ON SOME MIDDLE PERMIAN FOSSILS FROM THE SHIRAHONE LIMESTONE, NAGANO PREFECTURE, JAPAN

by

D. R. CHOI* and T. FUJITA**

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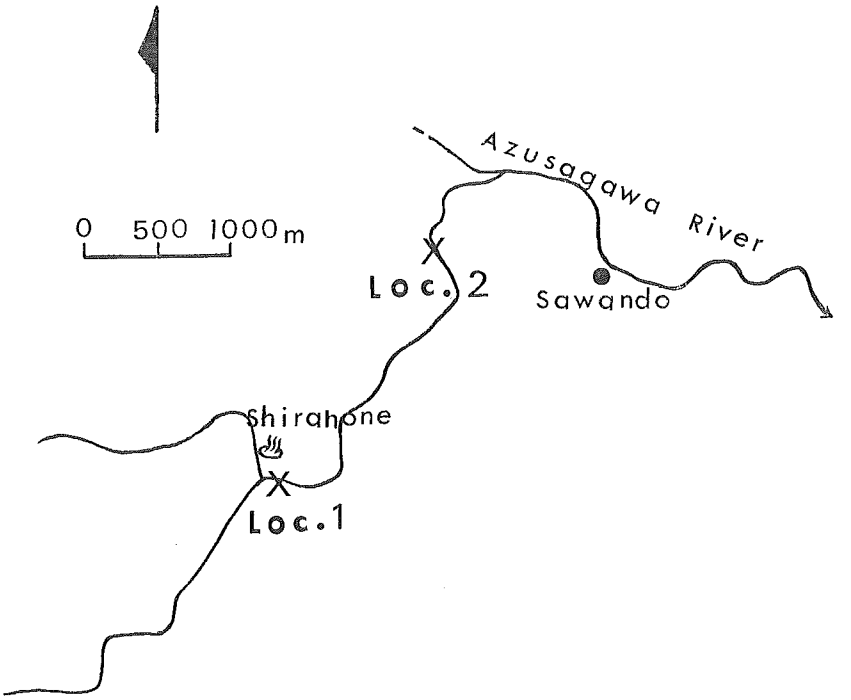
Introduction

In central Japan the thick sequence of upper Palaeozoic formation has been known to develop. A part of them has been called as the Azusagawa formation, which is cropping out typically in the tributary of the Azusagawa, Minami Azumi-gun, Nagano Prefecture. The formation is mainly composed of slate and chert in alternation, and is occasionally intercalated with lenses of basic tuff, limestone and conglomerate. The conglomerate bed is known as the Sawando conglomerate which corresponds to the Usuginu conglomerate in the Southern Kitakami Mountains, and represents therefore the age of upper Permian (MINATO, 1951a; TANAKA, KOBAYASHI & KAMEI, 1952).

Table 1. Previous record of fossils from the Shirahone limestone.

	MINATO (1951)	TANAKA et. (1952)	KAMEI (1956), & KAMEI et. (1959)
Parafusulina japonica (GÜMBEL)	×	×	×
Parafusulina kaerimizensis (OZAWA)	×	×	×
Parafusulina ambigua (DEPRAT)		×	×
Parafusulina sp.		×	
Pseudodoliolina ozawai YABE et HANZAWA	×	×	×
Neoschwagerina sp.			×
Schubertella sp.		×	×
Mizzia velevitana (SCHUBERT)		×	×
a coral		×	×
crinoid stem joints			×
Pelecypods			×

* Department of Geology and Mineralogy, Faculty of Science, Hokkaido University, Sapporo.
** Department of Geology, Faculty of Science, Shinshu University, Matsumoto, Nagano Prefecture.



Text-fig. 1.
Index map showing fossil localities. See also No. 4 in text-fig. 2. (T. FUJITA)

The Azusagawa formation as a whole is presumed to range from the middle Carboniferous to the upper Permain (MINATO, 1951a & b; KAMEI, 1956).

Fossil occurrence has been recorded from a limestone lens at the Shirahone hot spring. There the limestone bearing formation is steeply inclined towards west and is severely deformed. It is a matter of importance that the development of limestone appears to be closely related to the nearby occurrence of basic tuff body.

Previous record of fossils from the Shirahone limestone is shown in table 1.

One of the authors (FUJITA) collected some fossils at an outcrop of pinkish limestone (loc. 1) along Yunokawa valley, a tributary of the Azusagawa, near Shirahone. He also found some other fossils in a drift boulder of limestone, in a little lower course from the above locality 1 (Text-fig. 1). Undoubtedly the latter material must have come from a part of the Shirahone limestone embracing locality 1.

In the meantime, Professor M. MINATO, Hokkaido University, Sapporo, visited the Department of Geology, Shinshu University, Matsumoto, in early November 1969, for lecturing on Quaternary geology for the staff and students there. During his stay in Matsumoto, FUJITA talk with him on a fossil collection from the above localities. Professor MINATO was interested in a coral found out in a few limestone

slabs collected by FUJITA. According to Professor MINATO, the coral may be a species belonging to the genus *Yatsengia*. An existence of such a coral in the Shirahone limestone has been unknown by that time, he stated. Upon this kind teaching, one of the authors (FUJITA) wished to make detailed study on his collection from Shirahone. Professor MINATO kindly brought back a few limestone slabs containing corals to Sapporo and placed them for sectioning.

In Sapporo, one of the authors (D. R. CHOI) helped Professor MINATO in this concern. They found out very primitive forms of Neoschwagerinids in the number of thin sections newly made by CHOI, besides a coral, *Yatsengia* and a number of other fusulinid fossils.

A combination of *Yatsengia* and primitive forms of Neoschwagerinids in this fauna is so interesting in consideration of the horizon of the Shirahone limestone that Professor MINATO proposed to CHOI to make detailed description of the fossils in cooperation with FUJITA.

Table 2

AKASAKA HONJO (1957)	AKIYOSHI HASEGAWA (1963)	SHIRAHONE LIMESTONE	KITAKAMI CHOI (1970)		
Yabeina globosa	*Lepidolina shiraiwensis*		Kanokura series	Iwaiza-ki st.	*Lepidolina multiseptata shiraiwensis* *Lepidolina kumaensis*
Gifuella douvillei	*Gifuella douvillei*			Kattisawa stage	*Pseudodoliolina elongata*
Neoschwagerina margaritae	*Verbeekina verbeeki*				
	Neoschwagerina haydeni				
Neoschwagerina craticulifera	*Verbeekina heimi*				
	Neoschw. craticulifera				
Pseudodoliolina ozawai	*Parafusulina kaerimizensis*	*Neoschw. simplex* *Min. nipponica* *Paraf. kaerimizensis*			*Monodiexodina matsubaishi*
Minoella nipponica					*Parafusulina*
					Chusenella
Parafusulina granum-avenae					*Cancellina*

In the present paper, a small, but characteristic fauna of the Shirahone limestone will be accordingly given. Geological distribution of the mentioned fauna in this connection will be also briefly presented.

Following is a list of fusulinids and corals that we could identify.

Sample 1 (loc. 1)

A tabulate coral (probably a *Pseudofavosites*)

Schubertella sp.

Yangchienia compressa (OZAWA)
Pseudofusulina kraffti (SCHELLWIEN & DYRENFURTH)
Parafusulina kaerimizensis (OZAWA)
Parafusulina nakamigawai MORIKAWA & HORIGUCHI
Parafusulina sp.
Chusenella sp.
Minoella nipponica (OZAWA)
Neoschwagerina simplex OZAWA

Sample 2 (loc 2)
Yatsengia aff. *ibukiensis* MINATO
Parafusulina sp.

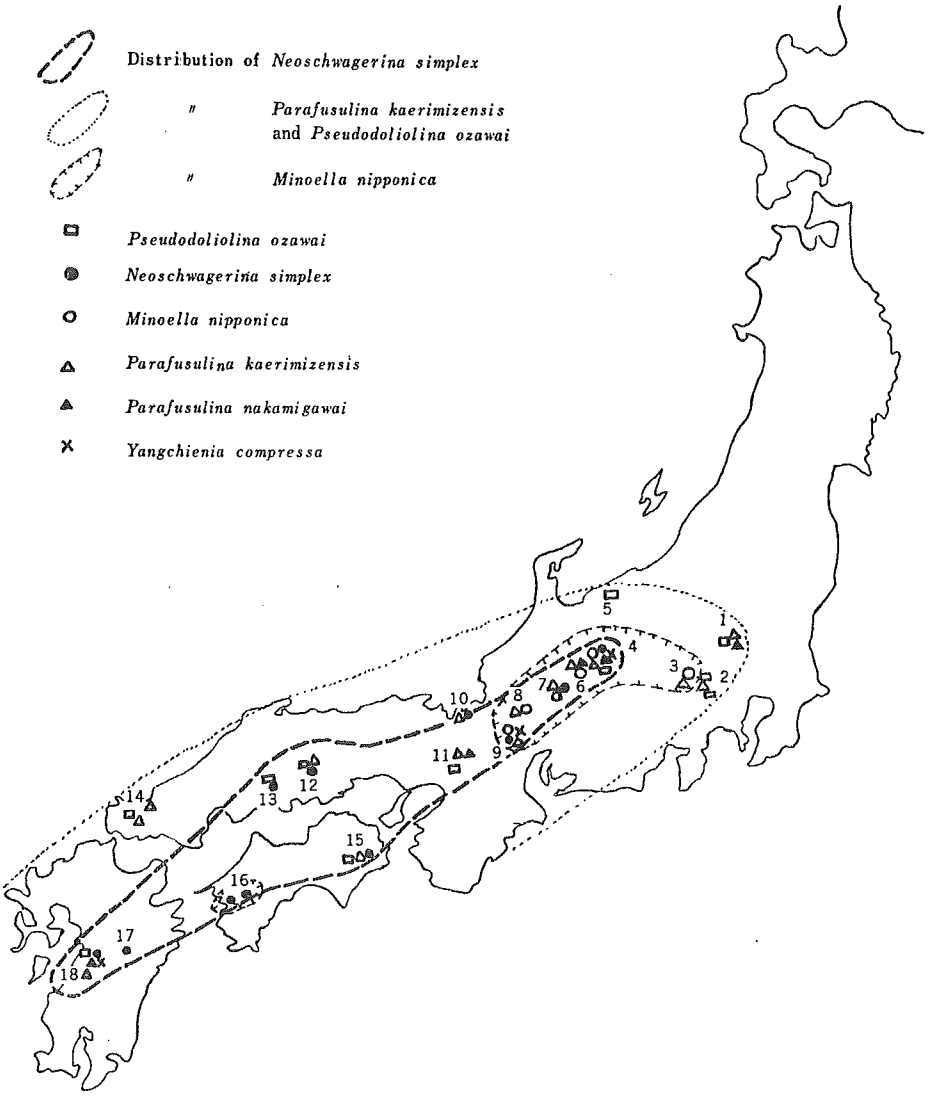
Judging from the association listed above, the Shirahone limestone is correlatable to the upper part of *Parafusulina kaerimizensis* zone, *Minoella* zone or *Neoschwagerina simplex* zone in Southwest Japan. Also it corresponds to the lower part of the Kattisawa stage, in the Southern Kitakami Mountains (Table 2).

When we examine the geological distribution and faunal association of some described species of fusulinids in this article, we may notice some interesting facts.

The association of *Neoschwagerina simplex*, *Minoella nipponica* and *Yangchienia compressa* is found in eastern Tethys region; Pamirs, China and Japan. Within Japan the association is geographically traceable rather linearly from Kyushu, through Shikoku, Akasaka to Shirahone. On the contrary *Pseudodoliolina ozawai*, *Parafusulina kaerimizensis* and *Parafusulina nakamigawai* are widely distributed throughout Southwest Japan. But all the groups above mentioned have never been found in the Permian of Kitakami and Abukuma Mountains. This contrast in distributional pattern may give important data in considering palaeoenvironments in middle Permian of Japan (Text-fig. 2).

Before stepping into description, we acknowledge with best regards Professor M. MINATO of Hokkaido University, under whose supervision the present work was carried out. We take pleasure to give our hearty thanks to Dr. M. KATO of Hokkaido University for his assistance to the present study. Professor N. Yamashita of Shinshu University was kind enough to read this paper in manuscript critically.

Repository; All materials described in this article are deposited in Department of Geology & Mineralogy, Faculty of Science Hokkaido University, Sapporo, Japan.



Text-fig. 2.
Geographical distribution of some middle Permian fusulinids referred in this paper in Japan. 1; Kuzu, 2; Shomaru-Toge, 3; Kannagawa, 4; Shirahone, 5; Omi, 6; Nyukawa, 7; Mino, 8; Ibigawa, 9; Akasaka and eastern part of Lake Biwa, 10; Wakasa, 11; Kyoto, 12; Atetsu and Oga plateau, 13; Jinseki-Yuki area, 14; Akiyoshi, 15; West of Anan, 16; Onogahara and its vicinity, 17; Kuraoka area, 18; Kuma.

Description of species

Order Foraminifera

Family Schubertellidae SKINNER, 1931

Subfamily Schubertellinae SKINNER, 1931

Genus ***Yangchienia*** LEE, 1933

Yangchienia compressa (OZAWA)

Pl. 1, figs. 4 & 5.

1927 *Fusulina compressa* OZAWA, pp. 142–143, pl. 37, fig. 6f; pl. 38, figs. 2b, 10, 13b, 16b; pl. 39, figs. 3 & 7.
1927 *Neofusulinella phairayensis*, OZAWA, p. 151, pl. 38, figs. 2a, 11 (part) & 12.
?1936 *Fusulinella compressa*, HUZIMOTO, pp. 40–41, pl. 2, fig. 9.
1957 *Yangchienia* cf. *compressa*, KOBAYASHI, pp. 265–266, pl. 1, fig. 17.
1961 *Yangchienia* sp., MORIKAWA & ISOMI, p. 8, pl. 9, figs. 12–14.
1963 *Yangchienia compressa*, KANMERA, pp. 90–92, pl. 11, figs. 5–13.
1963 *Yangchienia compressa*, SHENG, pp. 163–164, pl. 4, figs. 20–27.
1967 *Yangchienia compressa*, LEVEN, pp. 128–129, pl. 2, figs. 3 & 4.
1968 *Yangchienia compressa*, KOIKE, HASHIMOTO & SATO, pp. 204–205, pl. 32, figs. 28–38.

Lectotype: OZAWA's specimen, illustrated as fig. 7 on pl. 39 was chosen as lectotype of this species by KANMERA (1963).

Materials: UHR 19241a & UHR 19241b.

Description: Shell is minute, fusiform with pointed poles and weakly convex mid portion. Mature shell possesses $6\frac{1}{2}$ to 7 volutions with length probably of 1.75 mm and 0.7 mm in width. Inner first two volutions are endothyroid that is coiled askew to the later volutions of fusiform. Height of volution in a deep parallel section from the third to the sixth volution is, 0.06, 0.075, 0.09 and 0.13 mm respectively.

Diameter of proloculus is not measured owing to the absence of axial or sagittal sections at hand.

Spirothecal structure is not exactly observed, but may be composed of tectum and lower less dense layer in outer volutions. Thickness of the spirotheca is very thin throughout the shell; about 0.005 mm in inner, while at most 0.02 mm in outer volutions.

Septa are unfluted. Number of septa is 11? in the sixth volution in an illustrated specimen (pl. 1, fig. 5).

Tunnel is low and relatively broad. Tunnel angle is about 30° in outer volutions.

Chomata are well developed and conspicuous. They are low and broad.
Remarks: The present specimens are included in genus *Yangchienia* and not genus *Schubertella* by its larger shell, dense and broader chomata and more numerous volutions than the latter, although the wall structure of the present form is not clearly observed.

Among species of *Yangchienia* hitherto described the present form is most close to *Yangchienia compressa* (OZAWA), especially to one form described by KOBAYASHI (1957) from Ibukiyama limestone as *Yangchienia* sp., which was later regarded by KANMERA to be conspecific with *Yangchienia* compressa in all features. Other forms identified to this species possess well developed chomata, which are considered by us not to be of specific value.

It is very important that most previous forms of *Yangchienia compressa* except for HUZIMOTO's form, of which identification seems to be somewhat incorrect are closely associated with *Neoschwagerina simplex*, or *Minoella nipponica*, and also *Pseudodoliolina ozawai*. The association denotes *Minoella*, or upper part of *Parafusulina* zone, and *Neoschwagerina simplex* zone.

Family Schwagerinidae DUNBAR & HENBEST, 1930

Subfamily Schwagerininae DUNBAR & HENBEST, 1930

Genus ***Pseudofusulina*** DUNBAR & SKINNER, 1931

Pseudofusulina kraffti (SCHELLWIEN & DYRENFURTH)

pl. 1, figs. 6 & 7.

Synonym: See one of the writers' previous paper (CHOI, 1970)
Lectotype chosen by KANMERA & MIKAMI (1965): A specimen illustrated as pl. 6, fig. 1 by SCHELLWIEN & DYRENFURTH in 1909.
Materials: UHR 19233, UHR 19234, UHR 19235, UHR 19237, UHR 19236 and others.
Description: Shell is moderate in size, thick fusiform with slightly concave mid portion. Mature shell possesses 6 to $6\frac{1}{2}$ volutions and measures 6.4 to 6.6 mm in length and 3.5 to 4.0 mm in width, giving form ratio of 1.6 to 2.0. The shell expands rapidly until the fourth volution, while rather tightly beyond that. Height of volution from the first to the sixth volution in an illustrated axial section (pl. 1, fig. 7) is 0.14, 0.22, 0.26, 0.36, 0.39 and 0.42 mm.

Proloculus is moderately large for the size of the shell. Its diameter measures 0.30 to 0.39 mm.

Spirotheca is coarsely alveolar. Its thickness from the first to the sixth volu-

tion in average of four specimens is, 0.040, 0.050, 0.061, 0.072, 0.102 and 0.13 mm, respectively.

Septa are rather intensely, comparatively narrowly and irregularly fluted. Fluling becomes intense towards pole regions, while they reach almost the top of the chamber. Number of septa is not strictly counted on account of absence of ideal sagittal sections, but is about 10 in the first, 20 in the second, 25 in the third and 30 in the fourth volution.

Levee like chomata present only in the first volution.

Axial fillings are weakly developed, being confined in inner three to four volutions.

Remarks: this form is identical with *Pseudofusulina kraffti*, first described by SCHELLWIEN & DYRENFURTH as *Fusulina kraffti* and lately restudied by KALMIKOWA (1965), in its thick fusiform shell with concave mid portion, relatively loose coiling and thick spirotheca.

Genus ***Parafusulina*** DUNBAR & SKINNER, 1931

Parafusulina kaerimizensis (OZAWA)

Pl. 1, figs. 2 & 3.

1925 *Schellwienia kaerimizensis* OZAWA, pp. 31–32, pl. 4. figs. 6 & 7; pl. 6, fig. 5 (non pl. 4 , fig. 5).

?1936 *Pseudofusulina kaerimizensis*, HUZIMOTO, pp. 65–67, pl. 7, figs. 6–8; pl. 8, figs. 1–4.

1943 *Parafusulina kaerimizensis*, NAGAO & MINATO, figs. 1 & 2.

1958 *Parafusulina kaerimizensis*, TORIYAMA, pp. 194–197, pl. 30, figs. 6–12; pl. 31, figs. 1–8; pl. 32, figs. 1–9.

1959 *Parafusulina kaerimizensis*, KANUMA, p. 81, pl. 9, figs. 1–3.

1959 *Parafusulina kaerimizensis*, TORIYAMA & SUGI, p. 22, pl. 2, figs. 1–3.

1961 *Parafusulina kaerimizensis*, NOGAMI, p. 206, pl. 8, figs. 1–5.

1961 *Parafusulina kaerimizensis*, KAWANO, pp. 101–103, pl. 8, figs. 11 & 12; pl. 10, figs. 1–3.

?1962 *Parafusulina kaerimizensis*, SUYARI, p. 28, pl. 9, fig. 5.

1963 *Parafusulina* (*Parafusulina*) *kaerimizensis*, KANMERA, pp. 101–102, pl. 16, figs. 6 & 7; pl. 17, figs. 5–7; pl. 18, figs. 5–8.

1964 *Parafusulina kaerimizensis*, IGO, pp. 18–19, pl. 8, figs. 1–5.

?1967 *Parafusulina kaerimizensis*, MIYAMURA, pl. 4, figs. 4–7.

Lectotype: OZAWA's specimen figured as fig. 7 on pl. 4, chosen by TORIYAMA (1958, p. 165).

Materials: UHR 19262 and others.

Remarks: TORIYAMA (1958), NOGAMI (1961), KANMERA (1963), and IGO (1964) clarified the variation in shell size, expansion of the shell, intensity of septal fluting, and the mode of development of axial fillings in *Parafusulina kaerimizensis*.

The present form is safely included in *Parafusulina kaerimizensis* in all points above mentioned, although materials at our disposal are not sufficient enough.

KANMERA (1963) included this species in subgenus *Skinnerella* which was proposed by COOGAN in 1960. But we are in doubt if the difference of shell shape is good enough for subgeneric separation. Moreover morphological and phylogenetical relationships amongst various types of Schwagerinids are not yet fully clarified.

Parafusulina nakamigawai is readily distinguished from the present form in having more intensely fluted, thinner septa, and larger shell than the latter.

Parafusulina nakamigawai MORIKAWA & HORIGUCHI

Pl. 1, fig. 1.

1925 *Schellwienia kaerimizensis* OZAWA, p. 31, pl. 4, fig. 5 (non pl. 4, figs. 6 & 7; pl. 6, fig. 5).
1956 *Parafusulina nakamigawai* MORIKAWA & HORIGUCHI, pp. 262–263, pl. 35, figs. 1–7.
1958 *Parafusulina nakamigawai*, IGO & OGAWA, p. 52, pl. 2, fig. 5.
1959 *Parafusulina hirayuensis* IGO, pp. 250–251, pl. 4, figs. 1–3.
1959 *Parafusulina hayashii* IGO, pp. 249–250, pl. 4, figs. 4–6.
1961 *Parafusulina iwasensis* MORIKAWA & ISOMI, pp. 24–25, pl. 18, figs. 1–6, & 7 ?.
1963 *Parafusulina* (*Skinnerella*) *nakamigawai*, KANMERA, pp. 98–99, pl. 18, figs. 1–4.
1963 *Parafusulina nakamigawai*, SAKAGUCHI, pp. 110–111, pl. 9, figs. 1 & 2.
1963 *Parafusulina kuramensis* SAKAGUCHI, pp. 108–109, pl. 8, figs. 4–6; pl. 10, figs. 1–4.
1963 *Parafusulina hayashii*, SAKAGUCHI, pp. 111–112, pl. 11, figs. 1–7.
1964 *Parafusulina nakamigawai*, IGO, pp. 19–20, pl. 10, figs. 1 & 2.
1967 *Parafusulina nakamigawai*, LEVEN, pp. 164–165, pl. 20, fig. 2.
1967 *Parafusulina iwasensis*, MIYAMURA, pl. 5, figs. 5–8.

Material: UHR 19258.

Description: Shell is large, elongate subcylindrical with bluntly pointed poles. Mature shell possessing 7 volutions is 15.0 mm long, and 4.1 mm wide, giving form ratio of 3.7. Proloculus is spherical and measured 0.3 mm. Spirotheca is composed of tectum and keriotheca. It is gradually thickened outwards; 0.014 in the first, 0.03 in the second, 0.042 in the third, 0.055 in the fourth, 0.06 in the sixth, and 0.07 mm in the seventh volution in an illustrated specimen.

Septa are thinner than spirotheca, and are narrowly, irregularly and rather highly fluted. Septal fluting becomes more intense in pole regions. Axial fillings are weakly developed in inner four volutions. Phrenotheca is found in some parts of the fourth to the sixth volution.

Remarks: The present form is closely allied to both *Parafusulina nakamigawai* and *Parafusulina kaerimizensis*. But the writers are rather inclined to include this form in the former because it has elongated cylindrical shell with highly and narrowly fluted thin septa and weakly developed axial fillings.

Parafusulina iwasensis MORIKAWA & ISOMI from the east of Lake Biwa, to which the present form resembles most closely, is in fact conspecific with *Parafusulina nakamigawai*. Likewise, *Parafusulina hayashii* IGO, Parafusulina *hirayuensis* IGO from Hirayu, Southern Hida Mountains, and *Parafusulina kuramensis* SAKAGUCHI from Kyoto, are all nothing but *Parafusulina nakamigawai*. Although minor differences present among these forms in shell shape, nature of septal fluting, and the mode of development of axial fillings, we consider that they are within specific variation.

Genus ***Chusenella*** HSÜ, 1924 emend. CHEN, 1956

Chusenella sp.

Pl. 1, fig. 3.

Material: UHR 19232.

Remarks: A single tangential section of a poorly preserved specimen is at hand. It is assignable to th genus *Chusenella* because of having fusiform shell with pointed poles, tightly coiled inner volutions and heavy axial fillings. But the present form is specifically unidentifiable, since material is too scanty and insufficient to make detailed comparison.

Family Verbeekinidae STAFF & WEDEKIND, 1910

Subfamily Neoschwagerininae DUNBAR & CONDRA, 1928

Genus ***Minoella*** HONJO, 1959

Minoella nipponica (OZAWA)

Pl. 1, figs. 8 & 9.

1927 *Neoschwagerina* (*Cancellina*) *nipponica* OZAWA, pp. 160–161, pl. 34, figs. 12–17; pl. 35, figs. 8b & 10b; pl. 44, fig. 1a; pl. 45, figs. 4 & 5.

?1957 *Cancellina* cf. *nipponica*, KOBAYASHI, pp. 302–303, pl. 9, fig. 15.
1957 *Cancellina nipponica*, KANMERA, pl. 19, figs. 8–11.
1959 *Neoschwagerina* (*Minoella*) *nipponica*, HONJO, pp. 129–131, pl. 1, figs. 1–5 & 9; pl. 2, fig. 1.
1960 *Neoschwagerina nipponica*, KANUMA, pp. 66–67, pl. 10, figs. 3–6.
1960 *Minoella nipponica*, HONJO, pl. 1, figs. a, b & c; pl. 2; pl. 3.
1961 *Neoschwagerina nipponica*, MORIKAWA & ISOMI, pp. 26–27, pl. 20, figs. 15–19.
1961 *Neoschwagerina nipponica*, MORIKAWA & SUZUKI, p. 49, pl. 4, figs. 3 & 4; pl. 12, figs. 4–6.
1963 *Cancellina nipponica*, HANZAWA & MURATA, pl. 12, figs. 3–9; pl. 18, figs. 7,8, 11 & 12.
1966 *Minoella nipponica*, MINATO & HONJO pl. 2, fig. 1.
?1967 *Cancellina nipponica*, LEVEN, pp. 185–186, pl. 31, figs. 8 & 10.

Lectotype, chosen by HONJO (1959, p. 131): An axial section, pl. 34, fig. 15, OZAWA, 1927.

Descriptive remarks: This form possesses characteristically thinner spirotheca, slender septa, and less developed transverse septula than *Neoschwagerina simplex* described in this paper.

Shell is small, inflated and spheroidal with length of at most 3.3 mm and width of 2.0 mm, giving form ratio of about 1.5. Proloculus is spherical with outside diameter of 0.17 mm, and it is 0.075 mm in an illustrated specimen (slightly tangentially cut). Spirotheca is very thin and finely alveolar. It is 0.004 to 0.005 mm thick in the first two volutions and 0.018 mm in the outer. Transverse septula are weakly developed throughout the growth of the shell. They are low, triangularly shaped in axial section, being combined with parachomata near the septa. Secondary transverse septula are absent. Axial septula are comparatively well developed. *S* type of them occur from middle to outer volutions.

This form is, although good axial and sagittal sections have not been obtained, identical with *Neoschwagerina* (*Cancellina*) *nipponica* OZAWA from Akasaka, which is later transferred to *Minoella* newly established by HONJO in 1959.

Genus *Minoella* was proposed by HONJO upon the basis of nature of septula. In *Minoella* low transverse septula in early stage of ontogeny have tendency to decrease in height towards later volutions. Besides it has axial seputla of *o*, *i*,*v*, and *s* type. In addition, the writers consider that thin spirotheca and relatively large proloculus in *Minoella* are also important characteristics. These facts suggest us the phylogeny of *Minoella-Gifuella-Lepidolina* stock as already advocated by MINATO and HONJO (1959), and HASEGAWA (1965).

LEVEN's (1967) *Cancellina nipponica* from Pamirs should be reexamined in future because it is said to have no axial septula according to his description.

Genus *Neoschwagerina* YABE, 1903

Neoschwagerina simplex OZAWA

Pl. 1, figs. 10–12

1927 *Neoschwagerina simplex* OZAWA, pp. 153–154, pl. 34, figs. 7–11, 22 & 23; pl. 37, figs. 3a, 6a; pl. 44, fig. 5a.
1956 *Neoschwagerina simplex*, CHEN, pp. 55–56, pl. 12, figs. 13, 14 & 16 (non fig. 15).
1957 *Neoschwagerina simplex*, KANMERA, pl. 19, figs. 22 & 23; pl. 20, fig. 1.
1959 *Neoschwagerina simplex*, HONJO, pp. 139–142, pl. 3, figs. 1, 4 & 5; pl. 4.
1959 *Neoschwagerina spherica*, HONJO, p. 159, pl. 3, fig. 3.
1959 *Neoschwagerina simplex*, MINATO & HONJO, pl. 1, fig. 2.
1960 *Neoschwagerina* cf. *N. simplex*, KANUMA, pp. 67–68, pl. 11, figs. 1, 10, & 11.
1961 *Neoschwagerina rotunda*, MORIKAWA & ISOMI, pl. 2, figs. 17–20.
1962 *Neoschwagerina simplex*, ISHIZAKI, pp. 175–177, pl. 12, figs. 7 & 8.
1962 *Neoschwagerina craticulifera rotunda*, ISHIZAKI, pl. 11, figs. 12–15; pl. 12, figs. 1–3.
1962 *Neoschwagerina simplex*, SUYARI, p. 36, pl. 2, fig. 1.
1963 *Neoschwagerina simplex*, KANMERA, pp. 112–113, pl. 13, figs. 1–6; pl. 14, figs. 1–6; pl. 19, fig. 15.
1963 *Neoschwagerina simplex*, SHENG, pp. 234–235, pl. 34, figs. 14 & 15.
1967 *Neoschwagerina simplex*, LEVEN, pp. 189–190, pl. 32, figs. 8–10.

Lectotype chosen by HONJO (1959): An axial section, pl. 34, fig. 8, OZAWA, 1927.

Description: One sagittal section and two ill-oriented and slightly deformed specimens are available for study.

Shell is small, inflated fusiform with rounded poles. The shell size of mature specimen is known inexactly because of the absence of ideal axial section that is free from deformation. But the width of the shell attains as long as 3.5 mm in a shell with eleven volutions. Inner one or two volutions of staffeloidal shape are coiled at a large angle to the later volutions as are well demonstrated in a sagittal section (pl. 1, fig. 10). Height of volution from the first to the seventh volution in the same section is, 0.05, 0.05, 0.065, 0.08, 0.115, 0.14 and 0.17 mm, respectively. Proloculus is minute, measuring 0.05 mm in the same specimen.

Spirotheca is thick and coarsely alveolar especially in middle to outer volutions. Its thickness is 0.008 to 0.01 mm in the first two volutions, 0.035 to 0.04 mm in the sixth and 0.05 to 0.065 mm in the outer volutions.

Transverse septula are well developed throughout the shell. Their lower surface is combined with the top of Parachomata. Secondary transverse septula

are not present even in the outer volutions.

Axial septula are weakly developed, revealing some extent of variation. In a mature specimen (pl. 1, fig. 11), incipient type of axial septula begin to appear from probably the sixth volution, and *v* type septula is seen in the outer volutions. While in another ill-preserved specimen (pl. 1, fig. 10) initial axial septula are found only in the outer volutions.

Remarks: The present form is in every available respect identical with *Neoschwagerina simplex* described and figured by OZAWA (1927) although no suitable axial section have been obtained from Shirahone collection.

According to the study by MINATO and HONJO (1959 & 1966) concerning to the nature of axial septula, *Neoschwagerina simplex* is chracterized by the presence of *v* type axial septula.

So far as the axial septula are concerned, *Neoschwagerina craticulifera rotunda* described by ISHIZAKI from Onogahara, Shikoku, Japan, should be treated as *Neoschwagerina* simplex. We agree with KANMERA's opinion that one of CHEN's specimens (pl. 12, fig. 15) in 1956 is not conspecific with other *Neoschwagerina simplex*, since the former has well developed axial septula than the latter.

Quite recently, KOIKE, HASHIMOTO & SATO (1968) illustrated *Neoschwagerina* cf. *simplex* from Mindro, Philippines. So far as the writers are aware, no distinct axial septula are detectable in their illustrations. Taking account of thick spirotheca in their form, it should be better transferred to genus *Maklaya* (KANMERA & TORIYAMA, 1968).

Order Tetracoral HEACKEL

Family Aulophyllidae DYBOWSKI, 1873

Subfamily Yatsengiinae HILL, 1956

Genus ***Yatsengia*** HUANG, 1932

Yatsengia aff. ***ibukiensis*** MINATO

Pl. 2, figs. 1–3.

Compare with:

1955 *Yatsengia ibukiensis* MINATO, pp. 118–120, pl. 28, figs. 1 & 2; tex-figs. 9 & A–C.

1965 *Yatsengia ibukiensis*, YAMAGIWA, IMAI & YAMAMURO, pp. 217–220, figs. 1–5.

Description: Corallum compound, fasciculate and phaceloid. Corallite cylindrical, slender and measures 10 to 11 mm in calicular diameter in mature part.

In transverse section corallite is round and smooth in outline. Wall is thin,

fibrous and is about 100 microns in thickness. Major septa are thin, radially arranged and nearly reach axial column. They are fibronormal in fine structure, and weakly dilated towards epitheca; 100 to 150 microns in tabularium, and 200 to 250 microns in dissepimentarium. The number of the major septa are counted 23 to 26 in mature stage, and 15 to 17 in transverse sections of corallites possessing the calicular diameter of 6.0 to 7.0 mm.

Short minor septa are developed even in immature stage. They do not commonly cross over dissepimentarium. They measure at most 100 microns in thickness in a well oriented transverse section of a mature corallite. Dissepiments are concentric in younger stage, but they become herringbone in mature corallites. Dissepimentarium is narrow, and the boundary between dissepimentarium and tabularium is not clear. Tabularium is broad, about $\frac{7}{9}$ to $\frac{8}{9}$ the diameter of corallite.

Axial structure is distinct especially in mature stage, and occupies about $\frac{1}{3}$ the calicular diameter. Whereas it is not well differentiated from the tabularium in younger stage. It is composed of axial tabellae and septal lamellae. Median plate is not clearly discernible.

In longitudinal section, dissepiments are found to develop in two rows except for younger stage. They are rather variable in size. Tabularium is composed of sparsely arranged tabulae which are inclined downward and outward. They are counted about 5 in a vertical distance of 2 mm.

Axial tabellar are slightly arched upward.

Remarks: Genus *Yatsengia* was first established by HUANG in 1932 as subgenus of *Waagenophyllum*. The present form is safely included in genus *Yatsengia* in essential characteristics. It is distinguished from genus *Heritschioides* by less developed natures in size of corallites, number of septa, mode of development of axial column and dissepiments.

This form is characteristic in possessing highly developed features among *Yatsengia* known until present. *Yatsengia ibukiensis*, described by MINATO (1955) from Ibukiyama, central Japan, is most resembled the present form in the mode of development of major and minor septa, arrangement of dissepiments, but smaller size of corallite and less developed axial column of the latter. According to MINATO, Ibukiyama form is associated with *Misellina* cf. *ovalis*, *Pseudofusulina kraffti* and others. The same species was also lately described from Akasaka by YAMAGIWA, IMAI and YAMAMURO. Akasaka form which is associated with *Minoella nipponica* and *Neoschwagerina simplex* likewise differs from Shiraho form in that the latter contains larger size, well constructed axial column and shorter minor septa than the former.

Yatsengia kabayamaensis MINATO is readily discernible from the present form possessing smaller size, less developed axial column and dissepiments.

Yatsengia hangchowensis differs from the present form because of possession of

less developed chracteristics in every repect of the former.

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PLATE 1 AND EXPLANATION

Explanation of plate 1

Parafusulina nakamigawai MORIKAWA & HORIGUCHI

Fig. 1 Axial section, UHR 19258, ×10

Parafusulina kaerimizensis (OZAWA)

Fig. 2 Axial section, UHR 19262-a, ×10

Chusenella sp.

Fig. 3 Deep tangential section, UHR 19232, ×20

Yangchienia compressa (OZAWA)

Fig. 4 Axial tangential section, UHR 19241-a, ×20
Fig. 5 Deep parallel section, UHR 19241-b, ×20

Pseudofusulina kraffti (SCHELLWIEN & DYRENFURTH)

Fig. 6 Slightly oblique axial section, UHR 19233, ×10
Fig. 7 Axial section, UHR 19248, ×10

Minoella nipponica (OZAWA)

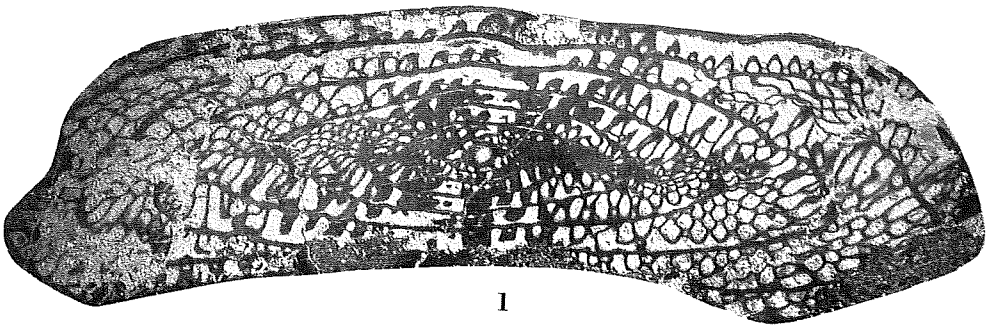
Fig. 8 Axial section of an immature stage, probably slightly tangentially cut, UHR 19231, ×20
Fig. 9 Parallel section. Attention to the nature of axial septula, UHR 19262-b, ×20

Neoschwagerina simplex OZAWA

Fig. 10 Sagittal section UHR 19245, ×20
Fig. 11 Sagittal parallel section, UHR 19253×20
Fig. 12 Tangential section, UHR 19237, ×10

(All specimens are from Shirahone, Nagano Prefecture, Japan)

Plate 1



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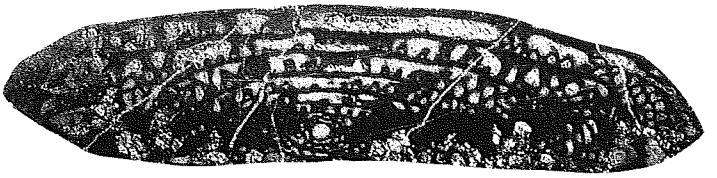

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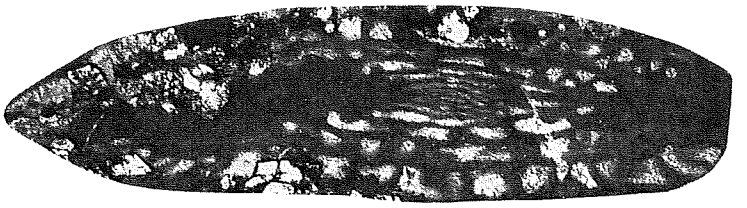

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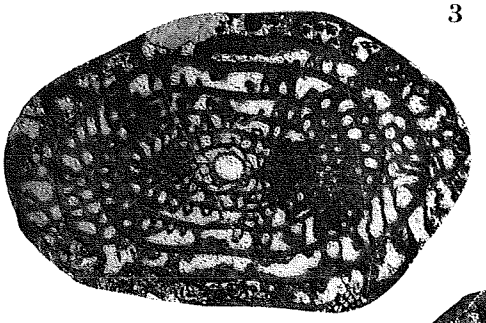

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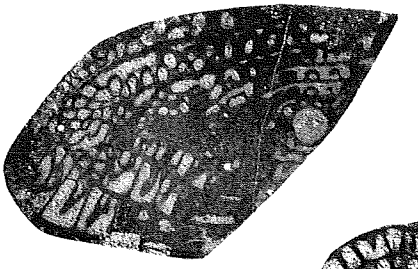

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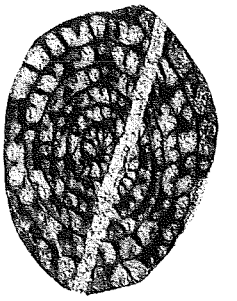

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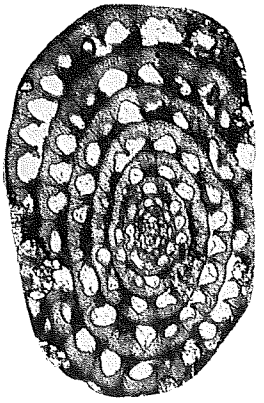

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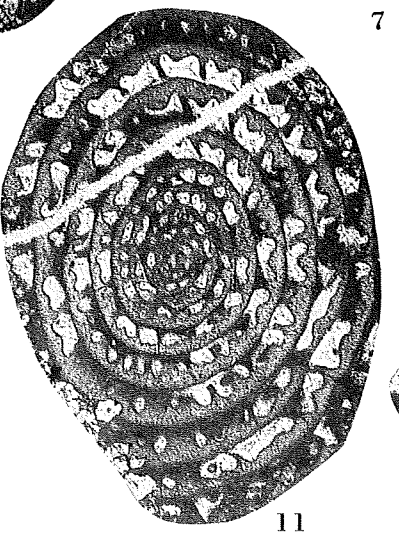

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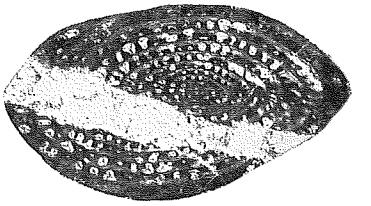


12

PLATE 2 AND EXPLANATION

Explanation of plate 2

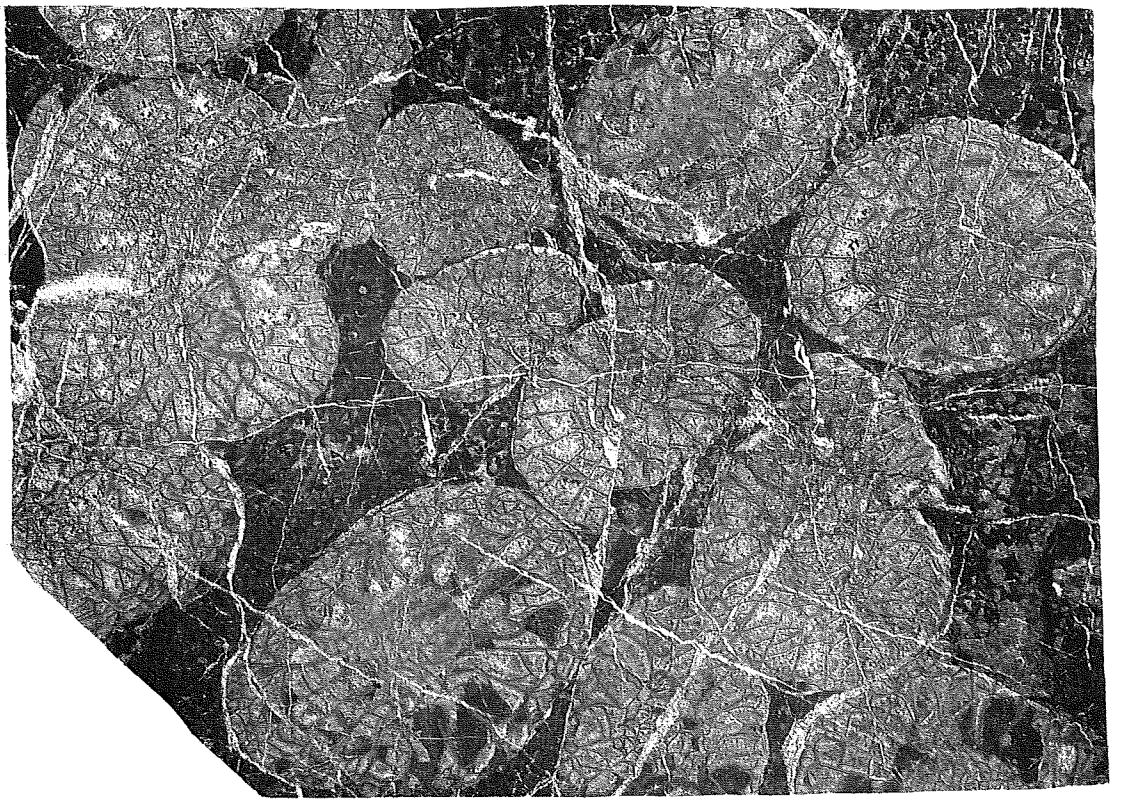
Yatsengia aff. ibukiensis MINATO

Figs. 1, 2 Transverse sections. 1-UHR 19265, ×4. 2-UHR 19264, ×4

Fig. 3 Longitudinal section 19223, ×10.6.

(Locality: shirahone, Nagano Prefecture, Japan)

Plate 2



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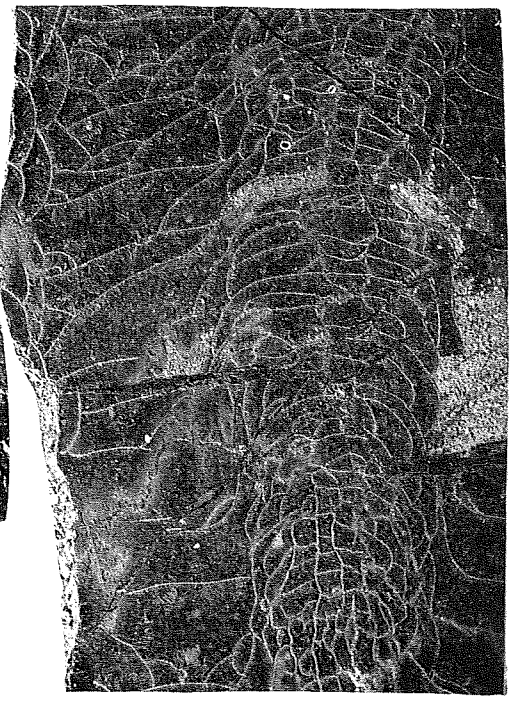

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