

LATE MISSISSIPPIAN AND EARLY PENNSYLVANIAN FUSULINID FAUNAS OF THE TAISHAKU LIMESTONE IN WEST JAPAN

by Kimiyoshi SADA (*)

Introduction

The Carboniferous and Permian reef complex Taishaku limestone located on about 90 km, to the northeast of the city of Hiroshima has been well known among the Japanese Upper Paleozoic stratigraphers and paleontologists for its wide distribution about 13 km. square and for being composed of thick marine limestones containing abundant fossils as well as large limestone uplands such as the Akiyoshi limestone, the Oga limestone, and the Atetsu limestone in West Japan. The Taishaku limestone was formerly studied from the stratigraphical and paleontological points of view by such many workers as HANZAWA (1941), HUIJIMOTO (1944), late ENDO (1957), AKAGI (1958), YOKOYAMA (1957, '59), SAKAGAMI and AKAGI (1961) and OKIMURA (1956). Many problems, however, have remained unsolved, particularly regarding the zonation by the Carboniferous fusulinids. Since 1965 I have carried out the studies of the fusulinid faunas and the stratigraphy of the Taishaku limestone and the Carboniferous part of it was divided into four fusulinid zones: the *Eostaffella kanmerai*, the *Millerella bigemmicula*, the *Profusulinella toriyamai* and the *Fusulinella taishakuensis* in ascending order. The fusulinids from all of the zones cited above were described in the preceding papers (SADA, 1967, '69, '70, '72, '73). In this paper is given the correlation of the late Mississippian and early Pennsylvanian fusulinid faunas of the Taishaku limestone.

I. — CARBONIFEROUS ROCK FACIES OF THE TAISHAKU LIMESTONE

The Carboniferous part of the Taishaku limestone is divisible into four fusulinid zones as shown in Table 1. In the central part of this limestone upland the *Eostaffella kanmerai* zone which belongs to the Dangyokei Formation named by YOKOYAMA (1957, '59) is composed of « schalsteins » and limestones, and in the eastern and northern marginal areas consists of « schalsteins » and limestones intercalated with cherts cropping out along the Tojo River, at Tameshige and just the south of Tou near the town of Tojo. The *Eostaffella kanmerai* zone includes the *Endostaffella delicata* and *Mediocris mediocris* zones proposed by OKIMURA (1966) without the paleontological study of fusulinids and smaller foraminifers.

The *Millerella bigemmicula* zone, the lower part of the Eimyoji Formation (YOKOYAMA, 1957, '59), is generally oolitic limestones in the central part of the upland and is mainly made up of limestones and cherts in the marginal.

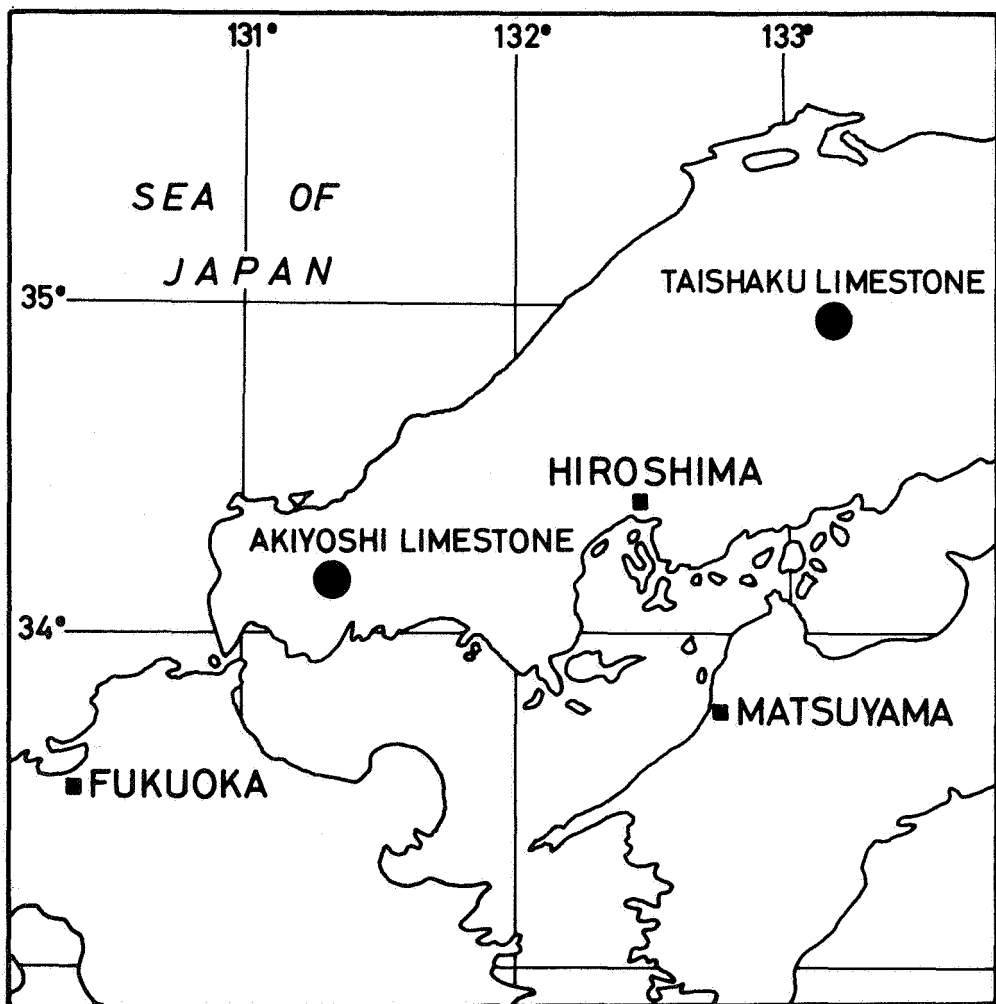
The *Profusulinella toriyamai* and *Fusulinella taishakuensis* zones (SADA, 1967, '70, '72) ascribable to the middle and the upper part of the Eimyoji Formation consist of massive and oolitic limestones.

II. — FUSULINID FAUNAS AND THEIR CORRELATION

Eostaffella kanmerai fauna

Eostaffella kanmerai fauna (SADA, 1969) is made up of *Eostaffella kanmerai* (IGO), *Millerella* ? sp. A, *Mediocris* sp. A, *Endothyra kibiensis* SADA, *E.* sp. A, *Quasiendothyra japonica*

(*) DEPARTMENT OF GEOLOGY, FACULTY OF GENERAL EDUCATION, HIROSHIMA UNIVERSITY, HIROSHIMA 730, JAPAN.



TEXT-FIG. 1. — Location map of the Taishaku limestone area in West Japan.

SADA, *Tournayella hiroshimana* SADA, *T. sp. A*, *T. sp. B*, *Monotaxinoides sp.*, *Burnsia?* sp., *Climacammina sp.*, *Tetrataxis spp.*, *Archaeidiscus sp.* and *Saccamminopsis sp.* Of these species, *Eostaffella kanmerai* is the typical representative species in this fauna. *Eostaffella kanmerai* (IGO) (1957) was described from the basal part of the Ichinotani Formation in Gifu Prefecture, Central Japan, in association with *Mediocris komatui* (IGO), «*Millerella*» *discoidea* IGO and corals indicating the late Lower Carboniferous (the Chesterian or the Viséan age). *Mediocris sp. A* is similar to *M. komatui* (IGO) in general shell shape and internal characteristics and these two species may be regarded to be of the same degree in the stage of the

development of the shell. *Tournayella hiroshimana* SADA has a resemblance in general shell shape to «*Millerella*» *discoidea* IGO (1957, pp. 177-178, pl. 2, figs. 1-3), which may be considered to belong to the genus *Tournayella*. *Eostaffella kanmerai* somewhat resembles in shell form *Eostaffella gigantea* (KANMERA) (1952, pp. 172-173, pl. 12, figs. 4-14) from the Lower Carboniferous Kakisako Formation in Kyushu but the former species is smaller in size and is remarked to be of more primitive form than the latter. In the general outline of the shell *Eostaffella kanmerai* reveals certain similarity to *Eostaffella oregonensis* SADA and DANNER (1973, pp. 155-157, pl. 23, figs. 1-10, 14-16) associated with *Hexaphyllia*

strongly indicative of the Viséan age from the Coffee Creek Formation in central Oregon. Both the species should be considered to be almost of equivalent in the evolutionary stage of the shell. CHANG (1962) described late Lower Carboniferous *Eostaffella* fauna consisting of 8 species of *Eostaffella* from the Hochow limestone in Anhui, China. Judging

Taking all these considerations into account, it would seem that *Eostaffella kanmerai* fauna in the Taishaku limestone corresponds to the North American Chesterian faunas (ZELLER, 1953; ANISGARD and CAMPAU, 1963; ROSS, 1967; SADA and DANNER, 1973) and to the late Viséan faunas (ROSOVSKAYA, 1963; AISENVERG et al., 1960) in RUSSIA.

FORMATION		DANGYOKEI FM.		EIMYOJI FM.	
SPECIES	ZONE	<i>Eost.kanmerai</i>	<i>Mil. bigemmicula</i>	<i>Prof. toriyamai</i>	<i>F. taishakuensis</i>
<i>Millerella marblensis</i>					
<i>M. bigemmicula</i>					
<i>M. ? sp. A</i>					
<i>M. sp. B</i>					
<i>Eostaffella kanmerai</i>					
<i>Mediocris sp. A</i>					
<i>Profusulinella toriyamai</i>					-----
<i>P. tujiformis</i>					
<i>Fusulinella taishakuensis</i>					
<i>F. biconica</i>					
<i>Pseudostaffella taishakuensis</i>					
<i>Nankinella yokoyamai</i>					
<i>Staffella akagoensis</i>					
<i>Eoschubertella sp.</i>					
<i>Endothyra kibiensis</i>					
<i>E. sp. A</i>					
<i>Quasiendothyra japonica</i>					
<i>Tournayella hiroshimana</i>					
<i>T. sp. A</i>					
<i>T. sp. B</i>					
<i>Monotaxinoides sp.</i>					
<i>Burnsia ? sp.</i>					
<i>Climacammina sp.</i>					-----
<i>Tetrataxis spp.</i>					-----
<i>Archaeodiscus sp.</i>					
<i>Saccamminopsis sp.</i>					
JAPAN		ONIMARUAN	KAMITAKARAN	ATETSUAN	AKIYOSHIAN
NORTH AMERICA		CHESTERIAN	MORROWAN	ATOKAN(=DERRIAN)	
RUSSIA		VISÉAN NAMURIAN	BASHKIRIAN		MOSCOVIAN

TABLE 1. — Stratigraphic ranges of Carboniferous fusulinids and their associated smaller foraminifers in the Taishaku limestone.

from its faunal assemblage, *Eostaffella kanmerai* faunas in Japan can be correlated with *Eostaffella hohsienica* fauna. *Eostaffella mosquensis* VISSARINOVA (1948) seems to be one of the most characteristic species in the Russian Viséan (C₄f) (AISENVERG et al., 1960), and it bears some similarity in general outline of the shell to *Eostaffella kanmerai*. These two species might be of an equal stage of the development of the shell.

Millerella bigemmicula fauna

Millerella bigemmicula fauna is composed of *Millerella bigemmicula* IGO, *M. marblensis* THOMPSON, *Eostaffella kanmerai* (IGO), *Climacammina* sp. and *Tetrataxis* spp., and among them *Millerella bigemmicula* and *M. marblensis* are the reliable index to the early Pennsylvanian. *Millerella bigemmicula* was originally described from the lower part of the

Ichinotani Formation in Fukuji area (IGO, 1957) and there the species was associated with such fusulinids as *Millerella* cf. *marblensis* THOMPSON, *Nankinella* cf. *plummeri* THOMPSON, *Pseudostaffella kanumai* IGO, etc., all indicating, to be sure, the early Pennsylvanian age. *Millerella bigemmicula* was also described by SADA (1964) from the lower part of the Kodani Formation in the Atetsu area, Okayama Prefecture and its accompanying species are *Pseudostaffella* cf. *kanumai* IGO, *Millerella inflecta* THOMPSON, *Eostaffella kanmerai* (IGO) and other indeterminable large species of *Eostaffella*. Among them, *Pseudostaffella* cf. *kanumai* and *Millerella inflecta* are good index fossils to the early Pennsylvanian age and *Eostaffella kanmerai*, as discussed already in my preceding paper (1965), was regarded as the important species having the fairly long stratigraphic range from the Upper Onimaruan to the Lower Kamitakaran in Japanese standard succession. Recently KOBAYASHI (1972) reported the early Pennsylvanian *Millerella* fauna consisting of *Millerella bigemmicula*, *M. marblensis*, *Eostaffella ultragigantea*, n. sp. (MS), etc., from the lower member of the Nagaiwa Formation in Iwate Prefecture. It seems that this fauna has a close similarity in the faunal assemblage to the *Millerella* faunas of the Ichinotani Formation, the Atetsu limestone and the Taishaku limestone.

The examination as is stated above on the faunal assemblage of the *Millerella bigemmicula* zone in the Taishaku limestone shows that the fauna can be correlated without doubt to the *Millerella bigemmicula* fauna of Fukuji (IGO, 1957) and the *Millerella bigemmicula-Eostaffella kanmerai* fauna of the Atetsu limestone (SADA, 1964, 1965) and that it may be of equivalent in age to the North American early Pennsylvanian *Millerella* faunas and to the early Bashkirian faunas in Donetz basin.

Profusulinella toriyamai
and **Fusulinella taishakuensis** faunas

The *Profusulinella toriyamai* fauna (SADA, 1972) is composed of *Profusulinella toriyamai* SADA, *P. jusiformis* SADA, *Millerella* sp. B, *Pseudostaffella taishakuensis* SADA, *Nankinella yokoyamai* SADA and *Staffella akagoensis* TORIYAMA, and the *Fusulinella taishakuensis* fauna (SADA, 1970) is made up of *Fusulinella taishakuensis* SADA, *F. biconica* (HAYASAKA) and *Eoschubertella* sp. The full discussion of these faunas is beyond the scope of this paper, but the faunal assemblages have been described here as they are important for the international correlation.

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SMET

N. V.

S. A.

B-2480 DESSEL

Waterwinningsputten	Puits de captage	Wasserbrunnen	Waterwells
Bronbemalingen	Rabattelements	Grundwasserabsenkung	Lowering of
Diepboringen	de la nappe aquifère	Tiefbohrungen	the ground water
Cimentinjecties	Forages profonds	Injectionsbohrungen	Deepwelldrilling
Zanddrains	Injections de ciment	Dränagen	Injection drilling
Benoto funderingspalen	Drains de sable	Benoto-Pfähle	Sanddrains
Horizontale	Pieux benoto	Industrieanlagen Reinigung	Benoto-piles
boringen	Forages horizontaux	Horizontale	Horizontal drilling
Industriële reiniging	Nettoyage industriel	Pressbohrungen	Industrial cleaning
Waterzuivering	Epuration des eaux	Wasseraufbereitung	Water treatment
Pompinstallaties	Installation de pompes	Pumpen	Pumpinstallation
Betonboringen	Forages en béton	Beton Bohrungen	Concrete drilling
Trekankers	Tirants d'ancrage	Zugankers	Tensile anchorages

Communiqué

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