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Neoschwagerines from the Yukawa group in the Atetsu Limestone Plateau

By

Kimiyoshi SADA

With 1 Table and 4 Plates

ABSTRACT. Five species of *Neoschwagerina* from the Maki formation, the lower part of the Yukawa group, of the Atetsu limestone in West Japan, are illustrated and described. These indicate that the Maki formation is of the upper Middle Permian age.

CONTENTS

I. INTRODUCTION

The Atetsu limestone plateau is located in the so-called "Kibi highland" of the central part of West Japan, and is well known as one of the large masses of the Carboniferous and Permian limestone as well as the Oga, the Taishaku, and the Akiyoshi limestone, all in West Japan. This limestone has been stratigraphically investigated by some workers, such as KOBAYASHI (1937), MOCHIZUKI (1938), OKIMURA (1958), IMAMURA (1959), and NOGAMI (1961).

However, concerning both Permian stratigraphy and Palaeontology of this limestone plateau, many problems have been left unsolved. In 1960, I summarized the stratigraphy of the Permian deposits in this district as follows in descending order;

Up. Permian	Yukawa group	Terauchi formation	*Lepidolina imamurai* zone *Yabeina shiraiwensis* zone*
		Maki formation	*Neoschwagerina douvillei* zone
Mid. Permian		Unconf.	
Low. Permian	Sabushi group	Shoyama formation	*Parafusulina* zone
		Iwamoto formation	*Pseudoschwagerina* zone

In this paper, I describe *Neoschwagerina craticulifera*, *N. minoensis*, *N. margaritae*, *N. douvillei* and *N. toriyamai*, sp. nov. from the Maki formation, the lower part of the Yukawa group.

Before going into the description, I express my hearty thanks to Professor Sotoji IMAMURA of Hiroshima University for his kind guidance and supervision of the typescript. To Professor Ryuzo TORIYAMA and Assistant Professor Kametoshi KANMERA both of Kyushu University, I wish to offer my sincere thanks for their kind guidance and encouragement through this study and for their kindness of reading the typescript. I also wish to express my thanks to Professor Teiichi KOBAYASHI of the University of Tokyo for giving me the oppotunity to examine the OZAWA's collection.

II. DESCRIPTIONS

Subfamily Neoschwagerininae DUNBAR and CONDRA, 1928, emend. KANMERA, 1957

Genus *Neoschwagerina* YABE, 1903

Type species.—*Schwagerina craticulifera* SCHWAGER, 1883.

Neoschwagerina toriyamai, sp. nov.
Pl. XI, figs. 1–11.

* The lower part of the Terauchi formation was interpreted by me (1960) under the name of *Yabeina globosa* Zone. My latest study, however, strongly suggests that the name of this zone is unsuitable. In the present paper, I newly designate it as the *Yabeina shiraiwensis* zone.

Material.—Holotype, Rg. No. IGSH-Hr-SA514-22, from the *Neoschwagerina douvillei* zone in the Hirosé area. This specimen is figured as fig. 3 on Pl. XI. Axial sections of paratypes, Rg. No. IGSH-Hr-SA514-19 here figured as fig. 3 on Pl. XI, IGSH-Hr-SA514-23 as fig. 10 on Pl. XI, IGSH-Hr-SA514-6 as fig. 7 on Pl. XI, IGSH-Hr-SA 514-17 as fig. 10 on Pl. XI, IGSH-Hr-SA514-25(a) as fig. 6 on Pl. XI, IGSH-Hr-SA 514-8 as fig. 5 on Pl. XI. Tangential sections of paratypes, Rg. No. IGSH-Hr-SA 514-34 (Pl. XI, fig. 11), IGSH-Hr-SA514-25(b) (Pl. XI, fig. 0), IGSH-Hr-SA514-14 (Pl. XI, fig. 4), IGSH-Hr-SA514-39 (Pl. XI, fig. 2), IGSH-Hr-SA514-38, IGSH-Hr-SA514-7 and IGSH-Hr-SA514-21. All from the Maki formation distributed in the Hirosé area (loc. No. Hr-SA514).

More than twenty specimens of this species from Yukawa (loc. Yu-SA15, Yu-SA 22 and Yu-SA13, Sada, 1960) were examined. Some specimens obtained from Kanikawa (loc. KT-SA7) of the eastern part of the Atetsu plateau are also referable to this species. Most of the specimens are more or less deformed.

Description.—The shell of *Neoschwagerina toriyamai*, sp. nov. is large and elongate fusiform, having a straight axis of coiling and bluntly pointed poles. The lateral slopes are straight to somewhat convex.

The largest length and width of the mature specimens can not be measured exactly, because the outer several volutions of the mature shell are eroded out in the time of deposition. The shell of fourteen volutions of the holotype is 6.9 mm. in length and 2.6 mm. in width, with a form ratio of 2.6. The shells of most specimens are 7.5 to 9.0 mm. in length and 3.5 to 4.5 mm. in width. The form ratio ranges from 2.1 to 2.6, and 2.3 in many of the specimens. The ratios of the half length to the radius vectors in the holotype are 1.5, 1.7, 2.1, 2.3, 2.4, 2.3, 2.4, 2.2, 2.2, 2.1, 2.1, 2.2, 2.3, 2.1, and 2.1, respectively, for the first to the fifteenth volution. The average ratios of the half length to the radius vectors in seven specimens are 1.7, 2.0, 1.8, 1.9, 2.1, 1.9, 1.9, 2.1, 1.9, 1.9, 2.1, 2.1, 2.2, 2.2, and 2.2, respectively, for the first to the fifteenth volution.

The proloculus is small and spherical to subspherical and its outside diameter measures 115 to 184 microns, mostly 128 to 138 microns. The shell is tightly coiled in the inner five or six volutions and expands more rapidly and uniformly in the outer ones. The average radius vectors of the first to the fourteenth volution in seven specimens are 42, 66, 128, 186, 285, 410, 408, 637, 789, 1225, 1085, 1232, 1496, and 1269 microns, respectively. The chambers are almost the same in height in the central two-thirds to three-fourths of the shell, and become higher in the polar regions.

The spirotheca is thin, consisting of a tectum and a finely alveolar keriotheca. The alveoli are clearly seen in the most parts of the shell. The thickness of the spirotheca measured at the thinnest point between adjacent primary spiral septula in the holotype is 9.5, 8.6, 14.3, 8.6, 17.1, 9.5, 10.5, 4.8, 6.6, 12.4, 6.7, 12.4, and 11.4 microns, respectively, for the first to the thirteenth volution..

The septa consist of the downward deflection of the tectum and the keriotheca on both sides of the tectum. The tips of most septa are bent anteriorly at the sharp angles and almost solidified. The septal counts in seven specimens are 6, 9, 9, 13, 12 ?, 14, 15, 17, 21, and 20 ?, respectively, for the first to the tenth volution. The axial septula develop throughout the shell.

One axial septulum occurs in the first volution, one to two in the sixth to the tenth, and two to three in the outer volutions.

The primary spiral septula are present throughout the shell, and are considerably broad. Their lower ends are in contact with the tops of the parachomata.

The secondary spiral septula do not occur in the first six to eight volutions of most of the specimens, but rudimentary secondary spiral septula occasionlly appear in the seventh to the ninth volution in some specimens.

The foramina are circular to ellipsoidal in the cross-section, and their diameters are small.

Remarks.—*Neoschwagerina toriyamai*, sp. nov. resembles *N. douvillei* OZAWA more closely than any other Japanese forms. They are, however, distinguished from each other, for *N. toriyamai* is larger and more elongate fusiform, the straight to somewhat convex lateral slopes, narrower polar regions, larger form ratios for corresponding volutions, smaller proloculus, thinner spirotheca, and broader primary spiral septula.

N. toriyamai is cleary distinguishable from *N. craticulifera* (SCHWAGER) and *N. craticulifera haydeni* (DOUTKEVICH and KHABAKOV). Major differences are seen in that the former species has a larger shell, a larger form ratio, and thinner spirotheca.

N. toriyamai is similar to *N. simplex* described by CHEN (1956, pp. 55–56, pl. 12, figs. 13–16) from the Maok'ou limestone, and it seems as if the latter is a form of the younger stage of the former. However, the present species differs from CHEN's specimen in having a larger shell, more numerous volutions at maturity, thinner spirotheca and more tightly coiled shell.

The species closely resembles an elongate form of *N. douvillei* (CHEN, 1956, pp. 58–59, pl. 13, fig. 5) from the Maok'ou limestone in general shell shape and internal features. The close similarity between *N. toriyamai* and CHEN's *N. douvillei* strongly suggest that both species may be conspecific. According to the kind private communication from Prof. S. CHEN, his opinion is as follows: "Now I reconsider that this form may be a variety of *N. douvillei* or even a different species of that genus." I believe that CHEN's form can be referred to this new species.

Occurrence.—*Neoschwagerina toriyamai*, sp. nov, was collected from the Maki formation at Hirosé (loc. Hr-SA 514), Tazu (loc. Tz-SA 7), Kanikawa (KT-SA 7), and Shimoyukawa (loc. Yu-SA15, Yu-SA22, and Yu-SA13). The first is a representative locality. The associated species are *N. douvillei*, *N. margaritae*, *N. minoensis*, *Yabeina katoi*, etc.

Geological horizon.—The *Neoschwagerina douvillei* zone.

Neoschwagerina craticulifera (SCHWAGER)
Pl. XIII, figs. 1–6.

1883. *Schwagerina craticulifera* SCHWAGER: in RICHTHOFEN's *China, Vol. 4*, p. 140, pl. 18, figs. 15-25.
1898. *Möllerina craticulifera*, SCHELLWIEN: *Palaeontographica, Vol. 44*, p. 258.
1903. *Doliolina craticulifera*, SCHELLWIEN: *Paläozoische und Triadische Fossilien aus Ostasien in Futterer's Durch Asien, Bd. 3*, pp. 125-174, pl. 5, fig. 5.
1906. *Neoschwagerina craticulifera*, YABE: *Jour. Coll. Sci. Vol. 21, Art. 5*, p. 3, pl. 1, fig. 3.
1909. *Neoschwagerina craticulifera*, HAYDEN: *Record Geol. Surv. India, Vol. 38, Part 3*, pp. 249, pl. 21, figs. 1-7.
1912. *Neoschwagerina craticulifera*, DEPRAT: *Mem. Serv. Géol. l'Indochine, Vol. 1, Fasc. 3*, pp. 47-49, pl. 2, figs. 1, 2, 4.
1914. *Neoschwagerina craticulifera* var. *rotunda* DEPRAT: *Ditto*, p. 26, pl. 8, figs. 6-13.
1927. *Neoschwagerina craticulifera*, OZAWA: *Jour. Fac. Sci. Vol. 2, Part 3*, pp. 154-156, pl. 40, figs. 1-3, 4-8, 10, 11a.
1942. *Neoschwagerina craticulifera*, TORIYAMA: *Japan. Jour. Geol. Geogr., Vol., 18, No. 4*, pp. 244-245, pl. 24, fig. 13.
1944. *Neoschwagerina craticulifera*, TORIYAMA: *Japan. Jour. Geol. Geogr., Vol. 19, Nos. 1-4*, pp. 81-82, pl. 6, fig. 26.
1947. *Neoschwagerina craticulifera*, TORIYAMA: *Japan. Jour. Geol. Geogr., Vol. 20, Nos. 2-4*, pp. 76-77, pl. 17, figs. 4-7.
1952. *Neoschwagerina craticulifera*, KONISHI: *Trans. Proc. Paleont. Soc. Japan, N. S. No. 5*, p. 159, pl. 14, fig. 6.
1957. *Neoschwagerina craticulifera*, KOBAYASHI: *Sci. Rep. Tokyo Kyoiku Daigaku, Sec. C, Vol. 5, No. 48*, pp. 303-305, pl. 9, fig. 8-13.
1958. *Neoschwagerina craticulifera*, TORIYAMA: *Mem. Fac. Sci. Kyushu Univ. Ser. D, Geology, Vol. 7*, pp. 215-220, pl. 40, pl. 41, figs. 1-5.
1959. *Neoschwagerina craticulifera*, HONJO: *Jour. Fac. Sci. Hokkaido Univ. Ser. 4, Vol. 10, No. 1*, pp. 142-146, pl. 3, figs. 6, 8, 9, pl. 6, figs. 5, 6.

The lectotype of Neoschwagerina craticulifera (SCHWAGER).—The original specimen figured by SCHWAGER (1883, pp. 140-143, pl. 18, fig. 17) were designated by THOMPSON (1948, p. 63) as the lectotype.

Material.—Axial sections from loc. SHB-SA and Hr-SA514, Rg. No. IGSH-SHB-SA1-18 (Pl. XIII, fig. 1), IGSH-SHB-SA1-15 (Pl. XIII, fig. 4), IGSH-SHB1-10 (Pl. XIII, fig. 2), IGSH-SHB1-16 (Pl. XIII, fig. 6), IGSH-Hr-SA514-8 (Pl. XIII, fig. 5, slightly oblique axial section), and IGSH-Hr-SA514-41 (Pl. XIII, fig. 3). A large number of specimens, from loc. Yu-SA23, Yu-SA24, Yu-SA51, Yu-SA18, Yu-SA22, Yu-SA11, and KT-SA7, were examined.

Description.—The shell of *Neoschwagerina craticulifera* (SCHWAGER) is small and inflated fusiform, with a straight axis of coiling and bluntly to rounded poles. The lateral slopes are convex. Although the largest length and width of the mature shell can not be known exactly due to the ill-preservation, the mature specimens of ten to eleven volutions have an axial length of 2.5 to 4.3 mm. and a median width of 1.5 to 2.5 mm. The form ratio is 1.6 to 1.7 in seven specimens. The average ratios of the half length to the radius vectors in five specimens are 1.1, 1.2, 1.2, 1.3, 1.4, 1.5, 1.5, 1.4, 1.4, 1.4, 1.3, and 1.3, respectively, for the first to the twelfth volution.

The proloculus is minute and spherical, having an outside diameter of 56.7 to 113.0 microns in five specimens. The shell is tightly coiled in the inner three to four volutions, but expands rapidly and uniformly in the outer volutions. The average radius vectors in five specimens are 78, 104, 173, 245, 311, 402, 516, 660, 779, 874, and 1335 microns, respectively, for the first to the eleventh volution. The heights of the chambers are the same throughout the length of the shell except in the polar regions where they are somewhat higher.

The spirotheca is thin, and is composed of a tectum and a keriotheca. The alveoli of the spirotheca are distinct. The thickness of the spirotheca at the thinnest point between adjacent septula in five specimens averages 18, 18, 18, 18, 18, 15, 15, 17, 18, and 28 microns, respectively, for the first to the ninth volution.

The septa are broad, consisting of the downward deflection of the tectum and the keriotheca, the latter is extending downward on both sides of the tectum. The septa are extending almost at a right angle to the spirotheca.

The axial septula occasionally appear in the inner five volutions and are very short. In the outer volutions they occur generally one to two between the adjacent septa. The primary spiral septula are present throughout the shell except in the first one. They are in deep contact with the tops of the parachomata. The secondary spiral septula are absent in the inner six to seven volutions, but beyond the sixth or the seventh volution the secondary spiral septulum rarely occurs between adjacent primary septula.

In the cross-section, the foramina are small and elliptical in shape.

Remarks.—*Neoschwagerina craticulifera* (SCHWAGER) is well-known in the middle Permian of Japan. Recently, the species was described in detail by TORIYAMA (1958) from the Akiyoshi limestone. He pointed out that the species was variable in its shell size and rate of expansion, and the lectotype (SCHWAGER, 1883, pl. 18, fig 17) was not typical for the species but represented an extremity of the specific variation. Judging from all the observable characters, the specimens described above are best referred to *N. craticulifera* (SCHWAGER).

Occurrence.—The species occurs abundantly in the Maki formation. The favourable localities are as follows; Hirosé (loc. Hr-SA514), Shimoyukawa (loc. Yu-SA15 and Yu-SA22), Futatsugi, Maki, Kanikawa (loc. KT-SA7) and others.

Geological horizon.—The *Neoschwagerina douvillei* zone.

Neoschwagerina minoensis DEPRAT em. OZAWA
Pl. XII, figs. 9–12.

1914. *Neoschwagerina craticulifera* var. *minoensis* DEPRAT: *Mém. Serv. Géol. Indochine, III^e Mém.* p. 27, pl. 7, figs. 9, 10.

1914. *Neoschwagerina multicircumvoluta* DEPRAT: *Ditto*, p. 27, pl. 8, figs. 2, 3. (non figs. 1, 4, 5)

1927. *Neoschwagerina mihoensis* DEPRAT, em. OZAWA: *Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 2, Part 3,* pp. 155–157, pl. 41, figs. 4–8, pl. 43, fig. 2b.

The lectotype of Neoschwagerina minoensis DEPRAT em. OZAWA.—The specimen illustrated as fig. 9 on pl. 7 by DEPRAT (1914), one of the syntypes, is here designated as the lectotype.

Material.—The specimens obtained from the Hirosé area are as follows: Axial sections, Rg. No. IGSH-Hr-SA 514-11, illustrated as fig. 11 on Pl. XII, IGSH-Hr-SA 514-32 (Pl. XII, fig. 12), IGSH-SHB-SA 1-1 (Pl. XII, fig. 10) and IGSH-SHB-SA 1-28 (Pl. XII, fig. 9). Besides them, there are many specimens from the following localities: loc. Yu-SA 18, Yu-SA 17, Yu-SA 12, Yu-SA 15, Yu-SA 22.

Description.—The shell of *Neoschwagerina minoensis* DEPRAT is moderate and rhombic, having a straight axis of coiling and considerably bluntly pointed poles. The lateral slopes are concave in the median portion. First two or three volutions are subspherical in shape and beyond the fourth volution the shell attains its mature shape.

The largest length and width of specimens are not known, because a few outer volutions of the mature shell were missing in the time of deposition. The mature specimen of fourteen volutions is 4.1 mm. in length and 3.5 mm. in width, giving a form ratio of 1.2.

The proloculus is very small and spherical. The expansion of the shell is slow and uniform in the inner three volutions, but is rapid in the outer volutions.

The spirotheca is considerably thin, and is composed of a tectum and a keriotheca. The average thickness of the spirotheca measured at the thinnest point between adjacent primary spiral septula in five specimens is 25, 21, 21, 21, 21, 16, 23, 18, 23, 25, 27, 25, and 23 microns, respectively, for the first to the thirteenth volution.

In the transverse section the septa are numerous, and one or two axial septula are intercalated between adjacent septa in the outer volutions. The primary spiral septula are present throughout the shell. The secondary spiral septula are developed in the last volution, but they are short.

Remarks.—*Neoschwagerina minoensis* was described by DEPRAT (1914) under the subspecific name of *N. craticulifera* from the Permian limestone of Akasaka, Japan.

OZAWA (1925) described and illustrated this species as *N. minoensis* from the same limestone bed of Akasaka. The species is not so common in the Permian rocks of Japan. My specimens, here illustrated, well agree with his specimens (pl. 41, figs. 4–8; pl. 42, fig. 2b) in the measured value and internal feautures.

Occurrence.—The specimens treated here were obtained from many localities in the Maki formation, and are associated with *N. toriyamai*, *N. douvillei*, *Yabeina katoi*, etc.

Geological horizon.—The *Neoschwagerina douvillei* zone.

Neoschwagerina douvillei OZAWA
Pl. XII, figs. 1–8.

1906. *Neoschwagerina globosa* DOUVILLE: *Bull. Soc. Géol. France*, pl. 17, figs. 1-2.
1912. *Neoschwagerina globosa*, DEPRAT: *Mém. Serv. Géol. Indochine, Vol. 1, Fasc. 3*, p. 51, pl. 4, figs. 1-4.
1925. *Neoschwagerina douvillei*, OZAWA: *Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. 45*, Art. 6, pp. 55-57, pl. 11, figs. 5-6.
1935. *Neoschwagerina douvillei*, GÜBLER: *Mém. Soc. France, No. 26*, pp. 111-113, pl. 6, fig. 2; pl. 8, figs. 6, 10 (non pl. 7, figs. 7, 8, 10, 11).
1936. *Neoschwagerina douvillei*, HUJIMOTO: *Sci. Rep. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2*, pp. 114-115,

pl. 23, figs. 1-5.

1947. *Neoschwagerina douvillei*, TORIYAMA: *Japan. Jour. Geol. Geogr. Vol. 20, Nos. 2-4*, pp. 78-79, pl. 17 fig. 8.

1956. *Neoschwagerina douvillei*, CHEN: *Palaeontologia Sinica New Ser. B, No. 6*, pp. 58-59, pl. 13, figs. 3-7; pl. 14, fig. 7.

1958. *Neoschwagerina douvillei*, TORIYAMA: *Mem. Fac. Sci. Kyushu Univ. Ser. D, Vol. 7*, pp. 222-227, pl. 14, figs. 9-13; pl. 42, figs. 1-6.

The lectotype of Neoschwagerina douvillei OZAWA.—DOUVILLE's specimen (1906, pl. 18, fig. 1) was designated by TORIYAMA (1958, p. 226) as the lectotype.

Material.—Specimens from loc. Hr-SA 514; Rg. No. IGSH-Hr-SA 514-4 (Pl. XII, fig. 2), IGSH-Hr-SA 514-11 (Pl. XII, fig. 1), IGSH-Hr-SA 514-22 (Pl. XII, fig. 6), IGSH-Hr-SA 514-24 (Pl. XII, fig. 4), IGSH-Hr-SA 514-3, etc. From loc. Yu-SA 18; Rg. No. IGSH-Yu-SA 18-86 (Pl. XII, fig. 3), IGSH-Hr-SA 8-60 (Pl. XII, fig. 7), IGSH-Yu-SA 8-26, IGSH-Yu 8-37, IGSH-Yu 8-45, IGSH-Yu 8-53, etc. Beside them, many specimens referred to the species were collected by me from the following localities: loc. Yu-SA 22, Yu-SA51, and Yu-SA13.

Description.—The shell of *Neoschwagerina douvillei* OZAWA is moderately large and inflated fusiform, with a straight axis of coiling, completely convex lateral slopes, and broadly rounded poles. The largest length and width of the mature specimens can not be measured, because the outer several volutions of the shell are eroded off in the time of deposition. The mature specimens of fourteen volutions are about 7mm. in length and 4 mm. in width, having a form ratio of 1.7 to 1.8. The first to third volutions are subspherical to ellipsoidal with rounded poles. Beyond the fifth volution the shell attains its mature shape.

The proloculus is of moderate size and spherical to ellipsoidal in shape, with an outside diameter of 115 to 246 microns. The shell is tightly coiled in the inner four to five volutions and expands more loosely but almost uniformly in the outer ones.

The height of the chamber is almost the same in the length of the shell except in the extreme polar ends.

The spirotheca is thin and consists of a tectum and a keriotheca. Fine alveoli are clearly seen even in the initial volution.

The septa are composed of the downward deflection of the tectum and the keriotheca. The latter extends down on both sides of the former for a short distance. The septa are bent anteriorly at a large angle in their tips. The axial septula are present throughout the shell. They are not equal in length and shape in the cross-section. The primary spiral septula occur throughout the shell, and the secondary spiral septula are not present in most volutions, but the short secondary spiral septula occur occasionally in the outer volutions.

Remarks.—In Japan, *Neoschwagerina douvillei* is common in the Middle Permian rocks. Recently, TORIYAMA described and illustrated the species (1958, pp. 223-237, pl. 41, figs. 9-13; pl. 42, figs. 1-6) from the Akiyoshi limestone. The specific characters of my specimens agree closely with those of the lectotype (DOUVILLE, 1905, pl. 18, fig.

1) and TORIYAMA's specimens.

Occurrence.—Abundant in the Maki formation; associated with *Neoschwagerina toriyamai*, *N. craticulifera*, *N. minoensis*, *N. margaritae*, *N. megaspherica*, and *Yabeina katoi*. Sparse in the Terauchi formation; associated with *Yabeina katoi*, *Y. shiraiwensis*, *Y. columbiana*, and *Sumatrina annae*. The favourable localities are Hr-SA514, Yu-SA22, Yu-SA51, Yu-SA18, Yu-SA13, Yu-SA52, Yu-SA17, Yu-SA12 and Yu-SA15.

Geological horizon.—The *Neoschwagerina douvillei* and *Yabeina shiraiwensis* zones.

Neoschwagerina margaritae DEPRAT
Pl. XIII, fig. 9.

1913. *Neoschwagerina margantae* DEPRAT: *Mém. Serv. Géol. Indochine, IIe Mém.* pp. 58-60, pl. 8, fig. 10, pl. 9, figs. 1-3.
1914. *Neoschwagerina margaritae*, DEPART: *Mém. Serv. Géol. Indochine, IIe Mém. Vol. 3*, pp. 28-29, pl. 7, fig. 3.
1925. *Neoschwagerina margaritae*, OZAWA: *Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. 14, Art. 6*, p. 58, pl. 11, figs, 1, 3.
1927. *Neoschwagerina margaritae*, OZAWA: *Jour. Coll. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 2, Part 3*, pp. 158-159, pl. 42, figs. 5, 7.
1936. *Neoschwagerina margaritae*, HUJIMOTO: *Sci, Rep. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2*, pp. 117-118, pl. 22, figs. 16-17, pl. 24, figs. 1-4.
1956. *Neoschwagerina margaritae*, CHEN: *Palaeontologia Sinica, New Ser. B, No. 6*, pl. 10, figs. 1-3.
1957. *Neoschwagerina margaritae*, KOBAYASHI: *Sci. Rep. Tokyo Kyoiku Daigaku, Sec. C, Vol. 5, No. 48*, pp. 305-306, pl. 10, figs. 1-2.

The lectotype of Neoschwagerina margaritae DEPRAT.—The specimen illustrated as fig. 1 on pl. 9 by DEPRAT (1913), one of the syntypes, is here designated as the lectotype.

Material.—Specimen from loc. Yu-SA22; Rg. No. IGSH-Yu-SA22-3 (Pl. XIII, fig. 9). Others are as follows: IGSH-Yu-SA9-1 to IGSH-Yu-SA9-10, IGSH-Yu-SA13-4, IGSH-Yu-SA13-6, IGSH-Yu-SA13-18, IGSH-Yu-SA13-21, IGSH-Yu-SA18-46, IGSH-Yu-SA18-25, IGSH-Yu18-36, IGSH-Yu-SA18-16, IGSH-Yu-SA18-21, IGSH-Yu-SA 11-14, IGSH-Yu-SA11-12, IGSH-Yu-SA11-2, IGSH-Hr-SA514-3, and IGSH-Hr-SA 514-23.

Descriptive remarks.—The shell of *Neoschwagerina margaritae* DEPRAT is large and globular to subspherical, possessing a straight axis of coiling. The shell of the first seven or eight volutions is tightly coiled and beyond the eighth volution the shell attains its mature shape. The adult specimens of sixteen volutions are measured as about 7 mm. in length and 6 mm. in width in five specimens. The maximum value of the adult specimens can not be known, because the last two or three volutions of the specimens are broken away in the time of deposition. The form ratio is about 1.1 to 1.2 in five specimens.

The proloculus is small and spherical, and its outside diameter is less than 100 microns. The expansion of the shell is very slow and uniform in the inner seven to eight volutions and more rapid in the outer ones.

The spirotheca is considerably thin, and is composed of a tectum and a keriotheca. Its thickness is measured as 46 microns in the outermost volution. The primary spiral septula are thin and straight. The secondary spiral septula are developed in the outer volutions, but they are thin and very short. The septa are thin and irregular in its shape. One axial septulum is present between the adjacent septa in the inner volutions, and one to three in the outer ones.

The present specimens show a fairly wide variation in shape and size of the shell, and they are more close to HUJIMOTO's specimens (1936, pp. 117–118, pl. 22, figs. 16, 17; pl. 24, figs. 1–4) and KOBAYASHI's (1957, pp. 306–308, pl. 10, figs. 3–6) rather than DEPRAT's original types (1913, pp. 58–60, pl. 8, fig. 10; pl. 9, fig. 1–3). The species is commonly found in the *N. douvillei* zone in this district, associating with *N. douvillei*, *N. toriyamai*, etc.

Occurrence.—Common in the Maki formation; associated with *Neoschwagerina craticulifera*, *N. douvillei*, *N. toriyamai*, and *Yabeina katoi*. Sparse in the Terauchi formation; associated commonly with *Yabeina katoi*, *Y. shiraiwensis*, *Y. columbiana*, and *Sumtrina annae*. The localities are Yu-SA22, Yu-SA9, Yu-SA13, Yu-SA18, Yu-SA11, and Hr-SA514.

III. SUMMARY

The fusulinid fauna of the Maki formation is mainly characterized by a large number of species of *Neoschwagerina*, associating with *Yabeina katoi* (OZAWA) and *Sumatrina annae* Deprat. The specific names and their distributions are summarized in the following table.

Localities / Specific names	Western part				Eastern part				
	L1	L2	L3	L4	L5	L6	L7	L8	L9
Neoschwagerina craticulifera (SCHWAGER)	×	×	×		×	×	×	×	×
N. minoensis DEPRAT		×				×	×	×	×
N. margaritae DEPRAT	×	×	×	×	×	×	×	×	×
N. megaspherica DEPRAT	×	×		×	×	×		×	×
N. douvillei OZAWA	×	×	×	×	×	×	×	×	×
N. toriyamai SADA, sp. nov.		×			×	×			×
Yabeina katoi (OZAWA)		×		×	×	×	×		×
Afghanella sp.	×	×		×			×	×	×
Sumatrina annae VOLZ	×	×	×	×	×	×	×	×	×
Verbeekina sp.	×		×	×	×	×	×	×	×
Parafusulina armstrongi THOMPSON		×							
P. sp.						×			×
Schwagerina spp.	×	×	×	×	×	×	×	×	×
Pseudodoliolina sp.	×			×			×		×

L1. Hongo L2. Hirosé L3. Tazu L4. Futatsugi L5. Maki
L6. Shimoyukawa L7. Yorikuni L8. Morikuni L9. Kanikawa

Of these, *Neoschwagerina douvillei* occurs most abundantly throughout the formation in many localities cited above. Therefore, I designate this formation as the *N. douvillei* zone.

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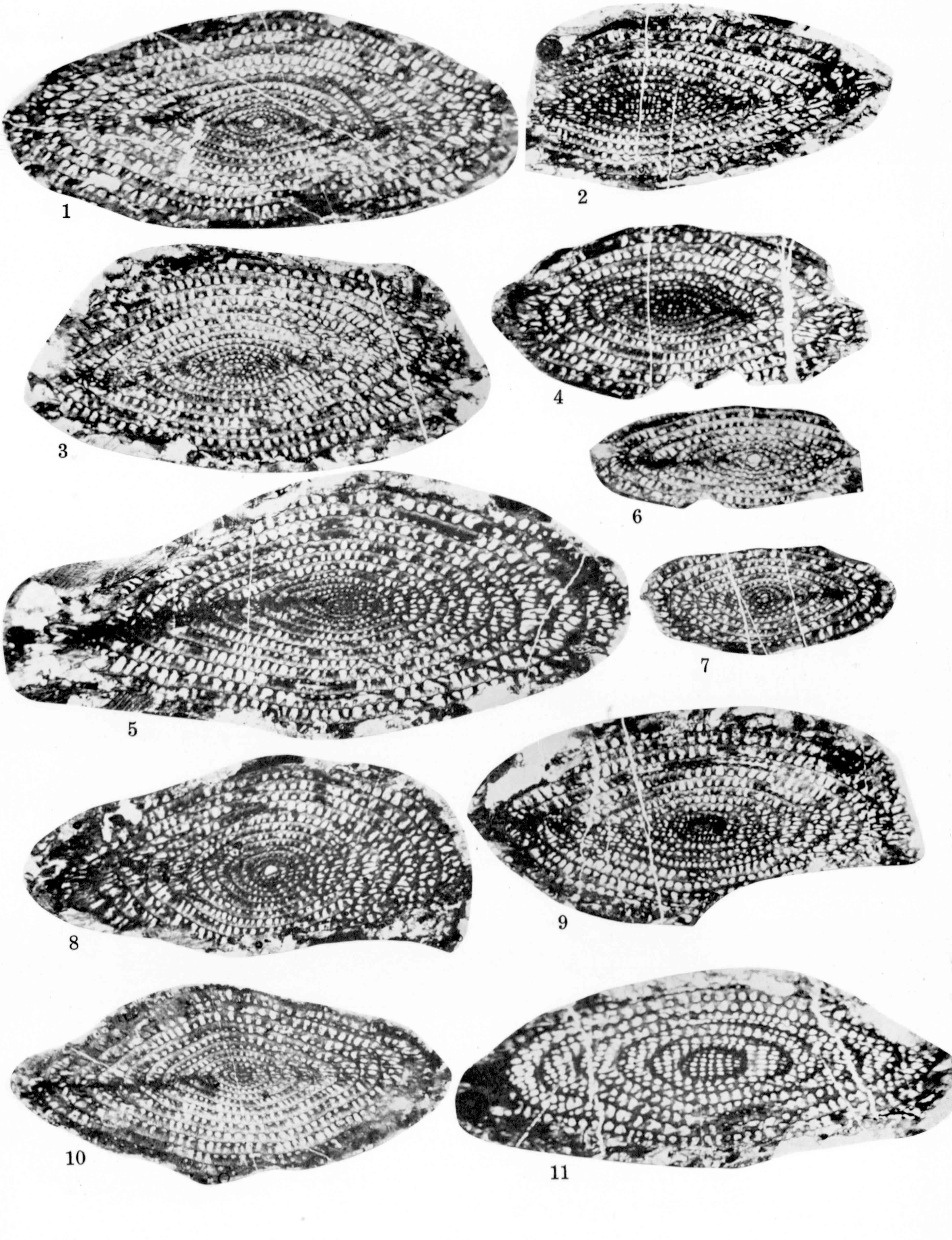
Explanation of Plate XI.

All × 10

Figs. 1–11.	*Neoschwagerina toriyamai*, sp. nov.	Page 118.
1.	Axial section of the holotype,	IGSH-Hr-SA 514–22.
2.	Tangential section of the paratype,	IGSH-Hr-SA 514–34.
3.	Axial section of the paratype,	IGSH-Hr-SA 514–19.
4.	Tangential section of the paratype,	IGSH-Hr-SA 514–14.
5.	Axial section of the paratype,	IGSH-Hr-SA 514–17.
6.	Axial section of the paratype,	IGSH-Hr-SA 514–25 (a).
7.	Axial section of the paratype,	IGSH-Hr-SA 514–6.
8.	Axial section of the paratype,	IGSH-Hr-SA 514–8.
9.	Tangential section of the paratype,	IGSH-Hr-SA 514–25 (b).
10.	Axial section of the paratype,	IGSH-Hr-SA 514–23.
11.	Tangential section of the paratype,	IGSH-Hr-SA 514–23.

(All from loc. Hr-SA 514)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Explanation of Plate XII.

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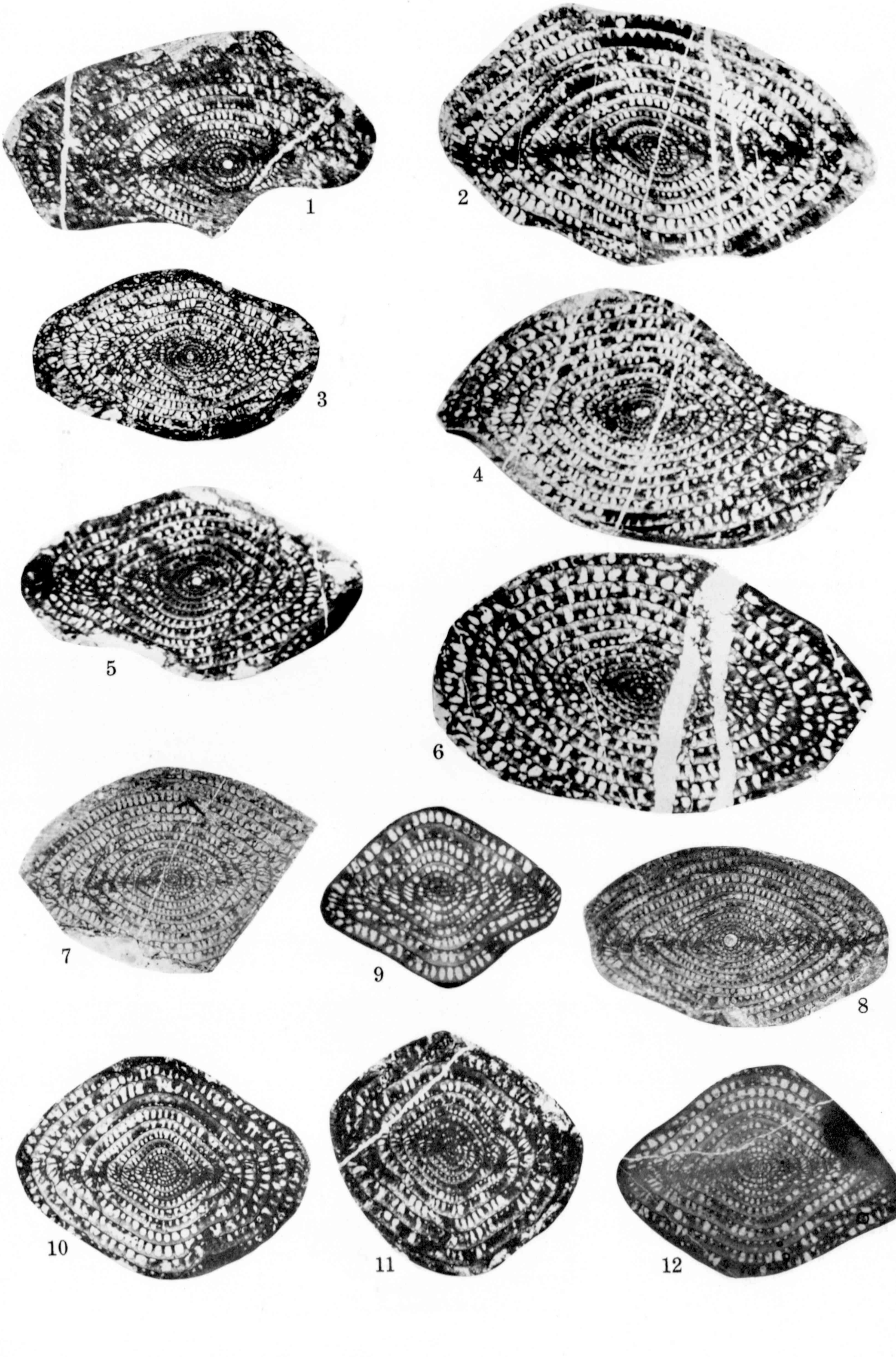
Figs. 1-8. *Neoschwagerina douvillei* Ozawa .... Page 123.

1.	Axial section from loc. Hr-SA 514,	IGSH-Hr-SA 514-11.
2.	Axial section from loc. Hr-SA 514,	IGSH-Hr-SA 514-4.
3.	Axial section from loc. Yu-SA 8,	IGSH-Yu-SA 8-86.
4.	Axial section from loc. Hr-SA 514,	IGSH-Hr-SA 514-24.
5.	Axial section from loc. Hr-SA 514,	IGSH-Hr-SA 514-10.
6.	Axial section from loc. Hr-SA 514,	IGSH-Hr-SA 514-22.
7.	Axial section from loc. Yu-SA 8,	IGSH-Yu-SA 8-60.
8.	Axial section from loc. Yu-SA 22,	IGSH-Yu-SA 22-8.

Figs. 9-12. *Neoschwagerina minoensis* Deprat em. Ozawa .... Page 122.

9.	Tangential section from loc. SHB-SA 1,	IGSH-SHB-SA 1-28.
10.	Axial section from loc. SHB-SA 1,	IGSH-SHB-SA 1-1.
11.	Axial section from loc. Hr-SA 514,	IGSH-Hr-SA 514-11.
12.	Axial section from loc. Hr-SA 514,	IGSH-Hr-SA 514-32.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EXPLANATION OF PLATE XIII.

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Figs. 1–6. *Neoschwagerina craticulifera* (SCHWAGER) .... Page 120.

1.	Axial section from loc. SHB-SA 1,	IGSH-SHB-SA 1–18.
2.	Axial section from loc. SHB-SA 1,	IGSH-SHB-SA 1–10.
3.	Axial section from loc. Hr-SA 514,	IGSH-Hr-SA 514–41.
4.	Axial section from loc. SHB-SA 1,	IGSH-SHB-SA 1–15.
5.	Axial section from loc. Hr-SA 514,	IGSH-Hr-SA 514–8.
6.	Sagittal section from loc. SHB-SA 1,	IGSH-SHB-SA 1–16.

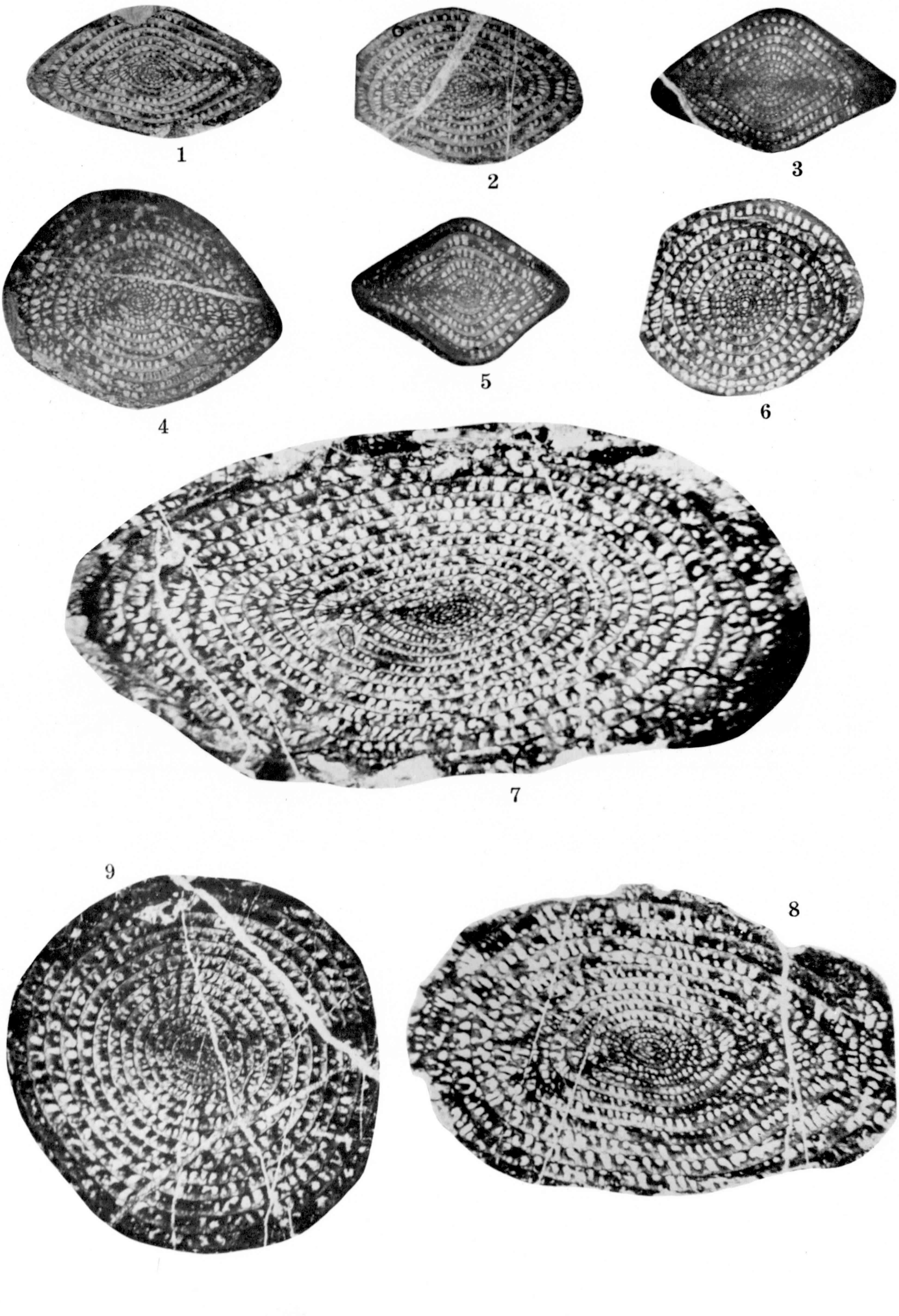
Figs. 7–8. *Neoschwagerina* sp. A

7.	Axial section (slightly oblique),	IGSH-Hr-SA 514–21.
8.	Axial section (slightly oblique),	IGSH-Hr-SA 514–4.

(All from loc. Hr-SA 514)

Figs. 9. *Neoschwagerina margaritae* DEPRAT .... Page 125.

9.	Axial section from loc. Yu-SA 22,	IGSH-Yu-SA 22–3.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EXPLANATION OF PLATE XIV.

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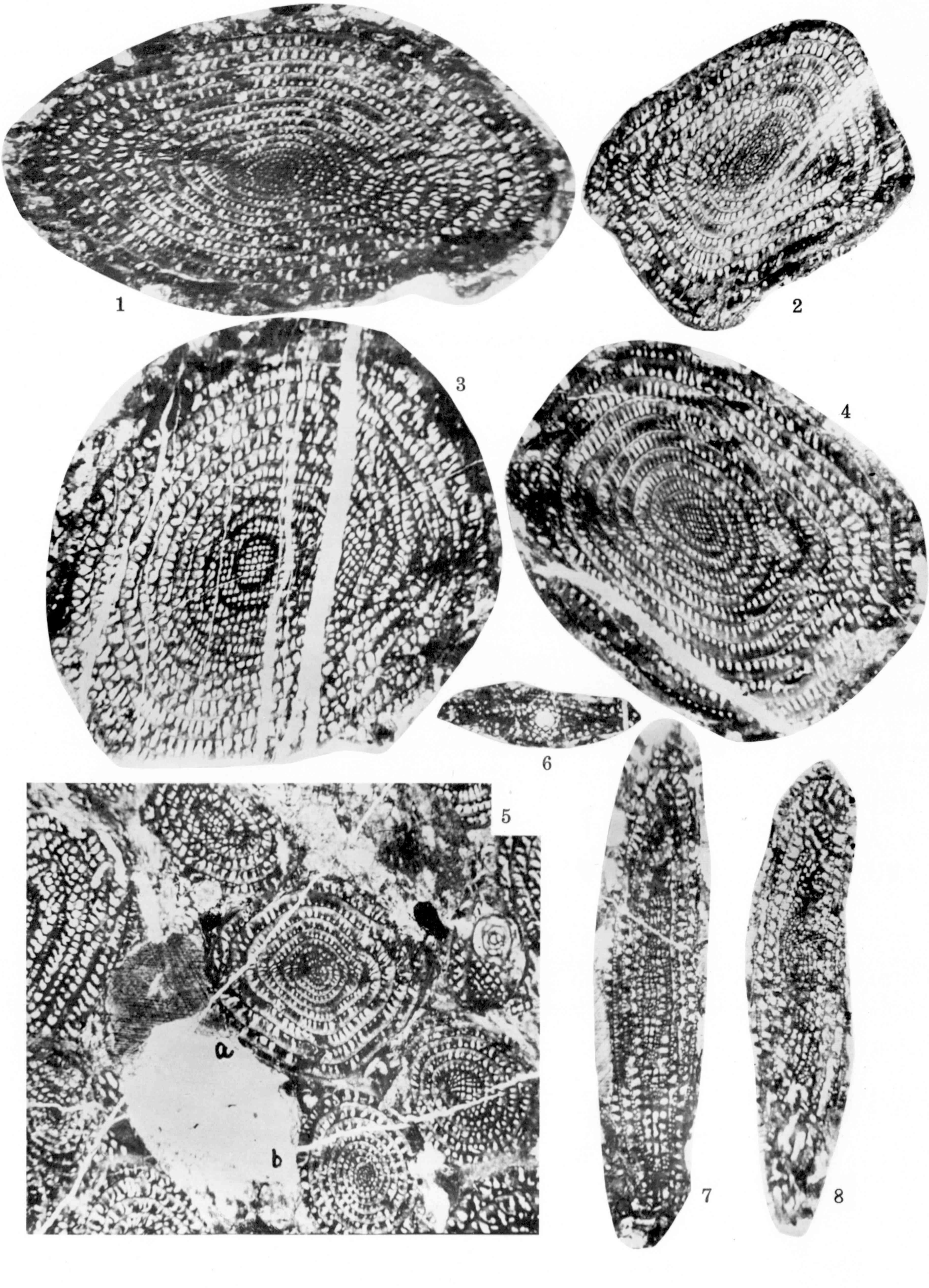
Fig. 1. *Neoschwagerina* sp. A
Slightly oblique axial section from loc. Hr-SA 514, IGSH-Hr-SA 514–7.

Figs. 2, 4. *Neoschwagerina* sp B.
2. Axial section, IGSH-Hr-SA 514–31.
4. Tangential section, IGSH-Hr-SA 514–23.
(All from loc. Hr-SA 514)

Fig. 3. *Yabeina* cf. *katoi* (OZAWA)
From loc. Hr-SA 514, IGSH-Hr-SA 514–22.

Fig. 5. *Neoschwagerina minoensis* DEPRAT em. OZAWA (a) and *Neoschwagerina craticulifera* (SCHWAGER) (b)
From loc. Hr-SA 514.

Figs. 6–7. *Sumatrina annae* VOLZ
6. Axial section, IGSH-Hr-SA 514–22.
7. Tangential section, IGSH-Hr-SA 514–23.
8. Axial section, IGSH-Hr-SA 514–8.
(All from loc. Hr-SA 514)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