Neoschwagerina from Joé Limestone, Hiroshima Prefecture, West Japan, with a note on *Neoschwagerina margaritae* DEPRAT

By

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With 2 Text-figure and 1 Plate

ABSTRACT. *Neoschwagerina margaritae* DEPRAT from the Carboniferous and Permian Joé Limestone exposed in Sanwa-Cho, Jinseki-Gun, Hiroshima Prefecture*, is described and discussed in this paper.

INTRODUCTION

Neoschwagerina margaritae DEPRAT is a well-known and valuable species which, together with its allied species, plays an important roll in the Zonal subdivision and correlation of the Middle Permian rocks in the province of eastern Asia. It was originally described from Lang-Nac, Indochina, and has been widely identified elsewhere in many districts of Japan and in China. In the Akasaka Limestone in which the successive occurrence of several neoschwagerines has been known it defines a particular Zone, that is, Ng Zone, as designated by OZAWA (1927), between the *Neoschwagerina craticulifera* Zone (Nc) below and the *Yabeina globosa* (= *Yabeina inouyei* DEPRAT) Zone (Ng) above, though it ranges still higher into the last Zone. Outside of Akasaka it was described from the Kwanto massif (HUJIMOTO = FUZIMOTO, 1936), the Ibukiyama Limestone (KOBAYASAI, 1957) of Central Honshu, the Maizuru belt (NOGAMI, 1958), the Akiyoshi Limestone (OZAWA, 1925), and the Atetsu Limestone (SADA, 1961, NOGAMI, 1961) of western Honshu, and the Tosayama Limestone (TORIYAMA, 1947) of Shikoku, and was listed also from many other districts.

Meanwhile there have been known three species which are morphologically very close to *N. margaritae*, and occur usually in association with it. They are *N. colaniae* OZAWA, *N. iisakai* TORIYAMA, and *N. cheni* SHENG.

In the course of my investigations on the Carboniferous and Permian Joé Limestone developed at Sanwa-Cho, Jinseki-Gun, Hiroshima Prefecture*, I made a large collection of neoschwagerines including *N. margaritae*. I have also had a good opportunity of examining the hypotypes of *N. margaritae* identified by OZAWA from Akasaka and Akiyoshi and original specimens of *N. colaniae* and studied the illustrated figures of *N. iisakai* and *N. cheni*. Through these studies I have been led to the conclusion that these three species are synonymous with *N. margaritae* from Akasaka.

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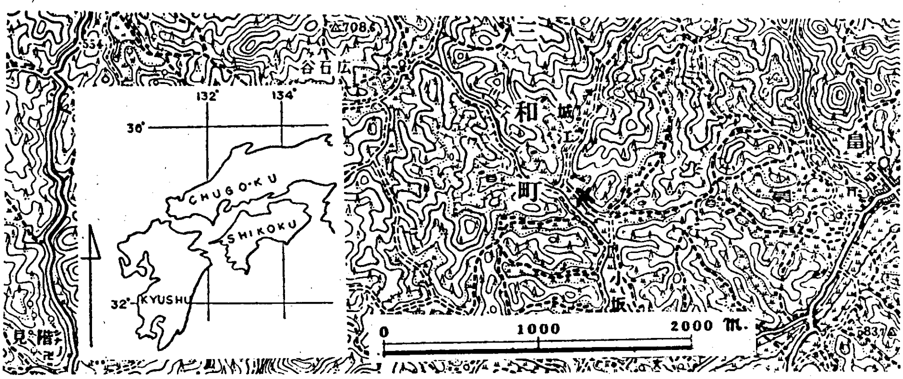

Text-fig. 1. Map showing the fossil locality in the Joé area, Hiroshima Prefecture.

In this paper I give a description of *N. margaritae* obtained from the locality stated above and discuss on *N. colaniae*, *N. iisakai* and *N. cheni*.

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DESCRIPTION

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

Genus *Neoschwagerina* YABE, 1903

Neoschwagerina margaritae DEPRAT

Pl. 58, figs. 1–12.

1913. *Neoschwagerina margaritae* DEPRAT. *Mém. Serv. Géol. l'Indochine, Vol. 2, fasc. 1*, pp. 58–60, pl. 8, fig. 10, pl. 9, figs. 1–3.

1925. *Neoschwagerina margaritae* OZAWA. *Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. 45, Art. 6*, pp. 58–60, pl. 11, figs. 1–3.

1925. *Neoschwagerina margaritae* COLANI. *Mém, Serv. Géol. l'Indochine, Vol. 11, fasc. 1*, pp. 122–123, pl. 24, figs. 1–7, 9.

1927. *Neoschwagerina margaritae* OZAWA. *Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. 2, Part 3*, pp. 158–159,

pl. 42, figs. 5, 7.
1927. *Neoschwagerina colaniae* OZAWA. *Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. 2, Part 3*, pp. 157–158, pl. 40, figs. 9, 12, 13; pl. 41, figs. 3, 11.
1936. *Neoschwagerina margaritae* HUZIMOTO. *Sci. Repts. Tokyo Bunrika Daigaku, Sec. C, Vol. 1, No. 2*, pp. 117–118, pl. 22, figs. 16–17; pl. 24, figs. 1–4.
1947. *Neoschwagerina margaritae* TORIYAMA. *Japan. Jour. Geol. Geogr., Vol. 20, No. 1*, p. 79, pl. 17, figs. 9–10.
1947. *Neoschwagerina iisakai* TORIYAMA. *Japan. Jour. Geol. Geogr. Vol. 20, No. 1*, pp. 81–82, pl. 17, figs. 12–17.
1956. *Neoschwagerina margaritae* CHEN. *Palaeontologia Sinica, New Ser. B, No. 6*, pp. 62–63, pl. 10, figs. 1–3.
1956. *Neoschwagerina colaniae* CHEN. *Palaeontologia Sinica, New Ser. B, No. 6*, pp. 59–60, pl. 14, figs. 1–4.
1957. *Neoschwagerina margaritae* KOBAYASHI. *Sci. Repts. Tokyo Kyoiku Daigaku, Vol. 5, No. 46*, pp. 306–308, pl. 10, figs. 3–6.
1957. *Neoschwagerina* cf. *colaniae* KOBAYASHI. *Sci. Repts. Tokyo Kyoiku Daigaku, Vol. 5, No. 46*, pp. 305–306, pl. 10, figs. 1–2.
1958. *Neoschwagerina cheni* SHENG. *Palaeontologia Sinica, Vol. 6, No. 3*, pp. 287–288, pl. 2, figs. 1–4.
1958. *Neoschwagerina* cf. *margaritae* NOGAMI. *Mem. Coll. Sci. Univ. Kyoto, Ser. B, Vol. 25, No. 2*, p. 101, pl. 1, fig. 7.
1961. *Neoschwagerina margaritae* SADA. *Jour. Sci. Hiroshima Univ. Ser. C. Vol. 4, No. 1*, pp. 125–126, pl. 13, fig. 9.
1961. *Neoschwagerina margaritae* NOGAMI. *Mem. Coll. Sci. Univ. Kyoto, Ser. B, Vol. 28, No. 2*, pp. 177–180. Taf. 4, figs. 1–5.
1961. *Neoschwagerina cheni* NOGAMI. *Mem. Coll. Sci. Univ. Kyoto, Ser. B, Vol. 28, No. 2*, pp. 174–177. Taf. 3, figs. 1–6.
non. 1935. *Neoshwagerina margaritae* GUBLER. *Mém. Soc. Géol. France. Neu. Sér. tome 11, fasc. 4*, pp. 106–108, pl. 7, fig. 1, 4, 6, pl. 8, fig. 4.

Types.—The illustrated specimen of DEPRAT (1913, pp. 58–60, pl. 9, fig. 1), one of syntypes, was designated as the lectotype of *Neoschwagerina margaritae* DEPRAT.

Material.—The neoschwagerines specimens of thin sections are ninty five from Joé Limestone. A number of them contains the present species. OZAWA's specimens (1927, pl. 47, figs. 5 and 7; pl. 41, figs. 10 and 11), from the Akasaka Limestone, were examined. Many specimens collected from the same limestone were also studied.

Measurements.—

(in Millimeters)

Specimen	Loc.	Rg. No.	Pl.	fig.	L.	W.	R.	Prol.
1	J.	IGSH-Je-SA 60–43	65	1	4.90	4.00	1.2	.037
2	J.	IGSH-Je-SA 60–07			4.40	3.90	1.1	.037
3	J.	IGSH-Je-SA 60–13	65	2	5.00	4.50	1.1	.043
4	J.	IGSH-Je-SA 60–14	65	4	5.15	4.75	1.1	.037
5	J.	IGSH-Je-SA 60–37	65	6	4.60	4.70	1.0	.037
6	J.	IGSH-Je-SA 60–39	65	10				.018
7	J.	IGSH-Je-SA 60–48	65	8	4.25	4.00	1.1	.037
8	J.	IGSH-Je-SA 60–32	65	9	4.75	4.25	1.2	.037
9	J.	IGSH-Je-SA 60–05	65	5	4.00	3.75	1.1	.037
10	J.	IGSH-Je-SA 60–57						.056
11	J.	IGSH-Je-SA 60–09			5.50	4.90	1.1	.056
12	J.	IGSH-Je-SA 60–61			3.00	2.50	1.2	.037
13	J.	IGSH-Je-SA 60–33			6.50	5.75	1.1	.056
14	J.	IGSH-Je-SA 60–40	65	7	6.00	4.40(+)?	about 1.3	.037

Specimen	Radius vector																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	.094	.151	.207	.283	.377	.491	.604	.755	.925	1.076	1.265	1.435	1.643	1.851	2.077				
2	.075	.113	.226	.340	.453	.604	.755	.925	1.133	1.322	1.548	1.870							
3	.056	.094	.132	.188	.264	.358	.472	.604	.755	.925	1.114	1.303	1.511	1.732	2.021				
4	.076	.113	.151	.264	.321	.396	.510	.642	.744	.944	1.114	1.303	1.492	1.718	1.926	1.983			
5	.056	.094	.132	.188	.264	.358	.434	.566	.680	.831	.982	1.171	1.341	1.548	1.756	1.983			
6	.037	.075	.132	.188	.245	.321	.434	.566	.717	.887	1.038	1.208	1.416	1.662	1.889				
7	.037	.075	.113	.188	.245	.321	.396	.528	.680	.812	.982	1.171	1.322	1.530	1.737	1.926			
8	.075	.113	.151	.207	.302	.377	.491	.604	.755	.906	1.038	1.227	1.378	1.567	1.832				
9	.056	.094	.207	.283	.377	.510	.642	.812	.963	1.190	1.378	1.567	1.775	2.021	2.266				
10	.056	.094	.151	.302	.377	.491	.604	.755	.925	1.076	1.265	1.473	1.662	1.889	2.115				
11	.056	.113	.188	.283	.377	.510	.642	.793	1.001	1.208	1.416	1.605	1.851						
12	.056	.094	.113	.170	.226	.321	.415	.547	.680	.831	.982	1.171	1.378	1.548	1.727				
13	.056	.075	.113	.170	.226	.321	.434	.585	.755	.906	1.095	1.284	1.511	1.737	2.115	2.417	2.682	3.002	
14	.056	.094	.151	.226	.321	.434	.585	.736	.925	1.114	1.303	1.322	1.511	1.737	1.983	2.191			
※15	.075	.132	.188	.283	.377	.472	.623	.793	.982	1.190									
※16	.070	.120	.165	.260	.380	.490	.602	.750	.900	1.040	1.220	1.370	1.540	1.710	1.880	2.070	2.290	2.520	
※17	.050	.100	.150	.210	.300	.400	.500	.630	.780	.930	1.090	1.240	1.445	1.670	1.850	2.100	2.320	2.600	2.800
※18	.070	.100	.160	.240	.370	.450	.550	.700	.850	1.080	1.220	1.450	1.620	1.800					
※19	.040	.080	.150	.200	.260	.450	.460	.600	.770	.950	1.150	1.350	1.600						
※20	.060	.100	.150	.250	.360	.470	.650	.850	1.020	1.250	1.500	1.750	2.000	2.250	2.500	2.800	3.200		
※21	.007	.120	.220	.420	.580	.740	.920	1.160	1.400	1.600	1.840	2.080	2.420	2.670	2.940	3.220	3.520	3.800	
※22	.070	.120	.160	.270	.380	.330	.620	.750	.900	1.040	1.220	1.340	1.530	1.710	1.880	2.070	2.290	2.520	
※23	.070	.100	.160	.210	.310	.450	.580	.750	.960	1.150	1.370	1.600	1.800	2.050	2.270	2.560			
※24	.080	.128	.171	.249	.328	.451	.563	.749	.868	1.050	1.201	1.370	1.548	1.733					
※25	.085	.105	.175	.230	.320	.420	.530	.650	.710	.880	1.020	1.280	1.330	1.490	1.670	1.880	2.050		
※26	.007	.140	.220	.420	.580	.740	.920	1.160	1.400	1.600	1.840	2.080	2.420	2.680	2.940	3.220	3.800		
※27	.040	.080	.130	.190	.260	.330	.430	.550	.700	.850	1.030	1.200	1.370	1.540	1.710				
※28	.080	.120	.180	.240	.325	.415	.504	.675	.810	1.000	1.200	1.425	1.670	1.900	2.135	2.37			
※29	.070	.100	.140	.205	.270	.365	.490	.635	.800	1.000	1.410	1.340	1.550	1.730					

※ 15. Holotype of *Neoschwagerina colaniae* OZAWA (1927). 16. OZAWA's *N. margaritae* (1927).
17–22. FUJIMOTO's *N. margaritae* (1936). 23. TORIYAMA's *N. margaritae* (1947).
24. NOGAMI's *N. margaritae* (1958). 25. CHEN's *N. margaritae* (1956).
26. DEPRAT's *N. margaritae* (1913). 27. *N. iisakai* TORIYAMA (1947).
28–29. *N. cheni* SHENG (1958).

Specimen	Half length																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	.075	.132	.207	.302	.377	.528	.661	.850	1.038	1.229	1.416	1.643	1.926	2.667				
2	.056	.094	.151	.245	.358	.604	.755	1.020	1.227	1.416	1.605	1.794						
3	.037	.075	.132	.188	.245	.377	.472	.604	.717	.906	1.095	1.227	1.416	1.605	1.794			
4	.037	.075	.132	.188	.264	.377	.491	.364	.774	.944	1.190	1.416	1.662	1.870	2.096	2.342		
5	.056	.094	.151	.207	.283	.396	.510	.604	.717	.887	1.076	1.322	1.454	1.605	1.832	2.077		
6	.037	.075	.132	.207	.283	.415	.547	.642	.755	.982	1.208	1.454	1.643	1.794	2.077			
7	.056	.094	.151	.245	.321	.472	.547	.680	.831	1.020	1.190	1.360	1.548	1.737				
8	.037	.094	.132	.188	.283	.434	.547	.680	.868	1.095	1.303	1.530	1.756	1.945	2.210			
9	.056	.113	.151	.188	.245	.321	.434	.566	.717	.925	1.114	1.341	1.548	1.737	1.983			
10	.075	.113	.188	.283	.377	.510	.661	.812	.982	1.190	1.378	1.605	1.851					
11	.075	.132	.188	.283	.340	.472	.566	.698	.887	1.095	1.303	1.511	1.756	1.983	2.134			
12	.037	.075	.113	.170	.264	.377	.472	.604	.812	1.001	1.208	1.416						
13	.056	.075	.113	.170	.283	.377	.516	.698	.850	1.076	1.322	1.512	1.775	2.021	2.266	2.606	2.985	3.305
14	.056	.094	.151	.226	.321	.472	.661	.850	1.075	1.246	1.512	1.775	2.079	2.361	2.606	2.971		

Specimen	Ratio of Hl. to Rv.																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0.8	0.9	1.0	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2				
2	0.8	0.8	0.7	0.7	0.8	1.0	1.0	1.1	1.2	1.1	1.0	1.1		0.9				
3	0.7	0.8	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	1.1	0.9			
4	0.5	0.7	0.9	0.7	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.2		
5	1.0	1.0	1.1	1.1	1.0	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0		
6	1.0	1.0	1.0	1.1	1.1	1.3	1.3	1.1	1.2	1.1	1.2	1.2	1.2	1.1	1.1			
7	1.5	1.3	1.3	1.3	1.3	1.5	1.4	1.3	1.2	1.3	1.2	1.2	1.2	1.2				
8	0.5	0.8	0.9	0.9	0.9	1.2	1.1	1.1	1.2	1.2	1.3	1.2	1.3	1.2	1.2			
9	1.0	1.2	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9			
10	1.3	1.2	1.2	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1					
11	1.3	1.2	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0					
12	0.7	0.8	1.0	1.0	1.2	1.2	1.1	1.1	1.2	1.2	1.2	1.2						
13	1.0	1.0	1.0	1.0	1.2	1.2	1.3	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1
14	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.1	1.1	1.2	1.3	1.4	1.4	1.3	1.3		

Specimen	Thickness of spirotheca																	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	.018	.016	.016	.011	.016	.011	.011	.011	.016	.011	.016	.016	.013	.013	.013	.027		
2	.013	.016	.016	.018	.016	.018	.018	.021	.023	.021	.021	.034	.036					
3	.004	.011	.013	.011	.013	.009	.021	.018	.013	.013	.011	.021	.027	.018	.027	.027		
4	.004	.011	.016	.023	.013	.023	.027	.034	.027	.027	.025	.021	.027	.034	.025			
5	.011	.011	.013	.011	.011	.016	.011	.013	.023	.027	.018	.013	.025	.027	.023	.027	.027	
6	.006	.011	.018	.016	.013	.016	.018	.021	.016	.023	.021	.023	.018	.023	.025	.021		
7	.006	.013	.021	.016	.021	.018	.022	.011	.016	.011	.013	.016	.021	.018	.016	.029		
8	.006	.009	.011	.006	.016	.016	.018	.018	.018	.013	.018	.018	.021	.021	.018	.027	.025	
9	.011	.009	.011	.011	.009	.016	.018	.011	.013	.023	.018	.021	.032	.016	.021	.023	.018	
10	.011	.018	.011	.016	.011	.013	.018	.011	.013	.021	.016	.018	.018	.016	.021			
11	.013	.011	.006	.016	.016	.016	.016	.011	.018	.018	.013	.023	.021	.011	.034	.023	.025	
12	.011	.009	.006	.011	.006	.011	.009	.011	.011	.016	0011	.016	.023	.018	.018	.018		
13	.011	.009	.011	.016	.006	.016	.011	.013	.018	.016	.018	.027	.023	.021	.027	.029	.034	.046
14	.011	.009	.011	.013	.011	.011	.013	.016	.016	.018	.016	.018	.023	.016	.025	.029	.021	

Description.—The shell of *Neoschwagerina margaritae* DEPRAT is moderate and globular to ellipsoidal, having a straight axis of coiling and rounded poles. The lateral slopes are convex. The adult specimens of sixteen to eighteen volutions are 4.60 mm. to 6.50 mm. long and 4.70 mm. to 5.75 mm. wide. The form ratio ranges from 1.0 to 1.1. Average ratios of the half length to the radius vectors in twelve specimens are 0.9 to 1.0 for the first to the fifth volution and 1.1 for the sixteenth.

The proloculus is minute and spherical. Its outside diameter ranges from 18 to 56 microns, averaging 38 microns in twelve specimens. The shell is tightly coiled in the inner volutions and expands uniformly in the outer ones. Average radius vectors in twelve specimens are 61, 102, 160, 239, 319, 420, 531, 674, 831, 1001, 1171, 1378, 1524, 1731, 1935, and 1983 microns, respectively, for the first to the sixteenth volution.

The chambers are almost the same in height throughout the length of the shell except for very extreme polar ends.

The spirotheca is thin, and consists of a tectum and a keriotheca. Average thickness of the spirotheca at its thinnest point between adjacent septula in twelve specimens is 10, 12, 13, 14, 13, 15, 17, 16, 17, 18, 17, 20, 23, 19, 23, 19, 23, 28, and 24 microns, respectively, for the first to the sixteenth volution.

The septa are somewhat thicker than the spirotheca, and composed of the downward deflection of the tectum and the keriotheca on both sides of the tectum for a short distance. In the inner volutions the tips of the septa are almost in contact with the deposits with the dense materials which seem to be continuous with the parachomata, but in the outer volutions those of most septa are solidified and bent anteriorly at a considerably high angle. The average septal counts in eight specimens are 5, 8, 13, 15, 17, 16, 14, 14, 15, 19, 25, 24, and 21, respectively, for the first to the thirteenth volution. The primary spiral septula are present throughout the shell. The secondary spiral septula are not observable in any part of the inner volutions, but the rudimentary secondary spiral septula rarely appear in the outer volutions, even if later in the eleventh volution. They are very short.

The foramina are circular to ellipsoidal in section.

Ontogeny.—The ontogenetic change of this species is remarkable in the shell-form, the number of volution and the appearance of the secondary spiral septula.

In the early stage (the shell of five volutions) of growth, the shell is spherical, with straight axis of coiling. The form ratio ranges from 0.7 to 1.3, but many of them are less than 1.0. One to two, very short axial septula occur between the adjacent septa. The secondary spiral septula are absent.

In the middle stage (the shell of eleven volutions) of growth, the shell is spherical to ellipsoidal, generally with a form ratio of 1.1. Two to three axial septula are developed between the adjacent septa. They are moderately long, having a length of about one-third to a half of the height of the chamber. The rudimentary secondary spiral septula occasionally appear in the eighth to the eleventh volution.

In the early adult stage (the shell of sixteen volutions) of growth, the shell is globular to ellipsoidal, with the form ratio ranging from 1.0 to 1.4. The shell expands rapidly. Three or four axial septula develop between the adjacent septa. They are irregular in the length and profile, and are thinning at their tips. A single secondary spiral septulum commonly occur between the adjacent primary spiral septula.

In the late adult stage (the shell of eighteen to twenty one volutions) of growth, the shell is usually globular giving the form ratio of 1.3. The septa are widely spaced and are numerous. Three to four axial septula occur between the septa. The secondary spiral septula are present between the adjacent primary ones, but they are short.

Remarks.—The above description is based entirely upon the Joé specimens. This species is most abundant among species of the genus *Neoschwagerina* of Joé Limestone, and shows a fairly wide specific variation in shape and size of the shell. The present specimens, however, can be identified with *Neoschwagerina margaritae* of DEPRAT (1913) and OZAWA (1925), etc. as discussed below.

DEPRAT's illustrated specimens (1913, pp. 58–60, pl. 8, fig. 10; pl. 9, figs. 1–3) of eighteen volutions are somewhat larger and more globular than the Joé specimens. The shells expand more rapidly. The primitive secondary spiral septula occasionally appear in the thirteenth volution.

The shell of OZAWA's illustrated specimens (1925, Vol. 45, Art. 6, pp. 58–60, pl. 11, figs. 1–3) is larger and more globular. The shell of the eighteen volutions is 10 mm. long and 8 mm. wide, with the form ratio of 1.25. The number of volutions of the syntypes ranges from fifteen to twenty. One axial septulum can be seen in the inner seven volutions and two to four in the fifth volution. The secondary spiral septula occasionally appear in the eighth volution.

OZAWA's specimens are considered to be of the early or the late adult stage of the species.

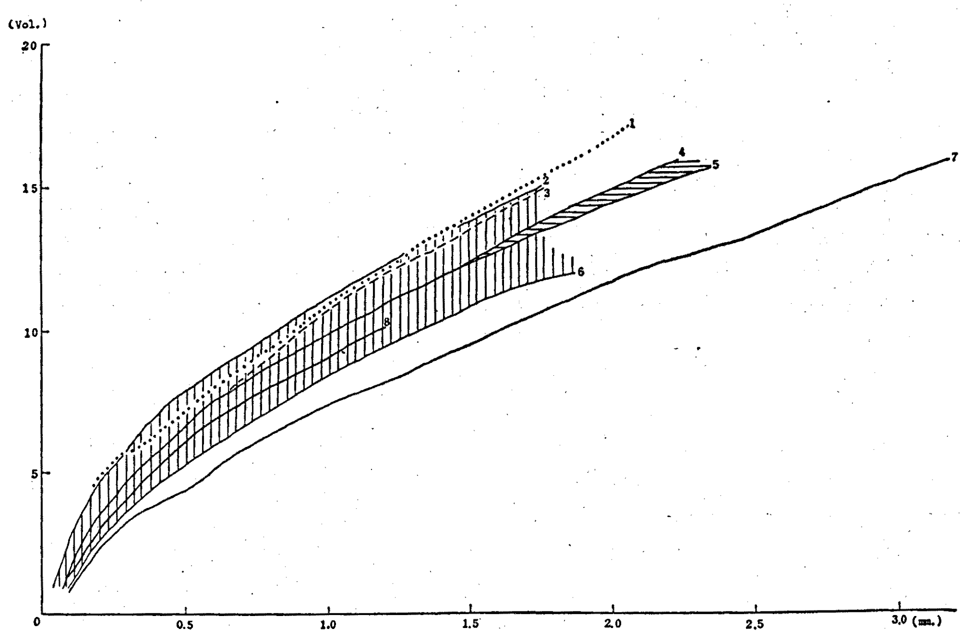
In 1927, OZAWA also described and illustrated the same species (pp. 108–159, pl. 42, figs. 5, 7) from the Akasaka Limestone. The shell of sixteen volutions illustrated as fig. 7 is larger and more globular than the Joé specimens. The specimens attains 7 mm. long and 5 mm. wide, with a form ratio of 1.4. It expands slowly in the inner five volutions, but rapidly in the outer several volutions. One axial septulum is developed in the inner five volutions, but two to three axial septula are present in the eleventh volution, three to four in the fifth volution. A single secondary spiral septulum first appears between the primary septula in the eight volution, but it is short.

HONJO (1959) established *Yabeina ozawai* based on OZAWA's *N. margaritae* (1927, pl. 42, figs. 5, 7). OZAWA's specimens, however, can be determined as being of the middle stage of *N. margaritae* DEPRAT, as can be judged from all the observable internal feauturs and statistics.

All the described and illustrated specimens of *N. margaritae* came from the western slope of the Joé Limestone at Sanwa-Chô, Jinseki-Gun, Hiroshima Prefecture, where the associated species are *N. craticulifera* and *N. douvillei*.

Comparison.—The shell of *Neoschwagerina margaritae* DEPRAT somewhat resembles *N. simplex* OZAWA (1927, pp. 153–154, pl. 34, figs. 7–11, 22, 23; pl. 37, figs. 3a, 6a) including *N. irregularis* HONJO (1959, pp. 146–147, pl. 3, figs. 2, 7). These forms can be distinguished easily, however, for *N. margaritae* has a larger shell, larger number of volutions, smaller parachomata, slender primary spiral septula, more closed space between adjacent spiral septula, thinner spirotheca, more tightly coiled shell in the inner volutions, and more numerous axial septula at maturity.

The general shape and rate of expansion of *N. margaritae* are similar to those of *Yabeina katoi* OZAWA (1927, pp. 159, pl. 41, figs. 1, 10; pl. 42, fig. 3, pl. 43, figs. la, 2a, 3, 5, 6) from Akasaka. These forms may be easily distinguished, however, by the smaller shell of mature specimens of *N. margaritae*, its lower chambers for corresponding volution, its thicker spirotheca, its broader septa and primary spiral septula, and shorter secondary spiral septula.



Text-fig. 2. Text Figure showing the specific variation of the radius vectors in *Neoschwagerina margaritae* DEPRAT

1. *Neoschwagerina margaritae,* CHEN (1956). 2–6. Variation of *N. margaritae,* SADA. 3. *N. iisakai* TORIYAMA (1947). 4–5. *N. cheni* SHENG (1958). 7. *N. margaritae* DEPRAT (1913). 8. *N. colaniae* OZAWA (1927).

Discussion.—On studying numerous specimens at my disposal and many author's illustrated figures of *N. margaritae*, I can hardly avoid the conclusion that this species is fairly variable in characters of the shell through growth as stated above.

OZAWA established *Neoschwagerina colaniae* (1927, pl. 40, figs. 9, 12, 13,; pl. 41, figs. 3, 10) on the specimens from the Permian limestone of Akasaka. The shell of the species is moderate, and globular to ellipsoidal. The specimen of fifteen volutions has a form ratio of 1.3, minute and spherical proloculus, and thin spirotheca. The secondary spiral septulum occasionally appears in the eighth volution, but it is short.

Reexamining the holotype of *N. colaniae* (1927, pl. 11, fig. 11) which was reported with *N. margaritae*, the latter of which can be identified by a slightly tangential section, I notice that characters of *N. colaniae* are exactly similar to those of *N. margaritae* of DEPRAT (1913) through the ontogenetic developments, and the former may be a form showing the early adult stage of the latter. They are, in my opinion, synonymous with each others. CHEN, and KOBAYASHI described the forms (Chen, 1956, pp., 59–61, pl. 11, figs. 5–8; KOBAYASHI, 1957, pp. 305–306, pl. 10, figs. 1–2) under the specific name of *N. colaniae* from the Permian rocks of Maok'ou and Ibukiyama, respectively, where they are really associated with the adult form of *N. margaritae*. Judging from their descriptions and illustrations, they may be, like OZAWA's specimens, identified with *N. margaritae*.

Neoschwagerina iisakai TORIYAMA (1947, pp. 81–82, pl. 17, figs. 12–17) from Tosayama, Shikoku, quite resembles the lectotype of *N. margaritae* DEPRAT through growth. In both forms the shells are moderate and globular. The primary spiral septula are well developed and closely spaced. The secondary spiral septula are observable in the middle stage. According to description, *N. iisakai* is associated with *N. margaritae* in the locality stated above and is not distinct enough for the specific separation from *N. margaritae*. The axial section of the species (pl. 17, fig. 12) is comparable with the early adult stage form from Joé. I conclude that *N. iisakai* should be referred to *N. margaritae* DEPRAT.

SHENG (1958) set up *Neoschwagerina cheni* (pp. 287–288, pl. 2, figs. 1–4) on the species from the Maok'ou limestone of Chinghai Province, Northwestern China. He remarked that the species was closely similar to *N. margaritae* DEPRAT in general shape of the shell, but differed therefrom in having much smaller size and fewer volutions, and width of the corresponding volutions in the species was much smaller in *N. margaritae* DEPRAT. Examining the descriptions and the illustrations of *N. cheni* SHENG, I recognized that the internal features and measured values fully agreed with those of the early adult stage of *N. margaritae* DEPRAT. The difficulty is, in fact, how to distinguish *N. cheni* from *N. margaritae*. Taking all this fact under the consideration, both species may probably be conspecific.

The statistics of my specimens nearly equal to those of CHEN's specimens (1956). The shells of his illustrated specimens (pl. 10, figs. 1–2), however, have larger number of volutions and are larger than any other known ones. They may be comprehended as the fully grown individuals.

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Explanation of Plate LVIII

All × 10, except Fig. 12.

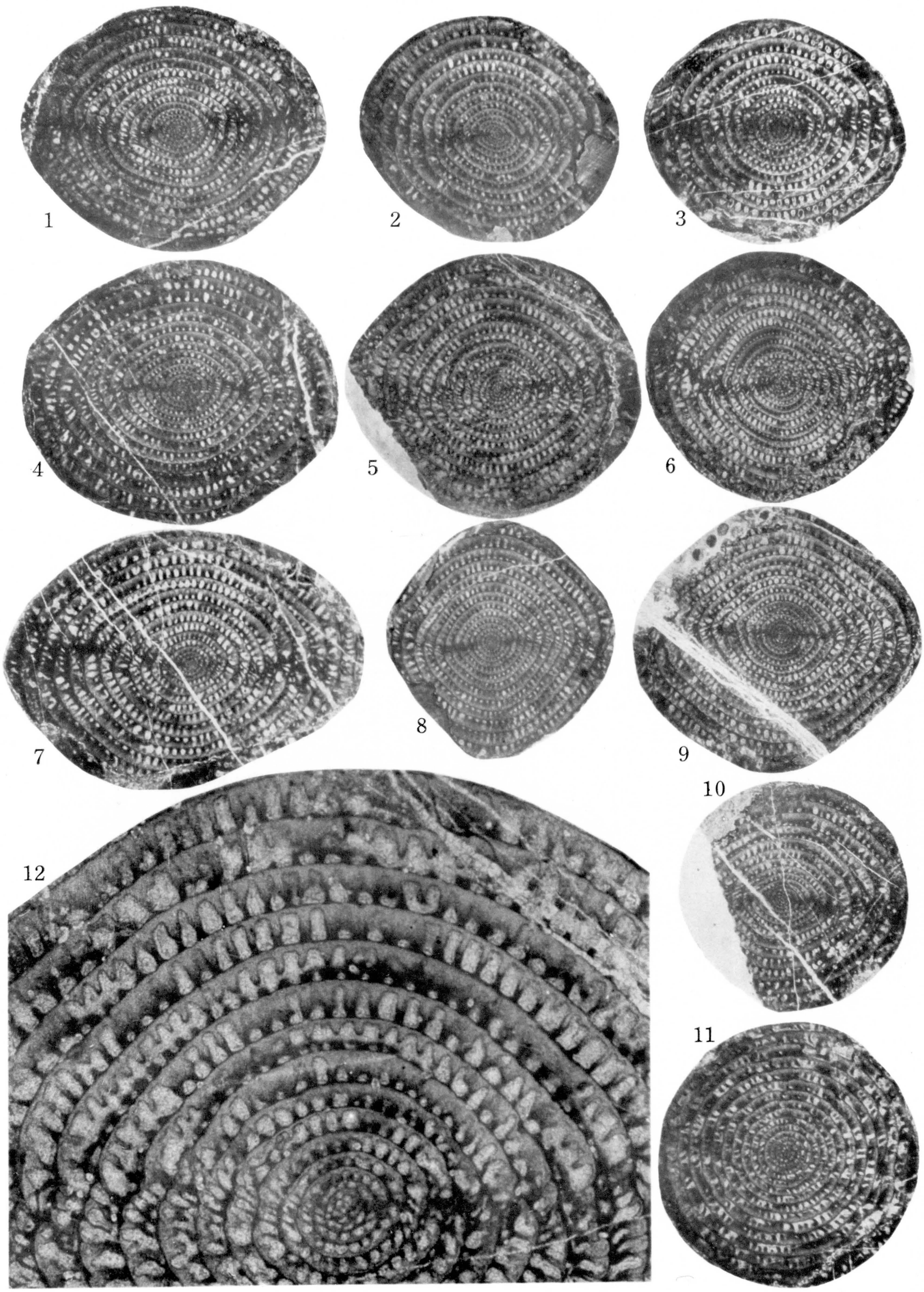
Figs. **1–12**. *Neoschwagerina margaritae* Depart .... Page 542

1–10. Axial section: Rg. No. IGSH-Je-SA 60–43, 60–13, 60–17, 60–14, 60–5, 60–37, 60–40, 60–48, 60–32, and 60–39.

11. Sagittal section: Rg. No. IGSH-Je-SA 60–4.

12. Enlarged figure of Fig. 5. × 32.4.

All from the western slope of the Joé Limestone. Loc. J.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