMAMURA, S., NUREKI, T. and OKIMURA, Y. (1966): The outline geology of West Chugoku backbone mountains. *Sci. Rept. Quasi-National Park, West Chugoku Mts. Shimane and Hiroshima Prefecture* (J).

INAI, Yutaka (1939): Geology of Iwaizaki on the Bay of Kesennuma (Preliminary report). *Jour. Geol. Soc. Japan,* **46**, (551), 428–432 (J+E).

INOUE, Juichi (1933): Geology of Aritagawa valley, Wakayama Prefecture (Pts. 1, 2). *Chikyu (The Globe)*, **19**, (5), 352–372; (6), 396–398 (J).

INOUE, Hideo (1955): On the dolomite deposit of the Ikagawa mine, Oita Prefecture. *Bull. Geol. Surv. Japan,* **6**, (3), 27–32 (J+E).

INOUE, S. and HAYASHI, T. (1956): The older rocks in the eastern part of Gifu city. *Jour. Geol. Soc. Japan,* **62**, (730), 363–364 (J).

*ISHII, A. and TAKAHASHI, H. (1960): Fusulinids from the Upper Permian Ogamata formation, central part of Kwanto massif, Japan. *Sci. Repts. Tokyo Kyoiku Daigaku,* [C], **7**, (66), 205–216, pls. 4–5.

ISHII, Jun (1960): Ozawainellinae and Staffelinae from Japan. *"Kaseki" ("Fossils")*, (1), 1–6 (J).

ISHII, Ken'ichi (1955): Itadorigawa Group in western Shikoku—On some problem concerning the Middle Pennsylvanian of Japan. *Jour. Geol. Soc. Japan,* **62**, (724), 20–29 (J+E).

——— (1957): On the so-called *Fusulina. Proc. Japan Acad.* **33**, (10), 652–656.

*——— (1958): Fusulinids from the middle Upper Carboniferous Itadorigawa group in western Shikoku, Japan, pt. 1, Genus *Fusulina. Jour. Inst. Polytech. Osaka City Univ.,* [G], 4, 1–28, pls. 1–5.

——— (1958): On the phylogeny, morphology and distribution of *Fusulina, Beedeina* and allied fusulinid genera. *ibid.,* 29–70.

——— (1959): On the evolution of Fusulinida. *Chikyu Kagaku (Earth Science)*, (45), 5–14 (J).

——— (1960): *Beeedeina* as polyphyletic genera. *Chikyu Kagaku (Earth Science)*, (48), 39 (J).

*——— (1961): Fusulinids from the middle Upper Carboniferous Itadorigawa group in western Shikoku, Japan, pt.3. Stratigraphy and concluding remarks *Jour. Inst. Polytech. Osaka City Univ.,* [G], 5, 31–52.

*——— (1962): Fusulinids of the middle Upper Carboniferous Itadorigawa group in western Shikoku; pt. 2, Genus *Fusulinella* and other fusulinids. *Jour. Geosci., Osaka City Univ.,* **6**, (1), 1–58, pls. 6–12.

ISHII, K., ICHIKAWA, K. and YAMASHITA, N. (1952): On the Kurosegawa tectonic zone in Ehime and Kochi Prefectures. *Jour. Geol. Soc. Japan,* **58**, (682), 286 (J).

*ISHII, K. and NOGAMI, Y. (1961): On the new genus *Metadoliolina. Trans. Proc. Palaeont. Soc. Japan., N. S.,* (44), 161–166, pl. 25.

*——— and ——— (1962): On *Yabeina shiraiwensis* OZAWA and *Yabeina yasubaensis* TORIYAMA. *Jour. Geosci., Osaka City Univ.,* **6**, (2), 59–72, pls. 1–2.

ISHII, K. and SUYARI, K. (1956): Distribution of conglomeratic facies in the Chichibu terrain in Shikoku. *Jour. Geol. Soc. Japan,* **62**, (730), 361–362 (J).

ISHII, K. and YAMAGIWA, N. (1961): A new species of the genus *Clisiophyllum* from the Upper Carboniferous of Ehime Prefecture. *Trans. Proc. Palaeont. Soc. Japan, N.S.,* (44), 153–156, pl. 23.

ISHII, K. *et al.* (1957): Geology of the Chichibu terrain along the highway from Kamiyakawa to Ino, Shikoku. *Jour. Geol. Soc. Japan,* **63**, (743), 449–454 (J+E).

——— (1958): On the fantsastic Klippen of the Sakawa basin, Shikoku—A reply to Prof. Teiichi KOBAYASHI—*Jour. Geol. Soc. Japan*, **64**, (750), 138–145 (J+E).

ISHIOKA, K. and KAMEI, T. (1950): Discovery of the Gotlandian formation in the upper part of Kuzuryu-River, Fukui Prefecture (Preliminary report). *Jour. Geol. Soc. Japan*, **56**, (653), 57–58 (J+E).

ISHIZAKI, Kunihiro (1960): On some evidences found within Ryoseki basin and their interpretation. *Sci. Repts. Tohoku Univ.*, Spec. vol. 4, 605–609 (J+E).

——— (1960): On the geology and tectonics in the area northeast of Kochi City, Shikoku—On the unconformable relationship between the Upper Paleozoic and the Lower Cretaceous—*Jour. Geol. Soc. Japan*, **66**, (780), 553–565 (J+E).

*——— (1962): A New locality and faunal assemblage of fusulinids from the limestone in the area west of Ryoseki, Kochi Prefecture. *Sci. Rept. Tohoku Univ.*, [2], Spec. vol. 5, 107–118, pl. 29.

*——— (1962): Stratigraphical and Paleontological studies of the Onogahara and its neighbouring area, Kochi and Ehime Prefectures, Southwest Japan. *Sci. Rept. Tohoku Univ.*, [2], **34**, (2), 95–185, pls. 7–12.

*——— (1963): Verbeekininae from the inferred upper Wolfcampian limestone in the west of Ryoseki, Kochi Prefecture. *Trans. Palaeont. Soc. Japan, N. S.*, (50), 51–64, pl. 9.

*——— (1963): Upper Carboniferous fusulinids from the Nakahata formation of the Hida massif—with special refence to fusulinids similar to *Fusulinella pseudobocki* (LEE and CHEN). *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (51), 102–114, pl. 16.

——— (1963): On some Carboniferous Ostracodes of the genus *Bairdia* from Japan. *Japan. Jour. Geol. Geogr.*, **34**, (2–4), 161–175, pl. 9.

——— (1964): Middle Permian Ostracodes from the Iwaizaki limestone, Northeast Japan. *Sci. Rept. Tohoku Univ.*, [2], **36**, (1), 139–160, pls. 16–19.

——— (1964): On some Carboniferous Ostracod genera from Japan. *Bull. Saito Ho-on Kai Museum Res.*, (33), 30–40, pl. 1.

ISOMI, Hiroshi (1955): The Carboniferous and Permian formations and fusulinids fossils in the area of upper reaches of the River Hino, Fukui Prefecture. *Bull. Geol. Surv. Japan*, **6**, (1), 19–22 (J+E).

——— (1955): Geological sheet map with explanatory text, Ogaki, 1 : 50,000. *Geol. Surv. Japan.*

——— (1956): Geological sheet map with explanatory text, Ominagahama, 1 : 50,000. *Geol. Surv. Japan.*

——— (1958): Permian rocks of the area to the north of Hamana-ko, Shizuoka Prefecture. *Bull. Geol. Surv. Japan*, **9**, (2), 77–82 (J+E).

——— (1965): Sole marks observed in the Upper Permian Maizuru Group around Maizuru City, Kyoto Prefecture, Japan. *Jour. Geol. Soc. Japan*, **71**, (839), 413–418 (J+E).

ISOMI, H. and KATADA, M. (1959): Consideration on some sedimentary features of non-metamorphosed Upper Paleozoic and Ryoke metamorphics in the northern part of Kiso mountainland, Central Japan. *Bull. Geol. Surv. Japan*, **10**, (12), 1037–1052 (J+E).

ISOMI, H. and KURODA, K. (1958): Geology of the western part of Wakasa district, Fukui Prefecture—with particular reference to the stratigraphy and structure of Permian—. *ibid.*, **9**, (3), 133–143 (J+E).

ISOMI, H. and NOZAWA, T. (1957): Geological sheet map with explanatory text, Funazu, 1: 50,000. *Geol. Surv. Japan.*

——— and ——— (1960): On the Structure of the Hida metamorphic rocks. *Chikyu Kagaku* (*Earth Science*), (48), 11–20 (J+E).

IWAI, J. and ISHIZAKI, K. (1966): A preliminary study on the Usuginu type con-

glomerate—with special reference to its paleogeographical and structural significance. *Contrib. Inst. Geol. Palaeont. Tohoku Univ.*, (62), 35–53 (J+E).

IWAO, Shuichi (1955): Petrographic characters of some bedded chert of Permo-Carboniferous formation in Japan. *Sci. Papers Coll. General Educ. Univ. Tokyo*, **5**, (1), 55–66.

IWAO, S. and MATSUI, H. (1961): Geological sheet map with explanatory text, Taira, Kawamae (incl. Ide), 1 : 50,000. *Geol. Surv. Japan.*

KAJITA, Sumiwo (1963): Geology of the upper reaches area of the Ibi River, Central Japan. *Sci. Repts. Liberal Arts Gifu Univ. (Nat. Sci.)*, **3**, (2), 192–201 (J+E).

KAKIMI, Toshihiro (1953): Paleozoic formations in the environs of Sakamotozawa and Nagaiwa, Ofunato-shi, Iwate Prefecture. *Jour. Geol. Soc. Japan*, **59**, (694), 344 (J).

KAMATA, N. and CHISAKA, T. (1955): Geological studies of the Upper Paleozoic in the neighbourhood of Shimoyahagi, Kesen-gun, Iwate Prefecture. *Mem. Fac. Sci. Liter. Chiba Univ. (Nat. Sci.)*, **1**, (4), 283–287 (J+E).

KAMBE, Nobukazu (1950): Geology of the Shidaka coal-field in Kasa-gun, Kyoto Prefecture. *Jour. Geol. Soc. Japan*, **56**, (654), 119–124 (J+E).

——— (1957): Geological sheet map with explanatory text, Kuraoka, 1 : 50,000. *Geol. Surv. Japan.*

——— (1960): Lower Triassic Kamura formation in Miyazaki Prefecture (Preliminary report). *Jour. Geol. Soc. Japan*, **66**, (778), 467 (J).

——— (1963): On the boundary between the Permian and Triassic System in Japan, with the description of the Permo-Triassic formations at Takachiho-cho, Miyazaki Prefecture in Kyushu and the Skytic Fossils contained. *Rept. Geol. Surv. Japan*, (198), 1–68, pls. 1–19.

KAMBE, N. and HIROKAWA, O. (1963): Geological sheet map with explanatory text, Sayo, 1 : 50,000. *Geol. Surv. Japan.*

KAMBE, N. and SAITO, M. (1957): The Lower Triassic discovered in the Takachiho district, Miyazaki Prefecture. *Bull. Geol. Surv. Japan*, **8**, (10), 577–578 (J+E).

KAMBE, N. and SHIMAZU, M. (1961): Geological sheet map with explanatory text, Kesennuma, 1 : 50,000. *Geol. Surv. Japan.*

KAMEI, Tadao (1949): A conglomerate bed in the Hida Paleozoic. *Mineral. and Geol.*, **3**, (1), 18 (J).

——— (1950): Hida Paleozoic, with special reference to the Murakami conglomerate. *Jour. Geol. Soc. Japan*, **56**, (656), 266 (J).

——— (1952): The stratigraphy of the Paleozoic rocks of the Fukuji district, southern part of Hida mountainland (Study on Paleozoic rocks of Hida, I). *Jour. Fac. Lib. Arts Shinshu Univ.*, (2), 43–74.

——— (1955): The Carboniferous System in the southern Hida mountains (preliminary report). *Jour. Geol. Soc. Japan*, **61**, (718), 306 (J).

——— (1957): On two Permian corals from the Mizuyagatani formation. *ibid.*, (7), 29–35, pls. 1–3.

——— (1961): Notes on Japanese Middle Devonian. *Chikyu Kagaku (Earth Science)*, (56), 1–9, pl. 1.

——— (1962): On the Devonian formation in the Hida mountainland. *"Geology of Hida massif"*, 33–43 (J+E).

KAMEI, T., YOSHIDA, S. and MAEDA, S. (1959): Fusulinids from the Permian of Kamiise, Fukui Prefecture. *Jour. Geol. Soc. Japan*, **65**, (763), 250 (J).

KAMEI, T. *et al.* (1962): Discovery of Permian fossils from the Utouyama limestone, Shiojiri city, Nagano Prefecture. *Chikyu Kagaku (Earth Science)*, (58), 32–34 (J).

KANMERA, Kametoshi (1951): Paleozoic formations in the Odao zone along the Hikawa valley, Kumamoto Prefecture. *Jour. Geol. Soc. Japan*, **57**, (670), 341–342 (J).

——— (1952): The Upper Carboniferous and the Lower Permian of the Hikawa valley, Kumamoto Prefecture, Kyushu, Japan. *ibid.*, 58, (676), 17–32 (J+E).

*——— (1952): The Lower Carboniferous formation of southern Kyushu with a description of some corals and fusulinids. *Mem. Fac. Sci. Kyushu Univ.*, [D], **3**, (4), 157–177, pls. 8–12.

——— (1952): Stratigraphy and fossil zones of the Paleozoic formations in South Kyushu. *Jour. Geol. Soc. Japan*, 58, (682), 319–320 (J).

——— (1953): Fossils and stratigraphy of the Kuma Formation—with special reference to the Upper Permian Series in Japan. *Jour. Geol. Soc. Japan*, **59**, (694), 362 (J).

——— (1953): The Kuma formation with special reference to the Upper Permian in Japan (Geological study of the Paleozoic in southern Kyushu, pt. 3). *ibid.*, **59**, (697), 449–468 (J+E).

*——— (1954): Fusulinids from the Upper Permian Kuma formation, southern Kyushu, Japan, with special reference to the fusulinid zone in the Upper Permian of Japan. *Mem. Fac. Sci. Kyushu Univ.*, [D], 4, (1), 1–38, pls. 1–6.

*——— (1954): The fusulinids from the Yayamadake limestone of the Hikawa valley, Kumamoto Prefecture, Kyushu, Japan, pt. 1. *Jour. Jour. Geol. Geogr.* **25**, (1–2), 117–144, pls. 12–14.

——— (1955): The Middle Permian Kozaki Formation with the remarkable conglomerate beds. *Jour. Geol. Soc. Japan*, **61**, (718), 346–347 (J).

*——— (1955): Fusulinids from the Yayamadake limestone of the Hikawa valley, Kumamoto Prefecture, Kyushu, Japan, pt. 2. Fusulinids of the Upper Carboniferous. *Japan. Jour. Geol. Geogr.* **27**, (3–4), 177–192, pls. 11–12.

*——— (1956): *Toriyamaia*, a new Permian fusulinid genus from the Kuma massif, Kyushu, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (24), 251–257, pl. 36.

——— (1957): Revised classification of *Cancellina, Neoschwagerina*, and evolution of Sumatrininae and Neoschwagerininae. *Mem. Fac. Sci. Kyushu Univ.*, [D], **6**, (1), 47–64.

——— (1957): Some evolutional series of the Subfamily Schwagerininae. *Jour. Geol. Soc. Japan*, **63**, (742), 444 (J).

*——— (1958): Fusulinids from the Yayamadake limestone of the Hikawa valley, Kumamoto Prefecture, Kyushu, Japan. pt. 3, Fusulinids of the Lower Permian. *Mem. Fac. Sci. Kyushu Univ.*, [D], **6**, (3), 153–215, pls. 24–35.

——— (1960): Coral fauna of the Kuriki Series of the Yayamadake. *Jour. Geol. Soc. Japan*, **66**, (778), 473 (J).

——— (1961): Upper Carboniferous corals from the Yayamadake limestone, Kyushu. *Mem. Fac. Sci. Kyushu Univ.*, [D], **10**, (2), 207–232, pls. 14–18.

——— (1961): Middle Permian Kozaki formation. *Sci. Rept. Kyushu Univ.* [*Geol.*], **5**, (4), 196–205 (J+E).

*——— (1963): Fusulines of the Middle Permian Kozaki formation. *Mem. Fac. Sci. Kyushu Univ.*, [D], **14**, (2), 79–141, pls. 11–19.

KANMERA, K. and FURUKAWA, H. (1964): Stratigraphy of the Upper Permian and Triassic Konosé Group in Kyushu. *Sci. Rep. Fac. Sci. Kyushu Univ.*, 4, (3), 237–258 (J+E).

KANMERA, K. and TORIYAMA, R. (1955): Carboniferous in West Chugoku and Kyushu. *Jour. Geol. Soc. Japan*, **61**, (718), 307 (J).

KANMERA, K. and MIKAMI, T. (1965): Succession and sedimentary features of the Lower Sakamotozawa Formation. *Mem. Fac. Sci. Kyushu Univ.*, [D], **16**, (3), 265–274.

*——— and ——— (1965): Fusuline zonation of the Lower Permian Sakamotozawa Series. *ibid.*, 275–320, pls. 44–53.

KANO, Hiroshi (1956): On the granite pebbles in the Paleozoic and Mesozoic conglomerates of Japan. *Jour. Geol. Soc. Japan*, **62**, (730), 363 (J).

——— (1958): On a granite-bearing conglomerate from the Choshi peninsula, Chiba Prefecture. *ibid.*, **64**, (757), 551–556 (J+E).

——— (1961): The conglomerates from Otani and Sawando in the Hida mountainlands as viewed from the conception of maturity. *ibid.*, **67**, (789), 350–359 (J+E).

KANO, H., NAKAZAWA, K. and SHIKI, T. (1961): Considerations on the Permian back grounds of the Maizuru districts judging from the conglomerates. *ibid.*, **67**, (791), 463–475 (J+E).

KANO, H. *et al.* (1959): On the high grade metamorphic rocks associated with the Yakuno intrusive of the Maizuru zone. *ibid.*, **65**, (764), 267–271, pl. 4 (J+E).

KANOMATA, N. and CHISAKA, T. (1955): Geological studies on the Upper Paleozoic in the neighbourhood of Shimoyahagi, Kesen-gun, Iwate Prefecture. *Jour. Coll. Arts & Sci. Chiba Univ.*, **1**, (4), 283–287 (J+E).

KANUMA, Mosaburo (1951): On the *Triticites* zone near the boundary between the Mino and Hida Provinces. *Jour. Geol. Soc. Japan*, **57**, (670), 266 (J).

——— (1952): Geological studies of the southern and southwestern parts of the Hida plateau (Preliminary report). *Bull. Tokyo Gakugei Univ.*, [*Chem., Geol.*], (3), 23–33 (J).

*——— (1953): On some Moscovian fusulinids from the southern part of Hida plateau, Gifu Prefecture, Japan. *Bull. Tokyo Gakugei Univ.*, **4**, 23–33, pl. 3.

——— (1954): On the Carboniferous–Permian boundary of the bordering area of Mino and Hida, Gifu Pref., Japan. *Bull. Inst. Geol. Mineral. Tokyo Kyoiku Daigaku*, (3), 143–147 (J+E).

——— (1955): On the Upper Carboniferous and Lower Permian of the bordering area of Mino and Hida, Gifu Prefecture. *Bull. Tokyo Gakugei Univ.*, [*Mathem. Geol. Phys.*], **5**, (4), 27–33, pls. 1–2.

——— (1955): Carboniferous System of the Oppara area, Kiyomi-mura, Ono-gun, Gifu Prefecture. *Jour. Geol. Soc. Japan*, **61**, (718), 307 (J).

——— (1956): Permian conglomerate of the Mino mountainland in the southern part of Gifu Prefecture. *Bull. Tokyo Gakugei Univ.*, **7**, 99–104 (J).

——— (1958): Stratigraphical and Paleontological studies of the southern part of the Hida plateau and the northeastern part of the Mino mountainland; pt. 1. Stratigraphy. *Jubilee Publ. Comm. Prof. H. Fujimoto*, 1–48.

*——— (1958–1960): Stratigraphical and Paleontological studies of the southern part of the Hida plateau and the northeastern part of the Mino mountainland; pt. 2, Paleontology, No. 2. *Bull. Tokyo Gakugei Univ.*, **9**, 27–57, pls. 2–3 (1958); No. 3, *Pseudoschwagerina*, *Pseudofusulina* and *Parafusulina*. *ibid.*, **10**, (3), 59–107, pls. 4–9 (1959); No. 4, *Ozawainellinae*, *Schubertellinae*, *Verbeekininae* and *Neoschwagerininae*. *ibid.*, **11**, 55–83, pls. 10–13 (1960).

——— (1960): Fossil zones in the Upper Carboniferous of Japan, particularly on the relation between the *Triticites* and the *Pseudoschwagerina* zone. *"Kaseki"* (*"Fossil"*), (1), 42–50 (J).

——— (1960): Revision of the Upper Carboniferous and Lower Perimian System in Japan. *Jour. Geol. Soc. Japan*, **66**, (778), 469 (J).

KANUMA, M. and IRIE, K. (1962): On the geology of the Yoro massif, Gifu Prefecture, Japan. *Bull. Tokyo Gakugei Univ.*, **13**, 211–217 (J+E).

*KANUMA, M. and SAKAGAMI, S. (1957): *Mesoschubertella*, a new Permian fusulinid genus from Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (26), 41–46, pl. 8.

*KANUMA, M., TAKAHASHI, Y. and MORI, Y. (1961): On the Upper Carboniferous and the Lower Permian of the Otaki district, Gifu Prefecture, Central Japan. *Bull. Tokyo Gakugei Univ.*, **12**, 107–118, pl. 14 (J+E) (Specific description in English).

KANUMA, M. *et al.* (1956): Permian conglomerates in the Kwanto and Chubu Provinces. *Jour. Geol. Soc. Japan*, **62**, (730), 361 (J).

KASHIMA, Naruhiko (1960): New fossil localities in the Onogahara district, Ehime Prefecture. *ibid.*, **66**, (772), 52 (J).

KATADA, M. and ISOMI, H. (1958): Geological sheet map with explanatory text, Agematsu, 1 : 50,000. *Geol. Surv. Japan.*

——— and ——— (1962): Geological sheet map with explanatory text; Ina, 1 : 50,000. *Geol. Surv. Japan.*

——— and ——— (1964): Geological sheet map with explanatory text; Shiojiri, 1 : 50,000. *Geol. Surv. Japan.*

KATADA, M. *et al.* (1953): Chemical composition of Paleozoic rocks from northern Kiso district and of Toyoma clayslates in Kitakami mountainland; I, Chemical composition of pelitic rocks; II, Chemical composition of psammitic rocks and basalts. *Jour. Japan. Assoc. Min. Pet. Econ. Geol.*, **49**, (3), 85–100; (4), 151–162 (J).

KATO, Makoto (1959): Some Carboniferous Rugose Corals from the Ichinotani formation, Japan. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **10**, (2), 263–287, pls. 1–3.

——— (1959): On some Carboniferous corals from the Kitakami mountains. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (33), 33–43.

——— (1959): Stratigraphic horizons of the Carboniferous corals in Ichinotani, Fukuji. *Jour. Geol. Soc. Japan*, **65**, (760), 47–48 (J).

——— (1959): Reply to H. IGO's discussion on the stratigraphic horizons of Carboniferous corals in Ichinotani, Fukuji. *ibid.*, **65**, (768), 561–562 (J).

KATO, M. and NAKAMURA, K. (1962): A Goniatite from the Omi limestone (Preliminary report). *Chikyu Kagaku (Earth Science)*, (63), 33–34 (J+E).

KATO, M. *et al.* (1964): Two major facies in the Upper Carboniferous of Japan and their relationship to volcanic activities. *Compte rendu, cinq. congr. intern. strat. geol. Carbon*, 499–504.

KATTO, J. and KAWASAWA, K. (1958): The Paleozoic System of the northern environs of Ino, Kochi Prefecture. *Res. Repts. Kochi Univ.*, **7**, (19), 1–8, 1 pl. (J).

KATTO, J. and SUYARI, K. (1956): Geology of Monobegawa basin in Shikoku (Studies on the Chichibu terrain of Shikoku, VII). *ibid.*, **5**, (23), 1–11 (J).

KATTO, J. *et al.* (1956): Geologie des nordlichen Sakawa-Beckens, Shikoku, Japan. (Studies on the Chichibu terrain of Shikoku, VI). *Chikyu Kagaku (Earth Science)*, (26–27), 1–9 (J+G).

KAWADA, Kiyosuke (1953): Geological studies on the Yamizo, Torinoko and Toriashi mountain blocks and their neighbourhood in the northeastern Kwanto district. *Sci. Repts., Tokyo Bunrika Daigaku*, [C], **2**, (15), 217–307.

KAWADA, K. and KANOMATA, N. (1948): On the Paleozoic fossils from pebbles in the conglomerates found in the southern foot of Torinoko mountain, Ibaragi Prefecture. *Jour. Geol. Soc. Japan*, **54**, (628–630), 17–18 (J+E).

KAWADA, Shigema (1954): Stratigraphical and Paleontological studies of Omi limestone in the Itagamine district, Niigata Prefecture. *Bull. Tokyo Univ. Educ. Geol. Mineral. Inst.* (3), 15–27 (J+E).

——— (1954): Stratigraphical and Paleontological studies of Omi limestone in the Mt. Kurohime district, Niigata Prefecture. *Miscel. Repts. Research Inst. Nat. Resources*, (35), 48–55 (J+E).

——— (1954): Stratigraphical and Paleontological studies of Omi limestone in the Mt. Myojo district. *ibid.*, (36), 39–48 (J).

——— (1955): Geological studies of the Shimizukura conglomerate in Omi-machi. *ibid.*, (37), 66–72, pls. 2 (J+E).

——— (1955): On the Carboniferous System in the vicinity of Omi. *Jour. Geol. Soc. Japan*, **61**, (718), 308 (J).

KAWADA, S. and FUJIMOTO, H. (1952): Stratigraphical and paleontological studies of the Omi limestone, especially of the Itagamine area, Niigata Prefecture. *ibid.*, 58, (628), 320 (J).

——— and ——— (1957): Study on the Paleozoic formations around the Chichibu mine. *ibid.*, **63**, (743), 413 (J).

KAWADA, S. and MORIKAWA, R. (1953): So-called *Parafusulina? japonica* and its stratigraphical significance. *Natural Science and Museum*, **20**, (1–2), 1–7 (J+E).

KAWAI, Masatora (1957): Geological sheet map with explanatory text, Tsuyama-Tobu, 1 : 50,000. *Geol. Surv. Japan.*

——— (1959): On the Late Mesozoic crustal movement in the western part of Hida plateau, central Honshu, Japan; pt. 2. *Jour. Geol. Soc. Japan*, **65**, (771), 760–765 (J+E).

——— (1962): Outline of Geology of the Chugoku region. *Mineral Resources for industrial use in Chugoku province.* (1), 1–7 (J).

——— (1963): On the deformation of the Mesozoic and Paleozoic systems in the Miné district, Yamaguchi Prefecture, Japan (Late Mesozoic crustal movements in the Chugoku province, the Inner zone of Southwest Japan, pt. II). *Bull. Geol. Surv. Japan*, **14**, (10), 701–723 (J+E).

——— (1963): On the "Nankeiseki" (Ganister) of Miné city, Yamaguchi Prefecture. *Mineral resources for industrial use in Chugoku province*, (2), 97–107 (J).

KAWAI, M., HIRAYAMA, K. and YAMADA, N. (1957): Geological sheet map with explanatory text, Arashimadake, 1 : 50,000. *Geol. Surv. Japan.*

KAWANO, Michihiro (1951): Observations on the Paleozoic formations along the Abu River. *Yamaguchi Jour. Sci.*, **2**, 87–91 (J).

——— (1953): Stratigraphy of Paleozoic in the northern part of Yamaguchi Prefecture. *Bull. Fac. Educ. Yamaguchi Univ.*, **3**, (1), 41–51 (J).

——— (1954): On the Permian System northeast of Yamaguchi city. *ibid.*, **4**, (1), 14–22 (J+E).

——— (1958): On the limestones of Handa and Zomeki plateaux, Yamaguchi Prefecture. *Jour. Geol. Soc. Japan*, **64**, (759), 692 (J).

——— (1959): Two new Permian corals from Yamaguchi Prefecture. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (36), 181–184, pl. 20.

*——— (1960): Some fusulinids from the Aratani conglomerate in the northeastern part of Yamaguchi city. *Sci. Rept. Tohoku Univ.*, [2], Spec. vol. (4), 223–230, pls. 24–25.

——— (1960): Stratigraphy of the Paleozoic formations and some considerations on their facies in Yamaguchi Prefecture. *Bull. Fac. Educ. Yamaguchi Univ.*, **9**, (2), 43–62.

——— (1961): Geology of the environs of Misen, Akiyoshidai, with special reference to the fusulinid zones. *Rept. Sci. Invest. Kannon cave remains, Akiyoshidai*, 49–54, pl. 30 (J).

*——— (1961): Stratigraphical and Paleontological studies of the Paleozoic formations in the western part of the Chugoku massif. *Bull. Fac. Educ. Yamaguchi Univ.*, [*Mathem. Sci.*], **11**, Spec. no., 1–133, pls. 1–15.

——— (1963): Correlation of the non-metamorphic Paleozoic formations in the western Chugoku province. *"Kaseki" ("Fossil")*, (6), 9–12 (J).

KAWANO, M., KAWAMURA, Y. and KAWAMURA, T. (1954): On the Permian System

northeast of Yamaguchi Prefecture. *Bull. Fac. Educ. Yamaguchi Univ.*, **4**, (1), 14–22 (J+E).

KAWANO, M. *et al.* (1956): Paleozoic formations of the southwestern part of Mino-Kanoashi mountainland. *ibid.*, **5**, (2), 97–102 (J+E).

——— (1963): Ota Group—on the geologic structure and age—. *Bull. Akiyoshidai Sci. Museum*, (2), 78–86 (J+E).

KAWANO, Y. and OZAWA, A. (1952): Geology of the dam site on the River Abu, Yamaguchi Prefecture. *Bull. Geol. Surv. Japan*, **3**, (8), 25–30 (J+E).

KIMURA, Toshio (1957): The geologic structure and the sedimentary facies of the Chichibu Group in the eastern Kii peninsula. A contribution to the geotectonic study of Southwest Japan. *Sci. Pap. Coll. General Educ. Univ. Tokyo*, **7**, (2), 244–272.

——— (1960): On the geologic structure of the Paleozoic Group in Chugoku, West Japan, *ibid.*, **10**, (1), 109–124.

KIMURA, T. and HORIKOSHI, E. (1959): On the geologic structure of the Chichibu terrain in west central Shikoku. *ibid.*, **9**, (2), 330–342.

KIMURA, T. and ISHIOKA, K. (1952): Geological structure of the Koga area, Horado-mura, Mugi-gun, Gifu Prefecture. *Jour. Geol. Soc. Japan*, **58**, (682), 285–286 (J).

KITAMURA, N. and TANI, M. (1953): Geology of the western parts of Isawa- and Nishi-Iwai-gun, Iwate Prefecture (Pts. 1, 2). *Jour. Japan. Assoc. Mineral. Petrol. Econ. Geol.*, **37**, 103–116, 140–147 (J+E).

KOBAYASHI, Manabu (1954): Geology of the environs of Nishitani-mura, Ono-gun, Fukui Prefecture. *Bull. Tokyo Univ. Educ. Geol. Mineral. Inst.* (3), 35–42 (J+E).

*——— (1956): On some new species of *Rauserella* from Mt. Ibuki, Shiga Prefecture, central Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (23), 225–228, pl. 32.

*——— (1957): Paleontological study of the Ibukiyama limestone, Shiga Prefecture, Central Japan. *Sci. Repts. Tokyo Kyoiku Daigaku*, [C], **5**, (48), 247–311, pl. 1–10.

KOBAYASHI, Masaru (1951): On the geology of the Funafuseyama and on the so-called Funafuseyama Klippe. *Jour. Geol. Soc. Japan*, **57**, (670), 263 (J).

KOBAYASHI, Teiichi (1930): On the Paleozoic formation developed within the Sakawa basin and along southern margin. *Jour. Geol. Soc. Japan*, **37**, (437), 66–69 (J).

——— (1932): On the Triassic formation and two "*Klippen*" of Paleozoic rocks in Sakawa basin. *ibid.*, **38**, (454), 361–380 (J).

——— (1939): On the geotectonics of Southwest Japan. *Jour. Geogr.* **51**, (604), 248–260 (J+E).

——— (1939): Discovery of Fusulina in limestone of "Tamagawa System". *Jour. Geol. Soc. Japan*, **46**, (552), 494–495 (J).

——— (1941): The Sakawa orogenic cycle and its bearing on the origin of the Japanese islands. *Jour. Fac. Sci. Imp. Univ. Tokyo*, **5**, (7), 219–578, pls. 1–4.

——— (1950): Regional geology; General Summary, 1–353; Chugoku Province, 1–241; Shikoku Province, 1–243. *Asakura Shoten Press* (J).

——— (1956): The mountain structure of the Japanese islands. *Proc. Eighth Pacific Sci. Congr.*, II-A, 743–751.

——— (1956): The insular arc of Japan, its hinter basin and its linking with the peri-Tunghai arc. *ibid.*, 799–807.

——— (1956): The Triassic Akiyoshi orogeny. *Geotekt. Symposium zu Ehern von Hans Stille*, Stuttgart, 85–101.

——— (1956): The shifting of the chert-bearing facies caused by the migration of geosyncline. *Gedenkboek H. A. Brouwer Verhand. van het Koninklijk Nederland. Geol. Mijnb. Genootschap*, **16**, 1–11.

——— (1959): The older Mesozoic Akiyoshi folded mountains. *Jour. Geogr.*, **68**, (3), 105–113 (J+E).

KOBAYASHI, T., FUJITA, A. and KIMURA, T. (1945): On the geology of the central part of southern Shikoku. *Japan. Jour. Geol. Geogr.* **20**, (1), 19–45.

KOBAYASHI, T., HORIKOSHI, Y. and the Second year students of Geol. Inst., Imp. Univ. Tokyo (1937): The geologic history of the Kibi plateau. *Jour. Geol. Soc. Japan*, **44**, (528), 797–821 (J).

KOBAYASHI, T. and IWAYA, Y. (1940): Discovery of the *Halysites*-bearing Imose limestone in the northeastern part of the Sakawa basin in Tosa and the geology of that part of the basin. *ibid.*, **47**, (565), 404–408 (J+E).

——— and ——— (1941): On the imbricated structure of the Sakuradani area in the Province of Awa. *Proc. Imp. Acad. Japan*, **17**, 110–115.

KOBAYASHI, T. and KIMURA, T. (1944): The Permo-Triassic break in the history of Radiolaria supplemented with the Sambosan-Higashigawa suite. *ibid.*, **20**, (4), 239–243.

KOBAYASHI, T. and MOCHIZUKI, H. (1938): Outline of the Decken-structure of the Kibi plateau in the Inner side of Southwest Japan. *ibid.*, **14**, 71–76.

KOBAYASHI, T. *et al.* (1937): On the geologic history of the Kibi plateau. *Jour. Geol. Soc. Japan*, **44**, (528), 797–821 (J).

——— (1940): On the geology of Nagato and Chikuzen provinces. *Jour. Geogr.*, **52**, (616), 242–249 (J) (English text, 6–8).

KOIKE, Toshio (1963): *Pseudoschwagerina* and *Parafusulina* zones of the Mt. Ryozen area and their correlation. *"Kaseki"* (*"Fossil"*), (6), 15–19 (J).

KOIWAI, Takashi (1963): On finding of the new localities of the fusulinid limestone from the Yunishigawa valley in Tochigi Prefecture. *Jour. Geol. Soc. Japan*, **71**, (837), 311–312 (J).

*KONISHI, Kenji (1952): Permian microfossils in the Dodo conglomerate of the Yasuba-type. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (5), 155–165, pl. 14.

——— (1952): Occurrence of *Gymnocodium*, a Permian alga in Japan. *ibid.*, (7), 215–221, pl. 20.

——— (1953): Restudy of some *"Pseudoschwagerina"* in Japan. *Jour. Geol. Soc. Japan*, **59**, (696), 435–436.

*——— (1954): Note on the Moscovian(?) deposits at Itoshiro-mura, Fukui Prefecture. *ibid.*, **60**, (700), 7–16, pl. 1 (J+E) (Specific description in English).

——— (1954): *Succodium*, a new Codiacean genus, and its algal associates in the Late Permian Kuma Formation of southern Kyushu, Japan (Studies on the Paleozoic marine algae of Japan—2). *Jour. Fac. Sci. Univ. Tokyo*, **4**, (2), 225–240, pls. 1–2.

——— (1954): A new species of *Gymnocodium* and its algal associates in the Permian Kosaki formation of southern Kyushu. *Japan. Jour. Geol. Geogr.*, **25**, (1–2), 1–19, pls. 1–2.

——— (1956): *Anatolipora*, a new Sadycladacean genus, and its algal associates from the Lower Carboniferous of Japan. *Quart. Colorado Sch. Mines*, **51**, (4), 109–127, pls. 1–3.

——— (1960): A prominent marine floral change during the Permo-Carboniferous. *Rep. Inst. Geol. Congr., XXI Session, Norden*, Pt. 22, 36–38.

——— (1961): Studies of Paleozoic Codiaceae and allied Algae, Pt. 1, Codiaceae (excluding systematic descriptions). *Sci. Rept. Kanazawa Univ.*, **7**, (2), 159–261, text-figs. 1–39.

——— (1963): The Carboniferous in *Geology of Japan* (TAKAI, MATSUMOTO & TORIYAMA, editors), 23–42. *University of Tokyo Press.*

KONO, Tei (1951): The Chichibu Paleozoic of the Nyukawa area, Gifu Prefecture (Preliminary report). *Jour. Geol. Soc. Japan*, **57**, (670), 264 (J).

——— (1952): The Chichibu System of the Nyukawa-mura area, Gifu Prefecture. *ibid.*, 58, (682), 321 (J).

KUSAKABE, Y. and MIYAMURA, M. (1958): On the Paleozoic formation south of Ise city, Mié Prefecture, Central Japan. *ibid.*, 64, (753), 269–280 (J+E).

KUSUMI, H. and KATAYAMA, S. (1962): Geology of Saijo area, Hiba-gun, Hiroshima Prefecture. *Bull. Fac. Educ. Hiroshima Univ.*, [2], (10), 59–69 (J+E).

KUSUMI, H., YOSHIMURA, N. and KATAYAMA, S. (1958): Geology of the Fukiya district, Okayama Prefecture. *ibid.*, [2], (6), 79–88 (J+E).

MABUCHI, Seiichi (1935): The Iwaizaki limestone and its stratigraphical position. *Bull. Saito Hoonkai*, (101), 1–18, (J).

MAEDA, Shiro (1958): Carboniferous fusulinids from Kamiise in Fukui Prefecture. *Jour. Geol. Soc. Japan*, 64, (756), 477 (J).

MAEDA, S. and HAMADA, T. (1962): *Waagenophyllum pulchrum* sp. nov. from a limestone pebble in the Takagami conglomerate at Choshi city, Chiba Prefecture. *Bull. Choshi Marine Lab., Chiba Univ.*, (4), 1–21, pls. 1–4.

*MAEDA, S. and MITSUOKA, T. (1961): *Parafusulina matsubaishi* from the pebble of the Takagami conglomerate in Choshi peninsula, Chiba Prefecture. *ibid.*, (3), 75–82, pls. 1–2.

MAKIYAMA, Jiro (1950): Regional Geology of Japan; Chubu Province, 1–233. *Asakura Shoten Press* (J).

MATSUDA, K. and IMAMURA, S. (1954): Permian formations of the Karita-mura area, Takata-gun, Hiroshima Prefecture. *Jour. Geol. Soc. Japan*, 60, (706), 301–302 (J).

MATSUMOTO, Tatsuro (1949): The Late Mesozoic geologic history in the Nagato province, Southwest Japan. *Japan. Jour. Geol. Geogr.*, 21, (1–4), 235–243.

——— (1951): An outline of the fundamental geologic structure in North Kyushu and West Chugoku. *Sci. Rept. Fac. Sci. Kyushu Univ.* [*Geol.*], 3, (2), 37–48 (J).

MATSUMOTO, T. and KANMERA, K. (1949): Contribution to the tectonic history in the Outer zone of Southwest Japan. *Mem. Fac. Sci. Kyushu Univ.*, [D], 3, (2), 78–90.

——— and ——— (1952): A guide book for the lower valley of Kumagawa. *Dept. Geol. Fac. Sci. Kyushu Univ.*, 1–71 (J).

——— and ——— (1964): Geological sheet map with explanatory text, Hinagu, 1 : 50,000. *Geol. Surv. Japan.*

MATSUMOTO, T., NODA, M. and MIYAHISA, M. (1962): Regional Geology of Japan; Kyushu Province, 1–423. *Asakura Shoten Press* (J).

MATSUSHITA, Susumu (1950–51): Geology of Kyoto Prefecture. *Chigaku* (*Earth Sciences*), *Inst. Geol. Mineral. Fac. Sci. Univ. Kyoto*, (2), 41–49; (3), 36–40 (J).

——— (1953): Regional geology of Japan; Kinki province. 1–293. *Asakura Shoten Press* (J).

MATSUZAWA, S. (1931): On the Paleozoic Formations and the conglomeratic bed with Fusulina limestone pebbles in the district south of the Naka River, Tokushima Prefecture. *Jour. Geol. Soc. Japan*, 38, (448), 43–44(J).

MIKAMI, Takahiko (1965): The Type Sakamotozawa Formation. *ibid.*, 71, (851), 475–493 (J+E).

MINATO, Masao (1942): Unconformity of the pre-Sakamotozawa stage (pre-Sakmarian) in the Kitakami mountainland, Northeast Japan. *ibid.*, 49, (581), 47–72 (J+E).

——— (1942): Zur Frage der Transgression der *Dibunophyllum*-Zone in Asia. *Jour. Geogr.*, 54, (644), 379–405 [Zusammenfassung s. 1–2] (J+G).

——— (1944): Stratigraphische Gliederung des Sud-Kitakami Gebirges, Japan. *Jour. Geol. Soc. Japan*, 51, (606), 83–90 (J+G).

——— (1947): Note on a coral of Lower Carboniferous type from the Kwanto mountainland. *Proc. Japan Acad.* **23**, (9), 121–124.

——— (1949): New species of *Streptorphynchus* from Japanese Upper Palaeozoic. *Japan. Jour. Geol. Geogr.*, **21**, (1–4), 327–330.

——— (1950): Stratigraphische Stellung der Hikoroichi-Serie. *Jour. Geol. Soc. Japan*, **56**, (655), 143–148 (J+G).

——— (1950): Toyoma-Sea, the Late Permian Inland-sea in the Kitakami mountainland, Northeast Honshu, Japan. *Proc. Japan Acad.*, **26**, (3), 80–86.

——— (1950): Geology of Kitakami mountainland. *Monogr. Assoc. Geol. Collab. Japan*, **5**, 1–28 (J).

*——— (1950): New discovery of Lower Carboniferous *Millerella* (Fusulinid Foraminifera in Manchuria). *Jour. Geol. Soc. Japan*, **56**, (658), 379–382, 5 figs. (J+E).

——— (1950): On the geological importance of the so-called Murakami-conglomerate. *Mineral. and Geol.*, **3**, (6), 230–233 (J).

——— (1951): On the existence of Usuginu-type conglomerate in the Hida mountainland. *ibid.*, **4**, (1–2), 1–3 (J).

——— (1951): On the Lower Carboniferous fossils of the Kitakami massif, northeastern Honshu, Japan. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **7**, (4), 355–382, pls. 1–5.

——— (1951): Localities of the Fusulinid Foraminifera in the Hida mountainland. *Mineral. and Geol.*, **4**, (3–4), 71–73 (J).

——— (1952–54): Study of the Paleozoic formations of Japan, I, II, III. *Bull. Geol. Committee Hokkaido*, **19** (1952), 1–26; **24** (1953), 26–37; **26** (1954), 38–46 (J).

——— (1953): Palaeogeographie des Karbons in Ostasien. *Proc. Japan Acad.*, **29**, (6), 246–253 (G).

——— (1953): On some reticulate Spiriferidae. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (11), 65–73.

——— (1955): Japanese Carboniferous and Permian corals. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **9**, (2), 1–202, pls. 1–43.

——— (1955): Zur stratigraphischen Lücke der Prä-Onimaru-Series (Ober Visé) in Japan. *ibid.*, [4], **9**, (1), 31–42 (G).

——— (1957): On the age of metamorphic complex in the Japanese islands. *Proc. Japan Acad.*, **33**, (10), 646–651.

——— (1958): On the age of the metamorphisms held in Japanese islands. *Jubilee Publ. Comm. Sixtieth Birthday, Prof. J. Suzuki*, 1–16 (J), 1–2 (E).

——— (1960): Three major orogenic movements in Japanese islands, with special remarks on granite conglomerate of Molasse type. *Chikyu Kagaku* (*Earth Science*), (46), 30–37 (J+E).

——— (1962): Die Vulkantätigkeit und der Plutonismus im Fernen Osten. Teil 1. Vulkantätigkeit im Fernen Osten, unter besonderer Berücksichtung der chronologischen Beziehungen. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **11**, (3), 481–506 (G).

MINATO, M. and FUJIWARA, Y. (1964): Palaeomagnetism and Palaeoclimatology of the Japanese islands. *Proc. Japan Acad.*, **40**, (2), 116–120.

——— and ——— (1964): Carboniferous Palaeomagnetism of the Kitakami mountains, northeastern Honshu, Japan. *Compte. rendu, cinq. cong. intern. strat. geol. Carbon*, 581–585.

MINATO, M., GORAI, M. and HUNAHASHI, M. (editors) (1965): The geologic Development of the Japanese Islands. *Tsukiji Shokan Co., Ltd., Japan*, 1–442, pls. 1–30.

MINATO, M. and HONJO, S. (1958): Shell structure of *Metaschwagerina*, n. gen. from Akasaka limestone. *Chikyu Kagaku* (*Earth Science*), (38). [Illustration only].

*——— and ——— (1959): The axial septula of some Japanese Neoschwagerininae with special remarks of the phylogeny of the Subfamily Neoschwagerininae

DUNBAR and CONDRA, 1928. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **10**, (2), 305–336, pls. 1–6.

——— and ——— (1965): On *Colania kwangsiana* LEE. *ibid.*, [4], **13**, (1), 1–5, pl. 1.

MINATO, M. and KATO, M. (1957): On the Carboniferous coral zones in the Akiyoshi Plateau, Southwest Japan. *Proc. Japan Acad.*, **33**, (9), 541–546.

——— and ——— (1957): On the Carboniferous Coral zones at Fukuji, Gifu Prefecture, Central Japan. *ibid.*, 547–552.

——— and ——— (1957): Two Carboniferous corals from the Kitakami mountains, Northeast Japan. *Trans. Proc. Palaeont. Soc. Japan., N. S.*, (28), 137–142.

——— and ——— (1958): A short note on *Lonsdaleoides toriyamai* MINATO. *ibid.*, (29), 172–174.

——— and ——— (1963): Fossils with the lowest Namurian aspect newly found by Dr. HASEGAWA in the Akiyoshi limestone. *Chikyu Kagaku* (*Earth Science*), (66), 32–42, pls. 1–2.

——— and ——— (1965): Waagenophyllidae. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **12**, (3–4), 1–241, pls. 1–20.

——— and ——— (1965): Durhaminidae (Tetracoral). *ibid.*, **13**, (1), 11–86, pls. 1–5.

MINATO, M., KATO, M. and HASEGAWA, Y. (1964): A note on the boundary between *Pseudofusulina* and *Parafusulina* zones in Japan. *Proc. Japan Acad.*, **40**, (10), 827–831.

MINATO, M. and KONOYA, M. (1963): On *Fusulinella* from Kaminokuni, Hiyama-gun, Hokkaido. *Jour. Geol. Soc. Japan*, **69**, (810), 161 (J).

MINATO, M. and NAKAMURA, K. (1956): On four Brachiopod species of the Subfamily Orthotetinae from the Kanokura Series of the Kitakami mountains, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (21), 149–155, pl. 24.

MINATO, M. and TAKEDA, H. (1956): On the Onimaru Series. *Jour. Geol. Soc. Japan*, **62**, (728), 281 (J).

MINATO, M. and SAITO, M. (1957): A new find of *Sciophyllum* (Tetracoral) from the Carboniferous of Japan. *Japan. Jour. Geol. Geogr.*, **28**, 91–94, pl. 5.

MINATO, M. *et al.* (1953): Biostratigraphie des Karbons im Kitakami-Gebirge, Nordöstliches Honshu, Japan. *Jour. Geol. Soc. Japan*, **59**, (695), 385–399 (J+G).

——— (1954): Zur Biostratigraphie der permischen Formation des Setamai-Geländes in Süd-Kitakami Gebirge. *ibid.*, **60**, (708), 378–387 (J+G).

——— (1959): On the volcanic rocks in the Japanese Paleozoic. 1st Report, Gotlandian and Devonian; 2nd report, Carboniferous; 3rd Report, Permian. *ibid.*, **65**, (761), 71–79; (762), 165–170; (763), 222–226 (J+E).

MITA, S. *et al.* (1952): Report on the Katsuura coalfied, Tokushima Prefecture. *Bull. Geol. Surv. Japan*, **3**, (11), 16–33 (546–563) (J+E).

MITSUNO, C. and OMORI, H. (1963): Geological map with explanatory text; Okayama Prefecture, 1 : 150,000. *Okayama Prefecture.*

MIYACHI, Sadanori (1966): Geological significance of the granite fragments in the Middle Permian Kozaki Formation, Central Kyushu. *Repts. Earth Sci. Dept., Gen. Educ., Kyushu Univ.*, (13), 9–14, pls. 5–8 (J+E).

MIYAMURA, Manabu (1956): The Paleozoic formation in the Yokoyama district, Gifu Prefecture, Central Japan. *Jour. Geol. Soc. Japan*, **71**, (832), 5–17 (J+E).

——— (1966): Geological structure of the Ibuki mountain range, Central Japan. *Memorial vol. Prof. S. Matsushita.* 53–66 (J+E).

MIZUTANI, Shinjiro (1957): Permian sandstones in the Mugi area, Gifu Prefecture, Japan. *Jour. Earth Sci. Nagoya Univ.*, **5**, (2), 135–151, pl. 1.

——— (1964): Superficial folding of the Paleozoic System of Central Japan. *ibid.*, **12**, (1), 17–83, pls. 1–5.

——— (1965): Paleozoic formation east of Mt. Ibuki. *Nagoya Chigaku* (*Earth Science Nagoya*), (20–21), 18–24 (J).

MORIAI, Tomio (1957): Geological study of the environs of Kamaishi mine, Iwate Prefecture. *Jour. Geol. Soc. Japan*, **63**, (742), 412 (J).

*MORIKAWA, Rokuro (1951): *Nagatoella fujimotoi* n. sp. and a new studying method for fusulinids. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (3), 81–84, pl. 8.

*——— (1952): Some *Schwagerina*-like *Parafusulina*. *Sci. Repts. Saitama Univ.*, **1**, (1), 29–34, pl. 1.

*——— (1952): On a new genus *Fujimotoella*. *ibid.*, **1**, (1), 35–38, pl. 1.

——— (1952): On the Shimokuzu conglomerate. *Jour. Geol. Soc. Japan*, 58, (681), 187–190 (J+E).

*——— (1953): *Triticites* limestone found in Okuchichibu. *Sci. Rep. Saitama Univ.*, [B], **1**, (2), 115–122, pl. 4.

——— (1953): Fusulinids from the Kitakami mountainous land. *Jour. Geol. Soc. Japan*, **59**, (691), 145–159 (J+E).

——— (1954): A new classification of the Subfamily Schwagerininae. *Chikyu Kagaku* (*Earth Science*), (19), 2–13 (J+E).

*——— (1956): Schwagerininae in the vicinity of the Shomaru pass, eastern part of Kanto mountainland, Central Japan. *Sci. Repts. Saitama Univ.*, [B], **2**, (1), 45–114, pls. 5–15.

*——— (1956): Fusulinids from Onagata, Kamiyoshida-mura, northern part of Kanto mountainland. *ibid.*, **2**, (2), 250–260, pls. 32–34.

*——— (1958): Fusulinids from the Akasaka limestone, Pt. 1. *ibid.*, **3**, (1), 93–130, pls. 12–26.

——— (1960): Permian fossil zones in Japan. *"Kaseki"* (*"Fossil"*), (1), 51–62 (J).

——— (1960): Thick limestone in the Upper Paleozoic of Japan. *Gypsum and Lime*, (48), 179–183 (J).

*——— (1960): Fusulinids from the Iwaizaki limestone. *Sci. Repts. Saitama Univ.*, [B], **3**, (3), 273–299, pls. 46–53.

——— (1960): *Parafusulina* found in the base of the Kamiyoshida Group, uppermost strata of the Chichibu System, northern part of Kwanto mountainland. *Jour. Geol. Soc. Japan*, **66**, (781), 684 (J).

——— (1962): A solidgraphic study of fusulinid foraminifera (1). *Sci. Repts. Saitama Univ.*, [B], **4**, (2), 139–147, pls. 5–7.

MORIKAWA, R. and ENDO, R. (1950): Geology of the Shomaru-toge area, Agano-mura, Iruma-gun, Saitama Prefecture. *Jour. Geol. Soc. Japan*, **56**, (656), 291 (J).

*MORIKAWA, R. and HORIGUCHI, M. (1956): *Parafusulina nakamigawai* n. sp. from the Adoyama formation in the neighbourhood of Kuzu city, Tochigi Prefecture. *Sci. Repts. Saitama Univ.*, [B], **2**, (2), 261–264, pl. 35.

*MORIKAWA, R. and ISOMI, H. (1960): A new genus, *Biwaella*, *Schwagerina*-like *Schubertella*. *ibid.*, **3**, (3), 301–305, pl. 54.

*——— and ——— (1961): Studies of Permian fusulinids in the east of Lake Biwa, Central Japan. *Repts. Geol. Surv. Japan*, (191), 1–29, pls. 1–21.

MORIKAWA, R. and KAWADA, S. (1953): Fusulinids from Maemonkura valley, west of the Chichibu mine. *Repts. Chichibu Natur. Sci. Museum*, (3), 61–64 (J+E).

*MORIKAWA, R. and KOBAYASHI, N. (1960): Two new species of *Oketaella* from Kwanto massif, Japan. *Sci. Repts. Saitama Univ.*, [B], **3**, (3), 307–312, pl. 55.

MORIKAWA, R. and SUZUKI, Y. (1958): *Neoschwagerina* in the Akasaka limestone. *Jour. Geol. Soc. Japan*, **64**, (759), 687–688 (J).

*——— and ——— (1961): Fusulinids from the Akasaka limestone, pt. 2. *Sci. Repts. Saitama Univ.*, [B], **4**, (1), 43–74, pls. 4–22.

MORIKAWA, R. and TAKAOKA, Y. (1960): Schwagerininae from Japan. *"Kaseki"* (*"Fossil"*), (1), 12–16 (J).

*——— and ——— (1961): Two new species of the *Parafusulina yabei* type from Tomuro, Totigi Prefecture, Central Japan. *Trans. Proc. Palaeont. Soc. Japan. N. S.*, (41), 33–40, pls. 7–8.

MORIKAWA, R. *et al.* (1956): Permian fossil zones in the Kwanto and Chubu provinces. *Jour. Geol. Soc. Japan*, **62**, (730), 359–360 (J).

——— (1958): Stratigraphy and Biostratigraphy of the "Iwaizaki limestone" in the southern Kitakami mountainland. *Jubilee Publ. Prof. H. Fujimoto*, 81–90, pl. 6 (J+E).

——— (1956): Geological studies of the Akasaka limestone. *Chikyu Kagaku (Earth Science)*, (26–27), 10–18 (J+E).

MORITA, Hiroshi (1952): Fusulina limestone from the vicinity of Nojiri-machi, Kiso province. *Jour. Geol. Soc. Japan*, **58**, (684), 443 (J).

MURATA, Masabumi (1958): On the Geologic structure of Akiyoshi plateau. *"Yukochu" ("Foraminifera")*, (9), 10–19 (J).

——— (1958): Stratigraphy and structure of the non-calcareous sediments in the northwest of Akiyoshi plateau. *Jour. Geol. Soc. Japan*, **64**, (759), 692 (J).

——— (1959): *Neoschwagerina*-limestone from the southwest of Yuasa-machi, Wakayama Prefecture. *ibid.*, **64**, (748), 54 (J).

——— (1960): The Permian stratigraphy and structure of Mt. Fujiwara-dake and its neighbourhood. *Sci. Repts. Tohoku Univ.*, [2], Spec. vol. 4, 599–604 (J+E).

——— (1961): On the geological structure of Akiyoshi plateau. *Contrib. Inst. Geol. Paleont. Tohoku Univ.*, (53), 1–46 (J+E).

——— (1964): Some Middle Permian Aviculopectinidae from the Kitakami massif, Northeast Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (54), 215–233, pls. 34–35.

——— (1964): Geological age of the Kanokura Formation in the southern part of the Kitakami massif, northeast Japan. *Saito Ho-on Kai Museum. Res. Bull.* (33), 17–29.

NAGANO EARTH SCIENCE ASSOCIATION (1957): Geological map with explanatory text, Nagano Prefecture, 1 : 200,000. *Nagano Prefecture.*

NAGAO, Takumi (1926): On some new facts found in the Mesozoic formations of Arita-gun, Kishu. *Jour. Geol. Soc. Japan*, **33**, (396), 378–384 (J).

NAGAO, T. and MINATO, M. (1941): *Corwenia hashimotoi*, a new Tetra-coral from the Upper Paleozoic of Shikoku. *Jour. Fac. Sci. Hokkaido Imp. Univ.*, [4], **4**, (2), 101–105, pl. 27.

——— and ——— (1943): *Parafusulina kaerimizensis* aus der Unterhalb der Brachiopoden-Zone liegenden Schicht in der Gegend von Nabeyama. *Jour. Geol. Soc. Japan*, **50**, (601), 262–263, text-fig. 1–2 (G).

NAKADA, S. and AMANO, Y. (1966): Discovery of *Waagenophyllum* from the Paleozoic in Kametsubo, Hyogo Prefecture. *ibid.*, **72**, (7), 352–353 (J).

NAKADA, S. and GOTO, H. (1958): Fusulinids from Ichikawa-machi, Hyogo Prefecture. *ibid.*, **64**, (753), 314 (J).

——— and ——— (1961): Discovery of fusulinids from Yokozeki, Himeji city. *ibid.*, **67**, (789), 360–361 (J).

NAKAGAWA, C. *et al.* (1952): Significance of the Sakashu unconformity. *ibid.*, **58**, (682), 286 (J).

——— (1959): Geology of the Kurosegawa district, Ehime Prefecture. *Jour. Gakugei, Tokushima Univ.* [*Nat. Sci.*], **9**, 33–58 (J+E).

NAKAMURA, Koji (1959): *Spinomarginifera* found in Japanese Permian. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (35), 143–146, pl. 15.

——— (1959): Some Lower Permian Sakamotozawa Brachiopods. *Jour. Fac. Sci. Hokkaido Univ.*, [4], **10**, (1), 199–207, pls. 1–2.

——— (1960): *Dictyoclostus* derived from the Middle Permian Kanokura Series

and the Lower Permian Sakamotozawa Series of the Kitakami mountains, Japan. *ibid.*, **10**, (3), 495–511, pls. 1–5.

NAKAMURA, Shintaro (1926): Fusulina-limestone of Shirasaki-mura, Hidaka-gun, Kii. *"Chikyu" ("The Globe")*, **6**, (5), 383 (J).

NAKANO, Mitsuo (1952): Geology of Kyowa-mura district, Shitsuki-gun, Okayama Prefecture, with special reference to the recent informations on the Mesozoic and Paleozoic. *Geol. Repts. Hiroshima Univ.*, (2), 15–30 (J+E) [Also *Jour. Geol. Soc. Japan*, 58, (682), 288–289 (J)].

NAKAZAWA, Keiji (1950): Geological age of the limestone conglomerate in the Kawanishi-mura district, Kasa-gun, Kyoto Prefecture. *"Chigaku" (Earth Science), Inst. Geol. Mineral. Univ. Kyoto*, (2), 38–39 (J).

——— (1951): Geologic structure of the Yakuno district (For the fossil collectors). *ibid.*, (4), 1–6.

——— (1959): Permian and Eo-Triassic *Bakevellias* from the Maizuru zone, Southwest Japan. *Mem. Coll. Sci. Univ. Kyoto*, **26**, (2), 193–213, pls. 3–4.

——— (1959): Mesozoic and Paleozoic formations of the Maizuru zone of Okayama Prefecture. *Repts. Natural Resources, Okayama Prefecture*, 1–6 (J).

——— (1960): Permian and Eo-Triassic Myophoriidae from the Maizuru Zone, Southwest Japan. *Japan. Jour. Geol. Geogr.*, **31**, (1), 49–62, pl. 6.

——— (1960): Two Permian Nautiloids from Japan. *ibid.*, **31**, (2–4), 121–127, pl. 10.

——— (1961): On the so-called Yakuno Intrusive rocks in the Yakuno district, Southwest Japan. *Mem. vol. Prof. J. Makiyama*, 149–161 (J+E).

NAKAZAWA, K. and NOGAMI, H. (1958): Paleozoic and Mesozoic formations in the vicinity of Kawanishi, Oe-machi, Kyoto Prefecture. *Jour. Geol. Soc. Japan*, **64**, (749), 68–77 (J+E).

NAKAZAWA, K. and OKADA, S. (1951): Geology of the Maizuru district, Kyoto Prefecture. *Mineral. and Geol.*, **3**, (2), 68–73 (J).

NAKAZAWA, K. and SHIKI, T. (1954): Geology of the Miharai-yama district, Yabu-gun, Hyogo Prefecture, Japan, with special reference to the Triassic Miharai-yama group. *Jour. Geol. Soc. Japan*, **60**, (704), 192–201 (J+E).

——— and ——— (1958): Paleozoic and Mesozoic formations in the vicinity of Kawahigashi, Oe-cho, Kyoto Prefecture, Japan. *ibid.*, **64**, (749), 57–67 (J+E).

NAKAZAWA, K., SHIKI, T. and SHIMIZU, D. (1954): Mesozoic and Paleozoic formations in the vicinity of Fukumoto, Okayama Prefecture. *ibid.*, **60**, (702), 97–105 (J+E).

———, ——— and ——— (1957): Mesozoic and Paleozoic formations of the Yakuno district, Kyoto Prefecture, Japan. *ibid.*, **63**, (743), 455–464 (J+E).

NAKAZAWA, K. and SHIMIZU, D. (1955): Discovery of *Glyptophiceras* from Hyogo, Prefecture. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (17), 13–18, pl. 3.

——— and ——— (1962): Permian and Triassic formations around Kanagawa, north to Okayama city, Japan. *Jour. Geol. Soc. Japan*, **68**, (806), 662–664 (J).

NAKAZAWA, K. *et al.* (1956): The *Lepidolina* zone in the Maizuru zone. *ibid.*, **62**, (730), 361 (J).

——— (1958): Summary of the Lower and Middle Triassic System in the Maizuru zone. *ibid.*, **64**, (750), 125–137 (J+E).

NEGA, Ichiro (1896): Fusulina from limestone of Itogawa-mura, Arita-gun, Kishu. *Jour. Geol. Soc. Tokyo*, **3**, (26), 64 (J).

NISHIDA, Kazuhiko (1962): Geology of the Nanjo masif, Fukui Prefecture. *Chigaku Kenkyu (Jour. Soc. Earthscientists and Amateurs, Japan)*, **13**, (2), 40–46 (J).

NODA, Mitsuo (1955): Stratigraphy and geologic structure of the Paleozoic formations in the vicinity of Yokokura-yama, Kochi Prefecture. *Rept. Earth Sci. Dept. Gen. Educ. Kyushu Univ.*, (1), 47–60 (J+E).

——— (1961): Geology of the Mikuni-toge district, Oita Prefecture, Japan, with

special reference to the Gotlandian deposit. *ibid.*, (7), 1–9, pls. 1–2 (J+E).

*NOGAMI, Yasuo (1958–59): Fusulinids from the Maizuru zone, Southwest Japan. pt. 1, Ozawainellinae, Schubertellinae, and Neoschwagerininae. *Mem. Coll. Sci. Univ. Kyoto*, [B], **25**, (2), 97–114, pls. 1–2; pt. 2, Derived fusulinids, **26**, (2), 67–82, pl. 1.

——— (1959): Geology of the central part of the Atetsu plateau, with special reference to the stratigraphy and structure of the Permian formations. *Jour. Geol. Soc. Japan*, **65**, (766), 459 (J).

*——— (1961): Permische Fusuliniden aus dem Atetsu-Plateau Südwestjapans. Teil 1. Fusulininae und Schwagerininae. *Mem. Coll. Sci. Univ. Kyoto*, [B], **27**, (3), 159–248, pls. 1–11; Teil 2, Verbeekininae, Neoschwagerininae u. a. **28**, (2), 159–244, pls. 1–7 (G).

——— (1962): Jungpaläozoikum in Atetsu-Plateau Südwestjapans. *ibid.*, **29**, (2), 161–176 (G).

*——— (1965): Neu-Untersuchung der von SCHWAGER beschriebenen Fusuliniden aus China und Japan: *Paläont. Zeitschrift*, **39**, (1/2), 51–71, Tf. 9–11 (G).

NONAKA, Jun-ichi (1946): On the Brachiopods of the Yamamba limestone in the Sakawa basin in the Province of Tosa. *Jour. Geol. Soc. Japan*, **52**, (610–612), 22–24 (J).

OGAWA, Takuji (1904): Geological sheet map with explanatory text, Toba, 1 : 200,000. *Geol. Surv. Japan.*

OGURA, Tsutomu (1921): Geological sheet map with explanatory text; Shobara, 1 : 75,000. *Geol. Surv. Japan.*

OKIMURA, Yuji (1958): Lower Carboniferous System of the Atetsu limestone plateau, Okayama Prefecture, Japan. *Jour. Geol. Soc. Japan*, **64**, (759), 692 (J).

*——— (1958): Biostratigraphical and paleontological studies on the Endothyroid foraminifera from the Atetsu limestone plateau, Okayama Prefecture, Japan. *Jour. Sci. Hiroshima Univ.*, [C], **2**, (3), 235–264, pls. 32–36.

——— (1963): Foraminiferal zones underlying the *Profusulinella beppensis* zone of the Akiyoshi limestone Group. *Geol. Rept. Hiroshima Univ.*, (12), 305–318, pl. 39 (J+E).

——— (1963): Characteristics of the smaller foraminiferal assemblage from the Carboniferous limestone of the Chugoku province. *"Kaseki"* (*"Fossil"*), (6), 1–6 (J).

*——— (1965): Endothyroid Foraminifera, *Endothyranopsis* from Japan. *Geol. Rep. Hiroshima Univ.*, (14), 253–264, pl. 21.

——— (1966): Microbiostratigraphical studies on the Foraminiferal faunas of the Lower Carboniferous Formations of the Chugoku region, Southwest Japan. *ibid.*, (15), 1–46, pl. 1 (J+E).

OKUBO, Masahiro (1951): Zur Hikoroichi-Serie und der bedeutenden Diskordanz vor der Hikoroichi-Epoche. *Jour. Geol. Soc. Japan*, **57**, (699), 195–209 (J+G).

——— (1951): Trilobites from Japan. *Chikyu Kagaku* (*Earth Science*), (4), 133–139 (J+E).

ONUKI, Yoshio (1937): New discovery of Gotlandian formation and stratigraphy of the Paleozoic formations in the Kitakami mountainland. *Jour. Geol. Soc. Japan*, **44**, (525), 600–604 (J).

——— (1956): Geology of the Kitakami massif (with geological maps and explanatory text). *Iwate Prefecture*, 1–182 (J).

——— (1959): On the Permian Brachiopod—genua *Leptodus* or *Lyttonia*. *"Chigaku Kenkyu"* (*Jour. Soc. Earthscientists & Amateurs, Japan*), **11**, (2), 96–119 (J+E).

——— (1960): Geological significance and some problems of the clay beds in an Upper Paleozoic formation. *Sci. Repts. Tohoku Univ.*, [2], Spec. vol. 4, 461–470 (J+E).

——— (1960): On the geological significance of the Kamaishi district. *Tohoku Kenkyu*, **10**, (2), 1–4 (J),

——— (1960): On the geological significance of the Miyako district. *ibid.*, **10**, (4), 19–22 (J).

——— (1962): Permian and Jurassic geosynclines in Japan. *Sci. Rept. Tohoku Univ.*, [2], Spec. vol. **5**, 321–328.

ONUKI, Y., ASAMA, K. and MORIAI, T. (1956): Rock facies and correlation of the Permian System in the Kitakami mountains. *Jour. Geol. Soc. Japan*, **62**, (730), 362 (J).

ONUKI, Y. and KUDO, H. (1954): The confirmation of the Permian System in the northern Kitakami mountainland. *ibid.*, **60**, (707), 360–362 (J).

ONUKI, Y. and MORIAI, T. (1959): Discovery of the Onimaru Formation in the southern part of Kamaishi mine. *ibid.*, **65**, (763), 249–250 (J).

ONUKI, Y. and YAMADA, Y. (1956): On the Nagaiwa formation, Kitakami massif. *ibid.*, **61**, (718), 305 (J).

ONUKI, Y., TAKAHASHI, K. and ABE, T. (1962): On the Motai Group of the Kitakami massif, Japan. *ibid.*, **68**, (806), 629–639 (J+E).

ONUKI, Y. *et al.* (1955): Recent knowledge on the Older rock formations in the Northern Kitakami mountains. *ibid.*, **61**, (718), 347 (J).

——— (1960): On the Permian System of the Maiya district in the southern Kitakami massif, Japan. *ibid.*, **66**, (782), 717–732 (J+E).

*OTUKA, Shozo (1964): On some Permian Fusulinids from Ozu, Gifu Prefecture, Japan. *Mem. Mejiro Gakuen Woman's Junior Coll.*, **1**, 29–36, pls. 1–2.

OTUKA, S. and KANEDA, T. (1965): Upper Paleozoic formations of the Ozu area, Ibi-gun, Gifu Prefecture, Japan. *ibid.*, **2**, 29–32 (J+E).

OZAKI, Hiroshi (1959): Stratigraphical studies on the Paleozoic conglomerate in the Tyosi peninsula, Tiba Prefecture, Japan. *Bull. National Sci. Mus. (Tokyo)*, (43), 188–201 (J+E).

OZAKI, K., YAMADA, K. and KATO, M. (1954): Permian formation in Kamianama-mura, Ono-gun, Fukui Prefecture. *Jour. Geol. Soc. Japan*, **60**, (706), 312–313 (J).

OZAWA, Yoshiaki (1922): Preliminary note on the classification of the Family Fusulinidae. *Jour. Geol. Soc. Japan*, **29**, 352–365 (J).

——— (1923): Stratigraphical study on the so-called Upper Chichibu Palaeozoic system including the Akiyoshi limestone. *ibid.*, **30**, (357), 222–243 (J).

*——— (1925): On the classification of Fusulinidae. *Jour. Coll. Sci. Imp. Univ. Tokyo*, **45**, 1–26, pls. 1–4.

*——— (1925): A brief critical revision of the *Fusulina* species recently described, with additional studies on Japanese Fusulininae. *Jour. Geol. Soc. Japan*, **32**, 19–27, pls. 9–10.

——— (1925): Fusulina-limestone of Omi-mura, Echigo province. *ibid.*, **32**, 27–35 (J).

*——— (1925): Palaeontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato, pt. 2, Palaeontology. *Jour. Coll. Sci. Tokyo Imp. Univ.*, **45**, (6), 1–90, pls. 1–14.

——— (1925): The post-Palaeozoic and late-Mesozoic Earth-movements in the Inner zone of Japan. *Jour. Fac. Sci. Imp. Univ., Tokyo*, [2], **1**, (2), 91–104.

*——— (1927): Stratigraphical studies of the Fusulina limestone of Akasaka, Province of Mino. *ibid.*, [2], **2**, (3), 121–164, pls. 34–46.

——— (1928): A new genus, *Depratella*, and its relation to *Endothyra*. *Contrib. Cushman Foram. Lab.*, **4**, (1), 9–10.

——— (1930): Read the geological map, Toba, 1 : 75,000, and interpret the geologic structure of that area. *Mem. vol. Dr. Takuji Ogawa.*

SADA, Kimiyoshi (1960): Middle and Upper Permian fusulinid faunas of the Atetsu limestone plateau, Okayama Prefecture. *"Yukochu" ("Foraminifera")*, (11), 54–61 (J).

——— (1960): On the Upper Permian Fusulinid fauna in the Atetsu limestone plateau, Okayama Prefecture. *Jour. Geol. Soc. Japan*, **66**, (777), 410–425 (J+E).

*——— (1961): *Profusulinella* of Atetsu limestone. *Jour. Sci. Hiroshima Univ.*, [C], 4, (1), 95–116, pls. 9–10.

*——— (1961): Neoschwagerines from the Yukawa group in the Atetsu limestone plateau. *ibid.*, 4, (1), 117–129, pls. 11–14.

*——— (1963): *Neoschwagerina* from Joé limestone, Hiroshima Prefecture, west Japan, with a note on *Neoschwagerina margaritae* DEPRAT. *Geol. Rept. Hiroshima Univ.*, (12), 541–552, pl. 58.

——— (1963): Biostratigraphy of the Atetsu limestone, Okayama Prefecture, based on the fusulinid foraminifera. *"Kaseki" ("Fossil")*, (6), 13–14 (J).

*——— (1964): Carboniferous and Lower Permian Fusulines of the Atetsu limestone in West Japan. *Jour. Sci. Hiroshima Univ.*, [C], 4, (3), 225–269, pls. 21–28.

——— (1965): Carboniferous and Permian stratigraphy of the Atetsu Limestone in West Japan. *ibid.*, [C], 5, (1), 21–80, pl. 1.

——— (1965): On the wall of *Triticites*. *Geol. Rept. Hiroshima Univ.*, (12), 265–275, pls. 22–23 (J+E).

*SADA, K. and YOKOYAMA, T. (1966): Upper Permian Fusulinids from the Taishaku limestone in West Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (63), 303–315, pls. 33–34.

SAITO, M. and KAMBE, N. (1954): Geology of Sankasho-Kuraoka district, Miyazaki Prefecture. New occurrence of Gotlandian, Permian, and Cretaceous sediments. *Bull. Geol. Surv. Japan*, 5, (3), 1–7, 103–109 (J+E).

SAITO, M. *et al.* (editors) (1960): *Geology and Mineral Resources of Japan*. 2nd ed., 1–304. *Geol. Surv. Japan*.

SAKAGAMI, Sumio (1955): Some observation on the boring core from Katsuboyama limestone. *Sekkaiseki (Limestone)*, (35), 1–5 (J).

*——— (1956): Fusulinids from the Limestone conglomerate in the Yagooki valley, Tamanouchi, Hinode-mura, Nishitama-gun, Tokyo-to, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (24), 259–265, pl. 37.

*——— (1958): Fusulinids from the Upper Permian conglomerates of the northern part of Itsukaichi, Tokyo-to, Japan. *Juor. Hokkaido Gakugei Univ.*, [2], 9, (2), 72–97, pls. 1–4.

——— (1958): Conglomerate in the Upper Permian System of the Itsukaichi, Tokyo-to. *Jubilee Publ. Mem. vol. Prof. H. Fujimoto*, 93–97 (J+E).

——— (1960): *Hayasakapora*, a new Permian Bryozoan genus from Iwaizaki, Miyagi Prefecture, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (39), 321–323, pl. 37.

——— (1960): *Nipponostenopora*, a new Carboniferous Bryozoan genus from Fukuji, Hida massif, Japan. *Japan. Jour. Geol. Geogr.*, **31**, (1), 9–12, pl. 2.

——— (1961): Japanese Permian Bryozoa. *Spec. Papers. Paleont. Soc. Japan*, (7), 1–58, pls. 1–30.

——— (1962): Discovery of *Profusulinella* from the Omi limestone, Niigata Prefecture. *Jour. Geol. Soc. Japan*, 68, (798), 175 (J).

——— (1962): Lower Carboniferous Bryozoa from the Hikoroichi Series, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (46), 227–242, pls. 35–37.

——— (1962–63): Lower Carboniferous Bryozoa from the Omi limestone, Japan, Pts. 1 and 2. *ibid.*, (48), 321–330, pls. 49–50 (1962); (49), 25–34, pls. 3–4 (1963).

——— (1963): Some Permian Bryozoa from the Yamanba limestone in the Sakawa basin, Shikoku, Japan. *ibid.*, (52), 155–160, pl. 24.

——— (1964): Bryozoa of Akiyoshi. Pt. 1, Permian Bryozoa from the Shigeyasu quarry. *Bull. Akiyoshi-dai Sci. Mus.*, (3), 1–24, pls. 1–8.

——— (1964): Bryozoa of Akiyoshi. Pt. 2, Lower Carboniferous Bryozoa from the Uzura quarry. *Trans. Proc. Palaeont. Soc. Japan,* (56), 295–308, pls. 44–45.

——— (1965): Revision of the Takagami conglomerate, Choshi peninsula, and descriptions of the Permian Bryozoa from its limestone pebbles. *ibid.*, (57), 1–7, pl. 1.

*SAKAGAMI, S. and OMATA, T. (1957): Lower Permian fusulinids from Shiraiwa, northwestern part of Omé, Nishitama-gun, Tokyo-to, Japan. *Japan. Jour. Geol. Geogr.*, 28, (4), 247–264, pls. 19–20.

——— and ——— (1959): *Triticites thalmanni* SAKAGAMI and OMATA and *Schwagerina guembeli omensis* SAKAGAMI and OMATA, new name for *T. intermedia* and *S. guembeli compacta*. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (34), 111.

SAKAGUCHI, Shigeo (1956): Permian System of the southern Tamba district and its fossil zones. *Jour. Geol. Soc. Japan,* **62**, (730), 364 (J).

——— (1957): On the Upper Paleozoic System around Izuruha, Kashida-mura, Minami-kuwata-gun, Kyoto Prefecture. *ibid.*, **63**, (743), 413–414 (J).

——— (1958): On the stratigraphical sequence and geological structure of the Western hills (Nishiyama) of Kyoto. *Mem. Osaka Univ. Liberal Arts and Educ.*, (6), 13–24 (J+E).

——— (1960): Stratigraphy and structure of the Sasayama basin in Hyogo Prefecture. *ibid.*, (8), 34–46 (J+E).

——— (1960): Notes on the mode of occurrence and origin of the cherts in the southern Tamba district. *ibid.*, (8), 47–59, pl. 1 (J+E).

*——— (1962–1963): Stratigraphy and Paleontology of the south Tamba district, pt. 1, Stratigraphy; pt. 2, Paleontology. *ibid.*, (10), 35–76; (12), 89–174, pls. 1–11.

SAKAGUCHI, S. and YAMAGIWA, N. (1958): The late Paleozoic corals from the southern part of the Tamba district. *ibid.*, (7), 163–178, pls. 1–5 (J+E).

——— and ——— (1963): Additional notes on Late Palaeozoic corals found in the southern part of the Tamba district. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (49), 9–14, pl. 2.

SAKAGUCHI, S., YAMAGIWA, N. and OZAKI, Y. (1955): Geology of the Nosé district (Preliminary report). Studies on the Paleozoic formations in the southern part of the Tamba plateau. *Jour. Geol. Soc. Japan,* **61**, (718), 345 (J).

SATO, Toshihiko (1955): Carboniferous System in the Soma district. *Jour. Geol. Soc. Japan,* **61**, (718), 305 (J).

———(1956): On the Tateishi formation and its Carboniferous coral fauna in the northeastern part of the Abukuma massif, Japan. *Sci. Rept. Tokyo Kyoiku Daigaku,* [C], (36), 235–261, pls. 9–12.

SEKI, Takeo (1938): Preliminary report on the fauna of Fusulina-limestone from Mt. Ibuki and its adjacent areas. *Trans. Palaeont. Soc. Japan* (in *Jour. Geol. Soc. Japan,* 45, 425–429) (J+E).

——— (1939): The Upper Paleozoic stratigraphy and structure of Mt. Ibuki and its neighbourhood. *Jubilee Publ. Prof. H. Yabe,* (1), 521–535 (J).

SHIBAZAKI, Tatsuo (1955): Geologic significance of the Toyoma Subsystem. *Chikyu Kagaku* (*Earth Science*), (23), 25–28 (J).

SHIIDA, Isao (1940): Geology of the Kesennuma district, Miyagi Prefecture. (Stratigraphical study of the southern Kitakami mountainland, VII). *Contrib. Inst. Geol. Paleont. Tohoku Univ.*, (33), 1–72, pls. 1–3 (J+E).

——— (1962): Stratigraphical and geotectonic studies of the Paleozoic Chichibu

and the Mesozoic Hitaka (Shimanto) terrains in the central part of the Kii mountainland, southern Kinki, Japan. *Res. Bull. General Educ. Nagoya Univ.*, (6), 1–58, pls. 1–6 (J+E).

SHIIDA, I., UMEDA, K. and KONAGAWA, S. (1953): Rept. 2nd General investigation, Nara Prefecture, Pt. Geology, Ryumon area. *Board of Educ. Nara Prefecture*, 1–38 (J).

SHIIDA, I *et al.* (1954): Rept. Cultural investigation, Nara Prefecture. Yoshinogawa area. *Board. Educ. Nara Prefecture*, 1–55 (J).

SHIKI, Tsunemasa (1959): On some compositional and textural properties of sandstones in the Maizuru zone, Southwest Japan, with special reference to their maturity. *Chikyu Kagaku* (*Earth Science*), (42), 5–17 (J+E).

——— (1961): Studies on sandstones in the Maizuru zone, Southwest Japan; II. Graded bedding and mineral composition of sandstones of the Maizuru Group. *Mem. Coll. Sci. Univ. Kyoto*, [B], **27**, (3), 293–308.

SHIMIZU, Daikichiro (1958): Brachiopod fossils from the Permian Maizuru Group. *ibid.*, **27**, (3), 309–350, pls. 15–18.

——— (1962): Brachiopod fossils from the Upper Permian Gujo Formation of the Maizuru Group, Kyoto Prefecture, Japan. *ibid.*, 28, (2), 243–254, pls. 8–9.

——— (1962): The Permian Maizuru Group, its stratigraphy and syntectonic succession through the Latest Paleozoic orogeny. *ibid.*, 28, (4), 571–609.

——— (1963): Permian brachiopod fossils of the Maizuru Group found on the north of Okayama city, Japan. *ibid.*, **30**, (2), 69–80, pls. 4–5.

——— (1963): Stratigraphy and Paleontology of the Maizuru Group, with special reference to fossil brachiopod assemblage and its vertical change. *"Kaseki"* (*"Fossil"*), (6), 20–26 (J).

SHIMIZU, Daikichiro *et al.* (1962): Stratigraphy of the Permian Maizuru Group, Southwest Japan—A study on the stratigraphy and geologic structure of the Maizuru zone, Pt. 10. *Jour. Geol. Soc. Japan*, **68**, (800), 237–247 (J+E).

——— (1962): Sedimentation of the Maizuru Group and Permian tectonic movement —A study on the stratigraphy and geologic structure of the Maizuru zone, Part 11. *ibid.*, **68**, (801), 334–340 (J+E).

SHIMIZU, S. and OBATA, T. (1936): Remarks on HAYASAKA's *Protocycloceras* cfr. *cyclophorum* and the Permian and Carboniferous orthoconic Nautiloids of Asia. *Jour. Geol. Soc. Japan*, **43**, (508), 11–29 (J+E).

SHIMIZU, Sanetaka (1896): Occurrence of Fusulina in the province of Shimotsuke. *ibid.*, **3**, (31), 194–195 (J).

*SUGI, Tomomitsu (1960): Restudy of *Verbeekina sphaera* OZAWA. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (39), 311–320, pl. 36.

——— (1960): Evolution of the Verbeenininae. *"Kaseki"* (*"Fossils"*), (1), 29–33 (J).

——— (1960): *Oketaella* from Japan. *ibid.*, (1), 39–41 (J).

SUGIYAMA, Toshio (1939): Some contributions to the knowledge of the Palaeozoic of the Akiyoshi district, Mine-gun, Yamaguchi Prefecture. *Jour. Geol. Soc. Japan*, **46**, (544), 13–22 (J+E).

——— (1944): Japanese Trilobites. *Geol. Rept. Inst. Geol. Mineral. Tokyo Kyoiku Daigaku*, (1), 21–31, pl. 1 (J).

——— (1944): On the Gotlandian fossils from Imose, Kusaka-mura, Takaoka-gun, Kochi Prefecture. *ibid.*, (1), 41–51, pls. 2–3 (J).

SUYARI, Kazumi (1954, 1958): Geology of the vicinity of Kamodani, Tokushima Prefecture, Pts. 1, 2. *Jour. Gakugei Tokushima Univ.* [*Nat. Sci.*], **5**, 94–101; 8, 47–57 (J+E).

——— (1956): Geology of Sakuradani area, Tokushima Prefecture. *Jour. Geol. Soc. Japan*, **62**, (730), 366 (J).

——— (1960): The volcanic activities of the Chichibu terrain in Shikoku. *Sci. Rept. Tohoku Univ.* [*Geol.*], Spec. vol. 4, 571–575 (J+E).

*——— (1961–1962): Geological and Paleontological studies in central and eastern Shikoku, Japan; pt. 1, Geology; pt. 2, Paleontology. *Jour. Gakugei Tokushima Univ.*, [*Nat. Sci.*], **11**, 11–76 (1961); **12**, 1–64, pls. 1–12 (1962).

SUYARI, K. *et al.* (1952): On the relationship between the Paleozoic formation and the Triassic System in the Sakashu area, Tokushima Prefecture. *Jour. Geol. Soc. Japan*, 58, (682), 286 (J).

SUZUKI, Tatsuo (1931): Geological sheet map with explanatory text; Kochi, 1 : 75,000. *Geol. Surv. Japan.*

——— (1933): Geological sheet map with explanatory text; Susaki, 1 : 75,000. *Geol. Surv. Japan.*

——— (1935): Geological sheet map with explanatory text; Unomachi, 1 : 75,000. *Geol. Surv. Japan.*

TACHIBANA, Koichi (1950): Devonian plants first discoverd in Japan. *Proc. Japan Acad.*, **26**, (9), 54–60.

——— (1952): On the Tobigamori Group in the Nagasaka district, Kitakami mountainland. *Jour. Geol. Soc. Japan*, 58, (683), 353–360; (684), 445–455 (J+E).

——— (1953): An observation on the strata bounded by different bedding-planes found in the so-called Usuginu conglomerate. *Geol. Repts. Inst. Geol. Mineral. Tokyo Univ. Educ.*, (2), 31–36 (J+E).

——— (1956): New Spiriferids from the Lowest Carboniferous of the Nagasaka district, Kitakami mountainland, Northeast Japan. *Sci. Rept. Fac. Arts & Liter., Nagasaki Univ.*, (5), 11–16, pl. 1.

——— (1962): On the Lowest Carboniferous *Syringothyris* and *Syringopleura* of the Nagasaka district, Northeast Japan. *Bull. Fac. Liberal Arts, Nagasaki Univ.*, [*Nat. Sci.*], **3**, 53–62 (J+E).

——— (1963): Upper Devonian and Lowest Carboniferous formations in the vicinity of Minamiiwairi, Higashiyama-machi, Iwate Prefecture; Pt. 1 (Study on the Devonian-Carboniferous boundary in the southwestern part of the Kitakami mountainland). *ibid.*, **4**, 31–43 (J+E).

TAKAHASHI, Eitaro (1963): Structure of the Mesozoic and Paleozoic formations of the drainage of the River Abugawa, Yamaguchi Prefecture. *Sci. Repts. Yamaguchi Univ.*, **14**, 49–52 (J+E).

——— (1965): On the so-called Miné Group in the environs of Tsunemori, Yamaguchi Prefecture. *Jour. Geol. Soc. Japan*, **71**, (833), 79–80 (J).

TAKAHASHI, E. and SUEMATSU, I. (1961): Structure of older formations of the Tsumo district, Mino-Kanoashi mountainland, Shimane Prefecture. *Sci. Rept. Yamaguchi Univ.*, **12**, 55–56 (J+E).

TAKAHASHI, E. *et al.* (1960): Paleozoic of the central part of Kuga mountainland, Yamaguchi Prefecture. *ibid.*, **11**, 147–149 (J+E).

——— (1960): Paleozoic of the western part of Mino-Kanoashi mountainland, Shimane Prefecture. *ibid.*, **11**, 151–154 (J+E).

——— (1961): Geologic structure of the Kane-Takamata district, Yamaguchi Prefecture. *ibid.*, **12**, 57–60 (J+E).

TAKAI, F., MATSUMOTO, T. and TORIYAMA, R. (editors) (1963): Geology of Japan. 1–279, *University of Tokyo Press*, Tokyo, Japan.

TAKAMURA, Hazime (1964): Discovery of *Neoschwagerina* and *Schwagerina* from the Paleozoic in the district of Kake-machi, Hiroshima Prefecture. *Jour. Geol. Soc. Japan*, **70**, (831), 598 (J).

TAKANO, Tei (1952): The Chichibu System of the Nyukawa area, Gifu Prefecture. *ibid.*, 58, (682), 321 (J).

TAKAOKA, Yoshinari (1951): On the Gozenyama Formation along the Tama valley. *ibid.*, **57**, (670), 264–265 (J).

——— (1954): The Gozenyama formation along the Tama valley, Tokyo-to, Japan. *Rept. Inst. Geol. Mineral. Kyoiku Daigaku,* (3), 29–34 (J+E).

——— (1958): Geological study of the upper valley of Naruki-gawa. *Rept. Tohogakuen (Tohogakuho)*, (7), 59–64, pl. 1 (J).

——— (1959): On the Japanese Schwagerininae. *ibid.*, (9), 55–88 (J).

——— (1959): On the discovery of *Kahlerina* KOCHANSKY-DEVIDÉ, 1955 from Gozenyama Formation along the Akigawa, Tokyo-to, Japan. *Jour. Geol. Soc. Japan,* **65**, (768), 570, 3 figs. (J).

*——— (1966): Fusulinids from the Mt. Tatoro, Mt. Kano, Mt. Futago and Mt. Shiraishi areas of the Kwanto-massif, Central Japan. *Bull. Chichibu Mus. Nat. History,* (13), 39–70, pls. 5–16.

TAKEDA, Hiroyuki (1960): Paleozoic formations in Shimoarisu village, southern Kitakami massif, Northeast Honshu, Japan. *Jour. Geol. Soc. Japan,* **66**, (782), 689–699 (J+E).

TAKEDA, H. and KAKIMI, T. (1956): Geologic structure in the vicinity of Komatsu, Kamiarisu-mura, Kesen-gun, Iwate Prefecture. *ibid.,* **62**, (730), 363 (J).

TAKEDA, H. and YOSHIDA, T. (1962): Onimaru Series (Upper Veséan) in the Kamaishi district, nothern Kitakami massif, Northeast Honshu, Japan. *ibid.,* **68**, (796), 33–40 (J+E).

TAKEI, Kensaku (1960): Permian ripple mark from the Kwanto mountainland. *Chikyu Kagaku (Earth Science)*, (49), 37–38 (J).

TAKEYAMA, Toshio (1933): The Paleozoic formations of Mt. Ibuki and Samegai. *Chikyu (The Globe)*, **20**, (5), 325–332 (J).

TAKIMOTO, Kiyoshi (1936): Geologic structure of the environs of Ryozensan, Inugami-gun, Shiga Prefecture. *ibid.,* **26**, 1–11 (J).

TAMURA, M., SATO, T. and TOYAMA, N. (1952): Discovery of Fusulina from Paleozoic formation in the northern part of Kitakami mountains. *Jour. Geol. Soc. Japan,* **58**, (679), 154 (J).

TANAKA, K., KOBAYASHI, K. and KAMEI, T. (1952): Stratigraphische Stellung der Sawando-Konglomerate. *Jour. Fac. Educ. Shinshu Univ.,* (2), 54–62 (J+G).

TATSUKE, Haruo (1955): Stratigraphy and structure of the Paleozoic System of the Mamba district, Kwanto mountains. *Jour. Geol. Soc. Japan,* **61**, (718), 345–346 (J).

TERAOKA, Yoji (1959): Paleozoic and Mesozoic formations in the southern area of Nariwa-machi, Okayama Prefecture, with special reference to the Upper Triassic Nariwa Group. *ibid.,* **65**, (767), 494–504 (J+E).

*THOMPSON, M. L. (1936): *Nagatoella,* a new genus of Permian fusulinids. *Trans. Proc. Palaeont. Soc. Japan,* (2), 15–23, pl. 12. [in *Jour. Geol. Soc. Japan,* **43**, (510), 195–203].

*TORIYAMA, Ryuzo (1942): The fusulinids of the Yasuba conglomerate in the province of Tosa. *Japan. Jour. Geol. Geogr.,* **18**, (4), 237–247, pls. 24–25.

*——— (1944): The Fusulinids in the limestone conglomerate of the Sakuradani area in the Province of Awa. *ibid.,* **19**, (1–4), 67–82, pl. 6.

*——— (1945): The Fusulinids in the limestone conglomerates of Inomine in the Province of Tosa. *ibid.,* **20**, (1), 1–11, pl. 1.

*——— (1947): On the Fusulinids in the Yasuba type of limestone conglomerate in the Kwanto mountainland. *ibid.,* **20**, (2–4), 33–39, pl. 9.

*——— (1947): On some fusulinids from Tosayama, Koti-ken, Shikoku, with a note on the stratigraphical range of *Neoschwagerina.* *ibid.,* **20**, (2–4), 64–82, pls. 26–27.

*——— (1952): Permian fusulinids from the Kitakami mountainland, Northeast

Japan. *Mem. Fac. Sci. Kyushu Univ.*, [D], **3**, 127–156, pls. 3–7.

——— (1953): Stratigraphy and fossil zones of the Paleozoic formations in Southwest Japan. *Jour. Geol. Soc. Japan*, **59**, (694), 290–292 (J).

*——— (1953): New peculiar fusulinid genus from the Akiyoshi limestone of Southwestern Japan. *Jour. Paleont.* **27**, (2), 251–256, pls. 35–36.

*——— (1954): A gigantic fusulinid species from the Kitakami massif, Northeastern Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (15), 179–182, pl. 24.

——— (1954): Geology of Akiyoshi. Pt. 1, Study of the Akiyoshi limestone Group; Pt. 2, Stratigraphy of the non-calcareous groups developed around the Akiyoshi limestone Group. *Mem. Fac. Sci., Kyushu Univ.*, [D], **4**, (1), 40–97; **5**, (1), 1–46.

——— (1957): Geology of Akiyoshidai. *Rep. Invest. Akiyoshidai, Yamaguchi Prefecture*, 1–36 (J).

*——— (1958): Geology of Akiyoshi. Pt. 3, Fusulinids of Akiyoshi, *Mem. Fac. Sci. Kyushu Univ.*, [D], **7**, 1–264, pls. 1–48.

——— (1960): Tentative classification of the fusulinid foraminifera. *"Kaseki" ("Fossil")*, (1), 34–38 (J).

——— (1961): Fusulinid zones of East Asia. *Proc. Ninth Pacific Sci. Congr. 1957*, **12**, 250–253.

——— (1963): The Permian in "Geology of Japan" (TAKAI, MATSUMOTO & TORIYAMA, editors). *Univ. Tokyo Press*, 43–58.

TSUKANO, Zenzo (1931): Outline of geology of the Katsuuragawa basin. *Chikyu ("The Globe")*, **16**, (1), 7–22 (J).

UEDA, Fusao (1963): The geological structure of the Permian and Triassic Systems in the Toyoma and Maiya districts, southern Kitagami massif, Northeast Japan. *Jour. Toyo Univ.*, [*Nat. Sci.*], (4), 1–78, pls. 1–19 (J+E).

WAKIMIZU, Tetsugoro (1902): Limestone of Akasaka, Mino. *Jour. Geol. Soc. Japan*, **9**, 71–75, 163–169, 205–212, 331–339 (J).

YABE, Hisakatsu (1899): On *Fusulina japonica* SCHWAGER from Tomuro, province of Shimotsuke. *Jour. Geol. Soc. Japan*, **6**, 189–194 (J).

——— (1902): Materials for a knowledge of the anthracolitic fauna of Japan, 1. *ibid.*, **9**, (110), 1–5 (English text), text-fig. 1.

——— (1902): On the genus *Schwagerina*. *ibid.*, **9**, 283–287.

——— (1903): On a Fusulina limestone with *Helicoprion* in Japan. *ibid.*, **10**, 1–13, pls. 2–3.

*——— (1906): A contribution to the genus *Fusulina*, with notes on a Fusulina limestone from Korea. *Jour. Coll. Sci. Imp. Univ. Tokyo*, **21**, (5), 1–36, pls. 1–3.

——— (1906): The occurrence of Fusulina in the geological sheet map area of Wakayama. *Jour. Geol. Soc. Japan*, **13**, (148), 41 (J).

——— (1940): Palaeozoic formations of the Japanese islands. *Proc. 6th Pacific Sci. Congr.*, **1**, 377–392.

——— (1948): Neoschwagerininae DUNBAR and CONDRA. *Proc. Japan Acad.*, **24**, (9), 1–9.

——— (1949): The zone of *Millerella* in Japan. *ibid.*, **25**, (1), 165–167.

——— (1949): Fusulinid zones in the Carboniferous of Japan. *ibid.*, **25**, (5), 168–174.

——— (1951): A new type of Lower Permian Tetracoralla, *Pseudoyatsengia*, nov. *ibid.*, **27**, (4), 200–204.

——— (1958): Carboniferous–Permian boundary in Japan. *ibid.*, **34**, (3), 150–152.

——— (1958): Peculiar geographical distribution of the Onimaru and Akiyoshi coral faunas in the Japanese Carboniferous. *ibid.*, **34**, (3), 154–158.

——— (1958): Devonian–Carboniferous boundary in Japan. *ibid.*, **34**, (4), 212–215.

——— (1958): Thick limestone of the Upper Carboniferous–Permian age in Japan;

An interpretation of their mode of deposition. *ibid.*, **34**, (4), 217–219.

——— (1958): Major division of the Carboniferous in Japan; I, II, Middle Titibu limestone facies. *ibid.*, **34**, (5), 274–279; (6), 368–372.

——— (1958): Some problems on the geologic structure of Akiyoshidai. *"Yukochu" ("Foraminifera")*, (9), 1–9 (J).

——— (1958): Carboniferous–Permian boundary and the stratigraphical position of the zone of *Triticites* in Japan. *ibid.*, (9), 40–43 (J).

——— (1963–1964): Permian–Triassic boundary in the Japanese islands. I. Kyushu; II. Kitakami mountainland. *Jour. Geogr.*, **72**, (6), 265–268; **73**, (4), 191–197 (J+E).

——— (1964–1966): *Lepidolina* problem. *Proc. Japan Acad.*, **40**, (3), 214–219; Supplementary notes, **42**, (2), 141–145; Final remarks, **42**, (6), 636–639. ..

——— (1964–1965): Problems on the genus *Lepidolina* (Pts. 1, 2). *"Kaseki" ("Fossils")*, (8), 134–145; (9), 36–55 (J).

YABE, H. and ENDO, S. (1920): Discovery of a stem of *Calamites* from the Palaeozoic of Japan. *Jour. Geol. Soc. Japan*, **27**, 65–69.

YABE, H. and HANZAWA, S. (1931): Palaeozoic and Mesozoic Foraminifera. *Leid. Geol. Mededeel.* Deel 5, 23–34.

——— and ——— (1932): Tentative classification of the Foraminifera of the Fusulinidae. *Proc. Imp. Acad. Japan*, 8, (2), 40–43.

YABE, H. and HAYASAKA, I. (1915–1916): Paleozoic corals from Japan, Korea and China. *Jour. Geol. Soc. Japan*, **22**, 55–70; 23, 57–75.

YABE, H. and MABUCHI, S. (1935): On two Upper Paleozoic Nautiloids from Japan and China. *Japan. Jour. Geol. Geogr.*, **12**, (1–2), 9–12, pl. 4.

YABE, H. and NODA, M. (1933): On the discovery of *Spirifer verneuili* MURCHISON in Japan. *Proc. Imp. Acad. Japan*, **9**, (9), 521–523, text-figs. 1–6.

YABE, H. and SUGIYAMA, T. (1931): Note on a new forms *Lophiostroma* from the Permian of Japan. *Japan. Jour. Geol. Geogr.*, **9**, (1–2), 17–19, pl. 3.

——— and ——— (1933): A new form of the genus *Omphalophyllia* collected from Yamamba, near Sakawa-machi, Province of Tosa (Shikoku). *ibid.*, **10**, (3–4), 111–114.

——— and ——— (1934): A new species of *Disjectopora* from Japan. *ibid.*, **11**, (3–4), 171–174, pl. 19.

——— and ——— (1934): *Amblysiphonella* and *Rhabdactinia* gen. and sp. nov. found from the Upper Palaeozoic limestone of Mimikiri, near Sakawa-machi, Tosa Province, Shikoku, Japan. *ibid.*, **11**, (3–4), 175–180.

——— and ——— (1936): Discovery of Lower Carboniferous corals from the Yatsushiro district in Kyushu. *Proc. Imp. Acad. Japan*, **15**, (9), 300–304, text-figs. 1–8.

——— and ——— (1942): *Akiyoshiphyllum*, a new type of Permian Rugose coral from Japan. *ibid.*, **18**, (12), 574–578, text-figs. 1–2.

YAMADA, R. and OHTA, Y. (1965): Discovery of *Lepidolina kumaensis* KANMERA from the Ohtani conglomerate in the Ise region, Fukui Prefecture. *Jour. Geol. Soc. Japan*, **71**, (837), 276–280 (J+E).

YAMADA, T. and FUJIMOTO, H. (1950): Study of the Fusulinid-limestone of Ibukiyama, Shiga Prefecture. *ibid.*, **56**, (656), 292 (J).

YAMADA, T., FUJIMOTO, H. and YOSHIDA, S. (1951): Paleontological study of the Nabeyama limestone in the Kuzu district, Tochigi Prefecture. *ibid.*, **57**, (670), 265–266 (J).

YAMADA, Yataro (1958): On the Nagaiwa Formation. *Jubilee Publ. Prof. H. Fujimoto*, 74–80 (J+E).

——— (1959): On the unconformity of the post-Nagaiwa~pre-Sakamotozawa Epoch in the Hikoroichi district. *Jour. Geol. Soc. Japan*, **65**, (771), 713–724 (J+E).

YAMADA, Y. and ONUKI, Y. (1956): On the Carobniferous Onimaru Series in the type locality. *ibid.*, **62**, (730), 363 (J).

YAMAGIWA, Nobuo (1954): New localities of Fusulinids and Tetracorals from the northern part of Settsu province. *ibid.*, **60**, (707), 356 (J).

*——— (1956): Neoschwagerininae from the Shima Peninsula, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (23), 235–242, pl. 34.

——— (1957): Stratigraphy and geological structure of the eastern area of Shima peninsula. *Jour. Geol. Soc. Japan*, **63**, (740), 263–272 (J+E).

——— (1960): The Late Paleozoic corals from the Maizuru zone, Southwest Japan. *Mem. Osaka Univ. Liberal Arts & Educ.*, [B], (9), 72–81, pl. 1.

——— (1961): A new species of *Lonsdaleoides* from Tokushima Prefecture, Southwest Japan. *Bull. Osaka Mus. Nat. Hist.*, (13), 87–90, pl. 4.

——— (1961): *Amygdalophyllum* sp. from Hyogo Prefecture. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (44), 152, text-fig. 1.

——— (1962): The Permo-Carboniferous corals from the Atetsu plateau and the coral faunas of the same age in the Southwest Japan. Pt. 1, The Permo-Carboniferous corals from the Atetsu plateau. *Mem. Osaka Univ., Liberal Arts & Educ.*, (10), 77–114, pl.s 1–8.

——— (1962): *Clisiophyllum awa* (MINATO) discovered from the Upper Carboniferous in Shima peninsula. *Jour. Geol. Soc. Japan*, **68**, (801), 349–350 (J).

*YAMAGIWA, N. and ISHII, K. (1957): *Yabeina* from Omura island, Shima, Mié Prefecture. *Jubilee Publ. Comm. Prof. H. Fujimoto*, 58–65, pl. 4.

——— (1957): Geology of Kamishima, Shima Peninsula. *Jour. Geol. Soc. Japan*, **63**, (743), 493 (J).

YAMAGIWA, N. and OTA, M. (1963): Faunas and correlation of "Uzura" quarry, Akiyoshi, Southwest Japan. Pt. 1, Corals. *Bull. Akiyoshi-dai Sci. Mus.*, (2), 87–93, pls. 1–2.

YAMANE, Shinji (1924): Geology of the environs of the city of Choshi. *Jour. Geogr.*, **36**, (420), 95–99 (J).

YAMASHITA, Noboru (1952): The Kurosegawa tectonic zone in Tokushima Prefecture. *Jour. Geol. Soc. Japan*, **58**, (682), 286–287 (J).

——— (1958): *Yabeina-Lepidolina* fauna found in the Sakawa basin, Shikoku, and its significance. *ibid.*, **64**, (749), 92–94 (J).

——— (1958): On the Silurian conglomerates of Inomine, Kochi Prefecture and their geological significance. *ibid.*, **64**, (758), 578–582 (J+E).

YAMASHITA, N. *et al.* (1955): Geological map of Kwanto region and its explanatory text, 1 : 300,000. *Naigai Chizu Publ. Co., Ltd.*

——— (1958): Geological map with explanatory text; Tomioka-Hiwasa, Tokushima Prefecture, 1 : 75,000. *Tokushima Prefecture.*

YANAGIDA, Juichi (1958): The Upper Permian Mizukoshi Formation. *Jour. Geol. Soc. Japan*, **64**, (752), 222–231 (J+E).

——— (1962, 1965): Carboniferous Brachiopods from Akiyoshi, Southwest Japan. *Mem. Fac. Sci. Kyushu Univ.*, [D], **12**, (1), 87–127, pls. 14–21; **16**, (2), 113–142, pls. 25–28.

——— (1963): Upper Lower Carboniferous brachiopods from Akiyoshi. *"Kaseki" ("Fossil")*, (6), 7–8 (J).

YANAGISAWA, Ichiro (1958): On a discovery of Trilobite from the Takakurayama Group (Permian), Abukuma mountains. *Jour. Geol. Soc. Japan*, **64**, (751), 207 (J).

YOKOYAMA, Tsuruo (1954): The Permian System in the Taishaku district. *ibid.*, **60**, (706), 302 (J).

——— (1957): Notes on some Carboniferous Corals from Taishaku district, Hiroshima Prefecture, Japan. *Jour. Sci. Hiroshima Univ.*, [C], **2**, (1), 73–82, pls. 10–12.

——— (1959): Geology of the Taishakukyo area. *Rept. Invest. for proposed sites for quasi-national park in Chugoku massif, Tottori, Shimane, and Hiroshima Prefec.*, 29–42, pls. 12–14 (J).

——— (1960): Permian corals from the Taishaku district, Hiroshima Prefecture, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, (38), 239–248, pls. 27–28.

——— (1960): The Paleozoic of Taishakukyo. *Geol. Guide book for Shobara, Shokozan, Taishakukyo*, 18–33 (J).

——— (1961): *Triticites* fauna from Taishaku, Hiroshima Prefecture. *Jour. Geol. Soc. Japan*, **67**, (786), 187 (J).

YOSHIDA, Saburo (1956–57): Stratigraphical and tectonical studies in the district neighbouring Kuzu-machi, Tochigi Prefecture. *Bull. Geol. Commit. Hokkaido*, (32), 1–10; (34), 1–5 (J+E).

YOSHIDA, Takashi (1951): The Paleozoic formations in the vicinity of Yonesato-mura, Esashi-gun, Iwate Prefecture. *Jour. Geol. Soc. Japan*, **57**, (670), 267 (J).

——— (1961): Geological sheet map with explanatory text, Kamaishi, 1 : 50,000. *Geol. Surv. Japan.*

YOSHIDA, T. and KATADA, M. (1964): Geological sheet map with explanatory text, Otsuchi & Karodake, 1 : 50,000. *Geol. Surv. Japan.*

YOSHIMURA, Norihisa (1954): The Permian System in the Koyama-mura area, Kawakami-gun, Okayama Prefecture. *Jour. Geol. Soc. Japan*, **60**, (706), (302) (J).

——— (1961): Geological studies of the Paleozoic groups in the Oga plateau, Central Chugoku, Japan. *Geol. Rept. Hiroshima Univ.*, (10), 1–36, pls. 1–4 (J+E).

YOSHIMURA, N., KATAYAMA, S. and KUSUMI, H. (1959): On some recent informations concerning the so-called "Hanagi thrust". *Mem. Fac. Educ. Hiroshima Univ.*, [2], (7), 43–51 (J+E).

YOSHINO, Masumi (1937): Paleozoic fossils found in the limestone of Taishakudai, Bingo province (Pts. 1, 2). *Jour. Geogr.*, **49**, (580), 269–278; (581), 307–318 (J).

Index

A

Abugawa area, 107, 133, 157
Abukuma massif, 52, 89, 118, 142
Adoyama Formation, 144
Aigyo Formation, 107
Aizawa Formation, 91
Akaishi massif, 108
Akasaka area, 77, 96, 125, 150
limestone, 96, 125, 150
Akasakan Stage, 48
Akenobe Formation, 153, 180
Akiyama area, 69, 77
Akiyoshi limestone, 58, 64, 72, 106, 132, 156, 186
Akiyoshian Stage, 41
Akka limestone, 118
Akuda Formation, 94
Akyu Formation, 69
Amatsuki Formation, 150
Ananori Formation, 69
Anegawa Formation, 177
Aohama Formation, 108
Aoi Formation, 148
Aomine Formation, 159
Arakigawa Formation, 53, 68
Arashima-Gokasho tectonic line, 134
Aratakiyama Formation, 60
Aratani Formation (conglomerate), 133, 158, 188
Asakaido Stage, 145
Ashidani Formation, 69
Ashimatagawa Group, 151
Aso-Gokasho area, 109, 160
Aso Group, 91, 119
Atetsu limestone (plateau), 54, 63, 71, 103, 104, 131, 154, 183
Atetsuan Stage, 40
Awagatake area, 143
Ayukawa Formation, 52
Azusagawa Group, 121

C

Chihara Formation, 153
Chin'nanzan zone, 113
Choshi peninsula, 173
Chugoku massif, 54, 63, 71, 103, 130, 153, 183

D

Daido Formation, 141, 173
Daigo Group, 74, 78
Dangyokei Formation, 56, 57, 64
Deguchi Formation, 126
Dodo Group, 181
Doi Formation, 172

E

Eimyoji Formation, 56, 57, 64, 72

F

Fuchu area, 58, 64, 156, 182
Fujikuradani Formation, 69
Fujiwaradake area, 100, 128, 152
Formation, 100, 128
Fuka Formation, 56
Fukase Group (facies), 162
Fukuji area, 53, 62, 67, 76, 83, 92, 122
Fukumoto area, 181
Funafuseyama area, 95, 123, 149
Futagami Formation, 60, 132
Futagoyama limestone, 66, 81, 90
Futaiwa Formation, 112
Futami Formation, 80

G

Gujo facies (faunule), 178
Gyojagaeri Formation, 110

H

Hachiman area, 77, 82, 94, 123
Haigyu Formation, 190
Hanagiri Stage, 90
Hanawa Formation, 118
Hanawa area, 142
Handa limestone, 72, 107, 132, 157
Hanetsuru dolomite Member, 143
Hario Formation, 147
Hashirimizu Formation, 170
Hata Formation, 147
Hatagasako Formation, 157
Hayachine tectonic belt, 88
Hida massif, 52, 62, 67, 76, 82, 91, 121, 145, 176
Higashi-uyama Group, 132
Hijima Formation, 130
Hikami Formation, 71
Hikawan Stage, 43
Hikoroichi and Setamai area, 85, 140
Hinode Formation, 176
Hinokawa area, 147
Hirawarabi Formation, 158
Hirayu Group, 93, 123, 145
Hiryuyama Formation, 116
Hisone Group, 162, 164
Formation, 163
Hitokabe area, 86
Hongo and Arakigawa area, 53, 94
Hongo Formation, 53, 94
Hosomidani area, 106

I

Ibaragawa Formation, 100, 129
Ibukiyama area, 70, 83, 98, 126, 151
limestone, 99, 126, 151, 193
Ichihara Formation, 152
Ichinosawa Formation, 121
Ichinose facies, 109
Formation (in Shikoku), 191
Group (in Maizuru zone), 178
Ichinotani Formation, 62, 67, 83
Group, 53, 62, 68, 76, 92
Idaniyama Formation, 105
Iinoya Formation, 108
Ikadaba area, 187
Formation, 107, 133, 157
Imajo area, 70, 78, 83, 97, 147
Formation, 78
Inner zone of Northeast Japan, 119, 142, 174
Ino area, 78
Inomine limestone, 166
Inugami Group, 101
Iriishikura Formation, 118
Iruma Group, 90
Ise area, 84
Isetoge Formation, 69
Ishifune area, 66
Formation, 75
Ishige Formation, 103
Ishiyama limestone, 150
Itadorigawa Formation, 74
Itagatani Formation, 167
Itanami Group, 151
Itanamiyama Group, 193
Itogawa Formation, 134
Itoshiro area, 76
Itsukaichi area, 176
Iuchi Formation, 180, 181
Iwahara limestone Member, 171
Iwaizaki limestone, 141, 172
Iwaizumi and Akka area, 118
Iwaki Formation, 113
Iwakura Formation, 159
Iwakurayama limestone, 127
Iwamoto Formation, 104
Iwanadome limestone, 121
Iwasayama limestone, 127
Izumiyama area, 188
Izuru Formation, 91
Izuruha Formation, 152
Izuto limestone, 107

J

Joé, 64, 156
Jinseki-Yuki area, 64, 106, 132, 186
Junigatake Formation, 146

K

Kabayama Member, 115
Kagamiyama Formation, 169
Kagemori Subformation, 90
Kaibuki Formation, 167

Kakisako Formation, 51, 61
Kamaishi Formation, 88
Kameiwa Formation, 112, 136
Kametsubo area, 153
Kamianama area, 69, 95
Kamiarisu – Ohashi area, 117, 141
Kamihirose conglomerate, 125
Kamikuzu Stage, 175
Kamitakaran Stage, 39, 40
Kamiyakawa Formation, 165
Kamiyoshida Group, 175
Kamodani area, 78
facies, 162
Group, 162
Kane Formation, 107, 133, 157
Kaneishi facies, 162
Kanikawa Formation, 154
Kannagawa area, 65
Kanokura Formation, 115, 116, 171
Kansaka limestone, 67
Kanzaki Formation, 95
Karasawa limestone Member, 143
Karita Formation, 183
Kasama Formation, 65, 75
Kashiwadaira Formation, 118
Kasshi Formation, 88, 117, 141, 173
Kasuga Formation, 151, 177
Kasukawa Formation, 151
Katada Formation, 107, 132
Katauchi Formation, 61
Katchizawa Member, 115, 140
sandstone Member, 140, 171
Kato Formation, 148
Katsuboyama zone, 89, 144
Katsuuragawa area, 161
Kawahigashi area, 179
faunule, 178
Kawakami area, 189
Group, 110, 160
Kawamo Formation, 52
Kawanishi area, 179
Kawanobori limestone, 113
Kawarakami Formation, 187
Keizuruyama area, 143, 174
Kenzan Formation, 135
Group, 161, 164
Kesennuma area, 86, 116
Kii Peninsula, 78, 84, 108, 134, 159, 188
Kinshozan biofacies, 51
Kiriwake Formation, 156
Kiso massif, 122, 147
Kitakami massif,
Northern part, 52, 88, 117, 141, 173
Southern part, 51, 61, 80, 85, 115, 140, 172
Kitayama area, 130, 152
Kiyotaki Formation, 98
Kochi Formation, 148
Group, 134, 160
Koda limestone, 107
Kodani Formation, 54, 63, 71
Kogawa Formation, 52
Kokuzosan Group, 167
Komagatake area, 174
Komukudani Formation, 148
Kono Formation, 146, 177
Konogidani Formation, 125
Kose Group, 181
Kotakigawa Formation, 53
Kotako Formation, 134
Koyama limestone, 56, 71, 105, 155
Kozaki Formation, 114, 139
Kuchibora Formation, 123
Kuki Formation, 167
Kuma Formation, 49, 192
massif, 114, 138, 169
Kuman biofacies, 51
Stage, 49
Kumogahata Formation, 152
Kumokawa Formation, 69
Kunimiyama Formation, 94
Kurahashira Formation, 94
Kurakaketoge Formation, 152
Kurama Formation, 130, 152
Kuraoka area, 113, 138
Kuratoko Formation, 180
Kuregatoge area, 186
Kuribayashi Formation, 88
Kurikian Stage, 42, 79
Kurohagi Formation, 56
Kuroiwa tectonic line, 190
Kurokawa Formation, 147
Kurosegawa area, 167
tectonic zone, 73, 189
Kusune facies, 162
Formation, 111, 135
Group, 162
Kuzuryu area, 124, 148
Kwanto massif, 52, 65, 75, 81, 89, 119, 143, 175
Kyodoko Formation, 157, 187
Kyushu (Chichibu terrain), 61, 75, 79, 85, 113, 138, 168, 192

M

Maedani Formation, 185
Maiya area, 87, 116, 140, 173
flora, 117
Maizuru Group (zone), 154, 177
Makatoji Formation, 148
Maki Formation (in Kwanto massif), 144
Maki Formation (in Atetsu area), 154
Maki Formation (in Akiyoshi area), 132
Mamba area, 144
Formation, 66, 75
Group, 89
Manajo Formation, 103, 130
Mandokoro Formation, 95
Manganji limestone, 98
Matsuo Formation, 167
Matsuoyama Formation, 127
Meigetsutoge Formation, 130
Meiji zone (belt), 138, 168
Mihara area, 186
Miharaiyama area, 180
Miharano(ro) Formation, 105, 194
Mikagura Formation, 144
Mikata Formation, 180, 181
Mikazuki Formation, 71
Minamitani Group, 180
Mino Formation, 102
Mino-Kanoashi massif, 133, 157, 187
Misogawa Formation, 147
Mitsu area, 182
Mitsudo Group, 54
Miyahama Formation, 135
Miyakawa Formation, 129
Miyakoda Formation, 108, 148
Miyano Formation, 133, 188
Miyanokuchi Formation, 84
Miyauchi facies, 162
Mizukoshi Formation, 192
Mizuyagadani Formation, 92
Moribu Formation, 94
Motomura Formation, 118
Mugitani Formation, 187
Mujinazawa area, 81
Myojo limestone, 53
Nabeyama area, 91, 119, 143
limestone (Formation), 47, 119

N

Nagaiwa Formation, 51, 61
Nagaiwan Stage, 40
Nagoe Formation, 54
Nakahata Formation, 68, 77
Nakakubo Formation, 137
Nakamura limestone, 56, 63, 72, 105, 131, 155
Nakatsugawa area, 90
Nakawada Formation, 89
Nanaai Formation, 82
Nanjo Group, 70, 78, 83
Narai Formation, 147
Neogawa - Ibigawa area, 96, 124, 149
Nichihara Formation, 187
Nishikori Formation, 87
Nishinoiri conglomerate, 176
Nishitani area, 69
Nishi-uyama Group, 185
Nishiyama area, 102, 129, 152
Nishiyoshino Group, 134
Noharadani Formation, 151
Nohi Group, 69, 77
Nojiri conglomerate, 125
Group, 125
limestone, 147
Nomata Formation, 147
Nomisaka facies, 110
Nomura Group, 73, 137, 167
North Kyushu, 108
Nosé area, 102, 130
Notabiyama Formation, 185
Notsu Formation, 84
Nukada Formation, 179
Nyukawa area, 67, 77, 93, 146
Group, 93, 146

O

Oashi Formation, 142
Oboradani Formation, 95
Oda [=Ota] Group, 60
Oga plateau, 56, 63, 71, 105, 131, 155, 184
Ogamata Formation, 175
Ogawago facies, 78, 109
Ohkuboan Stage, 39, 55
Oi Formation, 148
Oishi Formation, 98
Okuchichibu area, 81, 175
Okumyogata Formation, 94

Okuzumi Formation, 123, 147
Omatsu – Dosen area, 117
Omi limestone (plateau), 52, 62, 67, 82, 91, 121, 145
Omodani Formation, 112
Omoriyama Formation, 115
Omura isle, 159
Onimaru Formation, 51
Onimaruan Stage, 39
Onji Group, 73
Onogahara area, 137
Formation, 112
Onogi Formation, 127
Oppara Formation, 69, 82
Osakatoge Formation, 102
Osobudani conglomerate, 122
Osugi area, 189
Otagawa area, 106
Otaki Formation, 70, 77, 83
Otani conglomerate, 95
Formation, 125
Otaniyama Formation, 126
Otaru – Suita tectonic line, 73, 190
Otochi area, 168
Ottate Formation, 111, 135
Oura Formation, 148
Outer zone of Southwest Japan, 61, 73, 78, 84, 108, 133, 159, 188
Oya Formation (in Tamba zone), 124
Oya Formation (in Maizuru zone), 153
Ozodani Formation, 191

P

Pre-Maki unconformity, 155

R

Raidenyama zone, 144
Rodai Formation, 87, 116
Rokucho Formation, 165
Rokusuke Subformation, 90
Ryokami Group, 90
Ryozen Formation, 101, 128
Ryozensan limestone, 101
Ryugenji Formation, 132
Ryuhozan Group, 170

S

Sabushi Group, 103, 131, 154
Sakamotozawa Formation, 45, 85
Sakamotozawan Stage, 44, 45, 85
Sakashu area, 135
thrust zone, 189
Sakauchi Formation, 124, 149
Sakawa area, 137, 166
Sakuradani conglomerate, 74, 79
Sambosan Group (zone), 73, 187
Samegai Formation, 99
Samondake Formation, 96
Sanbonmatsu Formation, 187
Sano Group, 91
Sasamata Formation, 151
Sasayama area, 103
Sawadani Formation, 161
Group, 164
Sawando conglomerate, 122
Serita Formation, 157
Setamai area, 115
Shiba Formation, 52
Shidaka area, 179
Shikoku (Chichibu terrain), 73, 78, 84, 111, 134, 161, 189
Shima area, 109, 159
Shimadani Formation, 147
Shimajima Formation, 121
Shimokuzu Stage, 120
Shimomitani Formation, 149
Shimoyakawa Formation, 112, 165
Shimoyama limestone, 191
Shimozaisho alternation, 76
Shingai Formation, 136
Shinmito Formation, 130
Shin'yu area, 143
Shioya Formation, 146
Shirakidani area, 136
Group, 112
Shiraiwa Formation, 187
Shirasaki limestone, 161
Shiroi bank (in Hida massif), 93
limestone (in Kwanto massif), 52
Shiromaru Paleozoic zone, 75
Shiroyadake Formation, 160
Shizo Formation, 139
Shogase Formation, 78, 84
Shomarutoge area, 90, 120
Shoyama Formation, 131
Sonobe Formation, 103, 130
Sorayama Group, 53, 122

Sote Formation, 94
Sea, 94
Surugamine Formation, 153
Suzuka massif, 101, 128
Suzumiyama Formation, 133, 188

T

Taishaku Formation, 57
Taishaku mountain range, 119, 143
Taishaku plateau, 56, 63, 72, 105, 132, 155, 185
Taishakugawa Group, 56, 57, 64, 72
Takagami conglomerate, 174
Takagawa Formation, 168
Takahara – Nakaoku belt, 189
Takakurayama Group, 118
Takaoka Formation, 166
Takarao Formation, 178
Takatsuki Formation, 152
Takauchi faunule, 178
Takayama Formation, 98, 128
Takezawa Formation, 52
Taki Group, 103
Takura Formation, 83
Group, 97, 147
Tamanouchi conglomerate, 176
Tamba Group, 102
zone, 97, 102, 126, 150
Tameshige Formation, 57
Taniai Formation, 95
Tano Formation, 102, 129, 152
Tateishi Formation, 52
Tawarazu Formation, 113
Tenguyama Formation, 124
Tenjinnoki Formation, 140
Terauchi Formation, 183, 184
Tobiishi Group, 114
Tochu Formation, 86
Tokiyama Formation, 129, 152
Tokugotoge Formation, 121
Tokuyama Formation, 70, 96
Tokuyama – Sakauchi area, 70, 96, 149
Tomedoro Formation, 125
Tominoho Group, 123, 147
Toriashi Group, 65, 82
Tosayama Formation, 137, 165
Toyoma Subsystem (Group), 171, 172
Toyomane Formation, 118
Toyomane – Hanawa area, 118, 142
Toyonaga Formation, 71
limestone, 103
Tsubonata Formation, 84
Tsuchikura Formation (in Kitakami massif), 88
Tsuchikura Formation (in Tamba zone), 126, 151
Tsukumi zone (limestone), 113, 138, 168
Tsunemori Formation, 157
Tsutsumi Formation, 187
Tsuzumigatake Formation, 60

U

Uji Formation, 184
Ukiishi Formation, 189
Umetani Formation, 126
Unada Formation, 105
Uoganeyama Formation, 96, 124
Usuginu conglomerate, 172
Usuki area, 113, 138, 168
Utoyama limestone, 147
Uwanaro Formation, 191
Uwano Formation, 89
Uyamano Group, 132

W

Wakasa area, 97, 129, 148, 178
Wakasugi Group, 163, 165

Y

Yabuhara Formation, 147
Yaegahara Formation, 107, 157, 186
Yakuki Series, 118
Yakuno area, 179
Yamaguchi area, 133, 158, 188
Yamamba limestone, 137, 191
Yamasuge limestone Member, 47, 119, 143
Yamazaki conglomerate Formation, 173
Yanahara Group, 181
Yasuba conglomerate, 190
Formation, 64
Yasumoto Formation, 185, 186, 193
Yatsumori area, 142

Yayamadake limestone, 79, 85, 114
Yokokawa Formation, 147
Yokokurayama area, 166
Yokoyama Formation (in Hida massif), 124
Yokoyama Formation (in Maizuru zone), 180, 181
Yokozeki, 154
Yonagu Formation, 170
Yonezato area, 115
Yoro Group (massif), 99, 151
Yoshii Group, 156, 186
Yoshio Formation, 170
Yuasa area, 110, 134, 160, 189
Yukawa Group, 104, 154
Yukisawa Subsystem, 171
Yunoo Formation, 70
Yurugidake Formation, 113, 138, 169
Yuzuruha Formation, 61

Z

Zengosasu conglomerate, 66
Zensakusawa area, 174
Zomeki limestone, 133, 157

Index to the fossil zones and subzones

B

Beedeina higoensis – Wedekindellina prolifica subzone, 42

C

Cancellina nipponica zone, 126
Clisiophyllum awa zone, 65

D

"Dibunophylloides" ofukuense zone, 65

E

Endostaffella delicata zone, 39, 55, 57, 59
Eostaffella kanmerai subzone, 38, 53
Eostaffella sp. A – *Millerella* sp. A zone, 39

F

Fusulina (Fusulina) fujimotoi subzone, 76
Fusulina (Beedeina) higoensis subzone, 79
Fusulina (Beedeina) higoensis – Wedekindellina prolifica subzone, 77
Fusulina (Beedeina) lanceolata – F. (B.) ichinotaniensis subzone, 76
Fusulina ohtanii subzone, 79
Fusulina ohtanii – Fusulinella gracilis subzone, 42
Fusulinella asiatica subzone, 67
Fusulinella biconica zone, 57, 65, 72
Fusulinella bocki zone, 66
Fusulinella bocki – F. prolifica subzone, 74
Fusulinella eopulchra zonule, 72
Fusulinella hirokoae subzone, 74
Fusulinella imamurai zone, 55, 71
Fusulinella kamitakarensis subzone, 67

G

Gigantoproductus zone, 52

L

Lepidolina imamurai zone, 184
Lepidolina toriyamai zone, 49, 50, 178, 179, 181, 182, 183
Lyttonia fauna, 48, 183

M

Mediocris mediocris zone, 39, 55, 57, 59
Millerella bigemmicula – Eostaffella kanmerai zone, 55
Millerella bigemmicula – Pseudostaffella kanumai subzone, 54
Misellina claudiae zone, 47, 114, 139
Misellina ibukiensis zone, 47
Monodiexodina langsonensis zone, 45

N

Nagatophyllum satoi subzone, 58
Neokoninckophyllum nipponense zone, 38, 54
Neoschwagerina craticulifera zone, 48, 144, 152, 156
Neoschwagerina douvillei zone, 156
Neoschwagerina douvillei – N. margaritae subzone, 155

Neoschwagerina margaritae zone, 49, 144, 156
Neoschwagerina megaspherica zonule, 158
Neoschwagerina simplex zone, 48, 125, 139

P

Paleofusulina – Reichelina faunule, 178
Parafusulina hirayuensis subzone, 123
Parafusulina iisakai subzone, 123
Parafusulina kaerimizensis zone, 47, 131, 132
Profusulinella beppensis zone, 64, 65
Profusulinella beppensis – P. toriyamai zone, 41
Profusulinella fukujiensis zone, 62
Profusulinella toriyamai zone, 55
Pseudofusulina ambigua zone (subzone), 45, 46, 132, 144
Pseudofusulina fusiformis zone, 45
Pseudofusulina hexagonaria – Acervoschwagerina endoi zone, 94
Pseudofusulina japonica zone (subzone), 123, 155
Pseudofusulina kraffti zone, 126
Pseudofusulina kraffti magma subzone, 131
Pseudofusulina vulgaris zone (subzone), 45, 46, 89, 93, 102, 104, 107, 131
Pseudoschwagerina kanmerai subzone, 104
Pseudoschwagerina cfr. *muongthensis* zone, 90
Pseudoschwagerina morikawai zone, 46, 92
Pseudoschwagerina subsphaerica – Quasifusulina longissima ultima zone, 104
Pseudoschwagerina wongenhaoi zone, 90
Pseudostaffella antiqua zone, 39, 57, 59

R

Rugosofusulina arctica subzone, 104

S

Schwagerina yabei zone, 123
Siphonodendron hidense subzone, 38, 54
Staffella pseudosphaeroidea subzone, 79
Staffella pseudosphaeroidea – Fusulinella sp. subzone, 42
Sumatrina annae zonule, 158

T

Triticites exsculptus – T. hidensis zone, 83
Triticites kawanoboriensis kaishodaniensis subzone, 93
Triticites montiparus subzone, 102
Triticites matsumotoi subzone, 43, 85
Triticites opparensis subzone, 83
Triticites ozawai zonule, 107
Triticites yayamadakensis subzone, 43

V

Verbeekina verbeeki zone, 156

Y

Yabeina aff. *cascadensis* subzone, 185, 186
Yabeina globosa zone, 50, 154, 175
Yabeina hayasakai zone, 172
Yabeina shiraiwensis zone, 50, 154, 184, 185, 186
Yabeina shiraiwensis – Y. sp. A zone, 184

Z

Zellia nunosei zone, 45