BIOSTRATIGRAPHY AND CORRELATION OF THE PERMIAN OF JAPAN

by

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(with 2 text-figures and 3 tables)

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Abstract

Permian biostratigraphy is described for seven selected districts in Japan. A new biostratigraphic scheme is presented for the Permian in the Kitakami mountains, based on a number of assemblage zones. New names, Maehama and Nabekoshi Stages are proposed in the Toyoma Series of the Kitakami mountains. An attempt is made to correlate the Japanese Permian in the studied districts.

Introduction

International Subcommission on Permian Stratigraphy (President- Prof. D.L. Stepanov) of the IUGS is planning to correlate eventually the World Permian. Dr. E.Ya. Leven of the USSR and Minato have been asked to prepare a correlation table of the Permian in the Tethys province. At the request of Dr. Leven Minato in cooperation with Kato made a draft of correlation chart of the Permian of Japan, and sent it to Dr. Leven sometime ago. Then the present authors jointly prepared the second, modified version of the first draft, with explanatory text. We sent this manuscript also to Dr. Leven in 1976.

In 1977 Dr. Leven circulated his view on a kind of Permian standard in the Tethyan realm, based mainly on his data from Central Asia, but combined with data from the other regions. He asked research workers on Permian for comments on his scheme to be sent to Drs. Leven, Minato and S.V. Meyen (Secretary of the Commission). Thus Minato received several letters from some research workers somehow criticizing Leven’s scheme.

However, we feel that the first step we should take is to accumulate as many data as possible in connection with local biostratigraphy in many regions,
before we come to any concrete idea of correlation. We also feel it useful and
advisable to publish, if possible, such data as available sources of information
on the concerned problem.

It is the aim of the present paper to fulfil such a need. However we are fully
aware of that the paper is inevitably a sketch or an outline of the Japanese
Permian, since Minato, to his regret, has not been able to really organize a
working group for such a task in correlating the Permian deposits of entire
Japan.

Marine Permian deposits are widely distributed throughout Japan. They are
known in Hokkaido, Honshu, Shikoku, Kyushu and Okinawa.

Fig. 1 Surface distribution of Palaeozoic sediments and their metamorphosed counterparts
in Japan, indicating the locations of important districts for Permian deposits.
For biostratigraphy and correlation, however, seven districts are here purposefully chosen for consideration; namely the Kitakami mountains in N.E. Japan, and the Omi, Akasaka, Atetsu, Akiyoshi, Oita and Kuma mountain districts in S.W. Japan (Fig. 1).

In Japan, the southern Kitakami mountains represent one of the best geologically investigated districts where Palaeozoic deposits are most typically distributed. And the Permian deposits are characterized by detrital as well as carbonate facies. Geology of this district is, however, much complicated owing to the repeated crustal movements. Therefore stratigraphic succession is very difficult to establish there. Also fossils are more or less deformed and often obliterated though they are locally abundant.

Minato presents here a new scheme of biostratigraphy for the Permian of the Kitakami mountains (Fig. 2).

In the other districts, the Permian is represented mostly by carbonate facies except for the Kuma mountain district where detrital facies is more predominant. Fossils are better preserved in these districts than those from the Kitakami mountains. But stratigraphic succession in these districts is by no means complete for the entire Permian, and only fusulinid foraminifers have been extensively searched for. Brief description is made on the Permian of each district.

Apart from the above mentioned two types of sedimentary environments, namely the carbonate facies and the mixed facies of carbonate and detritus, another type of deposits is actually distributed in central and the outer zone of Southwest Japan. They are dominantly volcanic in lithologic character at least with regard to the Lower to Middle Permian.

Thus three different types are recognizable amongst Permian deposits of Japan (Minato & Kato, in Minato, Gorai & Hunahashi (eds.), 1965). But as to the last mentioned type, biostratigraphy is by no means thoroughly investigated as yet, and it is not described here.

Detailed and thorough consideration and comprehension of the Japanese Permian are to be presented in the other occasion when we organize a working group on the problems of Permian correlation in Japan in near future.

As a matter of fact Minato has long studied the Palaeozoic deposits distributed in a rather narrow strip called the Setamai-Sakari district in the southern Kitakami mountains in cooperation with a number of his students. Without their effort of detailed mapping, we could hardly establish the lithologic sequence and many bio- and assemblage zones of Palaeozoic there.

The Permian deposits are especially well developed in the Setamai-Sakari district. Accordingly description will be based mainly on the data from this district concerning to the Kitakami mountains. Various information sources
may be found from the accompanied list of references.

Although not mentioned in the text, Dr. Y. Fujiwara made a palaeomagnetic study on the Lower Permian sediments, and Dr. N. Minoura has been studying the sedimentary rocks including limestones in the Kitakami mountains. Prof. M. Hunahashi kindly taught us on the lithologic nature of the volcanic rocks and feldspathic sandstones intercalated in the Permian. These studies are actually of great help to establish a sequence of the Permian

Fig. 2 Correlation chart of the Permian of Japan.
A – slate; B – sandstone; C – limestone; D – conglomerate; E – alternation; G – unconformity; H – fault relation.
formations of the Kitakami mountains.

Then the Permian developed in Southwest Japan will be stated briefly, based on the researches hitherto carried out by a number of workers including ourselves.

We acknowledge Prof. F. Kahler of Klagenfurt, Austria, Dr. H. Kozur of German Democratic Republic, Dr. H. Taraz of Iranian Geological Survey, Prof. J.B. Waterhouse of the University of Queensland, Australia, for their kind comments on the major divisions on Permian, communicated to Minato.

Before stepping into description we would also like to acknowledge with many thanks Mr. S. Kumano for drawing figures, and Miss E. Mima for typing the present manuscript.
Kitakami Mountains

A. The boundary between the Carboniferous and Permian formations

The Permian deposits unconformably lie on the Carboniferous formations with the basal conglomerate of the Sakamotozawa Series (Minato, 1942; Nagao and Minato, 1943; Yamada, 1959; Kanmera and Mikami, 1965; Saito, 1966, 1968). The basal conglomerate rests directly on the limestone formation (Nagaiwa formation) with Profusulinella fauna, entirely lacking in the formations represented by Fusulinella—Fusulina—, and Triticites fauna. In many places, the basal conglomerate is also observed directly resting on the formations correlatable with the lower Tournaisian.

B. The Sakamotozawa Series

The Permian system in the Kitakami mountains is divisible into three series: the Sakamotozawa, the Kanokura and the Toyoma Series in ascending order. Of them the Sakamotozawa Series is lithologically and palaeontologically divided into two units: Kawaguchi Stage and Kabayama Stage.

1. The Kawaguchi Stage

a. Lophocarinophyllum suetomii Zone, Pla

The lower half of the stage is composed of conglomerate at its base. Sandstone and slate are predominant upwards. At the type area it is less than 50 m in thickness, but is locally very thick, reaching almost 300 m in thickness. It is lithologically composed of thick feldspathic sandstone, acidic and basic tuffs, coaly slate, etc. besides thick slate and calcareous slate in alternation. Marine fossils are not rare in the last mentioned part of the stage but have not been studied in detail.

The lower half of the Kawaguchi stage may be designated as Lophocarinophyllum suetomii Zone, Pla, since this solitary coral has been found rather widely from the calcareous slate, at the middle and lower part of this formation. Fragmental plant remains are also found in the lower part.

Fossils described from this zone may be listed below. All of them indicate the Permian.

Cordaites principalis (Germer), Wentzelella (Wentzelella) sp. (Minato and Kato, 1965a), Lophocarinophyllum suetomii (Minato), Waagenoconcha asiatica Zavodowsky, Derbyia sp. (Nakamura, 1972), cfr. Orthotetes callytharrensis (Thomas), Magniderbyia sp. (Nakamura, 1972), Streptorhynchus sp. (Nakam
mura, 1972), and small sized spiriferid resembling *Munella* (Minato MS).

b. *Zellia nunosei-Ferganites langsonensis* Zone, PIb

The upper half of the Kawaguchi stage is mainly composed of limestone, about 120 to 400 m in thickness. This is named as *Zellia nunosei-Ferganites langsonensis* Zone, PIb. This zone is also an assemblage zone; described fossils from this zone will be listed below.

**Fusulinids:**


**Corals:**


**Calcereous Algae:**

Ostracods:

Gastropod:
*Phymatifer pugiloides* Hayasaka

Amongst fossils above listed, *Pseudoschwagerina schellwieni* Hanzawa appears slightly earlier than the rest of fossils, *Chalaroschwagerina vulgaris* for instance.

*Durhamina kitakamiensis* Minato et Kato also is found from the relatively lower part of this zone. *Kindlella kitakamiensis* Ishizaki is said to be very resembled *Ulrichia minuta* described by Harris and Lalicker (1932) from the Wolfcampian, Kansas (Ishizaki, 1967). All the ostracods listed above are actually described by Ishizaki (1967) not from the Setamai-Sakari district but from the northern area, the Tassobe, as *Wentzelella* sp. listed from Pla in the foregoing paragraph.

2. The Kabayama Stage

The Kabayama stage is lithologically divided into two units: the lower half is chiefly composed of limestone, while the upper half is mainly consisting in slate and sandstone in alternation; although the upper half may be locally replaced by carbonate rocks.

The base of the Kabayama stage may be defined as the thin layer of conglomerate in the limestones as diagramatically shown in the correlation chart (Fig. 2). At the type area of the Sakamotozawa series, presence of unconformity is proved below the limestone conglomerate (Mikami, 1965) although in other areas, stratigraphically equivalent conglomerate is observed to be intraformational.

The limestone beds of the Kabayama stage may be divided into two assemblage zones (Plc and PId), and the uppermost part of this stage may be distinguished from both as Plc.
a. *Schwagerina* cf. *compact* Zone, Plc

**Fusulinids:**
*Pseudofusulina* aff. *pseudosimplex* (Chen), *Schwagerina* cf. *compacta* (White),
*Rugosofusulina* aff. *serrate* Rauser-Chernousova, *Schubertella* sp. (Choi, 1973),
*Toriyamaia laxisepata* Kanmera, *Nankinella* sp. (Choi, 1973), *Staffella* sp. (Choi, 1973),
*Nagatoella minatoi* Kanmera et Mikami, *Paraschwagerina* (Acervoschwagerina) sp. (Choi, 1973),
*Chalaroschwagerina vulgaris* (Schellwien et Dyhrenfurth), *Pseudofusulina krafft* (Schellwien et Dyhrenfurth),
*Para­fusulina aff. japonica* (Gümbel), *Parafusulina motoyoshiensis* (Morikawa),
*Misellina claudiae* (Deprat).

**Corals:**
*Waagenophyllum* (*Waagenophyllum*) polyseptata Minato, *Yatsengia kabayamensis* Minato, *Michelinia* (*Protomicelinia*) multitalbata (Yabe et Hayasaka),

**Calcereous Algae:**
*Macroporella* sp. (Endo, 1951), *Gyroporella longipora* Endo, *Anthracoporella magnipora* Endo,

**Gastropod:**
*Phymatifer* aff. *nodocarinatus* (Wanner)

In the southwestern part of the Kitakami mountains (Maiya area), there is a plant bearing formation, composed of slate with carbonaceous matter, which has been called the Rodai Formation (Mabuti, 1932; Onuki et al, 1960; Ueda, 1963). This formation rests on the limestones with *Pseudoschwagerina schellwieni*, *Zellia nunosei* and *Triticites* cf. *simplex*. Hence, the stratigraphical level of the plant bearing formation may be correlatable with Plc.

The following species is recorded from the Rodai formation (Asama, 1956):
Presence of *Gigantopteris Whitei* is especially worthy of note, since this species is one of characteristic elements of the Shansi formation of Taiyuan, Shansi province, North China (Halle, 1927).

The Rodai formation is overlain by the formation characterized by frequent occurrence of *Monodiexodina matsubaishi* (Fujimoto) probably correspondent to the Lower part of the Kanokura series to be later on described.

b. *Pseudofusulina fusiformis-Pseudofusulina ambiguа* Zone, PlId

Although the lithological boundary between the preceding assemblage zone and the present zone (PlId) is hardly discernible in the field, certain types of fusulinids such as *Pseudofusulina fusiformis*, *Pseudofusulina ambiguа*, *Parafusulina* aff. *gigantea*, etc. newly appear in this zone. Especially *Pseudofusulina ambiguа* occupies the highest level of this zone.

It may be also noted that *Pseudoschwagerina schellwieni* and *Chalaroschwagerina vulgaris* are still found in the lower part of this zone.

Fusulinids:

Corals:

Calcareaeous Algae:
c. *Mesolobus mesolobus* Zone, Plc

The overlying formation on the limestones represented by *Pseudofusulina fusiformis-ambigua* zone is chiefly composed of slate, and alternation of sandstone and slate, 200 m in total thickness. It is locally intercalated by seams of magnetite sandstone especially in the eastern part of the Setamai-Sakari district. Fossils are rare. The described species from this formation are as follows:


C. The Kanokura Series

The Kanokura Series rests on the Sakamotozawa Series with basal conglomerate. The conglomerate seems to directly cover the limestones of either Plc or Pld and sandstones characterized by *Mesolobus* fauna. Presence of unconformity between the Sakamotozawa and the Kanokura Series is almost doubtless, although the unconformity has not been evidently proved yet in the field.

The lower half of the Kanokura Series has been distinguished as the Kattisawa Stage from the upper half, the Iwaizaki Stage. It may be worth while mentioned that a few fusulinid species show a long geological range extending from the Kabayama Stage until the Kattisawa Stage: e.g. *Parafusulina motoyoshiensis*, *Chusenella pseudocrasssa* and *Monodiexodina matsubaishi*.

1. The Kattisawa Stage

The stage is mainly composed of sandstone and alternation of sandstone and slate, besides conglomerate at its basal part. There are at least two thin layers of limestone in both upper and lower part of this formation. Fusulinids found from the upper limestone are mostly ranging upwards until the lower
part of the Iwaizaki Stage, while the fusulinids of the lower limestone seem to show somewhat older aspect.

Thus the Kattisawa Stage may be divisible into two assemblage zones.

a. *Monodiexodina kofuganensis* Zone, PIIa


b. *Leptodus nobilis* Zone, PIIb

From the carbonate rocks stratigraphically positioned in the higher level, the following fusulinids, corals, calcareous algae and bryozoa have been described.


Calcareous Algae: *Mizzia velebitana* Schubert.

Brachiopods, bryozoa and pelecypods are not seldom found from the lower part of the Kattisawa Stage, but they are more predominant in the upper part. Fossils mainly described from the upper part may be listed below.


From Iwaizaki, south of Kesennuma City, Sakagami (1961) recorded the following bryozoans.

Brachiopoda:

Pelecyphoda:

Cephalopoda:

Conulariida:
Neocomunaria rectangularis (Hayasaka), Neoconularia sp. (Hayasaka, 1963), Calloconularia ? kitakamiensis Murata.
Trilobita:  
*Pseudophillipsia obtusicauda* (Kayser).

*Monodiexodina matsubaishi* is especially dominant throughout the Kattisawa Stage; *Rauserella alveolaris* also ranges from the lower to the upper division of the stage. Presence of *Cancellina* in the *Monodiexodina kofuganensis* zone is remarkable. While, *Colania kozuboensis* Choi found from the upper part of the Kattisawa Stage very resembles "Neoschwagerina" *douvillei* Ozawa, although *Colania kozuboensis* shows to range further upwards until the lower horizon of the Iwaizaki Stage.

2. The Iwaizaki Stage

The lower part of the Iwaizaki Stage is lithologically changeable from place to place; usually limestone or limestone and slate in alternation. But it is also represented by thick conglomerate with limestone lenses. Therefore, the lowest level of the Iwaizaki Stage has been defined at the first appearance of the *Lepidolina* fauna.

*Lepidolina multiseptata*-L. *minatoi* Zone, PIIC

Described fossils from this zone may be listed below:

Fusulinids:  

Brachiopoda:  

Ammonoids:
Propinacoceras aff. galilaei Gemmellaro, Tainoceras abukumaensis Hayasaka, Foordiceras akiyamai Hayasaka.

Corals:
Waagenophyllum (Waagenophyllum) indicum (Waagen et Wentzel), Wenzelloides maiyaensis Yabe et Minato, Parawentzelella (Parawentzelella) canali­fera sisophonensis Fontaine, Wentzelella (Szechuanophyllum) kitakamiensis Yabe et Minato, Yatsensia kiansuensis var. mabutii Minato.

Calcareous Algae:
Mizzia velebitana Schubert

Ostracods:

Bryozoa:

Many fusulinid species characterizing the Leptodus nobilis Zone disappear in the earlier half of the present zone. Rugose corals belonging to Waagenophyllidae seem to have been almost extinct in this zone.
Lepidolina minatoi appears to be more dominant in the upper part. Schwagerina acris occurs at the highest level with Lepidolina multiseptata and Condonofusiella explicata.

D. The Toyoma Series

The thick Toyoma Series is lithologically divisible into two major units: the Maehama Stage and Nabekoshi Stage in ascending order. The former of them is mainly composed of slate, with conglomerate at its base, while the latter is chiefly composed of sandstone with intercalations of thin limestone and conglomerate lense.

Characteristic and described fossils from this series may be listed below.

1. The Maehama Stage

Araxoceras cf. kiangsiense Zone, PIIa

Astartella toyomensis Nakazawa et Newell, Palaeoneilo ogachiensis Hayasaka, Bellerophon (Bellerophon) yabei Murata, Euphemitopsis kitakamiensis Murata, Paraconularia siitai (Sugiyama), Araxoceras cf. kiangsiense Chao, Protocycloceras cfr. cyclophorum (Waagen), Stacheoceras cf. trimuvi Diener, Eumedlicottia sp. (Bando, 1975), Artinskia sp. (Bando, 1975).

Among them, Araxoceras cf. kiangsiense occupies rather higher level than the other species.

2. The Nabekoshi Stage

Colaniella parva Zone, PIIIB

Colaniella parva (Colani), Paracolaniella leei Wang, Lantschichites sp. (Tazawa, 1975), Orthothrix cf. excavata (Geinitz), Tschernyschewia typica Stoyanow, Megousia nakamurai Tazawa, Megousia auriculata Muir-Wood et Cooper, Paramarginifera japonica Tazawa, Eolyttonia cf. nakazawai Shimizu, Palaeofusulina sp.

From the Toyoma Series the following land plants were recorded by Endo (1950) and Konno (1973):

Neocalamites superpermicus Konno, Paracalamites iwatensis Konno, P. takahashii (Endo).

Exact horizon for them is, however, difficult to mention at present.
Kuma Mountain District

The Kuma mountain district in central Kyushu is a terrain where Permian clastic sediments are predominantly developed, which is intercalated by large and small limestone lenses at various horizons. Biostratigraphy in the Kuma mountain region was worked out in detail by Kanmera 1954, 1958, 1963. But Permian sediments are so much folded and faulted that a continuous stratigraphic succession is difficult to establish there.

The Yayamadake limestone furnishes a good section for *Pseudoschwagerina* limestone, which is said to unconformably cover the *Triticites* limestone (Kanmera, 1952).

According to Kanmera (1958) the upper part of the Yayamadake limestone is defined as *Pseudoschwagerina* Zone which is further divisible into two fossil Zones.


The upper part of the Yayamadake limestone is superceded by pyroclastic deposits which produce no fossils.

To the south to the area of the Yayamadake limestone there develops the Kozaki formation consisting of slate and conglomerate in alternation with some limestone lenses which yield fossils. The formation is bounded by faults and is lithologically divided into the lower and upper subformations. The lower part is further faunistically contains two fossil horizons (Kanmera, 1961, 1963).

et Horiguchi, Monodiexodina kumensis Kanmera.

From the upper part of the lower subformation the following fusulinids were described:


Also from the topmost part of the Kozaki formation Kanmera (1963) recorded *Yabeina globosa* (Yabe), *Neoschwagerina minoensis* Deprat, *N. margaritae* Deprat, *Schwagerina* sp.

In between the area of the Yayamadake limestone and the area of the Kozaki formation there is distributed the Upper Permian Kuma formation, which is composed of sandstone, slate and conglomerate in alternation with several small lenses of limestone. This formation is again in fault contact with the other formations of different ages.

Fossils occur at three different horizons (Kanmera, 1954; Kanmera & Nakazawa, 1973).

From the lowest horizon *Lepidolina multiseptata shiraiwensis* (Ozawa), *Codonofusiella cuniculata* Kanmera and *Schwagerina* aff. *acris* Thompson et Wheeler were obtained.


Here it became clear that *Lepidolina kumaensis* occurs later than *Lepidolina multiseptata*, and that it is followed in turn by the uppermost horizon with *Codonofusiella* fauna.

**Oita Prefecture**

Quite recently the presence of *Codonofusiella – Palaeofusulina* fauna was ascertained by Kanmera both in the Oita and Miyazaki Prefectures (Kanmera &

Uppermost part of the Tsukumi limestone formation in the Oita Prefecture is largely dolomitized in lithologic character. The thickness is about 60 m and the limestone is faunistically divisible into two zones.

*Staffella* sp., *Nankinella* sp., *Danbarula* ? sp., and *Codonofusiella* sp. occur in the upper, while *Staffella* sp., *Nankinella* sp., *Reichelina changhsingensis* Sheng et Chang, *Palaeofusulina* sp., *Codonofusiella kueichowensis* Sheng occur in the lower.

The mentioned part of limestone of the Tsukumi formation is in fault contact with *Yabeina — Neoschwagerina* limestone and is considered to represent the uppermost Permian there.

A very similar faunal sequence is also known in the Mitai formation in the Miyazaki Prefecture, where *Palaeofusulina* cf. *simplicata* Scheng was obtained.

**Akiyoshi Limestone Plateau**

In the Akiyoshi limestone plateau Permian limestone is widely developed. Permian there is supposed to be unconformably overlying the Carboniferous limestone. Also an unconformity is suspected between *Parafusulina* limestone and *Pseudofusulina* limestone. Development of carbonate facies is however terminated by the top of *Yabeina shiraiwensis* limestone which is laterally changed into slate facies. Fossils denoting the uppermost Permian has not been recorded from Akiyoshi.

Since Ozawa (1925) there are a number of important stratigraphical as well as palaeontological contributions on the Permian of Akiyoshi (e.g. Toriyama (1954–1958); Hasegawa (1958, 1963); Ota et al. (1973)).

According to Hasegawa (1963) Permian fossils from the Akiyoshi limestone are as listed below in descending order:

**Limestone of Yabeina-Lepidolina zone** ................................ about 20 m


**Limestone of the Neoschwagerina-Verbeekina zone;**

*Gifuella douvillei* subzone ........................................................ 25 m

Fossils: *Gifuella douvillei* (Ozawa), *Neoschwagerina* sp. and “*Lonsdaleia-straea*” *ozawai* Minato
Verbeekina verbeeki subzone .................................. 35 m
Fossils: Verbeekina verbeeki (Geinitz) and Schwagerina spp.

Neoschwagerina haydeni subzone ................................ 7 m
Fossils: Neoschwagerina haydeni Dutkevich et Khabakov, N. craticulifera (Schwag.), N. cf. colaniae Ozawa, N. sp., Gifuella gigiensis Honjo, G. sp., Pseudodolololina pseudolepida (Deprat), P. ozawai Yabe et Hanzawa, P. sp. A. and Pseudofusulina gigantea (Deprat)

Verbeekina heimi subzone ....................................... 18 m
Fossils: Verbeekina heimi Thompson, V. verbeeki (Geinitz), Pseudofusulina edoensis (Ozawa), P. gigantea (Deprat), Afghanella schencki Thompson, A. ozawai Hanzawa, Pseudodolololina cf. pseudolepida (Deprat) and P. ozawai Yabe et Hanzawa

Neoschwagerina craticulifera subzone ...................... 20 m
Fossils: Neoschwagerina craticulifera (Schwager), N. irregularis Honjo, N. simplex Ozawa, N. sp., Parafusulina kaerimizensis Ozawa, Yatsengia sp. and Waagenophyllum sp.

Limestone of the Parafusulina zone ........................... 40 m
Fossils: Parafusulina kaerimizensis Ozawa, P. lutugini (Schellwien), P. sp., Pseudofusulina sp., Afghanella schencki Thompson, A. ozawai Hanzawa and Ipciphyllum subtimoricum (Huang)

Limestone of the Pseudofusulina zone:

Pseudofusulina kraffti magna subzone ............................. 110 m
Fossils: Pseudofusulina kraffti magna Toriyama, P. yobarensis (Ozawa), P. lepida (Deprat), P. cf. edoensis (Ozawa), P. cf. vulgaris globosa (Schellwien), Schwagerina krotowi (Schellwien), S. cf. regularis (Schellwien), S. cf. kueichihensis (Chen), S. sp. A., Misellina claudiae (Deprat), Nagatoella kobayashii Thompson, Schubertella kingi Dunbar et Skinner, Staffella yobarensis Ozawa, S. sp., Akagophyllum yabei Minato et Kato, A. akagoense (Ozawa) and Yokoyamaella yokoyamai (Ozawa)

Pseudofusulina vulgaris subzone ............................. 150 m
Fossils: Pseudofusulina vulgaris (Schellwien), P. vulgaris megasperherica Toriyama, P. globosa exilis Toriyama, P. watanabei (Ozawa), P. yobarensis (Ozawa), P. cf. ambigua (Deprat), Schwagerina satoi (Ozawa), S. etoi Toriyama, S. cf. krotowi (Schellwien), Dunbarinella cervicalis (Chen), D. cf. densa Toriyama, Triticites ellipsoidalis Toriyama, T. sp., Paraschwagerina akiyoshiensis Toriyama, P. sp., and Schubertella kingi (Dunbar et Skinner)

Limestone of the Pseudoschwagerina zone:

Pseudoschwagerina muongthensis subzone .......................... 100 m
Fossils: Pseudoschwagerina muongthensis (Deprat), P. sp. A, Tricitites simplex (Schellwien), T. ozawai Toriyama, T. montipara (Ehrenberg

*Triticites simplex* subzone .................................. 100 m


Apart from fusulinids and corals listed above some bryozoans and algae have been added to the faunal as well as floral contents of the Akiyoshi limestone. But other group of fossils, being scarce except for abundant crinoid stem joints, have been little investigated.

**Atetsu Limestone Plateau**

On the Permian part of the Atetsu limestone there are two major biostratigraphical contributions; namely by Nogami 1961a,b, 1962 and by Sada, 1965.

Here we follow Nogami for the division and faunal contents of the Permian of Atetsu.

Nogami’s scheme is tabulated in the accompanied chart, and his zones and subzones with fossil contents are listed below in ascending order.

**Pseudoschwagerina subsphaerica – Quasifusulina longissima ultima Zone**

**Quasifusulina longissima ultima – “Pseudoschwagerina” nakazawai subzone**

Oolitic limestone of about 50–70 m thick.


**Pseudoschwagerina subsphaerica subzone**

Muddy limestone of 40 m thick.

Fusulinids are *Pseudoschwagerina subsphaerica* Nogami, *Paraschwagerina kanmerai* Nogami, *Pseudofusulina atetsuensis* Nogami, *Schwagerina*
primigena" Nogami, Triticites obai Toriyama, T. pseudoarcticus Rauser-
Chernousova, T. sp., and "Schwagerina" aff. alpina (Schellwien).

Pseudofusulina vulgaris Zone
About 80 thick conglomeratic limestone.
Fossils are Pseudofusulina vulgaris (Schellwien), Psf. vulgaris globosa
(Schellwien), Psf. vulgaris exigua (Schellwien), Schwagerina spp., Psf.
krafftii magna Toriyama, Psf. krafftii form A, Psf. aff. fusiformis (Schell-
wien), Nagatoella kobayashii Thompson, and "Triticites" pseudosimplex
Chen.

Parafusulinula kaerimizensis – Pseudofusulina krafftii magna Zone
Pseudofusulina krafftii magna subzone
Massive limestone and conglomeratic limestone.
Thickness is about 40–60 m.
Fossils are Pseudofusulina krafftii magna Toriyama, Psf. krafftii form A, Psf.
globosa exilis Toriyama, Psf. aff. fusiformis (Schellwien), Nagatoella
kobayashii Thompson, Schwagerina sp., Psf. vulgaris (Schellwien), Psf.
vulgaris globosa (Schellwien), Psf. aff. edoensis (Ozawa), Schwagerina
semilucera Nogami, Sch. semilucera grande Nogami, Rauserella sp. and
Misellina sp.

Parafusulina kaerimizensis subzone
Massive limestone of about 10 m thick.
Fossils are Parafusulina kaerimizensis (Ozawa), Pseudodoliolina ozawai Yabe
et Hanzawa, and Pseudofusulina aff. edoensis (Ozawa).

Neoschwagerina douvillei – N. craticulifera Zone
Neoschwagerina craticulifera subzone
Conglomeratic limestone. Thickness unknown.
Fossils are Neoschwagerina craticulifera (Schwager), Afghanella sp., Pseudo-
doliolina ozawai Yabe et Hanzawa, Pseudofusulina aff. edoensis (Ozawa),
Psf. kusamensis Nogami, Parafusulina kaerimizensis (Ozawa), and
Raiserella sp.

Neoschwagerina douvillei – N. margaritae subzone
Mostly conglomeratic limestone of about 60 m thick.
Fusulinids are Neoschwagerina douvillei Ozawa, N. margaritae Deprat, N.
cheni Sheng, Sumatrina annae Volz, Pseudodoliolina pseudolepida
(Deprat), Pseudofusulina kusamensis Nogami, Verbeekina verbeeki
(Geinitz), Schwagerina globularis (Gubler), Neoschwagerina sp., Pseudo-
doliolina aff. lepida (Schwager), Raiserella sp., and Nankinella sp.

Yabeina shiraiwensis Zone
Yabeina shiraiwensis – Y. sp. A subzone
Lithology is conglomeratic limestone in the lower part and is slate with
limestone lenses in the upper part. Thickness is not described.


**Yabeina shiraiwensis** subzone

Mostly slate with a maximum thickness of about 100 m.

Fossils are *Yabeina shiraiwensis* Ozawa, *Neoschwagerina* sp. and *Sumatrina* sp.

**Akasaka Limestone**

The Akasaka limestone occupies a small hill, which is bounded to the west by a fault with non calcareous slate presumably of Permian in age. The limestone is covered by Quaternary sediments to the east. Therefore known succession represents “middle” part of Permian only, although fossils are abundant there.

Since the time of Gümbel (1878), Schwager (1883), Gottsche (1884) and Yabe (1902), Akasaka drew the attention of many palaeontologists.

Biostratigraphical studies are by Deprat (1914), Ozawa (1927), Akasaka Research Group (1956), Honjo (1959).

From the Akasaka limestone Honjo (1959) listed in descending order the following fossils:

**Yabeina Zone** ................................................. 100 m


**Neoschwagerina Zone**

*Gifuella douvillei* subzone .................................. 55 m

*Gifuella* cf. *douvillei* (Deprat)

*Yabeina ozawai* subzone .................................. 90 m


**Neoschwagerina craticulifera** subzone ......................... 62 m

*Neoschwagerina craticulifera* (Schwager), *N. irregularis* Honjo, *N. haydeni* (D. et K.)

*Pseudodoliolina ozawai* subzone .......................... 40 m
Pseudodoliolina ozawai Yabe et Hanzawa, Pseudofusulina spp., Verbeekina verbeeki (Geinitz), Verbeekina cf. heimi Thompson et Foster
Minoella nipponica subzone ........................................ 25 m
Neoschwagerina (Minoella) nipponica Ozawa, N. (M.) eonipponica Honjo, N. simplex Ozawa, N. sphaerica M. Maclay, Verbeekina minatoi Honjo (MS), Pseudofusulina spp., Pseudodoliolina ozawai Yabe et Hanzawa

Many fossils other than fusulinids have been described from the Akasaka limestone. They may be listed below.

Yabeina globosa Zone

Pelecypoda:
Etheripecten ? hayasakai (Murata) = Aviculopecten interstialis of Hayasaka, 1925, Hayasakapecten minoensis (Hayasaka), H. reticularis (Hayasaka), Waagenoperna hayamii Nakazawa et Newell, = Liebea sinensis of Hayasaka, 1925, Schizodus japonicus (Hayasaka), Solenomorpha elegantissima Hayasaka.

Scaphopoda:

Gastropoda:
Bellerophon jonesianus deKoninck, B. jonesianus hiulciformis Hayasaka, Pleurotomaria aff. multicarinata Mansuy, P. yokoyamai Hayasaka, Murchisonia yabei Hayasaka, Solenospira multicostata Hayasaka, Naticopsis wakimizui Hayasaka, N. minoensis Hayasaka, N. fasciata Hayasaka, N. cfr. praealta Wanner, Naticella japonica Hayasaka, T. magna Hayasaka, Spiromphalus yabei Hayasaka, Porcellia puzoides Hayasaka, Euconospira nipponica Hayasaka.

Cephalopods:
Koninckoceras sp. = Stearoceras sp., Coelogastrioceras giganteum Nakazawa, Stacheoceras sp.

Corals:
Trilobita:
*Pseudophillipsia obtusicauda* Kayser.

Calcareous Algae:
*Mizizia velebitana* Schubert, *M. yabei* Karpinsky, *Solenopora yabei* Endo, *Epimastopora kanumai* Endo, *Ortonella akasakaensis* Endo. (All these algal species are said to occur also from the *Neoschwagerina* limestone in Akasaka).

*Neoschwagerina* Zone

Hydrozoa ?:
*Stromatopora (Paralleropora) minoensis* Yabe et Sugiyama.

Corals:
*Praewentzelella honjoi* Minato et Kato.

Brachiopods:

Echinoid:
*Miocidaris spinulifera* Nishiyama.

Incertae sedis:
*Shikamaia akasakaensis* Ozaki.

Omi Limestone

Permian fusulinids at Omi were first described by Hayasaka (1924), which is followed by a number of biostratigraphical works (Kawada, 1954; Fujita, 1958; Hasegawa et al, 1969, etc.).

To date, however, a detailed description on its fauna is still not available, although overall faunal characteristics in the Omi limestone are quite like those of the Atetsu and the Akiyoshi.

Based on the work of Hasegawa et al (1969) the sequence of fusulinids in Omi may be tabulated in descending order as below:

*Yabeina-Lepidolina* Zone
“Yabeina” hayasakai Ozawa, Sumatrina annae Volz, Reichelina sp., Dunbarula sp., Kahlerina sp., Chusenella sp.

Neoschwagerina-“Gifuella” Zone
   Neoschwagerina craticulifera (Schwager), Gifuella sp., Gublerina sp., Pseudodoliolina sp., Neoschwagerina sp.

Parafusulina Zone
   Parafusulina kaerimuzensis (Ozawa), etc.

Pseudofusulina Zone

Pseudofusulina krafti subzone
   Pseudofusulina krafti (Schellwien), Schwagerina krotowi (Schellwien), Nagatoella kobayashii Thompson, Yangchienia sp., Misellina claudiace (Deprat), Staffella sp.

Pseudofusulina vulgaris subzone
   Pseudofusulina vulgaris (Schellwien), Paraschwagerina akiyoshiensis Toriyama, Schwagerina satoi (Ozawa), Schwagerina krotowi (Schellwien), Eoparafusulina ellipsoidalis (Toriyama), Triticites spp., Schubertella sp.

Pseudoschwagerina Zone

Pseudoschwagerina sp. subzone
   Pseudoschwagerina sp., etc.

Triticites simplex subzone
   Triticites simplex (Schellwien), Triticites spp.

Correlation

As described above, ammonoid cephalopods are extremely scarce within the Japanese Permian (Table 1).

Table 1  Sequence of Permian ammonites in the Kitakami mountains
(after Bando, 1975)

<table>
<thead>
<tr>
<th>Age</th>
<th>Series</th>
<th>Ammonoid Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Permian</td>
<td>Toyoma Series</td>
<td><em>Araxoceras cf. kiangsiensis</em> Zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Eumedlicottia</em> Zone</td>
</tr>
<tr>
<td>Early Permian</td>
<td>Kanokura Series</td>
<td><em>Timorites intermedium</em> Zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Stacheoceras iwazakiense</em> Zone</td>
</tr>
<tr>
<td></td>
<td>Sakamotozawa Series</td>
<td>(Unknown)</td>
</tr>
</tbody>
</table>
They are by no means sufficient for the correlation. The occurrence of corals is quite sporadic in the Japanese Permian. And Bryozoans and algae are both relatively long ranging. Conodont studies began only quite recently. Only fusulinids have been studied from various districts of Japan, so far. They occur abundantly, and therefore we have to rely heavily upon these fusulinids for the sake of Permian correlation (Toriyama, 1967).

Table 2 Succession of Japanese Permian Fusulinids

| Palaeofusulina + Colaniella parva |
| Araxoceras |
| Lepidolina kumaensis + L. minatoui |
| Yabeina globosa + Lepidolina multiseptata |
| “Neoschwagerina” douvillei |
| Neoschwagerina margaritae |
| Neoschwagerina craticulifera |
| Neoschwagerina simplex + Parafusulina kaerimizensis |
| Cancellina, Minoella, Maklaya |
| Misellina, Toriyamaia, Nagatoella |
| Pseudofusulina krafti + P. ambigua |
| “Pseudofusulina” vulgaris + Paraschwagerina |
| Pseudoschwagerina + Triticites |
| Triticites + primitive Pseudoschwagerina + Quasifusulina |

* distinction between these three assemblages has not been firmly established as yet.

Table 2 is a scheme of fusulinid succession in Japan, which is applicable to carbonate facies, and to such mixed environment that we have in the Kitakami mountains, to some extent.

Figure 2 is an attempt to correlate the Japanese Permian in the districts described above. As may be seen from the figure, three fold division of the Permian System may be tenable in Japan, especially in the Kitakami mountains.

International correlation posed difficulty since the world standard regions for Permian, e.g. Uralian and North American basin, are all beyond the Tethyan faunal realm.

With South China, however, the Japanese Permian correlates quite well.

Lower part of the Kawaguchi Stage of the Sakamotozawa Series, with the entry of Pseudoschwagerina is correlatable with the Chuanshanian and
THE PERMIAN OF JAPAN

Mapingian in China.

The Chihsian in South China now comprises both Misellina subzone and Cancellina subzone, the latter of which yields Pseudodolololina (Sheng and Lee, 1974). Thus it is correlatable with the upper part of the Kawaguchi Stage and the Kabayama Stage, both of the Sakamotozawa Series, and the lower part of the Kattisawa Stage of the Kanokura Series, from which Cancellina sp. was obtained (Choi, 1970). The rest of the Kanokura Series is correlatable with the Maokou limestone which comprises both Neoschwagerina and Yabeina zones.

In Japan, Lepidolina kumaensis and L. minatoi occur a little later than the first occurrence of L. multisepatata. It is certain that the top part of the Maokou limestone with Yabeina fauna corresponds to the Japanese Yabeina globosa-Lepidolina multisepatata Zone. But whether the part does include deposits corresponding to the Japanese L. kumaensis – L. minatoi zone or not is still an open question.

The newly proposed Maehama Stage corresponds to the Wuchiaping limestone based on the common occurrence of Araxoceras both in China and Japan. Also the Chinese Changhsing limestone is equivalent to the Nabekoshi Stage in the Kitakami mountains with Colaniella – Palaeofusulina fauna. Thus almost the whole Lopingian is correlatable with the Toyoma Series (Table 3).

Table 3  Correlation of the Permian of Japan, South China and the USSR

<table>
<thead>
<tr>
<th>Kitakami Mts., Japan (Minato et al, this paper)</th>
<th>South China (Sheng &amp; Lee, 1974)</th>
<th>U. S. S. R. (Correlation after Kahler, 1974)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toyoma Series</td>
<td>Nabekoshi Stage</td>
<td>Loping Series</td>
</tr>
<tr>
<td></td>
<td>Maehama Stage</td>
<td></td>
</tr>
<tr>
<td>Kanokura Series</td>
<td>Iwaizaki Stage</td>
<td>Yangsing Series</td>
</tr>
<tr>
<td></td>
<td>Kattisawa Stage</td>
<td></td>
</tr>
<tr>
<td>Sakamotozawa Series</td>
<td>Kabayama Stage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kawaguchi Stage</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tatarian              Kazanian
Ufimian               Kungurian
Artinskian            Sakmarian
Asselian
For further international correlation we have no new data of our own. But such an attempt based on fusulinids was presented by Kahler (1974), and we wish to follow him.

Thus the lower part of the Kawaguchi Stage, *Lophocarinophyllum suetomii* Zone, is the Asselian, being situated below the bed with *Pseudoschwagerina schellwieni* and *Zellia* of Sakmarian. The upper part of the Kawaguchi Stage, especially the earlier half of it is correlationable with the Sakmarian with the entry of *Pseudoschwagerina schellwieni*. The Artinskian starts with the appearance of *Pseudofusulina vulgaris* and may be equivalent to the rest of the Sakamotozawa Series. The Kungurian is designated by Kahler as *Cancellina* zone, which in the Kitakami mountains may be equivalent to the lower part of the Kattisawa Stage. The Kazanian and the Ufimian are both thought by Kahler as possible equivalent of *Neoschwagerina* zone, which is correlated with the later half of the Kattisawa Stage of the Kanokura Series. Tatarian starts from the *Yabeina—Lepidolina* zone. Therefore the Iwaizaki Stage of the Kanokura Series and the Toyoma Series may be the Tatarian.

References


Hanzawa, S. and Murata, M., 1963. The paleontologic and stratigraphic considerations on the Neoschwagerininae and Verbeekininae, with the descriptions of Fusulinid


Hayasaka, I., 1925. On some brachiopods from the Lyttonia horizon of the Kitakami, mountains. Japan. Jour. Geol. Geogr., 4:


Hayasaka, I., 1954. An occurrence of Neospirifer fasciger (Keyerling) in Japan, and a note on some associate Permian brachiopods from around Kesen-numa City, Northeast Japan. Collection of essays in commemoration of the Tenth Anniversary (1959) of Shimane University (Natural science).


Kon'no, E., 1973. New Species of Pleuromeia and Neocalamites from the Upper Scythian


Minato, M. (Chief Editor), 1965. The geologic development of the Japanese Island. Tsukiji Shokan, Tokyo, 1-142.


Murata, M., 1969. Molluscan fauna of the Toyoma formation (Late Permian). Saito Ho-on


Nishiyama, S., 1968. The echinoid fauna from Japan and adjacent regions. Part II. Palaeont. Soc. Japan, Special papers, 13:


Onuki, Y., 1956. Geology of the Kitakami Massif; One of the explanatory texts of the geological map (1/100,000) of Iwate Prefecture. Iwate Prefecture, 1-189.


Ozaki, K., 1968. Problematical fossils from the Permian limestone of Akasaka, Gifu


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