JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.
VOL. XLV., ARTICLE 6.

Paleontological and Stratigraphical Studies on the Permo-Carboniferous Limestone of Nagato
Part II. Paleontology.

By

Yoshiaki OZAWA.

With 14 Plates.

Introductory Remarks.

Up to this time there is no work giving description[1] of the fossils found in the Akiyoshi limestone district, though several geologists have surveyed it and published excellent papers on its geology.

The fossils which I have collected in the district consist of calcareous algae, Foraminifera, corals, Bryozoa and Brachiopoda found at various points on the limestone plateau and its surrounding area.

The number of fossil-species now known from the area amounts to 90. These 90 forms belong to different biological groups as shown in the following table.

Flora	No.	Fauna	No.
Alga	1	Protozoa	68
Conifera	2	Coelenterata	12
		Bryozoa	5
		Brachiopoda	2

As seen from this table, the most numerous are the Protozoa. And this is quite natural, because the limestone here developed, is principally built up of Fusulinae, as is usually the case with the Permo-Carboniferous limestone in Japan. This group is represented by a number of genera, and highly differentiated species showing several varieties. In the genera *Fusulina* and *Neoschwagerina* we see many species which are found more or less related. *Girtyina* and *Paleofusulina* do not occur in Japan.

As to the corals, they also represent a group rich in species. It is interesting to see that they are frequent in the region where diabase and schalstein are extensively found. They are invariably imbedded in an oolitic matrix associated with fragments of crinoid-stems.

(1) The detailed accounts of the geology and stratigraphy (part I) of the Akiyoshi limestone plateau will be published in near future.

Bryozoa and Brachiopoda are rare. However it is worthy of note that they are found only in certain localities. Their preservation is bad and the specific determination is frequently impossible.

On the whole, the Molluscoid fauna is rather meager and unimportant. The predominance of algae is also important. Crinoid-stems are abundant, but no determinable species were obtained. Among Rhaetic plants, which are rare, the most note-worthy is the occurrence of *Cycadocarpidium*.

The time range and distribution of the Akiyoshi fossils are as follows :—

Range and Distribution of Akiyoshi Fossils.

	Akiyoshi $C_1C_2C_3CPgP_1P_2P_3$	Ohmi Akasaka	Cammon Yunnan N. China	Afghan	Darwas	Other foreign countries.
CHLOROPHYCEAE						
Family Siphonocladiales						
1. Mizzia velebitana Schubert	× × ×	× ×				Guadalupe Mts. Velebit; Greece, etc. (a cosmopolitan species)
CONIFERALES INCERTAE SEDIS						
2. Cycadocarpidium swabii Nathorst	Omine coal-field					Scania, Sweden; Tonkin, Indochina.
3. Podozamites distans Presl	„					Scania; Persia; Tonkin; etc.
FORAMINIFERA						
Family Miliolidae						
4. Hemigordius japonica n. sp.	×					
5. Glomospira cf. gordialis J. et P.	× × ×		?			Europe.
6. Glomospira cf. pusilla Geinitz	× × ×		?			Europe.
Family Lituolidae						
7. Endothyra sp.	×					
Family Textularliidae						
8. Textularia cf. jonesi Brady	× ×					Europe.
9. Tetrataxis schellwieni n. sp.	×					
10. Tetrataxis linea n. sp.	×					
11. Tetrataxis conica Ehrenb. var.	× × ×	×				
12. Tetrataxis cf. maxima Schellw.	×	×				
13. Tetrataxis cf. conica var. gibba	×					
14. Bigenerina sumatrana Volz	×					Sumatra
15. Bigenerina cf. bradyi Möller	× × × ×					Russia (Arctic Region), Carnic Alps, North China
Family Lagenidae						
16. Lagena sp.	×					
17. Nodosaria cf. radicula Linné	×					Europe.
18. Lingulina sp.	×					
Family Rotalidae						
19. Spirillina grandis n. sp.	×					

		C_1	C_2	C_3	CP	g	P_1	P_2	P_3					
	Family Fusulinidae													
20.	Fusulinella bocki Möller	×												Arctic Provinces of Russia.
21.	Fusulinella biconica (Hayasaka)	×	×					×						
22.	Fusulinella itoi n. sp.						×							
23.	Staffella mölleri n. sp.	×												
24.	Staffella yobarensis n. sp.					×								
25.	Staffella waageni (Schwager)					×	×							Salt Range
26.	Schellwienia staffi n. sp.	×												
27.	Schellwienia cf. kattaensis Schw.	?	×											Salt Range; Yunnan; Indochina.
28.	Schellwienia ellipsoidalis var. orientis n. var.		×	×			×	×						
29.	Schellwienia vulgaris Schellwien		×									?	×	
30.	Schellwienia vulgaris var. globosa Schellwien.		×										×	
31.	Schellwienia kraffti Schellw.		×					×					×	
32.	Schellwienia yobarensis n. sp.					×								
33.	Schellwienia krotowi Schellw.		×											Ural.
34.	Schellwienia lutugini Schellw.			×										Ural.
35.	Schellwienia granum-avenae Roemer					×	×			×	×			Sumatra; Timor.
36.	Schellwienia japonica Gümbel				×			?	×	×				
37.	Schellwienia edoensis n. sp.				×	×	×							
38.	Schellwienia ambigua Deprat				×	×			×	×				
39.	Schellwienia kaerimizensis n. sp.			×										
40.	Schellwienia gigantea Deprat						×			×				
41.	Schellwienia exilis Schwager.						×		×					
42.	Schellwienia deprati n. sp.						×	×	×	×				
43.	Schellwienia richthofeni Schwager		×	×						×	×	×		? Korea.
44.	Schellwienia crassiseptata Deprat					×	×			×				
45.	Schellwienia incisa Schellw.		×							×		×		Carnic Alps.
46.	Schellwienia prisca Schellw.		×											Russia (Arctic Region).
47.	Schellwienia prisca var. parvula Schellwien		×											Russia (Timan)
48.	Schellwienia haydeni n. sp.		×											
49.	Schellwienia montipara Ehrenb.		×											Russia (Arctic Provinces).
50.	Schellwienia subobsoleta n. sp.		×											
51.	Schellwienia ominensis n. sp.						×							
52.	Schellwienia suzukii n. sp.						×							
53.	Schellwienia satoi n. sp.		×											
54.	Schellwienia oblonga n. sp.				×									
55.	Schellwienia lepida Deprat.					×								
56.	Schellwienia n. sp.						×							
57.	Schwagerina princeps Ehrenb.	×							×	×	×	×		Russia; Carnic Alps.

		$C_1C_2C_3$	CP	$gP_1P_2P_3$					
58.	Schwagerina muongthensis Deprat	×				×			
59.	Verbeekina verbeeki (Geinitz)		?	× ×	× ×	× ×	×		Sumatra.
60.	Verbeekina verbeeki var. sphaera n. var.		×		×	×			
61.	Verbeekina claudiae (Deprat)	×				×			
62.	Doliolina lepida (Schwager)		×	× × ×	× ×	× ×			Velebit
63.	Neoschwagerina craticulitera(Schw.)		×	× ? ×	? ×	× × ×	×		Velebit
64.	Neoschwagerina douvillei n. sp.			× ×	× ×	× ×			
65.	Neoschwagerina megasphaerica Deprat			× ?		×			
66.	Neoschwagerina margaritae Deprat var. nipponensis n. var.			×	× ×				
67.	Yabeina schellwieni (Deprat)			× × ×	×				
68.	Yabeina hayasakai Ozawa				×				
69.	Yabeina shiraiwensis n. sp.			×					
70.	Sumatrina annae Volz.			×	× ×	× ×	×		Sumatra; Velebit.
	ANTHOZOA								
	TETRACORALLA								
	Family Cyathophyllidae								
71.	Lonsdaleia floriformis crassiconus (M'Coy)	× ×			×				Europe, etc.
72.	Lonsdaleia enormis n. sp.	× ×							
73.	Lonsdaleia katoi n. sp.			×					
74.	Lonsdaleia yokoyamai n. sp.		×						
75.	Waagenophyllum frechi (Volz)			×					Sumatra.
76.	?Waagenophyllum gerthi n. sp.			×					
77.	Waagenophyllum timorica Gerth			? ×	×				Timor; Cambodge.
78.	Waagenophyllum akasakense (Yabe)			×	×				
79.	Waagenophyllum indica var. akagoense n. var.		×						
80.	Dibunophyllum rugosum var. ofukense n. var.	×							
81.	Nagatophyllum satoi n. sp.	×							
	Family Cyathoaxonidae								
82.	Polycoelia japonica n. sp.	×							
	TABULATA								
	Family Chaetetidae								
83.	Chaetetes sp.	× × ×	?	? ? ×	×				

	C_1	C_2	C_3	CPg	P_1	P_2	P_3	
MOLLUSCOIDEA								
BRYOZOA								
84. Fistulipora kotoi n. sp.		×						
85. Fistulipora nagatoensis n. sp.	×							
86. Geinitzella cf. columnaris		×						Salt Range; Europe.
87. Fenestella perelegans Meek		×						Salt Range; Indochina; etc.
88. Polypora sp.		×						
BRACHIOPODA								
89. Spirifer sp.		×						
90. Productus sp. aff. semireticulatus Martin	×							Cosmopolitan species.

Throughout the investigation, I have received useful instructions from Drs. Yokoyama and Yabe. Therefore I take this opportunity of expressing my most cordial thanks to them.

Description of the Species.

FOSSIL PLANTS.

CHLOROPHYCEAE.

Family Siphonocladiales.

Subfamily Siphoneae Verticillatae.

Genus Mizzia Schubert.

1. Mizzia velebitana Schubert.

Pl. I., figs. 1a, 2a. Pl. II., figs. 6b, 7c.

1908. *Mizzia velebitana* Schubert, Mitteilung über Foraminiferen etc. Jahrb. d.k.k. geolog. Reichsanst., Bd. LVIII., p. 382. Pl. XVI., figs. 8-11.

1908. *Mizzia velebitana* Schubert, Karpinsky, Einige problematische Fossilien aus Japan, Verh. Min. Gesells. St. Petersb., Bd. 46, p. 259, Pl. III, figs. 6,7.

1908. *Mizzia japonica* Karpinsky: Ditto.

1908. *Guadalpia* sp.? Girty. The Guadalpian Fauna, Prof. Paper, Geol. Surv. U.S.A., Vol. 58, p. 85, Pl. V., figs. 7-11.

1919. *Mizzia velebitana* Schubert: Pia, Ph. Négris's Roches Crystallophylliennes et Tectonique de la Grèce, 2 Appendice, p. 212. Figs. 56,57,59.

1920. *Mizzia velebitana* Schubert: Pia, Die Siphoneae Verticillatae vom Karbon bis zur Kreide, p. 19, Pl. I., figs. 12-23.

Very abundant in the Permian *Fusulina* limestone.

Localities: Kaerimizu,[1] Serida,[2] Yobara,[3] Okugawara,[4] Isa,[5] Omine, Shigeyasu, etc.

(1) 歸リ水 (2) 芹田 (3) 江原 (4) 奥河原 (5) 伊佐

CONIFERALES INCERTAE SEDIS

Genus Cycadocarpidium Nathorst.

2. Cycadocarpidium swabii Nathorst.

Pl. I., fig. 10.

1911. *Cycadocarpidium swabii* Nathorst: Über die Gattung *Cycadocarpidium* Nathorst, nebst einigen Bemerkungen über *Podozamites*, p. 5, Pl. I., figs. 11–15.

1920, *Cycadocarpidium swabii* Nathorst: Seward, Fossil Plants, Vol. IV., pp. 449–451. Figs. 812, C and D.

Several fragments of the leaflets, one of which bears two ovules without rudimentary leaflets as illustrated in the plate.

Most of these leaflets show about seven or eight veins. The exact length of the whole leaflet is unknown, but it may be taken for less than 5 cm. The width is 1 cm or a little more. From these characters the plant is to be identified with *Cycadocarpidium swabii* rather than with *Cycadocarpidium erdmanni*.

Locality and geological position :—

The specimen here described was obtained in the shale unconformably overlying the Permian *Fusulina* limestone at Ojigase[1] in Isamura. The shale is probably the lowest of the layers which form the Omine[2] Coalfied, the exact age of which and relation with the Yamanoi[3] plant bearing bed is still undetermined, though several opinions have been proposed by geologists. As *Cycadocarpidium*, according to Nathorst and Seward, is hither-to known only from the Rhaetic, we may safely conclude that the Omine Coalfield belongs to the Rhaetic just as the Yamanoi plant bearing series.

The present fossil is associated with *Podozamites distans* Presl and indeterminable fish bones.

Genus Podozamites Braun.

3. Podozamites distans Presl.

1883. *Podozamites lanceolatus* var. *distans* Schenk, in Richthofen's China, IV, p. 251, Pl. L, figs. 5 and Palaeontographica XXXI, p. 173, Pl. XIV, figs. 5, 8b, 9b, Pl. XV, figs. 9,10.

1891. *Podozamites lanceolatus* Yokoyama, Jour. Coll. Sci. Tokyo Imp. Univ., Vol. IV., p. 245, Pl. XXXIV., figs. 3,4. Mesozoic Plants from Nagato and Bitchu, p. 2. (1905).

1903. *Podozamites distans*, R. Zeiller, Flore Fossile des Gîtes de Charbon du Tonkin, pp. 159–163. Pl. XLII., figs. 1–4.

1920. *Podozamites distans* Seward, Fossil Plants. Vol. IV., p. 454.

Several fragments. The veins of the leaflets number 15. The leaflets are usually rather broader in proportion to their length than those of

(1) 伊佐村祖父ケ瀬. (2) 大嶺炭田. (3) 山野井.

Podozamites lanceolatus. As regards the separation of *Podozamites distans* from *P. lanceolatus*, we refer to Zeiller and Seward.

Occurrence.—Associated with the above described *Cycadocarpidium swabii* it occurs at Ojigase of Isamura.

FAUNA.
FORAMINIFERA.

Family Miliolidae.

Genus Cornuspira Schubert.
Subgenus Hemigordius Schultze.

4. Hemigordius japonica n. sp.

Pl. II., figs. 10, 11.

Shell planospiral, discoidal, thick; formed of numerous involute whorls of a non-septate tube with gradually increasing diameter. Only the last volution is visible. Diameter 1.8 mm. Thickness 1 mm. Earlier volutions labyrinthic and not spiral in a definite direction. The later ones involute and coiled in one plane.

Remarks, locality and age :—

This species is distinguished from the hither-to known by the perfect involution of the whorls and their number. It was observed in thin sections containing *Neoschwagerina craticulifera*, *Fusulina japonica*, etc.

Locality : Kaerimizu.

Age : lower Permian.

Subgenus Glomospira Rzehak.

6. Glomospira cf. gordialis (Jones and Parker)

Pl. II., fig. 6c.

1860. *Trochammina gordialis* Jones et Parker, Q.J.G.S., Vol. XVI., p. 309.

1869. *Trochammina gordialis* Jones, Parker et Kirkby. Ann. and Mag. Nat. Hist., Ser. 4, Vol. IV., p. 390, Pl. XIII., figs. 7,8.

1876. *Trochammina gordialis* Brady, Carboniferous and Permian Foraminifera. Paleontological Society, Vol. XXX., Pl. III., figs. 1-3. p. 77.

1906. *Glomospira gordialis* Schubert, Zur Geologie des Österreichischen Velebit, p. 381, Pl. XVI., figs. 3,6.

The species of Akiyoshi is known only by thin sections. It occurs very abundantly at several localities associated with Permian Foraminifera.

6. Glomospira cf. pusilla (Geinitz)

Pl. II., fig. 5a.

1869. *Trochammina pusilla* Jones, Parker and Kirkby, Ann. and Mag. Nat. Hist., Ser. 4, Vol. IX., p. 390, Pl. XIII, figs. 4-6.
1876. *Trochammina pusilla* Brady, Carboniferous and Permian Foraminifera, Paleontological Society, Vol. XXX., p. 78, Pl. III., figs. 4,5.
1908. *Glomospira aff. pusilla* Gein. Schubert, Zur Geologie des Oesterreichischen Velebit. p. 387.

This species was also recognized by the longitudinal sections. Diameter of tube in the last volution 0.17 mm. Length 1.2 mm. and breadth 0.81 mm. Thickness unknown. The Akiyoshi specimens are smaller than those described by Brady, etc.

Locality: Maruyama in Isamura ;[1] Serida in Beppumura,[2] etc.
Age: Permian.

Family Lituolidae.

Endothyra Phillips.

7. Endothyra sp.

Pl. XIII., fig. 2b.

Several kinds of sections of the genus are observable in those of the *Fusulina* limestone. The best of all is illustrated on the plate.

Family Texturaliidae.

Genus Textularia Defr.

8. Textularia cf. jonesi Brady

Pl. X., fig. 3c.

Compare :

Textularia jonesi Brady, Carboniferous and Permian Foraminifera.

The present species agrees with *Textularia jonesi* in the short, broad and complanate form, in the nearly opposite arrangement of segments and in the thin margin of the shell.

The Akiyoshi example (Pl. X, fig. 4c) is slightly smaller than those of the European Zechstein ; it is a little over 0.40 mm in length, though the width across the top is nearly equal to that of the European. The

(1) 伊佐村丸山. (2) 別府村芹田.

number of segments is twenty two, i.e., more numerous than in the English specimen described by Brady. Found in a thin section of the *Fusulina* limestone from the Lower Permian of Kaerimizu.

Genus Tetrataxis Ehrenb.

9. Tetrataxis schellwieni n. sp.

Pl. II, fig. 2a.

External form unknown. Shell spiral and trochoid, composed of several convolutions. Chambers simple. Apex rounded, apical angle 60.° Length 1 mm. Basal diameter almost equal to height.

This species is very characteristic and can never be confounded with other Permo-Carboniferous ones.

Age: Upper Permian.

10. Tetrataxis linea n. sp.

Pl. II., fig. 1.

Shell-form not quite certain, but judging from its longitudinal section, discoidal with indistinct apex, from which the surface descends slightly and evenly towards the margin. Basal diameter three millim. Height 0.43 mm. Apical angle more than 160.°

Remarks:—Although only a single specimen has been found, it is nevertheless so characteristic that I can not but create a new species on it.

As far as I can make out from the above specimen, the present species represents an extreme case of the depressed type of *Tetrataxis*. Among the hither-to known species, even *Tetrataxis maxima* var. *depressa* (Schellwien: die Fauna des karnischen Fusulinenkalks, p. 275, 1897.) has the apical angle of 130° (measurement on Schellwien's figure), though the later chambers arrange in an almost linear direction. (According to Schellwien the sample from Auernig has a basal diameter of 2.7 mm. with height 1.0 mm.). It must be added, however, that the number of the chamberlets of the present specimen coincides with that of *Tetrataxis maxima*.

Horizon and Locality:—The specimen was discovered by me in a thin section of the *Fusulina* limestone of Yunokami, Ofukumura.[1]

The age is Permian.

(1) 於福村湯ノ上.

11. Tetrataxis conica Ehrenb. var.

Pl. II, Figs. 6a, 7a.

Shell free, trochoid, with pointed apex, composed of spirally arranged chambers which narrow toward the apex and are not separated into chamberlets. Inferior side concave as in *Tetrataxis conica* var. *gibba* Möller. Convolutions 9-10. Apical angle about 90°. The largest example is 2.2 mm in diameter and 1.2 mm in height.

Remarks :—This species differs from Möller's species *Tetrataxis conica* var. *gibba* in the proportion of the height to the diameter and in the size of the apical angle. It occurs associated with *Verbeekina verbeeki* and *Neoschwagerina shiraiwensis* at Serida and Maruyama. The age is Upper Permian.

12. Tetrataxis cf. maxima Schellwien.

Compare :

1898. *Tetrataxis maxima,* Schellwien, Die Fauna des karnischen Fusulinenkalks, Teil 2, p. 274, Pl. XXIV., figs. 5-10.

The dimensions measured by Schellwien on the Carnic specimens and by me on that of Akiyoshi are as follows.

Diameter	Height	No. of Volutions	
1.04 mm.	0.72	5	Carnic specimens.
1.12	0.5	4-5	
2.7	1.0	10	
1.03	0.54	7	Akiyoshi specimen

The Akiyoshi specimen is represented by a single longitudinal section through the apex, on which account it is uncertain whether it is identical with the Carnic specimen or not. It occurs associated with *Neoschwagerina craticulifera* at Kaerimizu.

13. Tetrataxis cf. conica var. gibba Möller.

Compare :—

1877. *Tetrataxis conica* var. *gibba,* Möller, Die Foraminiferen des russischen Kohlenkalks. Mém. Acad. Imp. Sci. St. Pétersb. VII Ser., p. 73, Pl. II., figs. 4 a-c and Pl. VII., fig. 3.

The following are the dimensions of the Japanese specimen compared with the Russian.

Apical angle.	Length (height)	Diameter	Locality.
80°	0.22	0.28	Russia
75°	0.61	0.73	„
80°	0.81	1.00	„
80°	0.61	0.92	Akiyoshi.

The Akiyoshi specimen deviates more or less from the Russian in the thickness of the wall and the arrangement of the chambers. It occurs with *Verbeekina verbeeki* at Kaerimizu. The age is Permian. The Russian species is found in Lower Carboniferous.

Genus Bigenerina d'Orbigny.

14. Bigenerina sumatrana Volz.

Pl. II, fig. 3.

1904. *Bigenerina sumatrana* Volz, Zur Geologie von Sumatra, p. 96, fig. 26.

Early textularian biserial chambers reduced to small ones; on the contrary uniserial and rectilinear chambers strongly vaulted and evolute. Shell composed of numerous segments (12). Height nearly 4 mm. Width of last chamber 2.15 mm. Height of each biserial segment nearly equal and about 0.35 mm. Septa very short and bent.

Remarks, Locality and Horizon:—*Bigenerina sumatrana* is abundantly found in the uppermost *Fusulina* limestone of Akiyoshi. It is associated with *Sumatrina annae, Neoschwagerina douvillei* and *Neoschwagerina shiraiwensis*. Volz has recorded the present species from the Permian bed (his Upper Carboniferous formation) of Sumatra, where *Sumatrina annae* also occurs. The localities are Shigeyasu,[1] Shiraiwa,[2] Yoshinori,[3] all in Ominemura.

15. Bigenerina cf. bradyi (Möller).

Compare ;—

1877. *Cribrostomum bradyi* Möller, Foraminferen d. russ. Kohlenkalks, p, 53, Pl. III., figs. 1a-e, Pl. VI, fig. 1 and textfigs. 18,19.

(1) 大嶺村重安. (2) 白岩. (3) 吉則.

Segments composed of 5–7 biserial chambers followed by a single uniserial one. The dimensions are as follows.

Length	Height	
0.45 mm.	0.33 mm.	Average zigzag angle 90.°
0.83	0.61	

Our specimens are small compared with those of Russia and England, though the inner shell-structure shows a close resemblance to them. And I believe there is no need of separating it as a variety, because a difference in magnitude is not important in such a polymorphic organism as this species.

Localities and Horizon :—It is very frequent. Every thin section of the *Fusulina* limestone from Kaerimizu bears its fragment. Also in Russia and England it is frequently found throughout the Carboniferous limestone. Professor Yabe,[1] Schellwien[2] and Lörenthey[3] have recorded a form resembling this from various localities.

Family Lagenidae Carpenter.

Genus Lagena Walker and Jacob.

16. Lagena sp.

Pl. II, fig. 5b.

Shell conical and symmetrical. Orifice wide, neck short and irregular. Length 0.4 mm. Width 0.21 mm. Surface-characters unknown ; age Permian.

This is represented by a single longitudinal section.

Genus Nodosaria Lamarck.

17. Nodosaria cf. radicula Linné.

Compare :—

1876. *Nodosaria radicula* Linné, Brady, Carboniferous and Permian Foraminifera. Paleontogr. Soc. Vol. XXX., p. 124, Pl. X., figs. 6-16.

(1) Yabe, A Contribution to the Genus Fusulina, etc. p. 34.
(2) Schellwien, Die Fauna des karnischen Fusulinenkalks, p. 268, Pl. XXIII., fig. 14.
(3) Lörenthey, Mikroskopische Untersuchungen der paleozoischen Gesteine, p. 287.

Shell cylindrical, tapering, composed of several subglobose segments united in a straight line. Segments 7. Length 1.2 mm. Breadth of the last chamber 0.46 mm.

Remarks :—The Akiyoshi form closely resembles *Nodosaria radicula* Linné. But no specimen could be isolated from the matrix, the exact identification can not be made.

Locality and horizon :—According to Brady, *Nodosaria radicula* does not occur in any portion of the Carboniferous Limestone series, while it is not uncommon in the middle division of the Permian. The present form occurs together with *Verbeekina verbeeki* (Geinitz). It has been accidentally found in a thin section of the *Fusulina* limestone.

Locality : Shibukura[1] in Isamura.

Genus Lingulina d'Orbigny.

18. Lingulina sp.

Pl. II., fig. 8a.

Shell cylindrical, tapering, composed of nine segments. Chambers at first almost globular or subglobular, later somewhat laterally broadened and vaulted, though more or less depressed with the middle portion. Length 0.99 mm. The species is represented by a single longitudinal section found together with *Neoschwagerina craticulifera*, etc.

Age : Lower Permian.

Family Rotalidae

Genus Spirillina Ehrenberg.

19. Spirillina grandis n. sp.

Pl. II., fig. 4.

Shell represented by a complanate, plano-spiral non-septate tube ; volutions 5, of which the first 4 are involute and the last evolute. Diameter of shell 2.58 mm and its thickness 0.92 mm. This species closely resembles *Spirillina chinensis* Lörenthey (Mikroskopische Untersuchungen der paleozoischen Gesteine, p. 276, figures 26–29. 1880) which has four volutions, the earlier three being involute and the last evolute. The last volution is smaller than the others. For comparison the dimensions of these two forms are given.

(1) 澁倉.

	Height	Diameter
Spirillina chinensis	0.05 mm	0.25 mm
	0.08	0.27
	0.07	0.30
	0.07	0.34
Spirillina grandis	0.92	2.58

As seen from the above, the Akiyoshi specimen is 10 times as large as *Spirillina chinensis*. The inner structure, however, is almost identical.

Age: Lower Permian.

Locality: Kaerimizu.

Family Fusulinidae.

The following is a new classification of Fusulinidae as proposed by me.

Family *Fusulinidae* v. Möller.

A. Subfamily *Fusulininae* v. STAFF-WEDEKIND em. OZAWA.

Shell lenticular to fusiform. The shell-wall and septa consist essentially of the median lamella ("Dachblatt" or "lame spirale") and mesh structure ("Wabenwerk" or "réseau alvéolaire"), but a primitive form has often deposition or supplementary layers on both sides of the wall as well as of the septa. Mesh-work is often obsolete. Buccal aperture single. Carboniferous-Permian.

Genus *Staffella* n. gen.

Genotype *Staffella sphaerica* v. Möller.

Synonym: Staff's *Fusulinella*, Deprat's *Fusulinella* and v. Möller's *Fusulinella* (ex parte).

Shell lenticular or sphaeroidal. The axis of the volutions is the smallest diameter. Shell-wall composed of median lamella, alveolar structure (Möller's "Zwischenraum") and deposition layers (Möller's "innere Lamelle" and "supplementäre Kalkschicht") of which the last is often indistinct or obsolete. Septa almost plane and pierced by a relatively large single buccal aperture. Carboniferous-Permian.

Genus *Neofusulinella* DEPRAT (ex parte).

Shell globular or fusiform. The longest diameter lies in the axis of the whorls. Earlier volutions spheroidal and asymmetrical. Shell-wall thin and mesh-structure often obsolete. Septa almost plane. Buccal aperture large. No septal perforation.

It is an advanced genus of *Fusulinella*. Carboniferous ?-Permian.

Genus *Fusulina* FISCHER v. WALDHEIM.

Shell globular, fusiform or cylindrical. Earlier volutions almost symmetrical. Shell-wall composed essentially of thin lamella and alveolar structure. Deposition layers either developed or not. Septa strongly folded or almost plane. Septal perforation often present. We may distinguish three subgenera.

Subgenus *Fusulinella* v. MOELLER.

Synonym : *Neofusulinella* Deprat (ex parte).

Shell fusiform. Deposition layers well developed. Mesh-work obsolete. Septa strongly folded or almost not at all. No septal perforation. Staff's genus *Girtyina* is included in this genus.

Subgenus *Schellwienia* v. STAFF-WEDEKIND.

Shell globular, fusiform or cylindrical. Mesh-work generally distinct. Deposition layers often partly developed. Septal perforation present or not.

Subgenus *Schwagerina* MOELLER em. v. STAFF.

To the detailed diagnosis of the genus by v. Staff-Wedekind I have little to add.

Schwagerina has a single buccal aperture and the lower border of the septa of *Schwagerina princeps*, according to v. Staff, is strongly folded. On this account, *Schellwienia* and *Schwagerina* are often confounded.

B. Subfamily *Verbeekininae* v. STAFF-WEDEKIND em. OZAWA.

Shell sphaeroidal or fusiform. Shell-wall thin, composed essentially of thin lamella and mesh-work. In the specialized forms, *Sumatrina* and *Doliolina*, the mesh-work is absent. Structure of the primary septa similar to that of *Fusulina*. Septa not folded at all. Buccal aperture multiple and consequently basal skeletons well developed. No septal perforations. Upper Carboniferous-Permian.

Genus *Doliolina* SCHELLWIEN.

Subgenus *Doliolina* SCHELLWIEN. em. OZAWA.

Subgenotype *Doliolina lepida* (Schwager).

Shell cylindrical. Shell-wall thin, composed of compact thin lamella only. No deposition layers. Basal skeletons well developed. Primary septa only. Age Permian.

Subgenus *Verbeekina* v. STAFF.

Subgenotype *Verbeekina verbeeki* (Geinitz).

Shell, sphaeroidal to fusiform. Earlier volutions Endothyrian. Shell-wall composed of thin lamella and mesh-structure. Basal skeletons indistinct in earlier whorls. Upper Carboniferous-Permian.

Genus *Neoschwagerina* YABE.

Shell globular or fusiform. Volutions numerous, generally more than ten. Earlier volutions sphaeroidal and closely resembling those of the subgenus *Verbeekina*.

Transverse septa and lateral passages developed. False septa present or not. Shell-wall composed of thin lamella and mesh-work. Four subgenera may be distinguished. Age Permian.

Subgenus *Cancellina* HAYDEN.

No false septa. Subgenotype *Cancellina primigena* Hayden.

Subgenus *Neoschwagerina* s. str.

Three kinds of septa usually developed, viz., primary meridional, auxiliary meridional and primary equatorial. Auxiliary equatorial septa generally absent. Age Permian,

Subgenus *Yabeina* DEPRAT.

Four kinds of septa developed, viz., besides those found in *Neoschwagerina* s. str. there is a fourth, auxiliary equatorial. The septa compared with those of *Neoschwagerina* are more delicate ; their end usually swells out so that they resemble in general appearance those of *Sumatrina*.

Subgenus *Sumatrina* VOLZ.

Subgenotype *Sumatrina annae* Volz.

Volz's diagnosis is very detailed and I have little to add. Central chamber sphaeroidal and its wall composed of median lamella and alveolar structure, which latter is not visible in the shell-wall. Four kinds of septa well developed.

Remarks :—Deprat's new genus *Palaeofusulina* is here not mentioned, because it is not represented in my collection. But judging from his illustrations, it may be either Staff's *Girtyina* or *Fusulina* s. str.

Quite recently J.S. Lee described a new genus *Grabauina*[1] which, according to him, is distinguished from *Fusulina* by having the massive septa in first three or three and half volutions as in *Fusulinella*.

But so far as his textfigures of the genotype *Grabauina disca* is concerned, the earlier volutions are symmetrical and closely resemble those of *Fusulina* (*Schellwienia*), and no peculiarities of *Fusulinella* of Staff and Deprat are observed. The massive walls in the earlier volutions would be formed by the disappearance of the mesh-work after the deposition layers were developed. Therefore it seems to me unnecessary to separate the present genus from *Fusulina* s. str.

(1) J.S. Lee. Grabauina, a transitional form between *Fusulinella* and *Fusulina*. Bull. Geol. Soc. China. Vol. III, no. 1. pp. 51–54.

Genus Fusulinella v. Möller em. Ozawa.

Synonym: Schubertella v. Staff-Wedekind and Neofusulinella Deprat (ex parte).

20. Fusulinella bocki v. Möller.

Pl. III., figs. 7,9,10.

1877. *Fusulinella bocki* v. Möller, Die spiral-gewundenen Foraminiferen des russischen Kohlenkalks. Pl. V., figs. 3a-g and Pl. XIV, figs. 1-4.

Shell small, fusiform with pointed umbilical ends. Proportion of length to width usually 1.6:1. Septa almost plane in the median vaulted portion of shell, but slightly folded at both ends. Buccal aperture of the fifth volution about 0.13 mm. in length. Volutions 6; rate of evolution slow. Measurements are shown in the following table.

	Akiyoshi specimen			Russian specimen.		
	Height (Growth)	Breadth	No. of Septa	Height	Breadth	No. of Septa
Initial chamber	mm. 0.123-0.15	mm. 0.138		0.075	0.108	
1st volution	0.21-0.24	0.39	8-9	0.120	0.357	8
2nd „	0.34-0.38	0.46	12	0.300	0.468	12
3nd „	0.52-0.61	0.81	16	0.504	0.800	13
4th „	0.66-0.89	1.23	20	0.780	1.200	17
5th „	1.11-1.24	1.97	24	1.100	1.980	24.

Remarks:—v. Staff in his treatise "Beiträge zur Kenntnis der Fusuliniden" remarks on *Fusulinella bocki* v. Möller as follows.

"*F. bocki* v. Möller, wie bereits Schellwien erkannt hat, muss durchaus zu den Fusulinen gerechnet werden. Gerade diese Form hat aber v. Möller seiner Diagnose des Genus zu Grunde gelegt. Ich hebe deshalb hier ausdrücklich hervor; Taf. XIV Spir. gew. For. 1878) zeigt einen Erhaltungszustand, in dem die Kammerwände und Septen hell erscheinen und von einer dunklen Versteinerungsmasse umgeben sind.

Die letztere füllt jedoch nicht das ganze Kammerinnere aus, sondern lässt noch Raum für helle Kalkspatkristalle."

So far as I am aware, there is no such statement given by Schellwien in any of his papers, Schellwien's *Fusulina bocki* is the same as that of v. Möller and not *Fusulinella bocki* of the latter author, while Möller's *Hemifusulina bocki* is *Fusulina minima* of Schellwien.

Indeed Schellwien recognized the peculiar structure of the shell-wall and septa of *Fusulinella* observed by v. Möller excepting for the interpreta-

tion of the socalled "Zwischenraum" which he assigned, including median lamella, to the true structure of the shell-wall of *Fusulinella*. (Undoubtedly he accepted the same shell-structure of *Fusulinella* as that of the new genus *Staffella*).

Provided that v. Möller's diagnosis were wrong, then v. Staff's *Girtyina* should be included in *Fusulina*. Because, as is evidently shown in v. Staff's illustrations of *Girtyina schellwieni* and *Girtyina ventricosa* (Palaeontographica 1912, Pl. XVIII., figs 1,2,5,7–9), their shell structure exactly coincides with that of v. Möller's *Fusulinella bocki*. Judging from these facts, I insist that *Fusulinella* founded on *Fusulinella bocki* must be retained as it was by v. Möller.

Locality and geological horizon :—The Russian specimen comes from the underlying bed of the Upper Carboniferous formation of the Twerza River, etc. In the case of Akiyoshi, it is associated with *Dibunophyllum rugosum* var. *ofukense*, *Lonsdaleia floriformis crassiconus* and *Chaetetes* sp. It is found abundant at various localities, viz., Shishidedai,[1] Isa,[2] Tombstone Region and Ofuku-Dai.[3] The age may be Moscovian.

2. Fusulinella biconica (Hayasaka)

Pl. III, figs. 2,3,4.

1922. *Neofusulinella biconica* Hayasaka: The Limestone from Omimura, Prov. Echigo. P. 4.
1924. *Neofusulinella biconica* Hayasaka: On tne Fauna of the Anthracolithic Limestone of Omi-mura. Sci. Rep. Tohoku Imp. Univ., Sec. Series. Vol. VIII., No. 1, pp. 13–14. Pl. II., figs. 4,5,6,7.

Shell fusiform, highly vaulted in the median portion. Proportion of length to width 1.5 : 1. Initial chamber 0.16 mm in diameter. Volutions 6–9. Rate of growth and number of septa in each volution are as follows :

Volution	Rate of growth	No. of Septa	Thickness of wall.
1	0.257	7	
2	0.41	12	0.030
3	0.62	16	0.040
4	0.92	20	0.054
5	1.28	24	0.068
6	1.76	27	0.077
7	2.30	31	0.095
8	2.82	36	0.080

Remarks :—This is the largest form of the genus *Fusulinella*. As to the growth and external configuration it it resembles *Fusulinella lantenoisi*

1) 猪出臺. 2) 伊佐. 3) 於福臺.

(Deprat), which, however, has the smaller initial chamber, less numerous septa and the thickness of the spiral wall thinner.

Localities and age :—Quite abundant at Shibao,[1] Shishidedai, Isa and Ofuku-Dai, associated with the preceeding species.

Age : Moscovian.

22. Fusulinella itoi n. sp.

Pl. III., figs. 6,8.

Shell fusiform and small, with pointed extremities. Proportion of length to width 1.9 : 1. Septa almost plane, slightly folded at their extremities. Initial chamber small, less than 0.07 mm. in diameter. Length of buccal aperture 0.135 mm. in the 6th volution. Volutions 6–8. Rate of growth slow, as shown in the follwing table.

Volution	Growth	No. of septa	Thickness of Wall
1	0.162 mm.	9	
2	0.284	12	
3	0.432	15	0.0135
4	0.581	19	0.0162
5	0.824	21	0.0200
6	1.108	22	0.0200
7	1.459	27	0.0243
8	1.865	30	0.0270

Remarks, locality and age :—It resembles *Fusulinella bocki* v. Möller of the Russian Carboniferous limestone. But the detailed inner structures are more or less different. The difference of the rate of evolution, the thickness of the wall and the number of the septa are sufficient to separate the present one from the latter. Up to the present, this species has been found only at a single locality, viz., Shiraiwa, where it can be collected abundantly. It is associated with *Lonsdaleia katoi* n. sp., *Chaetetes* sp. and the Upper Permian Fusulinae such as *Neoschwagerina shiraiwensis* n. sp., *Neos. douvillei* Ozawa and *Sumatrina annae*.

Age : Upper Permian.

Genus Staffella Ozawa.

23. Staffella mölleri n. sp.

Pl. II., fig. 9.

Shell oval to spherical, axially somewhat short. Initial chamber shperical, diameter 0.077 mm. Volutions 6–7.

1) 芝尾.

One of the specimens measures 1.26 mm. in height and 1 mm. in diameter. Rate of growth slow.

Volution	Growth	No. of Septa.
1	0.15 mm.	8
2	0.26	12
3	0.46	17
4	0.68	21
5	0.92	
6	1.26	

Buccal aperture in the fifth whorl measures 0.185 mm. in length, i.e., one third of the breadth of that whorl.

Remarks :—The external configuration of the species resembles *Staffella sphaerica* from the Caucasus, but the latter on the whole is larger (4.75 mm. in height and 3.50 mm. in width) and has more numerous septa. The rate of growth shows a certain resemblance to *Fusulinella* (*Staffella*) *sphaeroidea* (v. Möller) and *Staffella quadrata* (Deprat) (these two species may be identical), from which, however the present species can be distinguished by its different form.

Age : Moscovian.

24. Staffella yobarensis n. sp.

Pl. III., figs. 1b, 5.

Shell small spheroidal, with height 0.311 mm. Axial length 0.25–0.30 mm. Buccal aperture measures about 0.054 mm in length at the third volution. Initial chamber small, less than 0.05 mm in diameter. Rate of evolution and number of septa are as follows.

Volution	Rate of evolution.	No. of Septa.
Initial chamber.	0.041 in diameter	
1	0.095	
2	0.169	
3	0·229	13
4	0.311	16

Remarks :—Among the spheroidal forms of the genus *Staffella*, this species is the smallest one. It occurs with *Fusulina* (*Schellwienia*) *yobarensis* at Yobara.

Age : Lower Permian.

25. Staffella waageni (Schwager).

Pl. IX., fig. 10.

1887. *Fusulinella Waageni* Schwager, Salt-Range Fossils. Palaeontologia Indica. p. 990, Pl. CXXVIII, figs. 10a-c.

In the highest horizon of the Akiyoshi Limsestone, associated with *Sumatrina annae*, though much less abundant, is a form which should be referred to *Staffella waageni* Schwager. This is a small lenticular species having a longitudinal diameter of 1 mm and the proportion of the height and width is 2.1 : 1. A section which is somewhat oriented in accordance with one of the axes is represented by fig. 10 of Pl. IX.

Genus Fusulina Fischer v. Waldheim.
Subgenus Schellwienia v. Staff-Wedekind.

Group of Fusulina longissima v. Möller.

26. Schellwienia staffi n. sp.

Pl. IV., fig. 1.

Shell slender, elongated, pointed at both extremities. Proportion of length to width 4 : 1. Length usually 4–5 mm. Septa and spiral wall thin, less than 0.03 mm in thickness. Buccal aperture short and low. Septa intensely folded. Initial chamber small, less than 0.1 mm in diameter. Volutions 5–6. Rate of growth very slow. Alveolar structure very minute, often thin deposition layer observable.

Remarks :—This species differs from the elongate form of the group of *Fusulina longissima* v. Möller in being smaller and in having an indistinct minute alveolar structure which character seems to me sufficient to make a new species. The shell-wall resembles that of *Fusulina obsoleta* Schellwien. Found associated with *Fusulinella bocki* v. Möller, at a single locality :—Shishidedai.

Age : Moscovian.

27. Schellwienia cf. kattaensis Schwager.

Pl. VIII., fig. 6b.

Compare :—

1885. *Fusulina kattaensis* C. Schwager, Salt Range Fossils, Pal. Indica, pp. 985-987. Pl. CXXXI., figs. 1-5.

1912. *Fusulina kattaensis* Deprat, Études des Fusulinidés etc. Mém. Géol. l'Indochine, vol. 1., fas. 3, pp. 31-32. Pl. IX., figs. 5-11.

Shell slender, straight, subfusiform, with more or less rounded ends.

Proportion of length to width 5 : 1. Volutions 6. Diameter of initial chamber 0.13 mm. or more. Rate of growth is as follows.

Volution	Growth		Thickness of Wall.	
1	0.23	0.28	0.013	
2	0.35	0.49	0.02	0.01
3	0.47	0.63	0.027	0.02
4	0.70	0.79	0.040	0.025
5	1.05	1.08	0.040	0.03
6	1.44	1.40	0.040	0.04
Locality	Akiyoshi	Yunnan	Akiyoshi	Yunnan.

Remarks :—In my collection this species is very scarce and was obtained at the single locality, the Kotô gorge. The specimens from Akiyoshi are rather short (8 mm.) compared with those of the Salt-Range and Tong'hai in Indochina, which measure usually 10 mm or more, but the inner characters are more or less similar to those of the latter two.

Horizon :—*Schwagerina muongthensis* subzone.

Group of Fusulina pusilla Schellwien.

28. Schellwienia ellipsoidalis Staff var.orientis n. var.

Pl. VI., fig. la, Pl. VIII., figs. 3,5.

Compare :—

1912. *Fusulina ellipsoidalis* Staff, Die Fusulinen (Schellwienien) Nordamerikas. p. 181, Pl. XVIII., fig. 4.

Shell ellipsoidal, resembling that of *Doliolina lepida*. Length 7 mm. Volutions 10–15. Initial chamber small, about 0.14 mm in diameter. Rate of evolution slow. Folding of septa moderate ; buccal aperture large and high.

Volution	Rate of growth	No. of Septa	Thickness of wall
Initial chamber.	0.14 mm.		
1	0.20	7	
2	0.27	10	
3	0.38	13	
4	0.52	14	
5	0.71	16	
6	0.93	19	0.013 mm.
7	1.21	20	0.027
8	1.57	24	0.032
9	2.00	26	0.042
10	2.46	29	0.042
11	2.96	32	0.068

Remarks :—By a transverse section only it is hard to determine whether the present species belongs to *Fusulina* or *Doliolina*. The form which resembles it most is, of course, *Fusulina ellipsoidalis* from Iowa in North America. The ratio of the length to width of the American species is 1.8 : 1 ; an axial length measures 5 mm., and the septa are at both ends extremely folded, accordingly in the longitudinal section a mesh-like appearance is observable at both ends, an important distinguishing character from the present variety. Their rate of evolution of later volutions also seems to be more or less different. The other allied forms are *Fus. contracta* Schellwien and *F. lepida* Deprat, from which the present species is distinguished by its larger size and more numerous volutions. The difference of septal folding is also an important character. The specimens occur at three localities, viz., Ofuku-Dai, Nakamura of Ominemura and Kaerimizu, where it is found associated either with *Doliolina claudiae* Deprat or with *Fusulina edoensis* (Permian species).

Age : Ouralian to Upper Permian.

Group of Fusulina vulgaris Schellwien.

29. Schellwienia vulgaris Schellwien.

Pl. VII., fig. 3.

1909. *Fusulina vulgaris* Schellwien, Monographie der Fusulinen. Palaeontographica, No. 56, p. 163, Pl. XIV., figs. 1-2.

Shell fusiform to rather globular. Proportion of length to width ranging from 1.5 : 1 to 1.2 : 1. Length 7–8 mm. Breadth 3.5–4.2 mm. Septa thin, often connected by thin lamellae. Volutions 5–6. Rate of growth rapid as shown in the following table :

Volution	Rate of growth	Thickness of wall.
1	0.81	
2	1.47	0.055
3	2.25	0.080
4	3.42	0.110
5	4.46	0.135
6	5.86	0.190

Initial chamber almost spherical, with diameter 0.3–0.5 mm. Septa numerous, about 45 in the 5th whorl (Darwas form has also 45.)

Remarks :—Externally *Schellwienia vulgaris* closely resembles *Schwagerina*, that is to say, in the external markings of the septa, the pointed ends and the swollen median portion. But the inner structures such as the folding of septa, the thin connecting lamellae, the rapid increase in size

of volutions and the large initial chamber are very characteristic in the present species and no form has ever been recorded which can be confounded with it.

On the other hand, it has many varieties which resemble one another in their inner structure as well as in their external appearance.

It is very interesting that the species is always found associated with several varieties of its own. At Darwas it occurs with its variesties *Fusulina vulgaris* var. *globosa*, var. *fusiform* and var. *exigua*. The Akiyoshi limestone also contains a variety, viz., var. *globosa*. The localities are Kaerimizu and Uyeyama[1] in Akagômura, Nakano-Dai[2] and the Kotô gorge[3].

Age: Ouralina.

30. Schellwienia vulgaris var. globosa Schellwien.

Pl. VII., figs. 1,2.

1912. *Fusulina vulgaris* var. *globosa* Schellwien, Die asiatischen Fusulinen. Pl. XIV., figs. 3-7, pp. 164-165.

Shell globular, highly vaulted in the median portion. Proportion of length to width ranging between 1.4 : 1 and 1.1 : 1. Volutions 7–8, rate of growth being rather rapid. Septa comparatively thick, connected by thin lamellae. Initial chamber medium in size, diameter 0.28–0.40 mm. Layer of alveolar network thick and strong, and septa extremely thin at both extremities.

Remarks :—The shell-appearance given in the figure is very peculiar and resembles that of *Fusulina globosa* Deprat or *Fusulina* (*Schwagerina*) *muongthensis*. Yet the inner characters are quite different, such as the rate of growth, and the structure and folding of septa. Rate of evolution, thickness of wall and number of septa in each volution are as follows :

Volution	Rate of growth.	Thickness of wall	No. of septa.
1	0.43	0.030	10
2	0.95	0.054	16
3	1.62	0.081	22
4	2.59	0.140	27
5	3.40	0.140	34
6	4.43	0.193	38
7	5.43	0.193	
7½	5.89	0.193	

In an exceptional case, the shell is almost spherical and the ratio is

1) 赤郷村植山. 2) 中ノ臺. 3) 厚東峡.

1 : 1. Initial chamber large, and growth more rapid as shown in the following table :

Volution	Rate of growth	Thickness of wall
Initial chamber	0.52 mm.	
1	0.71	
2	1.42	
3	2.22	0.15 mm.
4	3.11	0.22
5	4.47	0.22
6	5.75	0.18

Age : Ouralian.

31. Schellwienia kraffti Schellwien.

Pl. VII., fig. 4, Pl. VI., fig. 7.

1909. *Fusulina kraffti* Schellwien, Die asiatischen Fusulinen, p. 169, Pl. XVII., figs. 1-9.
1914. *Fusulina tenuissima* Deprat, Étude comparative dés Fusulinidés d'Akasaka. Mém. Géol. d'Indochine, Vol. III., fas. 1, p. 12, Pl. II., figs. 9-10.

Shell cylindrical, much rounded at both extremities. Length usually 11 mm. Proportion of length to width ranges from 3 : 1 to 2.5 : 1. Septa thickened at its underborder and intensely folded throughout. Initial chamber large, mostly measuring 0.35-0.40 mm in diameter, but also often up to 0.45 mm. Rate of growth of volution moderate : thickness of shell-wall steadily increasing. Volutions generally 7.

Volution	Rate of Growth	Thickness of wall	No. of septa
Initial chamber	0.04		
1	0.52	0.030	11
2	0.83	0.055	18
3	1.29	0.067	23
4	1.91	0.105	29
5	2.72	0.139	32
6	3.18	0.159	32
7	4.31	0.123	

Remarks. The species is related to *Fusulina tenuissima* Schellwien in its external configuration, and Deprat naturally identified a form from Akasaka with the latter by the characteristic appearance of its longitudinal section. But unfortunately he did not thoroughly compare the minute inner structures of the two, such as the number of the septa and the thickness of the wall of each volution. Schellwien makes the following remark concerning the structure of *Schellwienia tenuissima* : " Die Wandungen

zeichnen sich durch ihre merkwürdige geringe Stärke aus, welche von 0.02 mm. in den ersten bis zu 0.03 mm. in den letzten Umgängen schwankt; die äusserste Dicke der Wand, die im 6. Umgang eines sehr grossen Exemplares beobachtet wurde, betrug 0.04 mm.....Die Zahl der Septen beträgt im 2–6. Umgang ungefähr; 30, 34, 36, 37, 40."

On the other hand the thickness of the wall of *Schellwienia kraffti* increases only gradually and at last it attains 0.16 mm i.e. four times that of *Schellwienia tenuissima* Moreover, the number of the septa in each volution is different. For comparison, I mention the results of the measurements made by Deprat on an Akasaka specimen and by Schellwien on the type specimen from the Carnic.

Volution	Rate of evolution			
1	0.85	0.84	0.83	0.85
2	1.11	1.13	1.13	1.12
3	1.50	1.52	1.54	1.54
4	1.98	2.02	2.03	1.96
5	2.44	1.50	2.56	2.42
6	2.99	3.02	3.10	2.98
	Akasaka	Yunnan	Cammon	Carnic Alps. (Schellwien)
	After Deprat			

Table showing number of septa in each volution.

1	11			
2	18	18	30	30
3	23	24		34
4	25	31		36
5	29	38		37
6			40	40

As shown in the above tables, in spite of the perfect coincidence of the rate of evolution, the number of the septa of various forms shows a great difference.

The rate of evolution is undoubtedly an important if not an essential character in determining a species, but it seems to me that the measurements made by Deprat are not quite complete. Because, by looking at the illustrations given by Deprat, it can be easily known that the values given by him are those of the longitudinal section only, and those of the transverse section which are more important are not given. Furthermore, Deprat seems not to have taken the thin spiral wall and septa of *Schellwienia tenuissima* (comparable with those of *Schellwienia cayeuxi* Deprat) into

consideration, as he makes no remarks on their characters. *Schellwienia kraffti* shows not only a more or less deviation from Carnic *Fusulina tenuissima* in the rate of evolution and the ratio of the length to the width, but its spiral wall, as previously stated, is very thick. The characteristic points of *Schellwienia kraffti* are clearly represented in the photographs of Deprat's *Schellwienia tenuissima*.

Consequently there is hardly any doubt that Deprat's species from Akasaka (and Yunnan) is to be identified with *Schellwienia kraffti* from Darwas and that it differs from *Schellwienia tenuissima*.

32. Schellwienia yobarensis n. sp.

Pl. VII., figs. 7,8.

Shell small, fusiform or globular. Septa thick and strongly folded. Buccal aperture short and low. Spiral wall thick, but much weakened at both extremities. Alveolar beams large and thick. Initial chamber very large compared with its form ; its diameter often attaining 0.45 mm, but usually less than 0.35 mm. Volutions 3–4. Growth rapid.

	Rate of Growth		Thickness of wall	No. of Septa
	Type I	Type II		
1st volution	0.53 mm	0.65 mm	0.06 mm	8-10
2nd „	0.94	1.09	0.10	18
3rd „	1.45	1.65	0.16	23-25

Remarks :—This species is a characteristic among the group of *Schellwienia vulgaris* and may be regarded as a small form which does not attain the size of *Schellwienia vulgaris*, etc. and not as younger stage of the latter. It looks somewhat like *Schellwienia propinqua* Deprat from the Akasaka limestone, which, although showing almost the same rate of growth, has a few volutions. Moreover, the external outline and the structure of the septa are different, so that they can be easily distinguished from each other.

33. Schellwienia krotowi Schellwien.

Pl. VII., figs. 5,6.

1908. *Fusulina krotowi* Schellwien, Monogrphie der Fusulinen Pl. XV., figs. 1-8, pp. 168-169.

Shell globular. Axial length 5.57mm in a specimen with nine volutions, ratio of length to width ranging from 1.4 : 1 to 1.6 : 1. Septa thick and folded, but not so strongly. Buccal aperture small and short. Initial chamber also small, with diameter 0.18mm. Rate of evolution, thickness of spiral wall and number of septa in each whorl are as follows :

Volution	Rate of Growth	Thickness of wall	No. of Septa.
1	0.24	0.011	9
2	0.38	0.020	18
3	0.59	0.027	24
4	0.88	0.047	27
5	1.32	0.054	34
6	1.80	0.081	36
7	2.44	0.108	37
8	3.17	0.135	40
9	3.99	0.121	

Remarks :—*Schellwienia krotowi*, according to v. Staff, is a globular species, the proportion of the length to the width not exceeding 2 : 1, and the breadth at the end of the 4th volution being less than 1.4 mm. The initial chamber is also small, less than 0.25 mm in the diameter. The present specimen brought from Akiyoshi has more closely wounded whorls than that of the Arctic Regions in Russia, yet the essential internal structure and the general appearance are quite like the latter.

The specimens are quite abundant at Yobara, associated with *Schellwienia ambigua*, *Schellwienia oblonga* n. sp., and *Schellwienia yobarensis*.

Age : Lower Permian.

Group of Fusulina verneuili v. Möller.

34. Schellwienia lutugini Schellwien.

Pl. VI., fig. 4.

1878. *Fusulina verneuili* Möller, Spir. gew. Foraminif., Mém. Acad. St. Pétersb., VII Série Bd. 25, No. 9, Pl. II., fig. 2d.

1908. *Fusulina lutugini* Schellwien, Fusulinen, Part I, pp. 177–178. Pl. XVIII., figs. 2,3,7,8, 12–14.

Shell elongated, nearly cylindrical, with ends short and rounded. Average dimensions more than 10 mm in length and 2 mm in width. Volutions 5–7 in number. Ratio of length to width usually 5 : 1. Mean rate of increase of growth, thickness of wall and number of septa in each volution as follows :

Volution	Rate of growth	No. of septa	Thickness of wall.
Initial chamber	0.214 mm		mm.
1	0.34	12	0.018
2	0.56	18	0.027
3	0.86	21	0.041
4	1.24	23	0.054
5	1.71	26	0.069
6	2.23	32	0.067

Remarks. This is one of the most slender and elongated forms of the genus *Fusulina*. In this slender shape and the general internal characters, the species approaches *Schellwienia granum-avenae* Roemer from the Permian from which it is frequently difficult to distinguish. The comparison of these two species will be given in detail below.

The present species is the most abundant fossil among those preserved in the limestome of Akiyoshi. Several localities are known in the depressed zone of Kaerimizu.

Age : Lower Permian.

35. Schellwienia granum-avenae Roemer

Pl. VI., fig. 6.

1880. *Fusulina granum-avenae* Roemer, Über eine Kohlenkalkfauna der Westküste von Sumatra, Palaeontogr. XXVII., pp. 1-11.
1896. *Fusulina granum-avenae* Verbeek and Fennema, Java et Madoura, Part 2, p. 1131. Pl. I, figs. 1-10.
1912. *Fusulina granum-avenae* Deprat, Étude Géol. Yunnan Oriental, Part III, p. 26.
1915. *Fusulina granum-avenae* Schubert, Die Foraminiferen des jüngeren Paleozoikums von Timor, Pl. XXXIX, fig. 1, Pl. XLI, figs. 5-6. p. 53.

Shell resembling the preceding in shape. Ratio of length to width **4 : 1.** Initial chamber 0.25 to 0.35 in diameter. Volutions generally 7. Rate of growth, number of septa and thickness of wall in each volution are as follows :

Volution	Rate of growth.	No. of Septa.	Thickness of wall
Initial chamber	0.25 mm		
1	0.40	10	
2	0.59	18	0.03 mm
3	0.83	25	0.03
4	1.20	30	0.04
5	1.60	30	0.06
6	2.00	36	0.11
7	2.49	36	0.11

Remarks. The specimens show a considerable difference in their size, those of Akiyoshi being generally small and almost like *Schellwienia lutugini* above described from which it is almost impossible to distinguish by a mere glance.

The distinguishing characters are the thickness of wall, the proportion of length to width and the number of septa in each volution. The character of the folding of the septa is also an important distinction. Although I believe that the above characters of the present species are sufficient to

separate it from *Schellwienia lutugini*, still it may not be impossible that it is a mere variation of the latter.

Locality and age. Associated with the Upper Permian species such as *Sumatrina annae*, *Neoschwagerina douvillei* etc., it occurs abundantly at Shiraiwa, Ominemura.

Group of Fusulina japonica Gümbel.

Large forms of *Fusulina* with the typical fusiform shell. Wall and septa thick, the latter folded intensely. Growth generally rapid so that the shell attains a very large size.

Age: Permian.

36. Schellwienia japonica Gümbel.

1883. *Fusulina japonica* Gümbel, Schwager, Carbonische Foraminiferen aus China und Japan, in Richthofen's China. Vol. IV., pp. 121–124. Pl. XV., figs. 1–11.

1899. *Fusulina japonica* H. Yabe, On *Fusulina japonica* Schwager from Tomuro, Prov. Shimotsuke, J. G. S. Tokyo, Vol. VI., No. 65.

1903. *Fusulina japonica* H. Yabe, on a *Fusulina* Limestone with *Helicoprion* in Japan, J. G. S. Tokyo, Vol. X., pp. 6–8.

1906. *Fusulina japonica* H. Yabe, Contributions to the classification of the genus *Fusulina* etc., J. C. S. Tokyo, Vol. XXI., art. 5. Pl. II., fig. 1.

1914. *Fusulina japonica* H. Deprat, Étude comparative des Fusulinidés d'Akasaka et des Fusulinidés de Chine et d'Indochine, p. 7. Pl. I., figs, 1–9.

1915. *Fusulina japonica* Deprat, Les Fusulinidés des Calcaires carboniferiens et permiens du Tonkin, du Laos et du Nord-Annam. p. 7, Pl. I., figs. 17–20.

On this species, several important treatises and good illustrations have already been published among which those of Deprat are the most elaborate. At Kaerimizu the specimens occur abundantly associated with *Schellwienia edoensis* n. sp. and *Verbeekina verbeeki*.

37. Schellwienia edoensis n. sp.

Pl. VI., figs. 1b, 2,3.

Shell longer than the preceding, pointed at the extremities. Ratio of length to width 3.5 : 1. Volutions 7. Septa complicately folded near the ends of the shell. Initial chamber large, measuring 0.41–0.50 mm in diameter. Spiral wall very thick, often attaining 0.2 mm in thickness.

Volution.	Rate of growth	Thickness of wall
Initial chamber	0.43 mm.	0.029 mm.
1	0.64	0.040
2	1.03	0.054
3	1.59	0.095
4	2.40	0.162
5	3.20	0.216

Remarks. The present species is very closely related to the preceding, from which, however, it is distinguished by the more slender shape. Besides, the thick spiral wall and the manner of the folding of septa are also some characters to distinguish the present species from the others, such as *Schellwienish parumvoluta*, *Schellwienia gigantea*, *Schellwienia ambigua*, all described by Deprat.

Locality and age. The rock specimens containing this species were collected at Kaerimizu, Yobara and Ofuku Plateau (in the lenticular limestone in shale). Associated not only with *Schellwienia japonica* and *Verbeekina verbeeki*, but also with *Sumatrina annae*, it occurs abundantly in the Akiyoshi limestone.

Age: Permian.

38. Schellwienia ambigua Deprat.

Pl. IV., fig. 8.

1913. *Fusulina ambigua* Deprat, Étude des Fusulinidés de Chine et d'Inpochine, Mém. Serv. Géol. d'Indochine, Vol. II., Fas. 1. Pl. III., figs. 4–7, pp. 14–15.

The present species was described by Deprat in detail,who gave good figures of the characteristic sections, so that I have no more to add. For convenience of comparison I give the result of measurements of the rate of growth, thickness of the wall and number of the septa in each volution made on the Annam species by Deprat and on the Akiyoshi one by me.

Volution	Growth in mm.		Thickness of wall		No. of Septa	
Initial chamber	0.46	0.28				
1	0.61	0.60	0.025	0.027	14	15
2	0.92	0.96	0.043	0.048	20	20
3	1.39	1.40	0.069	0.072	26	26
4	1.97	2.00	0.081	0.084	28	29
5	2.65	2.60	0.095	0.096	34	39
6	3.26	3.20	0.081	0.086	36	39
Locality:	Akiyoshi	Annam	Akiyoshi	Annam	Akiyoshi	Annam.

Locality: Yobara. Age: Middle Permian.

39. Schellwienia Kaerimizensis n. sp.

Pl. IV., figs. 5,6,7. Pl. VI., fig. 5.

Shell elongated, nearly cylindrical, with both ends more or less sharply pointed. Proportion of length to width 4 : 1. Volutions 8–10. Initial chamber spherical, ranging in my specimen from 0.25 mm to 0.35 mm

in diameter. Measurements made on a number of specimens show the rate of growth almost equal and slow. Septa numerous.

The following table gives the measurements.

Volution	Growth	No. of Septa	Thickness of wall.
Initial chamber	0.28 mm.		
1	0.40	12	
2	0.59	23	0.007 mm.
3	0.81	28	0.027
4	1.11	33	0.041
5	1.54	34	0.054
6	2.03	39	0.081
7	2.55	46	0.081
8	3.30	48	0.110
9	3.88	49	0.095

Remarks :—Though the internal structure of the present species seen in a longitudinal section resembles more or less that of *Schellwienia lutugini* Schellwien, yet its resemblance to *Schellwienia japonica* Gümbel is greater. From *Schellwienia lutugini*, it differs much in the size of the shell and the number of the volutions. These differences alone seem to me to be sufficiently great to warrant the specific distinction of the two. Still a mention must be made on another specimen of the present species which show a smaller shape and less numerous septa, though the rate of growth and the particular internal character are always different from those of *Schellwienia lutugini.*

From *Schellwienia japonica* Gümbel, the present species is not so difficult to distinguish as in the case of *Schellwienia lutugini.* The rate of growth, the external configuration and the number of septa in each volution are different. On the whole the present one should be considered as an itermediate form between *F. japonica* and *F. lutugini.* There is only one rock-specimen among my collection obtained at Kaerimizu.

Age : Uppermost Ouralian-Permian.

40. Schellwienia gigantea Deprat.

Pl. IV., fig. 9.

1913. *Fusulina gigantea* Deprat, Étude des Fusulinidés. Mém. Serv. Géol. d'Indochine. Vol. II., fas. 1, pp. 29-30.Pl. I., figs. 1-6.

Shell fusiform with ends more or less rounded. Ratio of length to width 3 : 1. Volutions generally 6. Initial chamber large, more than 0.70 mm in diameter. Growth rather slow. The measurements given

in the following table were made on a specimen with 14 mm in length and 4.62 mm in width.

Volution	Rate of growth	No. of Septa.	Thickness of wall.
1	1.02	11	0.054
2	1.54	22	0.081
3	2.16	31	0.121
4	2.93	42	0.148
5	3.76		0.168
6	4.62		0.135

Remarks :—I think, there can be no doubt that my Akiyoshi specimen belongs to *Schellwienia gigantea* of Deprat, with which it exactly agrees in almost all internal characters excepting the rate of evolution which appears to be very variable. The measurements given by Deprat are in the following table.

Volution	Rate of growth	No. of Septa	Thickness of wall
1	1.48	0.048	11
2	2.12	0.096	22
3	3.28	0.108	31
4	4.28	0.132	42
5	5.00	0.280	
6	5.60	0.120	

When compared with the specimen from Laos, the Akiyoshi one is somewhat smaller, but no essential differences are recognizable between them. Two localities in the Akiyoshi area :—Iwakurayama of Hinaga and Ojigase in Ominemura.

Age : Upper Permian.

41. Schellwienia exilis Schwager.

1883. *Fusulina exilis* Schwager, Carbonische Foraminiferen aus China und Japan in Richthofen's China. Vol. IV., p. 125. Pl. XV., fig. 18, Pl. XVI., figs. 4,5.

1914. *Fusulina exilis* Schwager, Deprat, Étude des Fusulinidés de Chine et d'Indochine, Vol. III., fas. I, p. 17. Pl. II., figs. 6-8.

The type specimen of this species figured and described by C. Schwager is from the Akasaka limestone. Subsequently a good figure of a transverse section obtained from a specimen from the same locality was given by Deprat.

There is much doubt whether the horizon from which the specimens were obtained by Schwager and by Deprat is the same. Schwager states that his *Fusulina exilis* is associated with *Doliolina lepida*, while Deprat

obtained it from a higher horizon-the *Sumatrina* zone—in which at Akasaka no *Doliolina lepida* has ever been found, though at other localities it (Deprat's *Doliolina pseudolepida*) is very common.

The Akiyoshi specimen can be identified with both Schwager's and Deprat's species from Akasaka, but not with the form of Yunnan and Annam which Deprat considers as the same species; this latter is what I call in this paper *Schellwienia deprati*.

Locality and age :—Two localities are known, viz. Shiraiwa in Omine-mura and Shigeyasu.

Age : Permian.

42. Schellwienia deprati n. sp.

Pl. V., figs. 6,7.

1912. *Fusulina exilis* Deprat, Étude des Fusulinidés de Chine et d'Indochine. Vol. I., fas. 3, p. 24, Pl. VIII., figs. 13-14. Pl. VII., fig. 16.

1913. *Fusulina exilis* Deprat, Étude des Fusulinidés de Chine et d'Indochine. II Mém. p. 11.

Shell spindle-shaped, highly vaulted in median portion but thinning rapidly towards both ends which are generally pointed. Axial length about 6 mm and proportion of length to width 2.5 : 1 to 3 : 1. Initial chamber small, less than 0.2 mm in diameter. Growth of the volutions at first slow, but from the 5th or 6th volution rapidly increasing and attaining 3 mm in diameter.

Spiral wall at first very thin, as given in the following table. Septa numerous, buccal apertures short and low.

Volution	Rate of Growth	Thickness of wall	No. of Septa.
1	0.21	0.014	9
2	0.34	0.027	11
3	0.56	0.040	13
4	0.86	0.041	19
5	1.35	0.068	23
6	1.89	0.095	27
7	2.49	0.095	32

Remarks :—Deprat's description of *Schellwienia exilis* (excepting that of the Akasaka specimen) does not agree with his illustrations. If his measurements are correct, there is no doubt that his species from Tonkin is identical with Schwager's species from Akasaka. But judging from his photographs, the initial chamber is very small and the earlier volutions are very closely wounded and no coincidence with *Schellwienia exilis* Schwager is recognizable.

Probably the rate of evolution of *Fusulina exilis* identified by Deprat

was calculated from the measurement given by Schwager and not from his own made on the Tonkin sample. The present species which shows exactly the same character as Deprat's *Fusulina exilis*, is quite different in structure as well as in the rate of evolution from those of the true *Fusulina exilis*.

43. Schellwienia richthofeni Schwager.

Pl. V., fig. 1.

1883. *Fusulina richthofeni* Schwager, Carbonische Foraminiferen aus China und Japan. p. 135. Pl. XV., figs. 11-17.

1912. *Fusulina richthofeni* Deprat, Mém. Géol. d'Indochine, Vol. I., fas. 3, p. 30, Pl. VIII., figs. 15-16. etc.

Shell typically fusiform, acute at both extremities. Ratio of axial length to width 3 : 1. Growth rapid.

Thickness of spiral wall at first very feeble, but increasing suddenly and becoming very strong. Initial chamber spherical with diameter of 0.30 mm.

Volution	Rate of growth		Thickness of wall		No. of Septa.	
1	0.43	0.43	0.027	0.017	13	16
2	0.89	0.73	0.057	0.056	18	18
3	1.43	1.27	0.081	0.084	22	26
4	2.29	2.10	0.110	0.112	27	34
Locality	Edô	Yunnan	Edô	Yunnan	Edô	Yunnan.

Remarks .—Among the species of *Fusulina*, there is none which can be compared with the present species. Deprat makes the following remarks :—

" *F. richthofeni* est une espèce bien délimitée et que les coupes longitudinales et transversales suffisent à définir, à condition qu'elles passent par l'appareil embryonnaire ; comme pour toutes les espèces précédements dérites. Par as forme extérieure, elle se distingue bien de Fusulina brevicula renflée comme elle, mais avec un rapport de 2 : 1 au lieu de 3 : 1."

Locality and age :—A few specimens procured of this species were collected at Edô and on the Akiyoshi Plateau.

Age : Upper Ouralian.

44. Schellwienia crassiseptata Deprat.

Pl. V., figs. 10, 11, Pl. VI., figs. 8a, a'.

1915. *Fusulina crassiseptata* Deprat, Les Fusulinidés des Calcaires carboniferiens et permiens du Tonkins, du Laos et du Nordannam. pp. 3-4. Pl. I., figs. 12-16. Textfig. 1.

Shell typically fusiform. Proportion of length to width ranging from

2.5 to 3. Spiral wall and septa very thick. Initial chamber large, about 0.40 mm in diameter. Growth rapid, but not constant as is seen in the following table.

Volution	Rate of growth		(Akiyoshi specimens)		Thickness of wall.
Initial chamber	0.34	0.37	0.46	0.49	
1	0.56	0.59	0.77	0.86	0.054
2	0.90	0.98	1.32	1.32	0.081
3	1.50	1.60	2.06	2.09	0.121
4	2.23	2.28	2.80	2.96	0.135
5			3.76		

Remarks :—*Schellwienia crassiseptata* was described in detail by Deprat who gives good figures of characteristic sections, but I have some doubt on his observation and description. The chief points he referred to are as follows :

" La caractéristique principale de cette espèce réside dans l'épaisseur énorme de l'ensemble de la lame spirale et du réseau des poutrelles. Cette épaisseur croît avec une grande rapidité d'un tour à l'autre. Les poutrelles sont longues et minces, serrées. On voit qu'elles accompagnent sur toute sa longueur la cloison méridiennes, ce qui les fait renter dans notre groupe IV. Elle se distingue complètement de toutes les autres espèces connues, et au premier abord."

Judging from his text-figures, the septa seem not to belong to his 4th type and rather resemble that of *Schellwienia magnini* Deprat, though his illustrations (Plate) show quite a different structure. Figures 13 and 15 of plate I seem to represent a rather rare case while figures 12, 14 and 16 of Pl. I those of a usual one. The rate of evolution, according to his measurement, is slow, but his plate I, fig. 12 shows nearly the same rate of evolution as the Akiyoshi form.

The following is the table showing the rate of growth, thickness of wall and number of septa of *Schellwienia crassiseptata* as given by Deprat. (For purpose of comparison, those of Akiyoshi specimens are incerted).

Volution	Evolution	Thickness of wall		Number of Septa	
1	0.45	0.039	0.054	12	19
2	0.78	0.065	0.081	20	20
3	1.17	0.091	0.121	23	23
4	1.69	0.156	0.135	21	26
5	1.95				28
Locality	Cammon	Cammon	Akiyoshi	Akiyosh	Cammon

Locality :—Shiraiwa in Ominemura.
Age : Permian.

45. Schellwienia incisa Schellwien.

Pl. V., figs. 8,9.

1897. *Fusulina incisa,* Schellwien, Die Fauna des karnischen Fusulinenkalks. Paleontographica 44. pp. 252-253. Pl. XVIII., figs. 5-9 and Fl. XXII., fig. 2.
1912. *Fusulina incisa,* Deprat, Étude des Fusulinidés de Chine et d'Indochine, Mém. Serv. Géol. d'Indochine, Vol. I., fas. 3, p. 34. Pl. VIII., figs. 4,5.

Shell small, cylindrical, rounded at both extremities. Deep striations, running from end to end, almost straight. Ratio of length to width 3 : 1. Initial chamber small, 0.22 mm in diameter. Alveolar structure tolerably strong ; septa thin, strongly folded and pierced by long but low buccal aperture. Its length in the third volution 0.51 mm with height 0.043 mm. Growth of volutions slow.

Volution	Rate of growth	Thickness of wall	No. of Septa.
Initial chamber	0.17		
1	0.26	0.013	7
2	0.43	0.040	11
3	0.69	0.045	15
4	1.16	0.081	17
5	1.56	0.095	21

The above dimensions of *Fusulina incisa* from Akiyoshi coincide with those of the type specimen from the Carnic Alps described by Schellwien.

Volution	Rate of growth given by Schellwien.		No. of Septa.
Initial chamber	0.17	0.23	
1	0.30	0.35	
2	0.46	0.55	12
3	0.73	0.91	15
4	1.19	1.33	18
5		1.81	21

The specimens from Cammon and Yunnan described by Deprat seem to be larger than that above described. For comparison, I will quote here the measurements given by Deprat.

(Ratio of length to width of the specimen 3 : 1.).

Initial chamber	0.27–0.22 mm	0.22 mm		
1	0.42	0.49	0.35 mm	0.02 mm
2	0.70	0.72	0.56	0.04
3	1.11	1.14	0.88	0.06
4	1.62	1.68	1.29	0.09
5	2.30	2.42	1.90	0.14
	Cammon	Yunnan		Thickness of wall.

Locality : On the Akiyoshi Plateau.
Age : Lower Ouralian.

46. Schellwienia prisca (Ehrenberg), v. Möller.

Pl. V., figs. 4,5.

1878. *Fusulina prisca* (Ehrenb.) Möller, Mém. Acad. Géol. St. Pétersbourg, Ser. VII., vol. XXV,, no. 9, p. 59, Pl. III., fig. 1, and Pl. VI., fig. 2.

1908–'09. *Fusulina prisca* Schellwien, Monographie der Fusulinen, Part 1; Pl. XVIII., figs. 7–11, 13, 14, 16, 17. Palaeontogr. 55.

Shell elongately fusiform ; proportion of length to width 3.5 : 1 to 3.8 : 1. Axial length usually 10 mm. Septa thin, strongly folded ; buccal aperture short. Alveolar beams strong, almost 0.001 mm in thickness. Initial chamber less than 0.35 mm in diameter. Volutions 6. Measurements made on a great number of specimens show the rate of growth to be variable. The numbers given below indicate the total height of the shell at successive stages of evolution, number of septa and thickness of wall of each whorl. For comparison, the measurements given by v. Möller are also added.

Volution	Rate of growth				Thickness of wall	No. of Septa.
Initial chamber	0.25	0.30	0.23	0.28		
1	0.43	0.433	0.31	0.49	0.014	12
2	0.64	0.73	0.57	0.85	0.031	21
3	1.01	1.20	0.92	1.31	0.061	26
4	1.63	1.85	1.39		0.092	28
5	2.31	2.61	2.00		0.102	28
Locality	Akiyoshi		Arctic Region		Akiyoshi	

Remarks :—In general appearance, there are several species which resemble the present one. In external form and the folding of septa, it resembles the species of the group of *Schellwienia alpina* of the Carboniferous limestone of Russia, described by Schellwien in the Paleontographica. These differ from the present one solely in the thick shell wall.

The next one which resembles ours is *Schellwienia brevicula* Schwager, one of the common species in Eastern Asia. This, though similar in structure and the rate of evolution, has a stouter external appearance. According to C. Schwager the ratio of length to height of *Schellwienia brevicula* is 5 : 3, while in the present one it is at least 3 : 1.

Locality and age :—The rock specimen in which this species occurs was collected at Kuroiwa in Kyôwamura and Tombstone Region on the Plateau. Associated with *Schwagerina cf. muongthensis*, *Schellwienia incisa* and *Schellwienia* cf. *prisca* var. *parvula*, it occurs quite frequently.

Age : Lower Ouralian.

47. Schellwienia cf. prisca var. parvula Schellwien.

Pl. V., fig. 3.

Compare ;

1908-'09. *Fusulina prisca var. parvula*, Schellwien, Monographie der Fusulinien. Part 1, Palaeontogr. 55, p. 184, Pl. XIX., figs. 14,15.

A slender *Fusulina* which in its general appearance resembles *Schellwienia prisca*, but distinguished from the typical form by the smaller dimension and slower evolution of the whorls. Initial chamber small, its usual size being 0.16 mm. Number of Volutions 5 or 6. Ratio of length to width 2.8 : 1.

	Rate of growth	No. of Septa.
Initial chamber	0.11	
1st Volution	0.22	9
2nd	0.35	14
3rd	0.55	16
4th	0.82	18
5th	1.28	21
6th	1.97	

Locality : Tombstone region.

Age : Lower Ouralian.

48. Schellwienia haydeni n. sp.

Pl. IX., figs. 8,9.

Shell small, slender, spindle shaped. The largest specimen measures 7 mm in length and 2 mm in height. Ratio of length to width about 3.5: 1. Size of initial chamber not constant, varying from 0.15 to 0.30 mm. Spiral wall and septa thin. Buccal aperture large, but low, its length in the 6th volution attaining 0.4 mm or more. The rate of evolution, the thickness

of the spiral wall and the number of septa in each volution are given in the following table :

Volution	Rate of growth	No. of Septa.
Initial chamber	0.16-0.20	
1	0.27	9
2	0.43	16
3	0.66	20
4	0.98	23
5	1.45	25
5½	1.63	

Remarks :—The type specimen of this species is quite unlike *Schellwienia prisca* var. *parvula*, though I expect to find the intermediate forms. And the present form differs from *Schellwienia prisca* var. *parvula* chiefly in having a thinner spiral wall and the large initial chamber which are the important characters of distinction. For making comparisons, therefore, only the thin section cut exactly across the axial direction, so that the initial chamber and both extremities are within it, must be taken. On this account it is frequently impossible to distinguish this species from others, if the sections are not properly made.

This species is somewhat like *Schellwienia montipara*. The latter, however, has a much larger shell and thicker spiral wall, though the folding of septa is more or less alike.

Locality and age :—The preservation is generally excellent and several good specimens have been separated from the hard matrix of the rock. It is found associated with the group of *Schellwienia vulgaris* and is quite common at Uyeyama.

Age : Ouralian.

Group of Fusulina simplex.

49. Schellwienia montipara (Ehrenb.) Möller.

Pl. IX., fig. 1.

1878. *Fusulina montipara* Möller, Mém. Acad. St. Pétersb. Ser. VII., Bd. 25, No. 9, p. 61, Pl. III., fig. 2 and pl. VIII., fig. 2.

1908. *Fusulina montipara* Schellwien's posthumous Monograph on Fusulinidae. Part. 1. Palaeontogr. 55, p. 185, Pl. XIX., figs. 8-10.

Shell spindle-shaped, more or less vaulted in median portion. Proportion of length to width 2.5 : 1. Buccal sperture large. Septa thickened at the aperture. Spiral wall thick. Growth rather slow, number of volutions 6. The measurements on the rate of growth and thickness of wall made on the Akiyoshi specimens are as follows.

Volution	Rate of growth			Thickness of wall
Initial chamber	0.16	0.18	0.156	
1	0.24	0.26	0.228	
2	0.42	0.39	0.444	0.027
3	0.70	0.69	0.732	0.031
4	1.05	1.03	1.104	0.054–0.067
5	1.62	1.59	1.596	0.094–0.100
6	2.22	2.27	2.256	0.068–0.120
Locality	Akiyoshi		Russia	Akiyoshi

The number of septa in each volution of the Akiyoshi specimens almost coincides with that of the Russian.

Volution	Akiyoshi form	Russian form.
1	9	9
2	16	15
3	21	20
4	24	23
5	28	28

The breadth of the buccal aperture of the last volution is about 1/10 of the length of that volution.

Remarks :—The difference between the Akiyoshi and Russian species exists in the buccal aperture and in somewhat inflated ends of the former shell, characters which are, however, not at all important.

Abundantly found in the limestone of Tombstone Region on the Akiyoshi Plateau.

Age : Ouralian.

50. **Schellwienia subobsoleta** n. sp.

Pl. V., fig. 2, Pl. IX., figs. 2,4,5(?),6,7.

A small slender shell with more or less vaulted median portion. Proportion of length to width less than 3 : 1. Septa almost plane, thickened at the buccal aperture which is large and high and attains almost 0.5 mm in length. Spiral wall thin and alveolar beams feeble. Initial chamber also small. Rate of growth moderate.

Volution	Rate of growth		Thickness of wall.	
Initial chamber	0.14	0.11		
1	0.23	0.18	0.015	0.005
2	0.32	0.28	0.021	0.011
3	0.47	0.45	0.027	0.018
4	0.80	0.72	0.038	0.029
5	1.27	1.42	0.049	0.051
6		1.89		0.051

The number of septa in each volution is, in the first volution 10, in the 2nd 15, in the 3rd 18, in the 4th 20, in the 5th 24.

This shell somewhat reminds us of *Schellwienia obsoleta* from the Arctic Region of Russia, but when compared with the latter, it is more highly vaulted and thick-walled so that its alveolar structure is always distinct. Concerning the structure of the shell-wall and septal folding of *Schellwienia obsoleta*, Schellwien gives the following remarks :—

" Bezeichnend für die Art ist vor allem, das die Faltung der Septen so gut wie ganz fehlt. *Fusulina obsoleta* ist in dieser Hinsicht noch extremer ausgebildet als *Fusulina montipara* und gleicht darin nur den Fusulinellen, eine Ähnlichkeit, die um so bedenklicher ist, als in den gleichen Schichten *Fusulinella* vorkommen die äusserlich von unserer *Fusulina* überhaupt nicht zu unterscheiden sind und auch in den Längs- und Querschnitten in der Hauptsache nur durch die Poren der Wandungen abweichen. Diese Unterscheidung wurde auch dadurch erschwert, dass die Poren der *Fusulina obsoleta* ausserordentlich fein sind, so dass sie nur bei stärkerer Vergrösserung erkannt werden konnten."

This remark is also applicable to the distinctions of the present species from *Fusulinella* and *Schellwienia obsoleta*. It differs from *Schellwienia montipara* in its shell being less vaulted and its septa less folded.

Two localities are known. Kagekiyo Cave of Shishide-Dai and Tombstone Region on the Akiyoshi Plateau.

Age : Ouralian.

51. **Schellwienia ominensis** n. sp.

Pl. IV., figs. 3,4.

Shell small, spindle-shaped, more or less rounded at ends. Proportion of length to width 2 : 1. Septa thin. Buccal aperture broad, 0.25mm wide in the 5th volution (1/6 of the length of the whorl). Initial chamber spheroidal, with the diameter ranging between 0.15 and 0.25 mm. Volutions 5–6. The following are the values of the rate of growth, the number

of septa and the thickness of the spiral wall shown by the sample 3.40 mm in length and having 5 volutions :

Volution	Rate of growth	Thickness of wall	No. of septa
Initial chamber	0.216 mm		
1	0.338	0.013 mm	8
2	0.514	0.023	12
3	0.752	0.027	13
4	1.082	0.051	15
5	1.527	0.054	18

Remarks :—The external form and the internal structure, if we except the septa, is perfectly identical with those of *Schellwienia* (?) *magnini* Deprat of the Permian bed of Cammon. Yet there is an essential difference in the structure of septa. Concerning this structure of *F. Magnini*, Deprat makes a follwoing remark. " Le réseau alvéolaire très épais, accompagne la lame spirale dans son recourbement et la tapisse des deux côtés jusqu'a bas de sa course."

While the septa of *Schellwienia ominensis* are composed principally of the spiral wall, the alveolar beams are rather insignificant. It is closely related to *Schellwienia rouxi* Deprat from the Carboniferous limestone of Cammon, but the initial chamber of the latter is very small, though the rate of growth in both is more or less similar.

Locality :—Kamiryô in Ominemura.

Age : Upper Permian.

52. **Schellwienia suzukii** n. sp.

Pl. IV., fig. 2.

Shell fusiform, very small ; axial length less than 1 mm. Proportion of length to width 1.9 : 1. Spiral wall thin, only 0.03 mm thick even at the thickest portion. Septa weakly folded. Buccal aperture small, compared with the size of the shell. Initial chamber small ; rate of evolution slow.

Volution	Rate of growth	No. of septa
Initial chamber	0.148	
1 st	0.231	7
2 nd	0.369	10
3 rd	0.554	12

Remarks : The internal structure shows a close resemblance to that of *Schellwienia ominensis* above described. The differences are its small size, the slow rate of evolution and the less numerous septa.

Locality and age :—Associated with *Schellwienia ominensis*, it occurs very rarely at Kamiryô in Omine-mura.

Age : Upper Permian.

Group of **Fusulina dussaulti** Deprat.

53. **Schellwienia satoi** n. sp.

Pl. VIII., figs. 4, 6a, 8, Pl. IX.. fig. 3 ?

1923. *Fusulina vulgaris* Schellwien. J. S. Lee, Fusulinae from North China. Bull. Geol. Soc. China, Vol. II., No. 3-4, p. 65, Pl. I., figs. 1, 2.

Shell spindle-shaped and inflated in the median portion ; proportion of length to width 1.8 : 1. Number of volutions 5–7. Septa thin, strongly folded at both extremities, slightly thickened near the buccal aperture, which is small and low. Initial chamber very small, less than 0.15 mm in diameter. First three volutions closely wound, but from the fourth one rate of growth suddenly increasing. Wall thin, as is seen from the following table.

Volution	Rate of growth	Thickness of wall	No. of septa
1	0.24 mm	0.011 mm	10
2	0.42	0.026	13
3	0.77	0.049	18
4	1.40	0.061	20
5	2.32	0.088	28

Remarks :—This species appears to resemble more or less the two subgenera of *Fusulina*, *Schellwienia* and *Schwagerina*, coming between them. Among the species of *Schellwienia*, *Schellwienia dussaulti* Deprat from Yunnan and some allied forms are closely related to the present one. But there are also several marked differences. Firstly, the rate of growth in *Schellwienia dussaulti* is at first very slow though suddenly increasing from the 5th whorl. Secondly the number of septa in each volution differs greatly as is shown in the follwing table.

Volution	Rate of growth		No. of Septa.	
1	0.24	0.42	10	
2	0.42	0.84	13	
3	0.77	1.40	18	25
4	1.40	1.86	20	30
5	2.32	2.87	28	40
6		4.62		
7		5.20		
Species.	F. satoi	F. dussaulti	F. satoi	F. dussaulti.

A close relation may be found in *Schwagerina fusulinoides* Schellwien, but in this case we can easily separate the two by the comparison of their initial chamber and difference of the external configuration.

It can also, not be denied that the present one has an extremely close relation with *Schwagerina*. The thin septa and the small buccal aperture remind us of those of the latter genus, although the underborder of the septa is more thickened in *Schellwienia satoi*.

Locality and age :—*Schellwienia satoi* is on the whole very rare in the Akiyoshi limestone. It occurs in the lower *Fusulina*-zone associated with *Schellwienia kattaensis* at Hoso-ono in the Kotô gorge and at Uyeyama of Akagômura.

Age : Lower Ouralian.

54. **Schellwienia oblonga** n. sp.

Pl. VIII., figs. 7,9.

Shell large, longly fusiform. Proportion of length to width 3 : 1 at the end of the fourth volution. Spiral wall thin. Septa thin, about 5 times as thick as an alveolar beam and complicately folded. Buccal aperture small, less than 1 mm in length in the 4th volution. Initial chamber also very small, about 0.15 mm. in diameter. Rate of growth of earlier volutions slow but from the fourth volution rapidly increasing, so that at last the height of the shell attains 5 mm, and the length 15 mm.

Volution	Rate of growth	Thickness of wall	No. of septa
Initial chamber	0.15 mm		
1	0.24	0.018 mm	
2	0.38	0.024	
3	0.65	0.034	25
4	1.11	0.055	30
5	2.25	0.077	32
6	3.63	0.092	37
7	4.86	0.092	40

Remarks :—*Schellwienia oblonga* is very well characterized by a delicate structure and a rate of evolution which remind us of that of the subgenus *Schwagerina*. But it is easily distinguishable from that subgenus by the strongly folded septa and the elongate shell.

Schellwienia dussaulti Deprat, which may also be compared with the present species, has a globular form and its ratio of length to width is 2 : 1. The resemblance of the latter to *Schellwienia annamitica* Deprat from the Ouralian bed of Annam, is still greater, as this Annam species also has a

small initial chamber; and a weak spiral wall; the rate of evolution being likewise rapid and the folding of septa very great.

Therefore the present one might be a variety of *Schellwienia annamitica*. The following table shows the rate of growth, etc. in the two forms.

Volution	Rate of growth		Thickness of wall.	
1	0.48	0.24	0.018	0.022
2	0.80	0.38	0.024	0.042
3	1.40	0.65	0.034	0.050
4	2.28	1.11	0.055	0.060
5	3.24	2.25	0.077	0.072
6	4.85	3.63	0.092	0.081
	Annam sp.	Present sp.	Present sp.	Annam sp.

Locality and age:—Rare at Yobara, associated with *Schellwienia ambigua*. The geological horizon it occupies is the lower part of the *Sumatrina* subzone.

Group of **Fusulina minima** Schellwien.

55. **Schellwienia lepida** Deprat.

Pl. III., fig. 1a.

1914. *Fusulina lepida* Deprat, Étude comparative des Fusulinidés d'Akasaka et des Fusulinidés de Chine et d'Indochine, p. 15, Pl. II., fig. 5.

A single longitudinal section somewhat excentric. It is much like *Schellwienia contracta* Schellwien (Monographie der Fusulinen. Teil II; Die asiatischen Fusulinen. Paleontogr. 56, p. 159) in its small size and ellipsoidal shape. Yet the rate of evolution is slower than in the latter. Deprat recorded it from the zone of *Schwagerina princeps*, while the Akiyoshi specimen is found in the Permian associated with *Schellwienia ambigua* Deprat, *Schellwienia yobarensis* and *Verbeekina verbeeki*.

Locality: Yobara of the Ofuku Plateau.

Age: Permian.

56. **Schellwienia** n. sp.

Pl. IX., fig. 11.

In a thin section of the *Doliolina* limestone obtained at Serida, Beppumura, a good longitudinal section of a very small *Schellwienia* is found. This is undoubtedly a new species, but, as I can not get its transverse section, the detailed description is not given.

This species is somewhat elongated and sharp at both ends. Length

1.4 mm and width 0.45 mm. Initial chamber large. Shell-wall tolerably thick. Septa not so strongly folded.

Age : Upper Permian.

Subgenus **Schwagerina** v. Möller **em.** v. Staff.

57. **Schwagerina princeps** (Ehrenb).

1877. *Schwagerina princeps* v. Möller, Neues Jahrb. f. M. G. P., p. 143.
1877. *Schwagerina princips* v. Möller, Die spiral-gewundenen Foraminiferen d. russischen Kohlenkalks, p. 69. Pl. V., figs. la, b. and Pl, IX., figs. la, b.
1897. *Schwagerina princeps* Schellwien, Die Fauna der karnischen Fusulinenkalks, part 2. Paleontogr. 44, p. 258, Pl. XXI., figs. 5-7,9 and Pl. XXII., figs. 4-7.
1906. *Schwagerina princeps* Yabe, A Contribution to the Genus *Fusulina* etc., J. C. Sci. Tokyo, Vol. XXI., art. 3, Pl. I., fig. 2.
1912. *Schwagerina princeps* Deprat, Étude des Fusulinidés de Chine et d'Indochine, Vol. I., Part 3, p. 37. Pl. I., figs. 1-3.
1883. *Schwagerina princeps* Schwager, Carbonische Foraminiferen aus China und Japan in Richthofen's China. Bd. IV. pp. 132-135. Pl. XVI., figs. 15, 16 and Pl. XVII., figs. 1-8.
1923. *Schwagerina princeps* Ozawa, Fusulinidae from Honan, Jap. Jour. Geol. Geogr. Vol. II., p. 38

The present species has been thoroughly studied by several authors, such as Möller, Schwager, Schellwien and Deprat. The examples of Akiyoshi, inspite of their ill preservation, are sufficient enough to determine the species.

Found only at Edô in Akagomura.

Age : Upper Ouralian.

58. **Schwagerina muongthensis** (Deprat).

Pl. VIII., figs. 1,2.

1915. *Fusulina muongthensis* Deprat, Les Fusulinidés des Calcaires Carbonifériens et Permiens du Tonkin, du Laos et du Nord-Annam. p. 5, Pl. II, figs. 1-6.

Shell globular, highly swollen in the median portion, rapidly thinning towards both ends and terminating in sharp points. The numerous longitudinal striae found on the surface of the shell converge at both ends and are twisted in a sense opposite to that of the spiral of the shell. Proportion of length to width almost constant and 1.5 : 1. Initial chamber small, about 0.20 mm in diameter. Spiral wall and septa thin. Septal perforations recognizable, measuring 0.02 mm in diameter. Rate of growth rapid, as is seen in the following table.

Buccal aperture short and low.

Volution	Rate of Growth		Thickness of wall		No. of septa	
Initial chamber	0.12 mm	0.15 mm				
1	0.38	0.39	0.021 mm	0.016 mm	14	13
2	0.55	0.62	0.034	0.026	19	25
3	0.94	0.98	0.051	0.039	22	26
4	1.84	1.89	0.077	0.075	26	27
5	3.20	2.99	0.094	0.104	32	28
6	4.40		0.086	0.110		
Locality	I Akiyoshi	II Tonkin	I	II	I	II

Remarks:—If we look only at the external form, *Schwagerina muongthensis* is liable to be confounded with *Schellwienia globosa* Deprat, *Schellwienia vulgaris* var. *globosa* Schellwien and many species of *Schwagerina*, but when examining its longitudinal or transverse section, the difference is quite clear.

The internal structure of the present species is more or less like *Sckwagerina fusulinoides* or *Schwagerina fusiformis* Krotow. Yet on closer examination it can be easily distinguished.

Locality and geological horizon:—

Deprat collected the present species at Cham-chit near the valley of Muong-thé in Tonkin. According to him it is associated with *Schellwienia cayeuxi* Deprat, *Schellwienia alpina* Schellwien and *Schellwienia kozui*, which are the representatives of the Ouralian. At Akiyoshi it is associated with *Schellwienia incisa* and *Schellwienia prisca*.

I found it at two localities, viz. Tombstone Region and the cliff at Serida in Beppumura. Age Lower Ouralian.

Subfamily **Verbeekininae** v. Staff-Wedekind em. Ozawa.

Genus **Verbeekina** v. Staff.

59. **Verbeekina verbeeki** (Geinitz).

Pl. X., figs. 6, 7.

1875. *Fusulina princeps* Brady: Geol. Mag. p. 532, Pl XII., figs. 6a-c.

1876. *Fusulina verbeeki* Geinitz: Palaeontographica, Vol. XXII., p. 399.

1879. See note on *Schwagerina princeps* Möller: Die Foraminiferen des russischen Kohlenkalks. Mém. Acad. Imp. St. Pétersb. Vol. XXVII., No. 5, p. 73.

1880. *Schwagerina verbeeki* Roemer: Lethaea geognostica I, pp. 277-278, fig. 46 a,b,c, and Über eine Kohlenkalkfauna der Westküste von Sumatra. Paleontographica, Vol. XXVII.

1883. *Schwagerina verbeeki* Schwager: Carbonische Foraminiferen aus China und Japan. p. 135. Pl. XVI., figs. 17-18 and Pl. XVII., figs. 9-17.
1896. *Schwagerina verbeeki* (Geinitz): Verbeek and Fennema: Java et Madoura. Vol. II., p. 1134. Pl. I, figs. 11-22.
1898. *Möllerina verbeeki* E. Schellwien: Die Fauna des karnischen Fusulinenkalks, Part II. Paleontographica Vol. 44, p. 258.
1902. *Doliolina verbeeki* (Geinitz) Schellwien in Futterer's "Durch Asien".
1902. *Schwagerina verbeeki* H. Yabe: Materials for a knowledge of the Anthracolitic Fauna of Japan, I. Jour. Geol. Soc. Tokyo., Vol. IX., pp. 1-2. Textfigure 1.
1906. *Schwagerina verbeeki* Yabe: A Contribution to the Genus *Fusulina* etc. J. C. S. Tokyo, Vol. XXI, art. 5, Pl. I, fig. 2.
1909. *Schwagerina princeps* Hayden: Fusulinidae from Afghanistan. Records Geol. Surv. India. vol. 38. Pl. XVIII., figs. 1-7.
1909. *Verbeekina verbeeki* (Geinitz). Staff: Beiträge zur Kenntnis der Fusuliniden. Neues Jahrb. XXVII Beilage Bd. p. 476.
1912. *Schwagerina (Verbeekina) douvillei* Deprat: Étude des Fusulinidés de Chine et d'Indochine. I. Pl. I., figs. 4-6, pp. 38-40.
1913. *Schwagerina (Verbeekina) pseudoverbeeki* Deprat: Les Fusulinidés des Calcaires Carbonifériens et Permiens du Tonkin, du Laos et du Nord-Annam. p. 45, Pl. VIII., figs. 1-3.
1913. *Schwagerina douvillei* Deprat: ditto. pp. 47-48.
1914. *Schwagerina douvillei* Deprat: Étude des Comparative des Fusulinidés d'Akasaka (Japon), etc. Pl. IV., figs. 1-4. p. 24.
1924. *Schwagerina (Verbeekina) deprati* Hayasaka: On the fauna of the Anthracolithic Limestone of Omi-Mura in the western Part of Echigo. Sci. Rep. Tohoku Imp. Univ. 2nd. ser., Vol. VIII., No. I. p. 15. Pl. II., fig. 8, Pl. III., fig. 1.

A glance at plate 10, figure 6 will show that the Akiyoshi specimen corresponds exactly to Verbeek and Fennema's type of the species. Basal skeletons well developed in the later volutions. Initial chamber very small; succeeding whorls abruptly increasing in size so that the shell becomes very large with a diameter of almost 10 mm or more as given in the next table.

Rate of growth variable. For comparison, here quoted several measurements made on the rate of growth and the number of septa in each volution on the samples from various localities. Excepting those of the Akiyoshi and Akasaka specimens, the following are the measurements given by Deprat on *Schwagerina douvillei*.

Volution	Rate of growth						No. of septa	
	mm	mm	mm	mm	mm	mm		
1 st	0.13	0.22	0.18	0.15	0.20	0.13		
2 nd	0.26	0.35	0.36	0.30	0.25	0.25		
3 rd	0.39	0.49	0.68	0.60	0.50	0.43		
4 th	0.69	0.77	1.19	1.10	0.80	0.78	9	7
5 th	1.16	1.29	1.64	1.60	1.28	1.43	9	8
6 th	1.71	1.97	2.21	2.33	2.00	2.32	10	10
7 th	2.49	2.66	3.01	3.10	2.88	3.08	13	

Volution	Rate of growth						No. of septa.	
	mm	mm	mm	mm	mm	mm		
8 th	3.21	3.64	3.68	3.59	4.04	4.04	15	
9 th	3.98	4.59	4.35	4.45	4.90	4.78	20	
10 th	4.85	5.48	5.04	5.09	6.00	5.47	25	
11 th	5.69	6.26	5.70	5.70	6.80		30	
12 th	6.46	6.90	6.38	6.42	7.63		36	
13 th	7.24	7.51		6.90	8.40		42	
14 th	8.06	8.33		8.00	9.10			
15 th	8.91	9.01		8.90	9.60			
16 th	9.86			9.61	10.40			
17 th				11.04	11.20			
18 th				11.54	12.00			
19 th					12.80			
	I	II	III	IV	V	VI	I	II

I, II. *Verbeekina verbeeki*. Loc. Akiyoshi.

III, IV. *Schwagerina douvillei* Deprat. III., Yunnan.
IV., Akasaka.

V. *Schwagerina pseudoverbeeki* Deprat. Loc. Cammon.

VI. *Schwagerina verbeeki*. After Schwager.

Remarks. This species is excellently figured and described by several writers so that I have little to add.

Deprat in his monograph describes several species of *Schwagerina verbeeki*-type such as *Verbeekina* (*Schwagerina*) *douvillei*, *V. pseudoverbeeki* and *V. verbeeki*, and their distinctions are given by him in the following remark.

" *Schwagerina* (*Verbeekina*) *pseudoverbeeki* se distingue de *Schwagerina* (*Verbeekina*) *verbeeki* par la hauteur des tours de spire en dehors de toute autre différence. Elle s'écarte un peu moins de *Schw. douvillei* Deprat par ce caractère bien que la différence soit encore notable, mais l'absence totale de côtes basales rudimentaires dans *Schw. douvillei* et leur présence dans *Schwagerina* (*Verbeekina*) *pseudoverbeeki* n. sp., le nombre de tours qui ne dépasse pas 14 dans *Schwagerina douvillei* Deprat et s'élève à 23 au maximum dans l'autre, les dimensions générales des deux espèces les différencient complètement."

In the case of describing *Schwagerina douvillei* from Akasaka, Deprat says, " J'ai observé la presence de côtes basales rudimentaires, mais qui n'apparaissent qu'au quatorzième tour comme le montre nettement photographie 1, Pl. IV.—Les treize premiers tours en sont totalement dépourvus, de sorte que si l'on n'a pas affaire à un individu complètement développé on n'en observe aucune trace."

The above statements of Deprat seem to agree not quite with the facts. (1) In the interpretation of the absence or presence of the basal skeletons in longitudinal section, he falls into a serious error. The basal skeleton is merely an extension of the basal part of the primary septum ; and near the septum it is very strong and only gradually diminishes in strength as it recedes from the septum. Accordingly, if the axial section is cut through along the primary septa, the basal skeletons appear to be very prominent. Deprat's photograph (figure 3, Plate VIII., in the second memoir. 1913) of *Schwagerina pseudoverbeeki* exactly corresponds to this case. (2) The difference in the number of volutions is not so important as to make a specific separation. The Yunnan specimen has only twelve, while that of Akasaka has eighteen.

On these reasons we can safely conclude that both species of Deprat, *Schwagerina douvillei* and *Schwagerina pseudoverbeeki*, really belong to the same one. And furthermore his new species above cited are nothing but *Verbeekina verbeeki* itself.

On the contrary his *Schwagerina verbeeki* (Geinitz) is somewhat different from the above and has a more delicate structure and the rate of evolution closer, though it evidently belongs to the group of *Verbeekina verbeeki*.

Locality and Geologic Age:—In eastern Asia the present species seems to be quite numerous. It is the characteristic type restricted to the uppermost Fusulina limestone. The localities are Serida in Kyowamura, Shigeyasu, Shiraiwa, Yobara, and Ojigase in Ominemura.

60. **Verbeekina verbeeki** var. **sphaera** n. var.

Pl. X., fig. 3b.

1912. *Schwagerina verbeeki* (Geinitz) Deprat: Fusulinidés de Chine et d'Indochine (1st Mémoir). p. 40, Pl. I., figs. 7-11.
1913. *Schwagerina (Verbeekina) verbeeki* Deprat: ditto. 2nd Mémoir. p. 47.
1914. *Schwagerina (Verbeekina) verbeeki* Deprat: Étude des Fusulinidés d'Akasaka (Japon). Pl. II., figs. 5-7.

The preservation of the present species is often perfect in spite of its delicate structure. Both the spiral wall and septa are thinner than those of the type above described. The septa are not at all folded. These characters are necessary to identify the present species with Deprat's *Schwagerina verbeeki* from Akasaka and Yunnan, though the rate of growth is different from the values given by him.

1st volution	0.09 mm	0.19 mm	0.21 mm
2nd	0.11	0.29	0.30
3rd	0.24	0.62	0.58
4th	0.37	0.98	0.91
5th	0.57	1.40	1.32
6th	0.91	1.80	1.76
7th	1.42	2.43	2.32
8th	1.94	3.90	2.86
9th		3.50	3.36
10th		4.28	4.09
11th		4.66	4.46
12th		5.10	4.90
13th		5.52	5.30
14th		5.92	5.71
Locality:	Akiyoshi	Akasaka	Yunnan

Remarks. The rates of growth of Akiyoshi and Akasaka specimens show a conspicuous difference, especially in their earlier volutions. According to Deprat's illustrations only, his sections seem to run more or less oblique to the long or short axis ; consequently his measurements on such sections as figured by him must be taken as inconvincible, whereas one of the sections of the Akiyoshi specimens passing through the initial chamber, though not exactly through the centre, gives values approximating more to the truth.

Occurrence. Associated with *Fusulina japonica*, *Neoschwagerina craticulifera* and *Doliolina lepida*, it was obtained abundantly at Kaerimizu.

Age : Lower Permian.

61. Verbeekina claudiae Deprat.

Pl. XI., figs. 9,10,11.

1912. *Doliolina claudiae* Deprat: Étude des Fusulinidés de Chine et d'Indochine. Mém. Serv. Géol. l'Indochine. Vol. I., part. 3, Pl., IV., figs. 5-9. pp. 44-45

Shell globular, conspicuously vaulted in the median portion, having proportion of length to width 1.3 : 1. Volutions 9–10. Basal skeletons prominent, generally attaining two thirds of height of each volution. Initial chamber small and oval with longer diameter 0.09 mm and shorter one 0.08 mm. Rate of growth, number of septa and thickness of spiral wall together with those of the Yunnan species given by Deprat are as follows.

	Rate of growth			No. of growth		Thickness of wall
Initial chamber	0.135 mm	0.135 mm	0.09 mm			
1st Volution	0.216	0.22	0.21	5-7		0.012 mm
2nd	0.32	0.31	0.30	9-10	12	
3rd	0.47	0.45	0.45	11-13	15	
4th	0.65	0.60	0.63	16-17	19	
5th	0.84	0.81	0.79	19-20	22	0.019
6th	1.09	1.06	1.02	24	25	
7th	1.38	1.35	1.28	25	28	
8th	1.66	1.67	1.56	28	28	
9th	1.94			30		
10th	2.23					0.050
Localily:	Akiyoshi		Yunnan	Akiyoshi	Yunnan	Akiyoshi

Remarks. As regards the determination of this Akiyoshi specimen, only a comparison of the figures given by Deprat with those of my plate is enough to convince us of the identity of the two species. The slight discrepancies which might perhaps be detected in them are only due to the difference of size and the state of preservation. The Akiyoshi specimens are beautifully preserved, though it is not possible to isolate the individuals. The occurrence of this characteristic species which is at present restricted to the Uralian in the *Fusulina* limestone of Akiyoshi limestone plateau confirms my opinion already expressed that the layers of the limestone formation are inverted.

Locality and Age: It is noteworthy that the species is always associated with *Fusulina ellipsoidalis var. orientis*. Deprat gives the following note concerning its occurrence.

" J'ai retrouvé dans un calcaire du Cammon remplé de Fusulinelles cette jolie espèce que j'avais décrite dans l'Ouralien du Yunnan, et comme au Yunnan elle se trouve seule, dans aucune autre espèce soit de Fusuline, soit de Schwagérine, etc., elle semble former un horizon très constant."

Genus **Doliolina** Schellwien.

62. **Doliolina lepida** (SCHWAGER).

Pl. II., fig. 8b.

1883. *Schwagerina lepida* Schwager: Carbonische Foraminiferen aus China und Japan in Richthofen's China Vol. IV., p. 138. Pl. XVII., fig. 13 and Pl. XVIII., fig 1-14.

1898. *Möllerina lepida* (Schwager) Schellwien: Die Fauna des karnischen Fusulinenkalks. Paleontographica 44, p. 258.

1902. *Doliolina lepida* (Schwager) Sehellwien: Paleozoische und Triadische Fossilien aus Ostasien (in Futterer's Durch Asien) Vol. III., pp. 125–174.
1908. *Doliolina lepida* v. Staff: Beiträge zur Kenntnis der Fusuliniden. Neues Jahrbuch 1908. XXVII Beilageband. p. 476. Textfigures 9–10.
1912. *Doliolina lepida* Deprat: Étude des Fusulinidés de Chine et d'Indochine, etc. (1st Mémoir). Pl. V., fig. 10, Pl. VI., figs. 1–3. p. 45.
1912. *Doliolina pseudolepida* Deprat: ditto. p. 46. Pl. V., figs. 6–9. and Pl. VI., fig. 4.
1913. *Doliolina lepida* Deprat: Ditto (2nd Memoir) p. 49. Pl. X., fig. 18.
1913. *Doliolin lepida* var. *pseudolepida* Deprat: ditto p. 50.
1914. *Doliolina lepida* Deprat: Étude comparative des Fusulinidés d'Akasaka (Japon) (3rd Memoir) Pl. III., figs. 12–14.

This is an exceedingly frequent and well known Permian fossil. There are no species which are apt to be confounded with this species. *Doliolina lepida* mutation *pseudolepida* of Deprat which shows only little difference, both in its internal and external characters, is really the same form which is not worthy to be separated even as a mutation. J. Deprat in his second memoir naturally gives the following remarks concerning the *Doliolina pseudolepida*.

" J'avais décrit en 1912 cette Dolioline comme une espèce nouvelle. Bien qu'elle appartienne à un autre niveau, plus élevé, que *Doliolina lepida*, je regrette d'en avoir fait une espèce nouvelle et je propose de la nommer *D. lepida* Schwager mutation *pseudolepida* Deprat. J'emploie à dessein le nom de mutation et non celui de variété, suivant en cela les idées très judicieuses émises par notre savant confrére, M. Depéret, conservant le terme de variété pour les formes que se trouvent dans le même niveau que la forme-type et mutation lorsque les différence légères qui motivent une autre appelation s'observent dans un niveau plus élevé. C'est le cas ici."

But, so far as my opinion is concerned, *Doliolina pseudolepida* Deprat is neither a mutation-type nor a variety of *D. lepida* but *Doliolina lepida* itself, and therefore it is quite safe to consider *Doliolina lepida* as a persistent type which lived throughout the Permian period.

Occurrence and Age. Associated on the one hand with *Neoschwagerina craticulifera* and *Fusulina japonica*, and on the other with *Sumatrina annae*, it is quite numerous. The important localities are Kaerimizu in Akagomura ; Serida in Beppumura and Shigeyasu in Kamamura.

Age : Permian.

Genus **Neoschwagerina** Yabe.

Subgenus **1. Neoschwagerina** s. str.

63. **Neoschwagerina craticulifera** SCHWAGER

Pl. II., fig. 8c. Pl. XI., fig. 4.

1883. *Schwagerina craticulifera* Schwager: Carbonische Foraminiferen aus China und Japan in Richthofen's China. Vol. IV., p. 140. Pl. XVIII,, figs. 15–25.
1898. *Möllerina craticulifera* (Schwager) Schellwien: Die Fauna des karnischen Fusulinenkalks, Paleontographica 44. p. 258.

1903. *Doliolina craticulifera* E. Schellwien: Paleozoische und Triadische Fossilien aus Ostasien in Futterer's Durch Asien. Vol. III., pp. 125-174. Pl. V., fig. 5.
1906. *Neoschwagerina craticulifera* (Schwager) Yabe: A Contribution to the Genus *Fusulina* etc. p. 3. Pl. I., fig. 3. (non fig. 4.)
1909. *Neoschwagerina craticulifera* Hayden: Fusulinidae from Afghanistan. Record Geol. Surv. India. Vol. XXXVIII., part 3. pp. 248-249. Pl. XXI., figs. 1-7.
1912. *Neoschwagerina craticulifera* J. Deprat: Étude des Fusulinidés etc. Vol. I., fas 3, pp. 47-49. Pl. II., figs. 1,2,4.
1914. *Neoschwagerina craticulifera* Deprat: ditto (3rd Memoir) pl. VII., figs. 4-8. pp. 24-26.
1914. *Neoschwagerina craticulifera* var. *rotunda* Deprat. ditto Pl. VIII., figs. 6-13, p. 26. *Neoschwagerina craticulifera* var. *minoensis* Deprat. ditto p. 27. Pl. VIII., figs. 1-5.
1922. *Neoschwagerina craticulifera* var. *sphaeroidea* Ozawa. Preliminary Note on the classification of Fusulinidae. Jour. Geol. Soc. Tokyo, Vol. XXIX, Pl. IV., fig.

This is an very pretty, common and well-defined species of the genus *Neoschwagerina*. It was described in detail by Deprat who gives good illustrations of the characteristic sections to which I have little to add. In the Akiyoshi district, there are two localities, where the present species is known to occur, viz.; Kaerimizu and Omine (Schiraiwa). But the associated fossils are different. At Kaerimizu, it is found associated with the Lower Permian Fusulinae such as *Doliolina lepida*, *Verbeekina verbeeki*, *Fusulina japonica* and *Fusulina lutugini*. At Shiraiwa the associated fossils are all Upper Permian species, such as *Neoschwagerina douvillei*, *Sumatrina annae* and *Lonsdaleia* (*Waagenophyllum*) *akasakensis* Yabe.

J. Deprat separates the present species into several varieties, among which *Neoschwagerina craticulifera* var. *rotunda*, *Neoschwagerina craticulifera* var. *minoensis* and *Neoschwagerina multicircumvoluta* Deprat from Akasaka (Japan), so far as I know, have no sufficient characteristics to be separated as varieties. A form called *Neoschwagerina craticulifera* by Yabe and illustrated in his excellent treatise above cited (Pl. I., fig. 4) is really not such, though Hayden has quoted it as a megalospheric type of the same. As is distinctly observable in his illustration, the form from Okubo, Prov. Bitchu, has two or more auxiliary septa between each pair of the primary septa. Considering this fact, it rather belongs to my new species *Neoschwagerina Douvillei* which was called by Douvillé and Deprat *Neoschwagerina globosa* Yabe.

64. **Neoschwagerina douvillei** Ozawa.

Pl. XI., figs. 5,6,7.

1906. *Neoschwagerina globosa* (Yabe) H. Douvillé: Les Calcaires à Fusulines de l'Indochine. Bull. Soc. Géol. France, Pl. XVII-XVIII.
1912-'13 *Neoschwagerina globosa* J. Deprat: Étude des Fusulinidés etc. Mém. Géol. Indochine. Vol. I., fas. 3, p. 51. Pl. IV., figs. 1-4 and Vol. II., fas. I. p. 55.
1914. *Neoschwagerina globosa* J. Deprat: Étude des Fusulinidés comparatives d'Akasaka. pp. 29-30.

Shell spindle shaped. Proportion of length to width 1.8 : 1. In later volutions, two or more auxiliary septa intercalated between each pair of primary ones. Initial chamber measures 0.25 mm in diameter. Rate of growth is as follows.

1st Volution	0.35 mm	0.31 mm	0.30 mm	0.30 mm
2nd	0.49	0.42	0.41	0.42
3rd	0.63	0.54	0.57	0.56
4th	0.77	0.74	0.74	0.75
5th	0.99	0.99	1.02	1.00
6th	1.20	1.28	1.28	1.28
7th	1.44	1.64	1.63	1.65
8th	1.71	2.00	2.01	2.00
9th	1.94	2.33	2.35	2.35
10th	2.21	2.66	2.66	2.68
11th	2.52			
12th	2.87			
13th	3.15			
Locality	Akiyoshi	Yunnan	Akasaka	Laotienne
		After Deprat.		

No auxiliary equatorial septa.

Remarks. H. Douvillé who examined the Permian limestone of Pong-Oua gives many good illustrations of a species of *Neoschwagerina* which he identifies with *Neoschwagerina globosa* Yabe, but, so far as I am aware, no description has been published. In 1912 Deprat studied the same limestone and gives a detailed description and the better photographs of the same foraminifera which he also calls *Neoschwagerina globosa* (Yabe).

But after having studied the limestone ef Akasaka, Deprat came to the conclusion that the fossil which he called *Neoschwagerina globosa* before is not exactly the one described by Dr. Yabe. Nevertheless Deprat, on account of the insufficiency of photographs and the shortness of the description given by Yabe, proposed the name of *N. globosa* for the form from Pong-Oua which is fully described and illustrated with excellent figures, while to *Neoschwagerina globosa* of Akasaka he gives a new name, *Neoschwagerina inouyei*. The following is the remark made by Deprat.

" En étudiant les calcaires d'Akasaka, j'ai retrouvé l'espèce de Pong-oua, mais ici s'élève la difficulté, ce n'est pas, je ne la crois pas du moins, celle que Yabe avait en vue en décrivant sa *N. globosa*, car si elle possède comme à Pong-oua de nombreuses fausses cloisons intermédiaires, elle est dépourvue de cloisons transverses supplementaires.—De plus, j'ai étudié en

détail, a la partie supérieure des calcaires d'Akasaka, une grosse Néoschwagérine, terme intermédiaire entre les Néoschwagérines vraies et les Sumatrines, dont j'ai fait le nouveau sous-genre *Yabeina* qui, à la rigueur, pourrait se retrouve à Akasaka, bien que ce ne soit sans doute pas à elle que devait aller le nom donné par Yabe ; mais il est impossible de se dégager autrement de cette confusion résultant de la description incomplète de Yabe et du manque de figuration suffisante.....L'espèce que nous étudions ici est complètement dépourvue de fausses cloisons transverses, or, Yabe en signale dans son espèce, mais il est difficile, comme je l'ai dit plus haut, de se guider sur sa description sommaire."

In face of these facts, we can easily see that *Neoschwagerina globosa* of Yabe differs from *Neoschwagerina globosa* Douvillé and Deprat in the appearance of septa and the presence of false transverse septa alternating with true transverse ones. Accordingly, in order to avoid confusion, it seems to me to be more advisable to let the name of *Neoschwagerina globosa* as it is and to strike out the name of *Neoschwagerina (Yabeina) inouyei*, while the species described as *Neoschwagerina globosa* by Deprat and Douvillé should receive the name of *Neoschwagerina douvillei*.

This is a characteristic type of the Upper Permian period. It is associated with *Sumatrina annae*, *Doliolina lepida* and *Verbeekina verbeeki* (Geinitz).

Localities : Shigeyasu in Ominemura and Ojigase in Isamura.

Megalospheric type of the species (Pl. XI., fig. 7.)

The central chamber of the Akiyoshi specimens usually measures 0.30 mm or less in diameter, excepting those having a larger initial chamber (almost attaining 0.45 mm) which exactly agrees with figure 4, plate I of Yabe. Dr. Yabe's figure of a transverse section thought to be that of *Neoschwagerina craticulifera* is cited as a megalospheric type of the species which has usually a very small initial chamber. But, as already stated by me, it is evidently not *Neoschwagerina craticulifera*. The Akiyoshi specimen having a larger initial chamber is found side by side with the typical *Neoschwagerina douvillei* in the thin section and there should be no doubt that both individuals belong to one and the same species, when we consider their internal structures. The megalospheric form has no trace of being composed of two shells fused together, such a fusion being often actually observed in Fusulinidae. It is very curious that the present form closely approaches *Neoschwagerina megasphaerica* described by Deprat, and it is probably sure that *Neoschw. megasphaerica* might be a megalospheric form of *Neoschw douvillei* or *Neoschwagerina margaritæ* Deprat.

65. Neoschwagerina megasphaerica Deprat.

Pl. XI., fig. 8.

1913. *Neoschwagerina megasphaerica* Deprat: Étude des Fusulinidés etc. Mém. Serv. Géol. Indochine, Vol, II., fasc. 1, p, 57. Pl. VII., figs. 2,6 and Pl. IX., figs. 4–8.

A glance at plate XI, figure 1 will show that the present specimen agrees exactly with Deprat's type of the species. There are four sets of septa, i.e., primary—, auxiliary-meridional, primary-and auxiliary-transversal. But the last ones are developed only spontaneously in the later volutions. In a transverse section, one to three auxiliary meridional septa are intercalated between the primary ones. The initial chamber is very large, attaining about 0.8 mm in diameter.

Remarks. The rate of growth of the present species coincides with that of *Neoschwagerina hayasakai* n. sp., yet their internal structure is entirely different. My Zomeki samples, inspite of their abundant occurrence are very badly preserved, but their identity with Deprat's species is beyond doubt.

Age: Lower Permian.

66. Neoschwagerina margaritae Deprat.

Pl. XI., figs. 1,2,3.

1913. *Neoschwagerina margaritae* Deprat, Les Fusulinidés des Calcaires Carboniferiens et Permiens du Tonkin, du Laos et du Nord-Annam. pp. 58–60, Pl. VIII., fig. 10 and Pl. IX., figs. 1–3.

Shell globular and large. The largest example obtained measures 10 mm in length and 8 mm in height. Volutions 15–20. Initial chamber very small, less than 0.05 mm (exact value is not obtained because of the difficulty to make a proper section). Three sets of septa present: primary- and auxiliary-meridional, and primary-transverse. The former two at first alternate with each other though later the auxiliary ones increase in number and at last two to five of such are intercalated between the primary ones. They are all more slender than those of *Neoschwagerina craticulifera*. Rate of growth slower than that of the type species *Neoschw. margaritae* Deprat.

Locality	Akiyoshi	Lang-nac.
1st Volution	0.14	0.015
2nd	0.24	0.28
3rd	0.33	0.44
4th	0.53	0.84
5th	0.76	1.16

6th	0.99	1.48
7th	1.24	1.84
8th	1.50	2.32
9th	1.80	2.80
10th	2.14	3.20
11th	2.44	3.68
12th	2.74	4.16
13th	3.09	4.84
14th	3.43	5.36
15th	3.77	5.88
16th	4.15	6.44
17th	4.59	7.04
18th	5.05	7.60

Deprat gives the diagnosis of *Neoschwagerina margaritae* as follows:

" *Neoschwagerina margaritae* offre une forme trés globuleuse avec un rapport de 1.3 : 1. J'ai observé des échantillons de 12 mm de grande axe. Les tours sont nombreux. J'en ai compté 18 dans un échantillon de 7.60 mm. de diamètre. La seule espèce dont *N. margaritae* se rapproche, par le nombre de tours, est *N. multicircumvoluta* Deprat que j'ai trouvée au Yunnan, mais les différences éclatent immédiatement dans la lenteur de l'accroisement de *N. multicircumvoluta* qui, pour 20 tours de spire, n'atteint que 3.04 mm de diamètre. Les cloisons principales méridiennes sont beaucoup plus approchées que dans *N. megasphaerica* Deprat et on ne trouve normalement qu'une fausse cloison, arrondie, un peu irrégulière le plus souvent, entre deux cloisons principales successives. Les cloisons transverses sont larges a la base et dèlimitent en section longitudinale une loge arrondie en demicercle a la partie supèrieure, etc."

But the development of the false septa (auxiliary meridional) is various, and also among my specimens I can often observe one or two false meridional septa between each pair of primary meridional ones. Deprat's illustrations, though not excellent, present the same character. Deprat's *Neoschawgerina multicircumvoluta* (Yunnan form) shows the character quite like that of *Neoschwagerina craticulifera* and the only difference is in the rate of evolution, and that difference is very slight. Therefore it is better to consider the former either a variety or microspheric type of the latter.

Locality and age: It is the most common species in the upper horizon of the Akiyoshi *Fusulina* limestone. It seems to be a very

persistent type. Localities: Shiraiwa, Shigeyasu, Shibukuro, Ojigase, Ofuku, Yunokami and Handa in Kyowamura.

Age: Upper Permian.

Subgenus 2. **Yabeina** Deprat.

A characteristic feature of this subgenus, as given by Deprat, is the shape of the septa, which though very slender at their point of attachment to the wall rapidly swell below. In consequence, their general appearance approaches rather those of *Sumatrina*. Auxiliary equatorial septa always present between transverse ones.

67. **Yabeina schellwieni** (Deprat).

Pl. X., figs. 3a,4.

1913. *Doliolina schellwieni* Deprat: Étude des Fusulinidés de Chine et d'Indochine et Classification des Calcaires à Fusulines, Pl. VIII., fig. 4-9. pp. 51-52.

1922. *Yabeina minima* Ozawa: Preliminary Notes on the Classification of the Family Fusulinidae. Jour. Geol. Soc. Tokyo. Vol. XXIX., pl. IV., fig 3.

Shell small fusiform. Proportion of length to width 1.8 : 1. The greatest axial length measured 3 mm by the sample having 8 volutions. Four sets of septa, primary- and auxiliary-meridional, primary- and auxiliary equatorial. The former two alternate with each other and the latter two also alternate, but in the earlier volutions the auxiliary equatorial often wanting. The free ends of these septa are characterized by coalescence of the alveolar beams and always swell more or less. Initial chamber small, less than 0.2 mm in diameter. Rate of evolution is as follows.

	Rate of growth of *Neoschwagerina schellwieni*			*Doliolina neoschwagerinoides*
1st Volution	0.23 mm	0.20 mm	0.48 mm	0.24 mm
2nd	0.33	0.30	0.72	0.40
3rd	0.46	0.41	0.96	0.62
4th	0.59	0.54	1.20	0.76
5th	0.74	0.70	1.48	1.00
6th	0.97	0.88		1.27
7th	1.29	1.15		1.56
8th	1.58			1.96
	Akiyoshi species		Annam sp.	Loc. Annam

Remarks. In spite of the Annam species having well developed auxiliary meridional and primary and auxiliary equatorial septa, Deprat includes it in *Doliolina*. The Akiyoshi species differs from the Annam

one chiefly in having more strongly developed false transverse (auxiliary equatorial) septa and accordingly I was a long time in doubt whether I ought to separate the Akiyoshi species from the Annam one, but after some examination of many thin sections I found that in the development of the false equatorial septa there are several intermediate stages.

By the transverse section only, it is very hard to distinguish the present species from *Neoschwagerina craticulifera* though the former has less numerous volutions. But a glance at their respective longitudinal sections will show where the difference really is, viz., the presence of auxiliary equatorial septa formed by grouping of alveolar beams, the end of which is soldered together. However it must be kept in mind that the false transverse septa can not be observed in the earlier volutions, though this case is very scarce.

It is a persistent species and comes from all horizons of the Permian limestone. Kaerimizu, Shigeyasu, Maruyama and Shiraiwa are the important localities.

68. Neoschwagerina (Yabeina) hayasakai Ozawa.

Pl. X., fig. 5.

1922. *Yabeina hayasakai* Ozawa. Preliminary Notes on the Classification of the Family Fusulinidae. J. G. S, Tokyo. Vol. XXIX., Pl. V,, fig. 1.

1924. *Neoschwagerina craticulifera* Hayasaka. On the Fauna of the Anthracolithic Limestone of Omi-mura in the western Part of Echigo. Sci. Rep, Tohoku Imperial Uuiversity, Sec. Series. Vol. VIII., No. 1. pp. 18-19. Pl. III., figs. 8,9.

Shell globular strongly vaulted at the median portion. The largest specimen which I possess, 6 mm in breadth and about 8.5 mm in length. Proportion of length to width 1.4 : 1. The auxiliary equatorial septa alternates with the primary ones. Chamberlets transversely elongated and axially short as is usually the case in the subgenus *Yabeina* founded by Deprat.

Initial chamber large, about 0.80 mm in diameter. All kinds of septa swell at their free ends. Rate of growth slow as is shown in the following table. For convenience of comparison, the rate of growth of *Neoschwagerina* (*Yabeina*) *globosa* Yabe and *Sumatrina multiseptata* Deprat measured by Deprat are also quoted.

	Yabeina hayasakai	*Sumatrina (? Yabeina) multiseptata*	*Yabeina globosa*
Initial chamber	0.89 mm	0.5 mm	0.02–0.03 mm
1st Volution	1.08	0.82	0.15
2nd	1.26	1.11	0.20
3rd	1.51	1.33	0.30
4th	1.79	1.52	0.40
5th	2.13	1.75	0.55
6th	2.48	2.00	0.75
7th	2.83	2.29	1.00
8th	3.17	2.53	1.30
9th	3.64	2.72	1.62
10th	3.91	2.97	2.00
11th	4.28	3.30	2.50
12th	4.58	3.60	2.90
13th	5.17	3.90	3.42
14th	5.64	4.37	4.00
15th		4.75	4.45
16th		5.08	5.35
17th	5.39	5.99	5.95
	Akiyoshi	Akasaka	Akasaka

Remarks. In respect of the size and shape, the present species shows certain identity with *Neoschwagerina globosa* Yabe and *Neoschw.* (*Yabeina*) *shiraiwensis* Ozawa, and both occur in the uppermost horizon of *Fusulina* limestone in Japan. There exists, however, a striking difference among them in the size of the initial chamber and the rate of growth. The present *Yabeina hayasakai* has the largest initial chamber and the slowest rate of evolution compared with the latter two. The character of the septa resembles that of the two others. Accordingly they are very intimately related and the form having the larger initial chamber may be a megalospheric type of *Yabeina globosa*.

Sumatrina multiseptata described by Deprat has almost the same rate of growth and large initial chamber as the present one, but the structure of septa, supposing his observation is correct, differs far from that of the present. Nevertheless the present species has a very close relation with *Sumatrina multiseptata*.

Locality and Age. It is obtained at Omi, Prov. Echigo. Associated fossils, *Verbeekina verbeeki* (Geinitz) and *Doliolina lepida* Schwager.

Age: Upper Permian.

69. Yabeina shiraiwensis n. sp.

Pl. X., figs. 1,2. Pl. II., figs. 2b, 5c, 7b.

Shell large fusiform, more or less vaulted in the median portion. Proportion of length to width ranging from 1.5 : 1 to 1.8 : 1. Largest specimen I obtained measuring about 9 mm in length and 5.5 mm in width. Four sets of septa present, their structure and appearance alike those of *Yabeina globosa* illustrated and explained by Deprat. Initial chamber spherical, nearly 0.30 mm in diameter. The following table shows the rate of growth compared with that of *Yabeina globosa* and *Yabeina hayasakai.*

	Yabeina shiraiwensis		*Yabeina globosa.*	*Yabeina hayasakai.*
Initial chamber	0.30 mm	0.23 mm	0.20–0.03 mm	0.89 mm
1st Volution	0.43	0.34	0.15	1.08
2nd	0.64	0.46	0.20	1.26
3rd	0.86	0.63	0.30	1.51
4th	1.07	0.84	0.40	1.79
5th	1.33	1.05	1.55	2.13
6th	1.59	1.28	0.75	2.48
7th	1.89	1.51	1.00	2.83
8th	2.19	1.75	1.30	3.17
9th	2.53	2.01	1.62	3.54
10th	2.81	2.28	2.00	3.91
11th	3.21	2.55	2.50	4.28
12th	3.65	2.82	2.90	4.68
13th	4.07	3.09	3.42	5.17
14th	4.50	3.41	4.00	5.64
15th	4.93	3.75	4.45	
16th	5.40		5.35	
Locality	Akiyoshi	Serida	Akasaka	Omi.

Measurements made on a number of specimens show the rate of growth to be variable.

Remarks. The species *Yabeina shiraiwenses* is very closely related to *Yabeine globosa* Yabe. The separation can not be made only by comparison of external appearance which is nearly resembling. But a glance of the orientated section easily reveals their difference. The present one has not only the large initial chamber, but the rate of growth is wholly different from that of *Yabeina globosa* Yabe.

The size of the initial chamber is the most important point. I have not only examined more than twenty orientated sections, and in one case I have also carefully polished a beautiful sample, measuring the diameter of

the initial chamber as well as I could. The largest value obtained on this occasion did not surpass 0.32 mm. And so far as I am aware, no examples offer a value of more than 0.35 mm. On the other hand, a diameter of *Yabeina globosa* is extremely small, viz., usually 0.02 or 0.03 mm.

Locality and Age :—This is the most common species of the Akiyoshi limestone but seems to be restricted to the upper division of the *Fusulina* limestone. Localities : Serida, Shiraiwa, Hinaga, Yobara, Okugawara and Ojigase.

Age : Upper Permian.

Subgenus 3 **Sumatrina** Volz.

70. **Sumatrina annae** Volz.

Pl. X., fig. 8. Pl. I., figs. 1b, 2b.

1904. *Sumatrina annae* Volz. Zur Geologie von Sumatra. Geol. u. Pal. Abhandl., Bd. X., Ht. 2. Neue Folge, Bd. IV., p. 98.
1906. *Neoschwagerina annae* (Volz) Yabe. A Contribution to the Genus Fusulina etc. Jour. Coll. Sci. Uokyo Vol. XXI., art. 5, Pl. II,, fig. 4.
1906. *Sumatrina annae* Douvillé. Calcaires à Fusulines de l'Indochine, Bull. Soc. Géol. France. 4 Sér. Tome VI., pp. 567-576.
1909. *Neoschwagerina annae* (Volz) Hayden, Fusulinidae from Afghanistan. Rec. Geol. Surv. India. Vol. XXXVIII., part 3. pp. 250-251. Pl, XXII., figs. 8-14.
1912. *Neoschwagerina (Sumatrina) annae* Volz Deprat, Étude des Fusulinidés de Chine et d'Indochine (1st Memoir) pp. 56-57. Pl. V., figs. 1-5. Textfig. 30.
1912. *Neoschwagerina (Sumatrina) annae* var. *stricta* Deprat, ditto. Pl. V., fig. 2.
1913. *Neoschwagerina (Sumatrina) annae* Deprat. ditto. 2nd Mém.

This species has already been described in detail by several authors from the Upper Permian Formation in various countries. Deprat has separated the elongated form from a rather globular one as a variety. But the form is variable and it seems to be justified to consider *Sumatrina annae* var. *stricta* only as an elongated form of *Sumatrina annae*.

Hayden's samples from Afghanistan are globular in shape and one of them has very large initial chamber. He explained it as a megalospheric type.

Literature of Fusulinidae.[1]

1859. E. Eichwald, Lethaea Geognostica.
1870. E. Suess, Über das Vorkommen von Fusulinen in den Alpen. Verh. d. k. k. geol. Reichsanstalt, Bd. 24.
1873. Meek and Worthen, Geol. Surv. of Illinois, Vol. V.

1) See Schellwien's posthumous monograph " Die asiatischen Fusulinen." (Paleontographica 56, page 171, 1909).

1875. H. B. Brady, On some Foraminifera from the West Coast District, Sumatra. Geol. Mag., Vol. II.
1876. H. B. Brady, A Monograph of Carboniferous and Permian Foraminifera (the Genus Fusulina excepted). Paleontological Society, London. Vol. XXX.
1876. H. B. Brady, Notes on a group of Russian Fusulinae, Ann. Mag. Nat. Hist., 4 Series, Vol. XVIII.
1876. H. B. Geinitz, Zur Geologie von Sumatras Westküste. Paleontographica XXII.
1876. G. Stache, Fusulinenkalke aus Oberkrain, Sumatra u. Ohio. Verh. d. k. k. geol. Reichsanstalt, 19. Dez.
1877. V. v. Möller, Über Fusulinen und ähnliche Foraminiferenformen des russischen Kohlenkalks. Neues Jahrbuch f. Mineralogie etc.
1878. V. v. Möller, Die spiralgewundenen Foraminiferen des russischen Kohlenkalks. Mém. Acad. Imp. Sci. St. Pétersb. VII sér. XXV.
1879. V. v. Möller, Die Foraminiferen des russischen Kohlenkalks. Mém. Acad. Imp. Sci. St. Pétersb. VII sér., t. XXVII.
1880. V. v. Möller, Über einige Foraminiferen führende Gesteine Persiens. Jahrb. der. k. k. geolog. Reichsanstalt. XXX.
1880–1881. F. Roemer, Über eine Kohlenkalk-fauna der Westküste von Sumatra. Paleontographica XXVII.
1880–1881. F. Roemer and F. Frech, Lethaea geognostica I. Lethaea Palaeozoica, Bd. I. Stuttgart.
1883. C. Schwager, Carbonische Foraminiferen aus China und Japen in Richthofen's China, Vol. IV.
1884. C. Gottsche, Über Japanisches Carbon. Zeitschr. Deutsch. Geol. Ges. 36.
1887. C. Schwager, Protozoa in W. Waagen, Salt Range Fossils, Vol. I, Productus Limestone. Mem. Geol. Surv. India, Palaeontologia India, Ser. XIII.
1888. Krotow, Geologische Forschungen am westlichen Uralabhange in den Gebieten von Tscherdyn und Soolikamsk. Mém. Com. Géol., Vol. VI.
1889. T. Tschernyschew, Über eine Sammlung aus dem Carbon der Umgegend von Vladivostok. Bull. Comm. Géol. VII.
1892. E. Schellwien, Die Fauna des karnischen Fusulinenkalks. I. Paleontographica XXXIX.
1894. E. Schellwien, Über eine angebliche Kohlenkalkfauna aus der ägyptisch-arabischen Wüste. Zeitsch. Deutsch. Geol. Ges., p. 68.
1896. D. M. Verbeek and Fennema, Description géologique de Java et Madoura. Vols. I and II. Amsterdam.

1897–1902. Fr. Frech, Lethaea geognostica I. Lethaea Paleozoica II. Bd. Stuttgart.

1897. E. Lörenthey, Mikroskopische Untersuchungen der paleozoischen Gesteine. In Wissensch. Ergebn. der Reise d. Graf. B. Szechenyi in Ostasien, III. Budapest.

1897–1898. E. Schellwien, Die Fauna des karnischen Fusulinenkalks II. Paleontographica 44.

1898. G. Fliegel, Die Verbreitung des marinen Obercarbon in Süd- und Ost-asien. Zeitschrift d. Deutsch. Geol. Ges., 50.

1898. B. Koto, Classification of the Carboniferous Limestone of Akasaka (in Japanese) Jour. Ceol. Soc. Tokyo. Vol. V.

1898. D. Lienau, Fusulinella, ihr Schalenbau u. ihre systemat. Stellung. Zeitschr. d. Geol. Ges. S. 409–419.

1899. H. Yabe, On Fusulina japonica Schwager from Tomuro, Prov. Shimotsuke. Jour. Geol. Soc. Tokyo, Vol. VI.

1901. J. Enderle, Über eine anthracolithische Fauna von Balia Maden in Kleinasien. Beitr. z. Pal. u. Geol. Oesterr.-Ungarn u. d. Or. XIII, S. 43–109.

1902. Chapmen, the Foraminifera. London.

1902–1903. Schellwien, Paleozoische u. Triadische Fossilien aus Ostasien in Futterer's Durch Asien III.

1902. H. Yabe, Materials for a knowledge of the Anthracolitic Fauna in Japan, I. Jour. Geol. Soc. Tokyo. Vol. IX.

1903. H. Yabe, On a Fusulina Limestone with Helicoprion in Japan. Jour. Geol. Soc. Tokyo, Vol. X.

1904. G. H .Girty. Triticites, a new Genus of Carboniferous Foraminifera. Am. Jour. Sci., Vol. XVII.

1904. Volz, Zur Geologie von Sumatra. Geol. u. Pal. Abh. Bd. X, Anhang II., Einige neue Foraminiferen u. Korallen sowie Hydrokorallen aus dem Oberkarbon Sumatras.

1906. Michele Gortani, Paleozoico Carnico, Pal. Italica Vol. XII.;

1906. Douvillé, Sur la structure du test dans les Fusulines. Compt. Rend. Séance. Ac. Sci Paris.

1906. Douvillé, Les Calcaires à Fusulines de l'Indochine. Bull. Soc. Géol. France, 4 sér., VI, p. 576–587.

1906. H. Yabe, A Contribution to the genus Fusulina etc., Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XXI., art. 5.

1907. E. Koken, Indisches Perm und die Permische Eiszeit. Neues. J. f. M., etc. Festband, pp. 446–546.

1907. Research in China in three volumes and Atlas published by the Carnegie Institution of Washington.

1907. Schubert, Vorläufige Mitteilung über Foraminiferen und Kalkalgen aus dem dalmatischen Carbon. Verh. d. k. k. Geol. Reichsanstalt.

1908. E. Schellwien, Monographie der Fusulinen, nach dem Tode des Verfassers herausgegeben und fortgesetzt von Günter Dyhrenfurth und H. v. Staff. Teil I, die Fusulinen des russischarktischen Meeresgebietes. Paleontographica. 55.

1908. Schubert, Zur Geologie des österreichischen Velebit (nebst Paleontologischem Anhang). Jahrb. d. k. k. Geol. Reichsanstalt. LVIII Band.

1908. Schubert, Beiträge zu einer natürlichen Systematik der Foraminiferen. Neues Jahrb. XXV. Beil. Bd.

1908. H. v. Staff, Zur Entwicklung der Fusuliniden. Zentralblatt f. Min., etc., No. 22.

1908. H. v. Staff, Über Schalenverschmelzungen und Dimorphismus bei Fusulinen. Sitzungsbericht d. Ges. Naturf. Freunde, Berlin.

1908. P. v. Wittenburg, Neue Beiträge zur Geologie und Paläontologie der Werfener Schichten Südtirols, mit Berücksichtigung der Schichten von Vladivostok. Centralbl. f. Min., etc.

1908. G. H. Girty, Guadalpian Fauna, Professional paper 58.

1908. H. Mansuy, Contribution à la Carte géologique de l'Indochine. Paléontologie.

1909. H. v. Staff, Beiträge zur Kenntnis der Fosuliniden. Neues Jahrb. Beil. Bd. XXVII.

1909. P. v. Wittenburg, Geologische Studien an der ostasiatische Küste im Golfe Peter des Grossen. Neues Jahrb. f. Min., etc. XXVII Beilage-Bd.

1909. E. Schellwien, Monographie der Fusulinen, Teil. II. Paleontographica 56.

1909. Hayden, Fusulinidae from Afghanistan, Record Geol. Surv. India, Vol. 38.

1910. H. Yabe, Structurproblem der Fusulinenschale. Beitr. z. Geol. u. Pal. Oesterreich-Ungarns etc. Bd. 23.

1910. H. v. Staff, Die Anatomie und Physiologie der Fusulinen, Zoologica, Heft 58.

1910–1911. H. v. Staff and Wedekind, Der Oberkarbone Foraminiferensapropelit Spitzbergens, Bull. Geol. Inst. Univ. Upsala Vol. X.

1912. H. v. Staff, Monographie der Fusulinen, Teil III, Paleontographica 59.

1912–1913. J. Deprat, Étude des Fusulinidés de Chine et d'Indochine et

Classification des Calcaires à Fusulines. Mém. Serv. Géol. l'Indochine, Vol. I, fasc. 3 and Vol. II, fas. 1.

1914. J. Deprat, Étude Comparative des Fusulinidés d'Akasaka (Japon) et des Fusulinidés de Chine et d'Indochine. Mém. Serv. Géol. l'Indochine, Vol. III. fasc. 1.

1913. O. Altpeter, Beiträge zur Anatomie und Physiologie von Alveolina. Neues Jahrb. XXXVI Beilage Band.

1914. W. Deecke, Über Foraminiferen, Neues Jahrb. f. Min., etc.

1915. R. Schubert, Über Foraminiferen Gesteine der Insel Letti. Jaarboek van het Mijnwesen p. 169.

1915. J. Deprat. Les Fusulinidés des Calcaires carbonifériens et Permiens du Tonkin, du Laos et du Nord-Annam. Mém. Serv. Géol. de l'Indochine, Vol. IV., fasc. 1.

1915. Schubert, Die Foraminiferen des jüngeren Paleozoikums von Timor. Paleontologie von Timor. Lief. II, Abh. 3.

1920. H. Yabe and Hayasaka, Paleontology of Southern China in Geographical Research in China, Vol. III and Plates.

1922. Dacqué, Vergleichende biologische Formenkunde der fossilen niederen Tiere. Berlin.

1922. I. Hayasaka, Limestone from Omimura, Prov. Echigo. Japanese Journal, Vol. I.

1922. Y. Ozawa, Preliminary Notes on the Classification of the Family Fusulinidae. Jour. Geol. Soc. Tokyo. Vol. XXIX.

1923. Y. Ozawa, Stratigraphical Studies of The Akiyoshi Limestone, Jour. Geol. Soc. Tokyo. Vol. XXX.

1923. J. S. Lee, A graphic method to aid specific determination of Fusulinoids and some results of its application to the Fusulinae from N. China. Bull. Geol. Soc. China. Vol. II, nos. 3–4.

1923. Y. Ozawa, On some species of Fusulina from Honan, China. Jap. Jour. Geol. Geogr. Vol. II.

1924. J. S. Lee, New Terms in the description of the Fusulinidae. Bull. Geol, Soc. China, Vol. III, no. 1.

1924. J. S. Lee, Grabauina, A transitional form between Fusulinella and Fusulina. Bull. Geol. Soc. China, Vol. III, no. 1.

1924. I. Hayasaka, On the Fauna of the Anthracolithic Limestone of Omi-Mura in the Western Part of Echigo. Sci. Rep. Tohoku Imp. Univ., Second Series (Geology). Vol. VIII, No. 1.

1925. Y. Ozawa, On the Classification of Fusulinidae. Jour. Coll. Sci. Tokyo Imp. University. Vol. XLV, Art. 4.

ANTHOZOA.
TETRACORALLA.

Family **Cyathophyllidae** E. et H.

Genus **Lonsdaleia** M'Coy.

71. **Lonsdaleia floriformis crassiconus** M'Coy.

Pl. XIII., fig. 1.

1915. *Lonsdaleia floriformis crassiconus* (M'Coy). St. Smith, The Genus Lonsdaleia and Dibunophyllum rugosum (M'Coy), Q. J. G. S. Vol. 71, p. 247, Pl. XX., figs. 3-10.

Other literature see the above paper.

According to St. Smith, *Lonsdaleia floriformis crassiconus* differs from *Lonsdaleia floriformis floriformis* em. Martin in the following points, viz., the turbinate shape and tendency towards lateral freedom on the parts of corallites, the prevalence of the characteristic type of central column, the long septa and relatively small dissepiments.

The Akiyoshi specimens are both the fasciculate and massive corallites, only the latter appears to be very predominant.

The type of the central column is characteristic of the subspecies, but the medial plate is minor and in general appearrance it is radially symmetrical. Minor septa either long or mere septal ridges. Both the major and minor septa, in large proportion reach to the epitheca, but usually the pure dissepimental area is developed.

Horizon and locality :—*L. floriformis crassiconus* is abundant in the limestone at Maruyama in Isamura where it is associated with *Lonsdaleia enormis* n. sp. Dr. Hayasaka records it from the lower horizon of the limestone of Omimura, Prov. Echigo. The geological horizon has been discussed and determined by Vaughan as the upper *Dibunophyllum* Zone, viz., Younger Lower Carboniferous, but at Akiyoshi it is often found associated with Moscovian *Fusulinae*.

72. **Lonsdaleia enormis** n. sp.

Pl. XIV., figs. 1,2,3,4.

Corallum fasciculate, corallites straight and parallel, often attaining a considerable length. External surface covered by straight striae, or interseptal ridges. Calyx deep, its diameter measuring about 2 cm or 3 cm. Central column stout and prominent.

In the transverse section the central column, composed of irregularly twisted septal lamellae and sparse axial tabellae. Tabular region broad, its breadth attaining about two fifths of the cross diameter. Tabulae

moderately spaced and almost horizontal, but towards the central column they are somewhat curved and form saucer-shape.

Dissepimental area narrow, invaded, but not completely, by the septa. Septa of two orders. The major septa extend from the extra-thecal region almost to the central column, but they rarely reach the axial structure on the one hand and the epitheca on the other. Minor septa one half of the major in length. Number of major septa 32–36.

Remarks.—The distinctive character of the present species is firstly the structure of the central column which is very peculiar and has no exact indication of the cone-in-cone type in the longitudinal section, though the septal tabellae show more or less radial arrangement; secondly, the good development of the minor septa which are in other species generally represented by mere ridges; thirdly, the narrow zone of the pure dissepimental area which is often absent and a large proportion of both the septa reach the epitheca.

The nearest species to the present is *Lonsdaleia duplicata* Martin, from which the present one can be easily distinguished by the characters above described. Moreover *L. duplicata* is always smaller than the present.

Lonsdaleia siblyi has the central column of loose mesh-work which resembles that of the present one, however, the tabulae of the former are strongly arched and axially inclined and the tabulated area is very narrow.

Horizon and locality :—It is abundant, though very badly preserved, at Tobinosu of Odamura associated with *Nagatophyllum satoi* n. gen. et sp., etc. The horizon is the lowest of the Akiyoshi limestone formation.

Age : Younger Lower Carboniferous.

73. **Lonsdaleia katoi** n. sp.

Pl. XIII, figs. 2,3,4,11.

Corallum fasciculate. Corallites cylindrical, sinuous and free laterally, provided with a distinct wall. The interseptal ridges prominent and rugosity somewhat accentuated. Diameter of corallite 1–1.5 cm.

Central column loosely and irregularly constructed, composed of a well developed medial plate, a few incomplete septal tabellae and axial lamellae. In the longitudinal section it exhibits a loose irregular cone-in-cone type and has a well defined boundary. Horizontally tabulated zone narrow and loose. In the adult specimen, endotheca is well developed. Septa, of two orders, the major extend from the endothecal region to almost near the central column, but rarely reach the axial structure. The minor septa usually short, only half a length of the longer ones. (It must

be kept in mind that even in the well grown form a certain proportion or whole of the septa, especially the major reach the epitheca ; and when a new corallite appears, the peripheral dissepimental zone becomes very broad as illustrated in fig. 4, plate XIII).

The number of the major septa in the typical case is about 28 and as many minor ones are intercalated between each pair of the former.

The characteristic of the present form is its mode of gemmation ;-new corallite makes its appearance where the vesicular dissepiments are well developed, hence in the peripheral zone of an older corallite as in the case of *Lonsdaleia* (*Waagenophyllum*) *frechi* Volz and *Polythecalis confluens* Yabe and Hayasaka.

There is one more interesting case of gemmation which is characteristic to the single corallite and in the genus *Lonsdaleia* it has never been described. That is a calicular gemmation due to rejuvenation, viz., a young corallite arises in the mother calyx and by gradual growth, it occupies the whole space of the latter. Therefore the corallite remains always simple. (See plate XIII, figure 11).

Cyathophyllum described by Lambe from the Palaeozoic beds of Canada shows the same interesting and complicated mode of gemmation as the present species. In this connection Prof. Dacqué gives the following interesting explanation :

" Bei den ältesten Korallen nur ist ein Mittelding zwischen Riffbildung durch Stöcke und durch Einzelindividuen entwickelt, wenn nämlich knospende Korallen auch Larven aussandten, diese sich aber nicht alle wegbegaben oder fortgetragen wurden, sondern teilweise an und auf ihm heranwuchsen, ohne dessen Weiterentfaltung zu unterdrücken. Dann entstanden zusammengesetzte Kolonien. Diesen Fall scheinen die Hexakorallen aber regelmässig zu zeigen. z. B. *Cyathophyllum* oder *Polyorophe*. Es existierten anfänglich also wohl nur Einzelkorallen, worauf ja auch deren besonders grosse Zahl unter den ältesten Tetrakorallen hinweist, während richtig knospende Stöcke erst später erschienen und entwickelteren Gruppen angehörten."

Remarks. The present species resembles *Lonsdaleia duplicata* and its varieties which are common in the Lower Carboniferous limestone in Europe. But by a closer examination one can easily understand the difference between them. Namely the good development of the minor septa, the continuity of some proportion of both series of the septa with epitheca, the narrow horizontally tabulated zone and irregular and loose construction of the central column of the present species are the important distinguishing characters.

If one considers the gemmation of the present *Lonsdaleia katoi* it represents a quite imbricate type of the typical *Lonsdaleia*.

The specimens associated with several Upper Permian Fusulinae and corals occurs abundantly at Shiraiwa, Ominemura.

Age: Upper Permian.

74. Lonsdaleia (? Waagenophyllum) yokoyamai, n. sp.

Pl. XIII, figs. 5,6.

Corallum massive, corallites polygonal in cross section, their diameter attaining 1 cm. Epitheca moderate in thickness but often much thickened by septal ridges. The central column in the transverse sections shows typical cobweb structure with an eminent medial plate; in the longitudinal sections it presents the cone-in-cone type, and it is strongly marked off from the horizontally tabulated area which is exceedingly narrow and followed by the obliquely arranged small vesicles. Pure dissepimental area narrow and usually traversed by both kinds of septa. Major septa 20–24 and often radiating axially from the epitheca but not extending to the columella. Minor septa variable in length, often as long as the major but usually only half as long.

Remarks.—The nearest species to the present is *Lithostrotion loatianense* Mansuy, whose weathered surface is figured by Mansuy, but, as a thin section showing the detailed internal structure is not illustrated, an exact comparison can not be made. H. Mansuy gives the following description concerning the central columella of *Lithostrotion loatianense*. "Les plus grandes cloisons paraissent s'enrouler au centre et former la columelle, ayant environ 2.5 mm diamêtre. La lamelle diamétrale de la columelle est peu apparente." Then it may be more natural to include Mansuy's specimen in *Lonsdaleia*. The distinguising characters of Mansuy's species from the present one are the small columella, less prominent median plate and the long sinuous major septa which invade the central column.

The chief differences of the Akiyoshi specimens from *Lonsdaleia volzi* Yabe and Hayasaka are the smaller size, less development of the pure dissepimental area and the thick epitheca. The internal structure is thoroughly identical.

Locality: Kaerimizu in Akagomura.

Age: Ouralian—Lower Permian.

75. Lonsdaleia (Waagenophyllum) frechi Volz.

Pl. XII., fig. 8.

1904. *Lonsdaleia frechi* Volz, Zur Geologie von Sumatra. Geol. u. Paleontologische Abhandl. v. Koken, Neue Folge, Band 6, p. 100, figs. 32–34.

This fossil is remarkable for the composite turf-like growth of the corallites and the occurrence of a new coral in the pure peripheral dissepimental zone. In our specimens these peculiarities are not recognized, but the inner structure is quite the same as in Volz's sample from Sumatra.

The growth of the septa, endotheca and the dissepimental area of the species are very irregular. Volz's description is very excellent and I have little to add.

Volz gives only good figures of the corallites and the transverse section, I add here the description of the longitudinal section. The central column shows loose and irregular cone-in-cone structure. The outer dissepimental area is broad and very abnormaly developed, nearly reaching the central column. Horizontally tabulated zone not observed.

Remarks.—It has been already noticed by Yabe and Hayasaka (Paleozoic Corals from Japan, Korea and China, J. G. S. Tokyo, vol. 23, p. 65. 1914.) that the present species is not a normal *Lonsdaleia* and a transitional type between typical *Lonsdaleia* and *Polythecalis*, the latter founded by them.

It must be added, however, that the septa of *Lonsdaleia frechi* generally reach the external wall and the peripheral dissepiments occur in exceptional cases. Accordingly it may be rather adequate to say that the present one is a transitional type between *Waagenophyllum* and *Polythecalis*.

Locality and age. This interesting species is collected at Shibukuro, Ominemura. The hard matrix of the specimens contains *Neoschwagerina* (*Yabeina*) *shiraiwensis* n. sp., *Neoschwagerina douvillei* Ozawa and *Sumatrina annae* Volz. The age is undoubtedly Upper Permian.

76. **Lonsdaleia gerthi** n. sp.

Pl. XIII., fig. 10. Pl. XII., figs. 9-12.

Associated with *Lonsdaleia katoi* already described, a very peculiar form is found at Shiraiwa in Ominemura. Comparing with *Lonsdaleia katoi*, the internal structure of the present species is very far apart and by mere inspection they seem to have no relation whatever.

The species has the following characters :—

Central column strong and bisymmetrical in cross section, composed of merly septal tabellae. The arrangement of tabellae resembles that of *Carruthersella*[1] Garwood or that of *Carcinophyllum wichmanni* Gerth. Columella of full grown specimen well defined and separated from major septa excepting counter septum which is continuous with the central plate.

1) Gerth in his recent work (Die Anthozoen der Dyas von Timor) gave the following opinion concerning *Carruthersella*:—

Septa of two orders, major and minor. Major septa strong and generally reach the epitheca, but when the outer area of dissepiments is developed, the bases of the septa thickened and fused together to form the pseudowall. Minor septa either confined to this pseudowall or represented by mere septal ridges.

Outer area when present, formed of narrow zone of very coarse dissepiments.

Longitudinal section :—Central column strong, composed of closely packed axial tabellae. Tabulated zone narrow and very irregular. Dissepiments large and loosely arranged.

Mode of Gemmation. The young corallite rests on the horizontal tabulae, which are curved and form the external wall of the new corallite. Two cases are observed.

77. **Lonsdaleia (Waagenophyllum) timorica** Gerth.

Pl. XIII., figs. 7,8.

1912. *Lonsdaleia indica* Waagen and Wentzel. H. Mansuy, Mission du Laos, Mém. Géol. l,Indochine, Vol. I., art. 4, p. 9, Pl. I., figs. 3a-e, Pl. II., figs 1.

1908. *Lonsdaleia indica,* H. Mansuy, Contribution à la Carte geologique de l'Indochine, Paléontlogie, p. 55, Pl. 14, figs. 2,2a.

1922. *Lonsdaleia timorica* Gerth, Die Anthozoen der Dyas von Timor. Paleontologie von Timor. Lief. X. P. 74, Pl. 145, figs. 1,2.

Corallum composite, astraeform forming irregular mass. Corallites prismatic, five to seven sided of somewhat unequal size and measuring 5–8 mm in diameter. Columella loosely constructed and asymmetrical provided with a few axial tabellae and septal lamellae. Medial plate complete, though more or less sinuous and irregular. In the longitudinal section, the central column exhibits somewhat flattened cone-in-cone appearance and has a well defined boundary. Horizontally tabulated area

---

" Garwood hat 1907 für eine *Clisiophyllidae* aus dem englischen kohlenkalk die Gattung *Carruthersella* aufgestellt, die dadurch ausgezeichnet ist, dass bei ihr die Säule durch Ausfüllung der Hohlräume zwischen den einzelnen Skelettelementen eine vollkommen dichte Struktur bekommt. Salée beschrieb dann 1913 aus dem belgischen Karbon eine Art, bei der die Skelettstruktur nur noch teilweise dicht ist. Die beiden mir vorliegenden permischen Arten zeigen alle Übergänge von der offenen zur dichten Struktur, so dass die Abtrennung der Gattung *Carruthersella* von *Carcinophyllum,* die ja auch bereits Skelettverdickung aufweist, nicht aufrecht zu erhalten ist."

But Drs. Yabe and Hayasaka in 1915 separated *Waagenophyllum* from *Lonsdaleia* and *Lithostrotion* from *Lithostrotionella* by the absence or presence of the vesiculated peripheral zone. If this classification is reasonable, Garwood's *Carruthersella* is distinguished from *Carcinophyllum* by the development of the dissepimental area not invaded by septa. (It seems to me that the absence or presence of peripheral dissepimental area is not so important characteristic as to make the generic separation.)

broad and regular. Dissepimental zone composed of 3 or 5 layers of vesicles, and dissepiments moderately arched with the convex side distally and axially directed. Both septa, major and minor, in alternation and a large proportion of the major septa reaching the columella. Minor ones five sixths of the major in length and 18–24 in number.

Remarks.—Drs. Yabe and Hayasaka, in the description of *Waagenophyllum akasakense*, most reasonably expressed the opinion that *Lonsdaleia indica* described by Mansuy rather belongs to the group of *Lonsdaleia salinaria* Waagen and Wentzel.

Our specimen is identical with Mansuy's *L. indica* and very far apart from the typical *L. indica* from the Salt Range. It is also evident that the form resembles *Waagenophyllum salinaria* and *Waagenophyllum wynnei*, both described by Waagen and Wentzel from the middle *Productus* limestone of the Salt Range, by the massive type of the corallum, the size of the corallite and the good development of the septa. Still, some important differences can be recognized.

Lonsdaleia salinaria according to Waagen and Wentzel has about 20 to 24 primary septa and an equal number of the secondary and tertiary septa. While the present *W. timorica* has not only less primary ones, but also no tertiary septa.

Moreover, the central columella of the former rather resembles a type of that of *Dibunophyllum* or *Clisiophyllum* in vertical section, and the tabulated area is restricted to a quite narrow zone followed by many layers of the minutely vesiculated zone.

On the other hand the central columella of the present exhibits exactly the cone-in-cone structure, the horizontally tabulated area is broader and the dissepiments are larger and sparsely arranged.

For the distinction of *Waagenophyllum timorica* from *W. wynnei*, the same characters can be adduced that have been quoted already as distinctive between the present and *W. salinaria*.

Locality : Shigeyasu in Ominemura and Serida in Beppumura.

Age : Upper Permian.

78. **Lonsdaleia (Waagenophyllum) akasakensis** Yabe.

Pl. XIV., figs. 5,6.

1902. *Lonsdaleia akasakensis* H. Yabe, Materials for a knowledge of the Anthracolithic Fauna of Japan J. G. S. Tokyo, Vol. 9, p. 4, fig. 3.

1913. *Lonsdaleia (Waagenophyllum) akasakensis*, Yabe and Hayasaka, Palaezoic Corals from Japan, Korea and China. J. G. S. Tokyo, Vol. 22, p. 100.

The species was originally described by Prof. Yabe under the name *Lonsdaleia akasakensis* on the specimen collected at Akasaka. Afterward,

when he and Hayasaka studied several Paleozoic corals of Japan, etc., this type of *Lonsdaleia* was determined to be separated from the typical European *Lonsdaleia* and the new name *Waagenella* was given which was altered again by Dr. Hayasaka to *Waagenophyllum*[1], because the former term had been previously employed.

Description. Corallum composite, corallites conocylindrical and flexuous. Septa of two orders, both thin and more or less sinuous. The central column is composed of septal tabellae and axial lamellae. Medial plate short, often tortuous and sometimes indistinct. Horizontal tabulae not developed.

Remarks. Though no complete sections have ever been figured, it is certain that the present one is identical with the specimen from Akasaka. The most important characteristic of the species is an absence of the horizontal tabulae which is observed generally in *Lonsdaleia*. Mode of gemmation is also very interesting. It resembles that of *Diphyphyllum* and *Synaptophyllum*, viz., the new corallite is formed by the elongation of the septa which project at first outwardly like a wart and then form a new corallite (see Plate XIV, figure 5.).

Horizon : Upper Permian.

Locality : Shiraiwa and Shigeyasu, both in Ominemura.

79. **Lonsdaleia (Waagenophyllum) indica** W. et W. var. **akagoensis** n. var.

Pl. XIV., figs. 7,8,9.

Corallum fasciculate, corallites cylindrical and subparallel. Interseptal ridges and rugosity somewhat developed. Diameter of the calyx ranges from 6 to 12 mm.

Central column thick occupying one fourth of the diameter of the entire calyx. Corallum built up of very loosely and irregularly constructed axial tabellae and septal lamellae, the latter sinuous and intensely twisted. In longitudinal section, the central column shows the retiform type of the structure.

Horizontal tabulae distinctly but anormally developed and connecting the area between the columella and the vesiculated zone. They are tilted towards the central column so that the distal surface faces axially. Dissepiments large, directing the convex side inwardly. Septa not numerous, 20 to 28 major and as many minor ones, all reach the epitheca, but

1) I. Hayasaka: On the Fauna of the anthracolithic Limestone of Omi-mura. Sci. Rep. Tokoku Imp. Univ. Second Series (Geology), Vol. VIII., No. 1, p. 23.

often peripheral dissepimental area not invaded by septa. Major ones partly reach the central column and even invade it. Septal ridges eminent.

Remarks. In its general feature of the transverse section this species presents a close resemblance to *Waagenophyllum indica* Waagen and Wentzel, especially in the quite irregular arrangement of dissepiments and loose structure of the central column, and I was a long time in doubt whether I ought to separate the present from the latter, but after some consideration I found that the specimens from Akiyoshi were distinct from the Indian forms not only in the indefinitely developed peripheral vesiculated area, but also by an unusual construction of the central column and the horizontally tabulated area.

A comparison of tbe figure 6 on plate XIV and Waagen and Wentzel's figure 4 on plate 105 and figures 1d, 3c on plate 51 will distinctly show those differences.

Whilst in *Lonsdaleia indica* the central column sohws typical cone-in-cone structure and its horizontally tabulated area is either very narrow or not developed at all.

Locality and age. Abundantly found in the limestone directly above the zone of *Schwagerina princeps*. It is associated with *Doliolina claudiae* Deprat and *Fusulina ellipsoidalis* var. *orientis*.

The age is uppermost Ouralian.

Locality : Kaerimizu in Akagomura.

Dibunophyllum Thomson and Nicholson.

80. **Dibunophyllum rugosum** M'Coy var. **ofukuense** n. var.

Pl. XII., figs. 6,7.

Compare :—

1915. *Dibunophyllum rugosum* S. Smith, on the Genus Lonsdaleia and Dibunophyllum rugosum, p. 265, Pl. 21. figs. 3-16. Q. J. G. S. London, Vol. 71.

Dibunophyllum rugosum was described by M'Coy as *Lonsdaleia rugosa*. S. Smith, in 1915, studied the original samples of M'Coy and determined that they possess all the structural characters of *Dibunophyllum* Thomson and Nicholson.

Akiyoshi specimens deviate more or less from the type of the form.

Horizontal section :—Central axis composed of fine septal lamellae and axial tabellae, crossed by one thick prominent medial plate. Septa of two orders ; major ones 24 to 28 in number, alternate with the same number of minor septa which are very short or represented by mere septal ridge. No pure dissepimental area. Dissepiments crowded at the peripheral zone.

In the vertical section the medial plate is a long and thick solid line from which delicate and closely set laminae of the axis diverge downwards, but pass gradually into the larger and more horizontal tabulae. Dissepiments small, numerous and strongly arched with the convex side distally and axially directed. Cardinal fossula unobserved.

Remark :—The most important difference between the Akiyoshi specimens and the European type is the structure of the central column, which in the former is very stout and occupies quite one third of the cross diameter, and the septal lamellae and tabellae are very much crowded ; in consequence, its structure closely resembles that of the typical *Dibunophyllum*.

Most interesting are the associated fossils. *Dibunophpllum* is a common fossil of the younger Lower Carboniferous in Europe and almost all the material examined by S. Smith came from the upper Brown Limestone of Llangollen, Gorwen. Treflach and Mold D_2-D_3).

The Akiyoshi species, on the other hand, is associated with *Fusulinella bocki* Möller, *Fusulinella biconica* Hayasaka and *Fusulina* (*Schellwienia*) *staffi* n. sp., which are older Upper Carboniferous representatives.

Locality : Ofukudai and Hosoono in Kyowason.
Age : Moscovian.

Nagatophyllum n. gen.

Corallum composed of circular, tapering and proliferous stems ; internally it consists of three areas ; 1st, a cylindrical, defined complex axis, built up of a medial plate and axial tabellae ; 2nd, a zone of strong, vertical and radiating septa, connected by thin oblique transverse dissepiments ; 3rd, broad pure dissepimental area between the septated zone and the epitheca, composed of regularly arranged dissepiments extending obliquely upwards and outwards. Septa, of two orders, rest upon a platform of the dissepiments and have always their corresponding row of the dissepiments. The septal fossula often conspicuous, especially in the young corallite.

Remark. The genus *Nagatophyllum* agrees with *Lonsdaleia* in the following characters ; 1st, the presence of the triareal structure ; 2nd, division of the central area into two equal halves by a medial plate. Still several important differences can be recognized between them. The most distinctive peculiarities of *Nagatophyllum* are the presence of the septal fossula, and the structure of the central column. The central column of *Lonsdaleia* is composed of a medial plate, radiate septal lamellae and axial tabellae, while that of *Nagatophyllum* consists of a medial plate and axial tabellae and no septal lamellae, and the major septa, instead of extending inwards the central structure, are curved spirally at the columella.

Therefore, in the full grown specimen the major septa appear to be radiating from a ring formed by coalescence of the upper portion of the septa as illustrated in figures 3 and 5 on plate XII.

Moreover, in the adult specimen of *Nagatophyllum* one or two rings (not endotheca) can be observed both in the central columneral and pure dissepimental area. (See figure 3, Plate XII).

A further difference is constantly observed between them in the horizontal section, which is, that the external pure vesicular area in *Nagatophyllum* is formed by radially and regularly arranged dissepimental rows, and each septum, both major and minor, has its corresponding vesicular row directed to the centre.

Age : Carboniferous.

81. **Nagatophyllum satoi** n. sp.

Pl. XII., figs. 1,2,3,4,5.

External character unknown. Corallum composite, elongate conical or conocylindrical. Diameter of corallite 3–4 cm, but often attaining 5 cm or more, length unknown.

Transverse section. Central area relatively small, formed of columella, composed of medial plate and axial tabellae, the former directs to the septal fossula and the latter direct their concave side towards the plate. Septa, of two series, minor and major, rest upon the dissepiments of the external area ; the major ones long and extending to and spirally surrounding the central column, but not taking part in forming the central columella ; minor ones very short and often indistinct. Pure dissepimental area broad, occupies 1/3 of the cross diameter, its breadth constant throughout. Dissepiments arranged in radiating rows, on each row rests the septum, therefore the number of the septa equals that of the dissepimental rows.

Longitudinal section. The axial tabellae form a series of very delicate inosculating tabellae directed in an ascending manner from the exterior of the central area towards the columellarian line, with which they finally become connected.

Immediately external to the central area a narrow zone (interlocular space) is found, which is formed by a layer of regularly arranged saucer-shaped horizontal tabulae, the concave side directing upwards.

The distinguishing characters are its large size, small columella and the peripheral dissepimental area.

Horizon and Locality :—

It is associated with *Lonsdaleia enormis* and *Fistulipora nagatoensis*.
Locality: Tobinosu in Odamura.
Age: Dinantian.

Family **Cyathoaxonidae** E. et H.

Genus **Polycoelia** King.

82. **Polycoelia japonica** n. sp.

Pl. XIV, figs. 10,11,12.

External character unknown.

Corallum simple, short conical. Diameter of calyx 1.2 cm. Epitheca thick, 2 mm or more. No columella and dissepiments. Septa 26. Four principal ones divide the calyx in four compartments, of which two contain four and other two contain 7 minor septa of inequal length.

Remarks. I had at first identified the present species with *Plerophyllum sulcatum* which has 28 septa, of which 4 are prominently developed and the others subequal, the arrangement of which in four quadrants greatly resembles that of the present one, but the septa of the present species, so far as my scanty specimens are concerned are not laterally in contact in the lower portion of the corallite and the calyx seems to reach the bottom of the caliculum, consequently its interlocular and central areas are not filled up with solid tissue. Therefore it seems to be preferable to prepare a new diagnosis.

Among the Permian *Polycoelia*, *Polycoelia profunda* described by Geinitz seems to have the closest resemblance to the present one. But the arrangement of the minor septa is quite different.

Horizon and Locality:—The genus *Polycoelia* seems to be very rare and hitherto described species are all restricted to Permian. But recently Grabau has recorded a new genus, *Tachylasma*, from Carboniferous beds in China which is probably, so far as the genotype *Tachylasma cha*[1] is concerned, synonymous with *Plerophyllum*[2] Hinde and has the nearest relation with *Polycoelia*.

The present specimens, associated with *Nagatophyllum satoi*, *Lonsdaleia enormis*, *Fistulipora nagatoensis* and *Productus* cf. *semireticulatus*, occurs in a lower horizon than the *Lonsdaleia floriformis* subzone. Thus its Lower Carboniferous age is certain. Two samples have been collected at

1) Grabau: Paleozoic Corals of China. Palaeontologia Sinica. Ser. B. Vol. 2, fas. 1. pp. 34-36. 1922.

2) H. Gerth: Die Anthozoen der Dyas von Timor, p. 93. Paläontologie von Timor. IX Lieferung. 1920.

Tobinosu of Odamura, but while making a thin section one was badly damaged, and no sample showing the external aspect is preserved.

TABULATA E. et H.

Family **Chaetetidae** E. et H.

Genus **Chaetetes.**

83. **Chaetetes** sp.

Pl. XII., fig. 12b. Pl. XIII, fig. 106.

Corallum irregularly expanded; corallites subcylindrical and more or less six-sided in cross section. Average diameter of corallite 0.1 mm. The internal structure consists of flat septa stretching completely across. Bounder wall thick and pierced by doubtful pores or transverse lines.

At first sight one might be somewhat doubtful where to place this species, whether in *Chaetetes* or other genera; the small size of the corallites and radial aggregate of corallum certainly suggesting the former genus, but the indistinct mural pores, which appear to be rather rare are not the character of the genus.

Occurrence. It is found throughout the Akiyoshi Limestone and in certain horizons it forms a conspicuous bed, as in the case of the *Fusulinella* Zone.

MOLLUSCOIDEA

BRYOZOA

Family **Fistuliporidae** Ulrich.

Genus **Fistulipora** M'Coy.

84. **Fistulipora kotoi** n. sp.

Pl. I., figs. 3,4,5.

Zoarium probably ramose, branches $\frac{1}{2}$ cm in diameter. Apertures quite small and interspaces very wide. Zoaecia thin-walled, circular or oval, diameter usually attains 0.2 mm and within a length of one millimeter three autopores are found.

Zoaecial tubes proceed in gradual curve to the surface upon which they open almost perpendicularly. Diaphragms or tabulae rather regular. in distribution. About five tabulae contained within a space of 1 mm. Vesicles irregular, usually small and angular, surrounding zoaecia in one or two series. In longitudinal section, vesicles very prettily arranged in one row or two.

Remarks. The distinctive features of this well marked species are ramose zoarium, regularly arranged vesicles and equally distributed horizontal tabulae. The zoaecial and vesicular structure of the present one resembles that of *Fistulipora parasitica*,[1] which has thin incrusting lamellae and never appears with free lamellae or branches. The size of zoaecium also differs. From *Dybowskiella grandis*[2] and *D. expansa*, the present one can be easily distingulished in the size of zoaecium and mesopore.

This species is represented by a small ramose zoaecium which was collected in the *Fusulina* limestone at Kaerimizu. The associated fossils are the group of *Fusulina vulgaris* and *Fusulina montipara*, etc.

Age: Uralian.

85. **Fistulipora nagatoensis** n. sp.

Pl. I, figs. 6,7.

Zoarium explanate, commonly attached to foreign body, but sometimes free and provided with epitheca, often composed of layers, each one millimeter or two in thickness. Zoaecium oval, showing trifoliate form. Its diameter less than 0.2 mm :—about three in space of 1.2 mm, and in autopore lunarium obsolete. Wall of mesopores somewhat completely developed, usually 8 to 12 tabulae exist in the space of one millimeter. Tabulae of autopores few, only one tabula is observable.

Remarks. The species most closely resembles *Fistulipora muscosa* Nicholson and Foord,[3] but in their microscopic characters the two species are distinguishable; the autopores in *Fistulipora muscosa* are larger than those of the present one, only three of them being required to fill the space of two millimeters in the former; while in the latter it takes five. Further, the wall of mesopores of *Fistulipora muscosa* are incompletely developed, though the close-set tabulae coalesce to form a vesicular tissue.

Age and Locality. This species is not unfrequently met with in the hard gray limestone at Tobinosu, Otamura. No separated specimens can be obtained from the hard matrix. The age is Lower Carboniferous.

---

1) Waagen and Wentzel: Salt Range Fossils, Coelenterata. Paleontologia India, p. 923, Pl. XLV., fig. 6, Pl. CV., figs. 1 4. 1886.

2) Waagen and Wentzel: ditto. p. 918 and p. 922.

2) *Dybowskiella* was founded by Waagen and Wentzel, but was afterwards abandoned and included in *Fistulipora* by several American paleontologists. See Girty's Guadalpian Fauna, in Professional Paper, no. 58, p. 126. 1909.

3) Nicholson and Foord: On the genus *Fistulipora* M'Coy, with descriptions of several species. Ann. Mag. Nat. Hist., Ser. V, No. 16, p. 501.

Family **Batostomellidae** Ulrich.

Genus **Geinitzella** Waagen and Wentzel.

86. **Geinitzella** cf. **columnaris** Schlotheim.

Compare :

Geinitzella columnaris Waagen and Wentzel: Coelenterata in Salt-Range Fossils, Pl. CXII., figs. 1-5, Pl. CVI., figs. 1-4 and Pl. CXV., fig. 1, etc.

This form is represented by thin transverse and imperfect longitudinal sections which permit the determination of only a few of its distinctive characters. The diameter of the zoaecium is less than 0.2 mm. Wall of zoaecium is very thin in the middle of branches, but with very strong secondary thickening towards the periphery. Tabulae seem to be scarce or even entirely absent. Locality : Sako in Kyowamura.

Family **Fenestellidae** King.

Genus **Fenestella** Lonsdale.

87. **Fenestella perelegans** Meek.

Pl. I, figs. 8,9.

1885. *Fenestella perelegans* Waagen and Wentzel, Productus Limestone Fossils, Bryozoa. Palaeontologia Indica, Ser. XIII., pp. 777-778. Pl. LXXXVII., figs. 1-3.

Zoarium of irregularly foliar expansion, several fragments were obtained. Branches 18 or 20 in 1 cm, comparatively slender and about 0.3 mm wide.

Dissepiments short, slender and somewhat depressed. Fenestrules oval or long oval, about two times as long as width, with about 18 in 1 cm. Obverse side of branches rounded and occupied by from three to five thread-like longitudinal striae; fenestrules longer than on obverse and subquadrate in form.

Remark. The Akiyoshi specimens are exactly identical with the form described by Waagen and Wentzel who have figured very pretty samples. Girty,[1] in the description of *Fenestella spinulosa* Conrad, remarks that *Fenestella perelegans* is imperfectly known and its carina is said to be nearly obsolete. However, Akiyoshi specimens, as well as Indian species, have distinct carinas, though they often become closed and obscured.

It appears most to resemble *Fenestella nodulosa*, *F. spinulosa*, *F. shumardi* Prout and *F. parvipora*.[2] The former two species have been

1] Girty: op. cit. p. 138. 1908.

2) Condra: New Bryozoa from Coal-measures of Bebraska. Amer. Geologist, 1902. pp. 343-344.

carefully compared by Waagen and Wentzel and the latter two have large and round carina.

Age and Locality. This is a very abundant species; there are many fragments of it among my Akiyoshi collection. All were obtained at the Sako quarry in Kyowamura. Waagen and Wentzel recorded it from the Middle *Productus* Limestone of Salt-Range.

Genus **Polypora** M'Coy.

88. **Polypora** sp. ind.

Zoarium expanding growth of medium size; branches straight, scarcely bifurcating, extending tolerably parallel, about 0.8 to 0.9 mm in thickness. Fenestrules subelliptical to oblong, 0.8 to 0.85 mm in length by 0.35–0.50 mm wide, 7 or 8 in space of 1 cm.

Zoaecia irregularly scattered. Apertures circular without peristome, 0.08 to 0.1 mm in diameter, about their diameter apart, 35 to 40 apertures in 1 cm.

Remark. It is represented by two fragments. This species answers very well to Ulrich's description of *Polypora nodocarinata*.[1] It differs, however, from the form here provisionally identified as that species in its regular distribution of zoaecia, (in *Polypora nodocarinata* zoaecia in four regular alternating ranges) thicker dissepiments and oval or elliptical fenestrules. It may prove to be the same, but this is rather unlikely. It would aprear to be a new species. But it must be conceded that the imperfect preservation of the Akiyoshi species may have led to misinterpretation of real characters. Another similar species is *Polypora spinulifera* Ulrich,[2] which however shows distinct differences in certain points, such as the small spines irregularly distributed in the obverse side.

It is found at Sako quarry where it is associated with other important Bryozoa above described.

Age: Uppermost Carboniferous.

BRACHYOPODA

Family **Spiriferidae** King.

89. **Spirifer** sp. ind.

The specimen which clearly possesses the appearance of the group, is insufficient to determine the specific name. It is a poorly preserved

1) Ulrch: Paleozoic Bryozoa in Geological Survey in Illinois. Paleontology of Illinois. Vol. VIII, Part 2. p. 601, Pl. LXI, figs. 9, 9a.

2) Ulrich: Paleozoic Bryozoa in Geological Survey in Illinois. Paleontology of Illinois. Vlo. VIII, Part 2, p. 598, Pl. LXI, 2,2a,3,3a,4,4a.

ventral shell with a length of 9 cm. The surface of the shell is marked by finer radiating costae. A sinual depression runs very distinctly from the top of beak to the anterior part. So far as I am concerned, it can not be definitely identified with any of the described species, but is somewhat allied to such forms as *Spirifer sinctiformis* from the Upper Carboniferous limestone of the Volga. The locality is Sako quarry in Kyowamura.

Family **Productidae** Gray.

90. **Productus** sp.

A single ventral valve imperfectly preserved. It is much like *Productus semireticulatus* from Lower Carboniferous limestone in various countries.

Locality : Tobinosu in Odamura.

Supplement.

While the present paper is in press, a very important and valuable contribution[1] to the study of Fusulinidae is published by Miss Colani under the title "Nouvelle Contribution à l'Étude des Fusulinidés". In the work, the author not only summarized and criticised the Deprat's works, but also described several new species of Fusulinae from Indochina. When I looked over this paper, I found that the following new species given in the present paper are synonyms of the species described by Colani.

Fusulina deprati n. sp. = *Fusulina douvillei* Colani.

(See :—Mém. Serv. Géol. Indochine. Vol. XI., Fas. I. Pl. X., figs. 5,25 ; Pl. XIII., figs. 2–26. pp. 98–99. p. 141.)

Verbeekina verbeeki var. *sphaera* n. var. = *Verbeekina verbeeki.*

Neoschwageaina (*Yabeina*) *shiraiwensis* n. sp. }
" " *hayasakai* Ozawa }
= *Neoschwagerina multiseptata* (Deprat) em Colani.

I give the following remark on *Sumatrina multiseptata* Deprat :— "*Sumatrina multiseptata* described by Deprat has almost the same rate of growth and large initial chamber as the present one (*Yabeina hayasakai*), but the structure of septa, supposing his observation is correct, differs far from that of the present. Nevertheless the present species has a very close relation with *Sumatrina multiseptata*".

But, as I can not examine the original section of *Sumatrina multiseptata*, I described the form having the septa of *Yabeina*-type as a new species. If Colani's observation is correct, the above two new species of *Yabeina* are the synonyms of *Yabeina multiseptata*.

---

1) Mém. Serv. Géol. Indochine. Vol. XI. fas. 1. 1924.

INDEX.

G.

H.

L.

M.

N.

T.

V.

W.

Y.

PLATE I.

Plate I.

Figs. 1a, 2a. Mizzia velebitana Schubert. ×15. p. 5.

Figs. 1b, 2b. Sumatrina annae Volz. ×15. p. 64.

Fig. 2c. Lagena sp. p. 12.

Figs. 3,4,5. Fistulipora kotoi n. sp. ×15. p. 81.

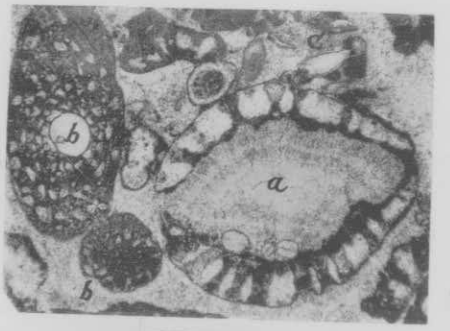
Figs. 6,7. Fistulipora nagatoensis n. sp. ×15. p. 82.

Figs. 8,9. Fenestella perelegans Meek. 8. Reverse side. p. 83.
9. Obverse side. 8. ×5. 9. ×10.

Fig. 10. Cycadocarpidium swabii Nathorst. ×1.5. p. 6.

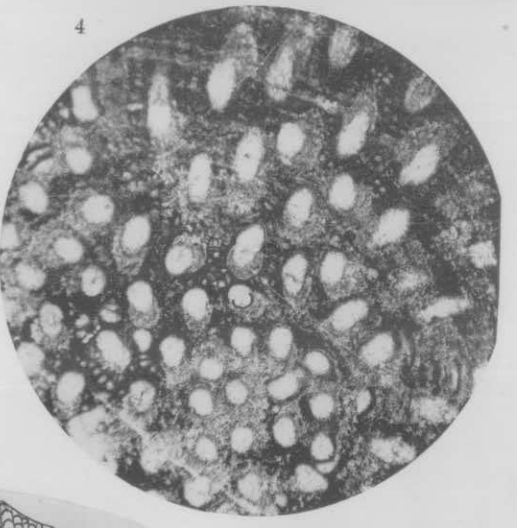
1

2

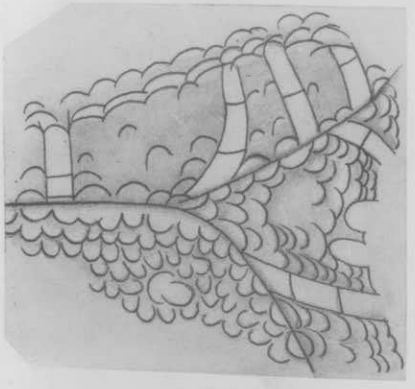


3

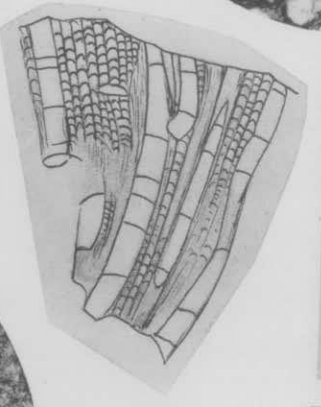
4



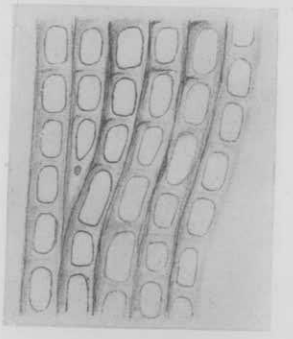
6



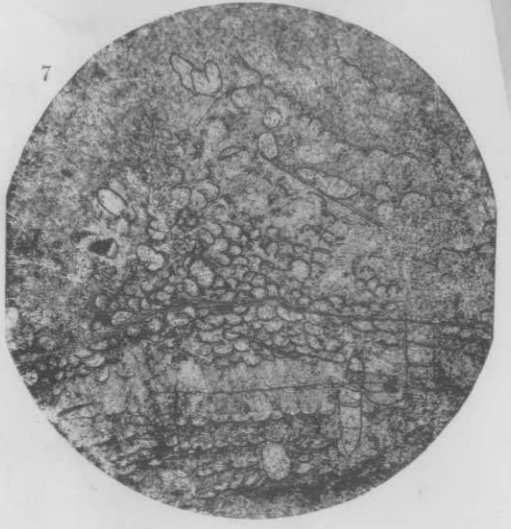
5



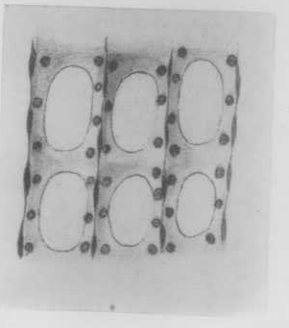
8



7



9



10

Y. Ozawa : Paleontological Studies on the Limestone of Nagato.

PLATE II.

Plate II.

Fig. 1. Tetrataxis linea n. sp. ×15. p. 9.

Fig. 2a. Tetrataxis schellwieni n. sp. ×15. p. 9.

Figs. 2b,5c,7b. Yabeina shiraiwensis n. sp. ×15. p. 63.

Fig. 3. Bigenerina sumatrana Volz. ×15. p. 11.

Fig. 4. Spirillina grandis n. sp. ×15. p. 13.

Fig. 5a. Glomospira cf. pusilla (Geinitz). ×15. p. 8.

Fig. 5b. Lagena sp. p. 12.

Figs. 6a, 7a. Tetrataxis conica Ehrenb. var. ×15. p. 10.

Figs. 6b. 7c. Mizzia velebitana Schubert. p. 5.

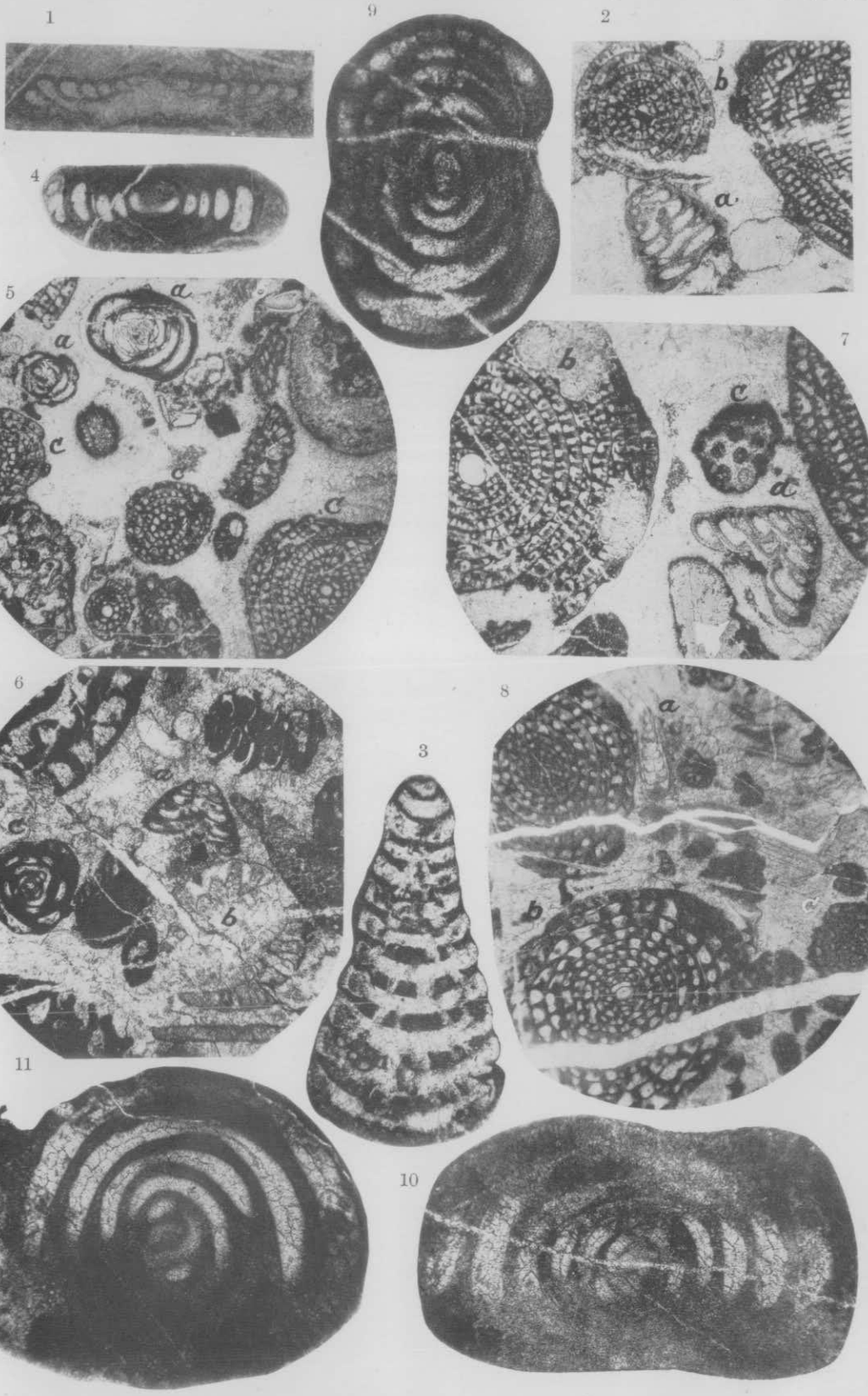
Fig. 6c. Glomospira cf. gordialis (Jones et Parker). p. 7.

Fig. 8a. Lingulina sp. ×15. p. 13.

Fig. 8b. Doliolina lepida (Schwager). p. 53.

Fig. 9. Staffella mœlleri n. sp. ×45. p. 19.

Figs. 10, 11. Hemigordius japonica n. sp. ×45. p. 7.



Y. Ozawa: Paleontological Studies on the Limestone of Nagato.

PLATE III.

Plate III.

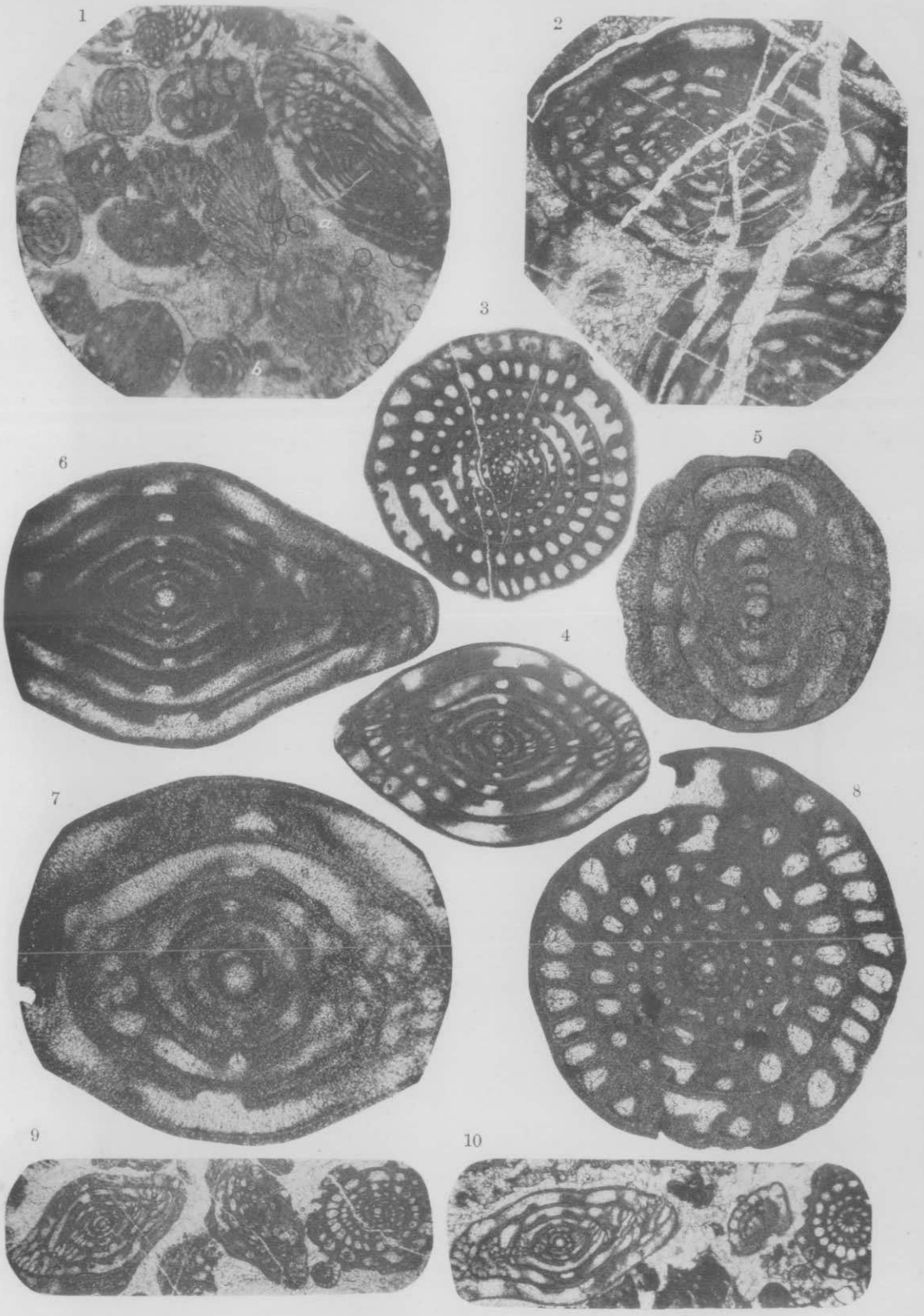
Fig. 1a. Schellwienia lepida (Deprat) ×15. p. 46.

Figs. 1b, 5. Staffella yobarensis n. sp. 1b ×15. 5 ×45. p. 19.

Figs. 2,3,4. Fusulinella biconica (Hayasaka). ×15. p. 18.

Figs. 6,8. Fusulinella itoi n. sp. ×45. p. 91.

Figs. 7,9,10. Fusulinella bocki Möller. 7 ×45. 9,10 ×15. p. 17.



Y. Ozawa: Paleontological Studies on the Limestone of Nagato.

PLATE IV.

Plate IV.

Fig. 1. Schellwienia staffi n. sp. ×15. p. 21.

Fig. 2. Schellwienia suzukii n. sp. Left, Undeterminable Schellwienia. ×45. p. 43.

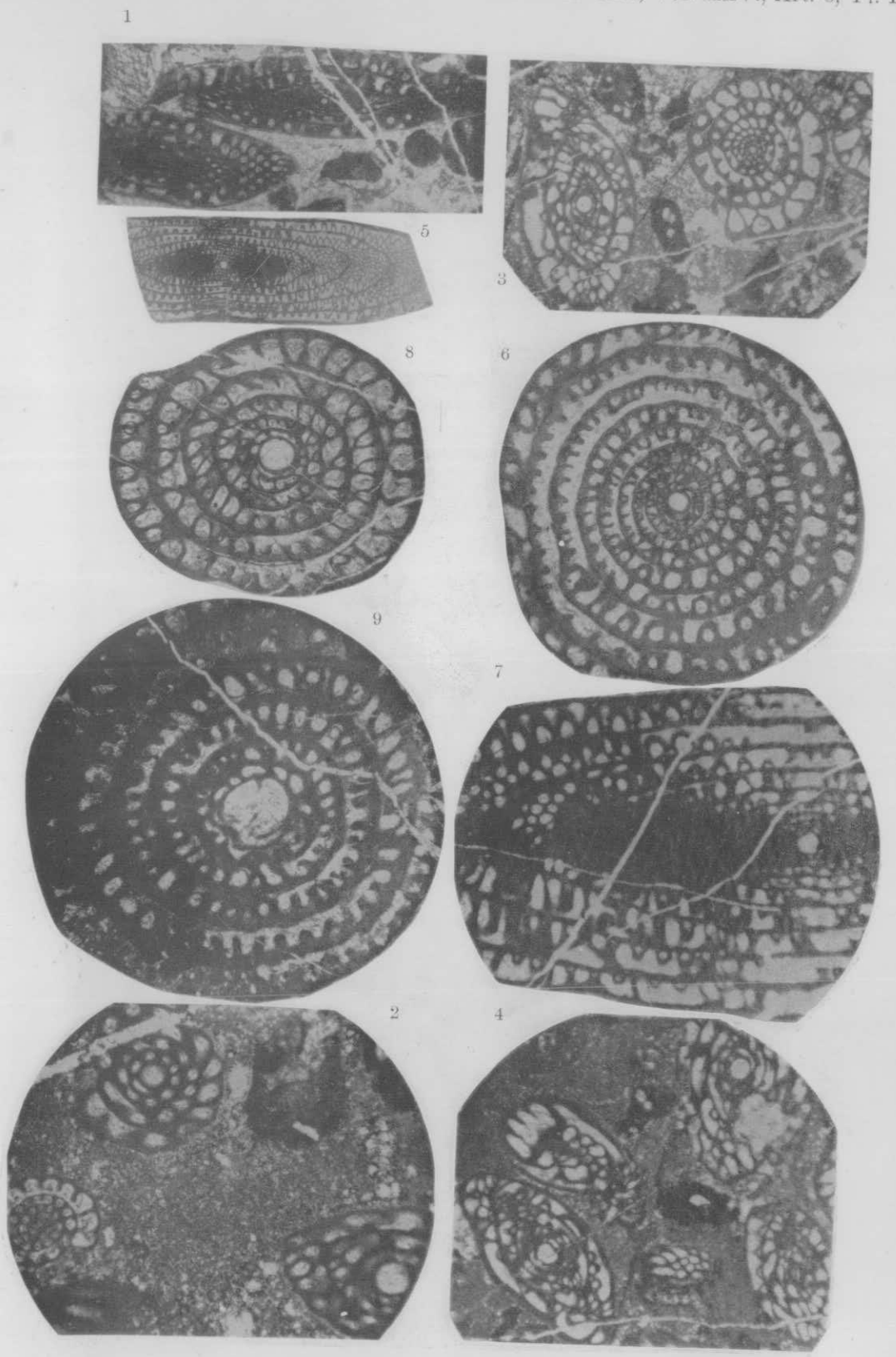
Figs. 3,4. Schellwienia ominensis n. sp. ×15. p. 42.

Fig. 5. Schellwienia kaerimizensis n. sp. Loc. Tomuro in Prov. of Kozuke. ca ×4.5. p. 31.

Figs. 6,7. Ditto. ×15. Loc. Kaerimizu. p. 31.

Fig. 8. Schellwienia ambigua Deprat. ×15. p. 31.

Fig. 9. Schellwienia gigantea Deprat. ×15. p. 32.



Y. Ozawa: Paleontological Studies on the Limestone of Nagato.

PLATE V.

Plate V.

Fig. 1. Schellwienia richthofeni Schwager. ×15. p. 35.

Fig. 2. Schellwienia subobsoleta n. sp. ×15. p. 41.

Fig. 3. Schellwienia cf. prisca var. parvula Schellwien. ×15. p. 39.

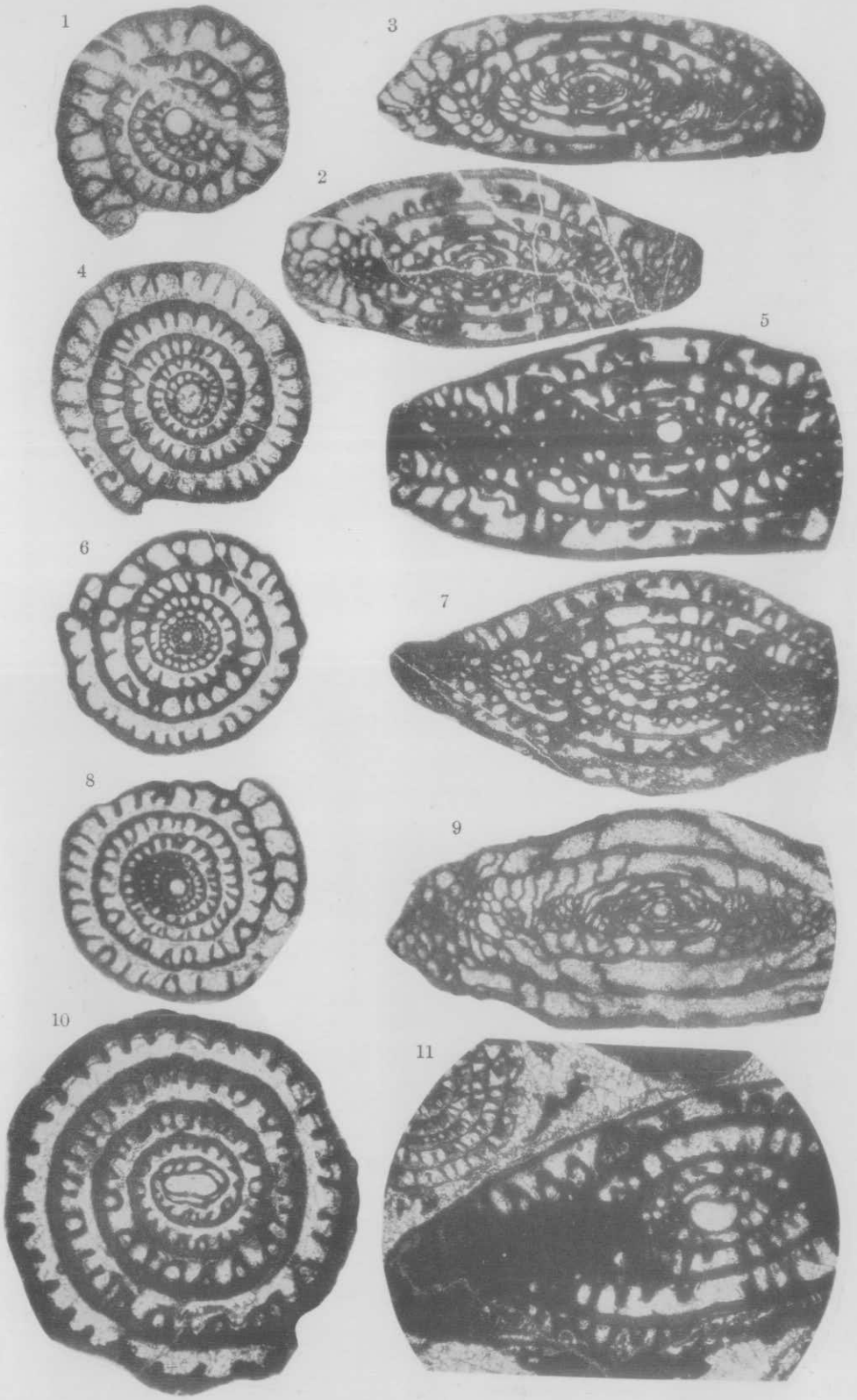
Figs. 4,5. Schellwienia prisca (Ehrenb.) v. Möller. ×15. p. 38.

Figs. 6,7. Schellwienia deprati n. sp. ×15. p. 34.

Figs. 8,9. Schellwienia incisa Schellwien. ×15. p. 37.

Fig. 10. Schellwienia crassiseptata Deprat (Schalenverschmelzung). p. 35.

Fig. 11. Ditto. ×15. p. 35.



Y. Ozawa: Paleontological Studies on the Limestone of Nagato.

PLATE VI.

Plate VI.

Fig. 1a. Schellwienia ellipsoidalis var. orientis n. var. ca ×4.5. p. 22.

Fig. 1b,2,3. Schellwienia edoensis n. sp. ca ×4.5. p. 30.

Fig. 4. Schellwienia lutugini Schellwien. ca ×4.5. p. 28.

Fig. 5. Shellwienia kaerimizensis n. sp. ca ×4.5. p. 31.

Fig. 6. Schellwienia granum-avenae Roemer. ca ×4.5. p. 29.

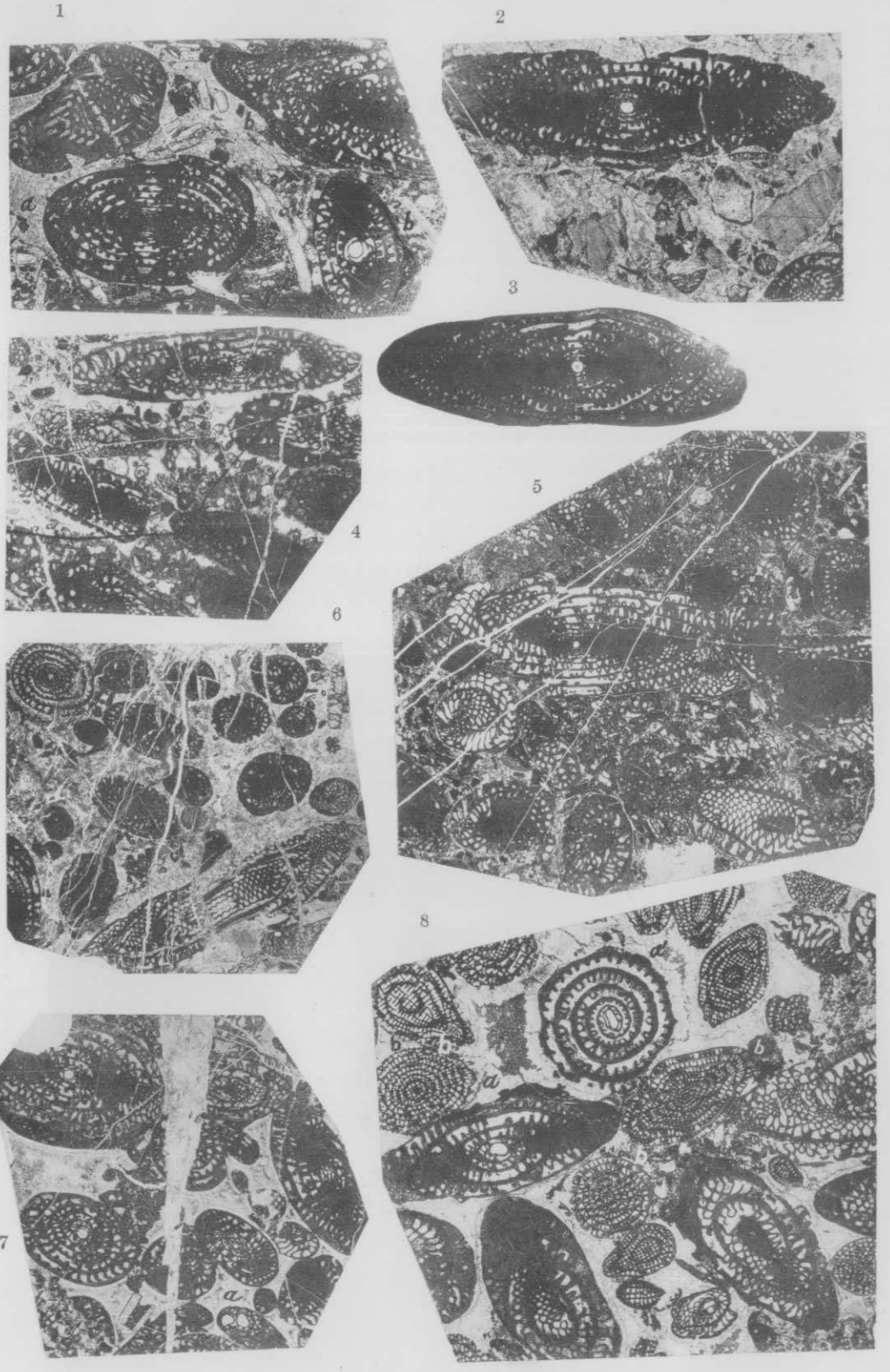
Fig. 7. Schellwienia kraffti Schellwien. ×45.

a. Schalenverschmelzung. p. 25.

Figs. 8a,a'. Schellwienia crassiseptata Deprat. ×4.5. p. 35.

a'. Schalenverschmelzung. p. 35.

Fig. 8b. Neoschwagerina craticulifera Schwager. ×4.5



Y. Ozawa : Paleontological Studies on the Limestone of Nagato.

PLATE VII.

Plate VII.

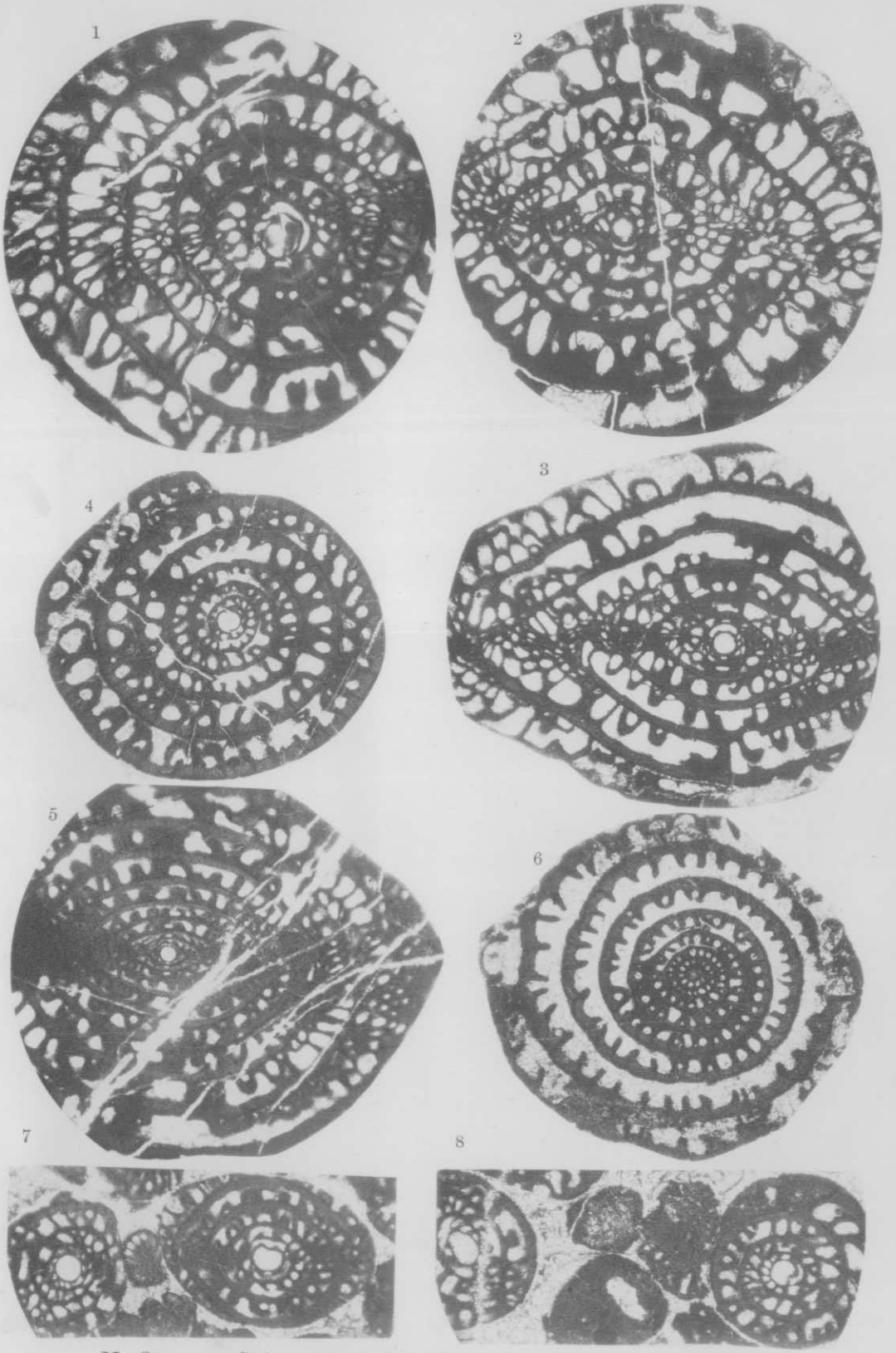
Figs. 1,2. Schellwienia vulgaris Schellw. var. globosa Schellwien. 1. A very globular form. ×15.

Fig. 3. Schellwienia vulgaris Schellwien. ×15. p. 23.

Fig. 4. Schellwienia kraffti Schellwien. ×15. p. 25.

Fig. 5,6. Schellwienia krotowi Schellwien. ×15. p. 27.

Figs. 7,8. Schellwienia yobarensis n. sp. ×15. p. 27.



Y. Ozawa: Paleontological Studies on the Limestone of Nagato.

PLATE VIII.

Plate VIII.

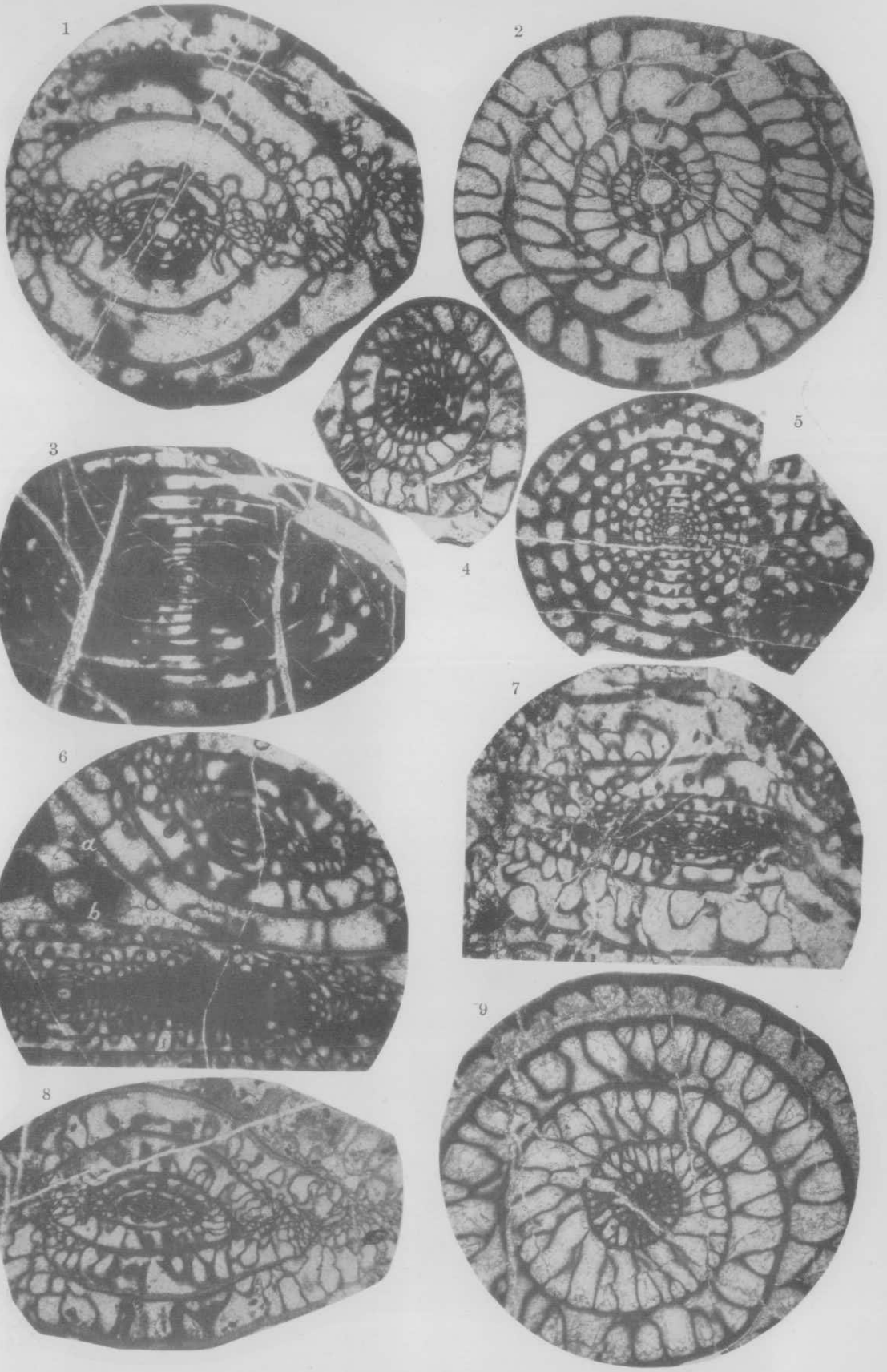
Figs. 1,2. Schwagerina muongthensis (Deprat). ×15. p. 47.

Figs. 3,5. Schellwienia ellipsoidalis var. orientis n. var. ×15. p. 22.

Figs. 4,6a,8. Schellwienia satoi n. sp. ×15. p. 44.

Fig. 6b. Schellwienia cf. kattaensis Schwager. ×15. p. 21.

Figs. 7,9. Schellwienia oblonga n. sp. ×15. p. 45.



Y. Ozawa : Paleontological Studies on the Limestone of Nagato.

PLATE IX.

Plate IX.

Fig. 1. Schellwienia montipara (Ehrenb.) Möller. ×15. p. 40.

Figs. 2,4,?5,6,7. Schellwienia subobsoleta n. sp. ×15. p. 41.

5. Microsphaeric form (?). p. 41.

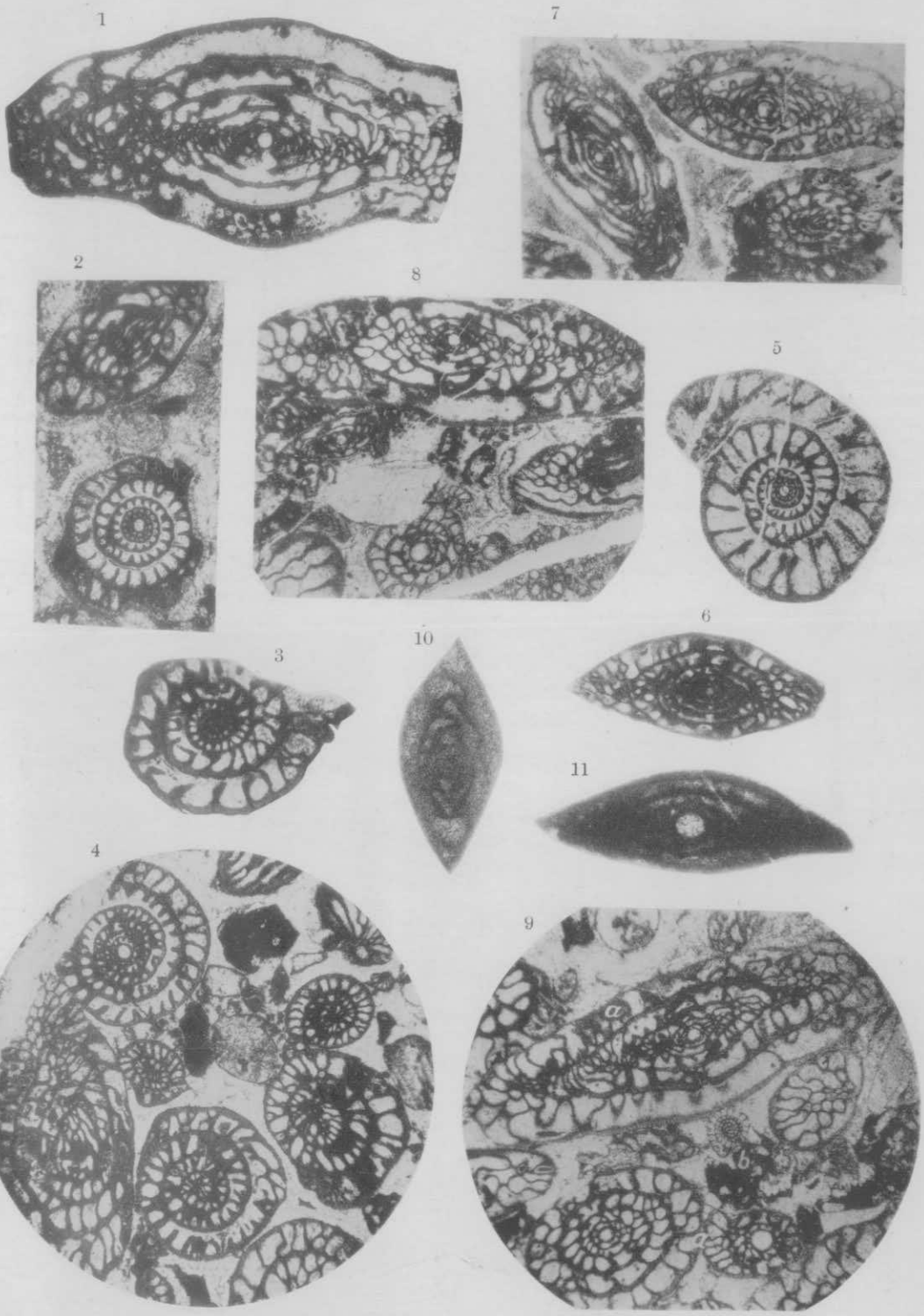
Fig. 3. ?Schellwienia satoi n. sp. ×15. p. 44.

Figs. 8,9a. Schellwienia haydeni n. sp. ×15.

Fig. 9b. Neofusulinella sp. ×15.

Fig. 10. Staffella waageni Schwager. ×45. p. 21.

Fig. 11. Schellwienia n. sp. ×45. p. 46.



Y. Ozawa : Paleontological Studies on the Limestone of Nagato.

PLATE X.

Plate X.

Figs. 1,2. Yabeina shiraiwensis n. sp. p. 63.

Figs. 3a,4. Yabeina schellwieni (Deprat). 3a ×12. 4 ×15. p. 60.

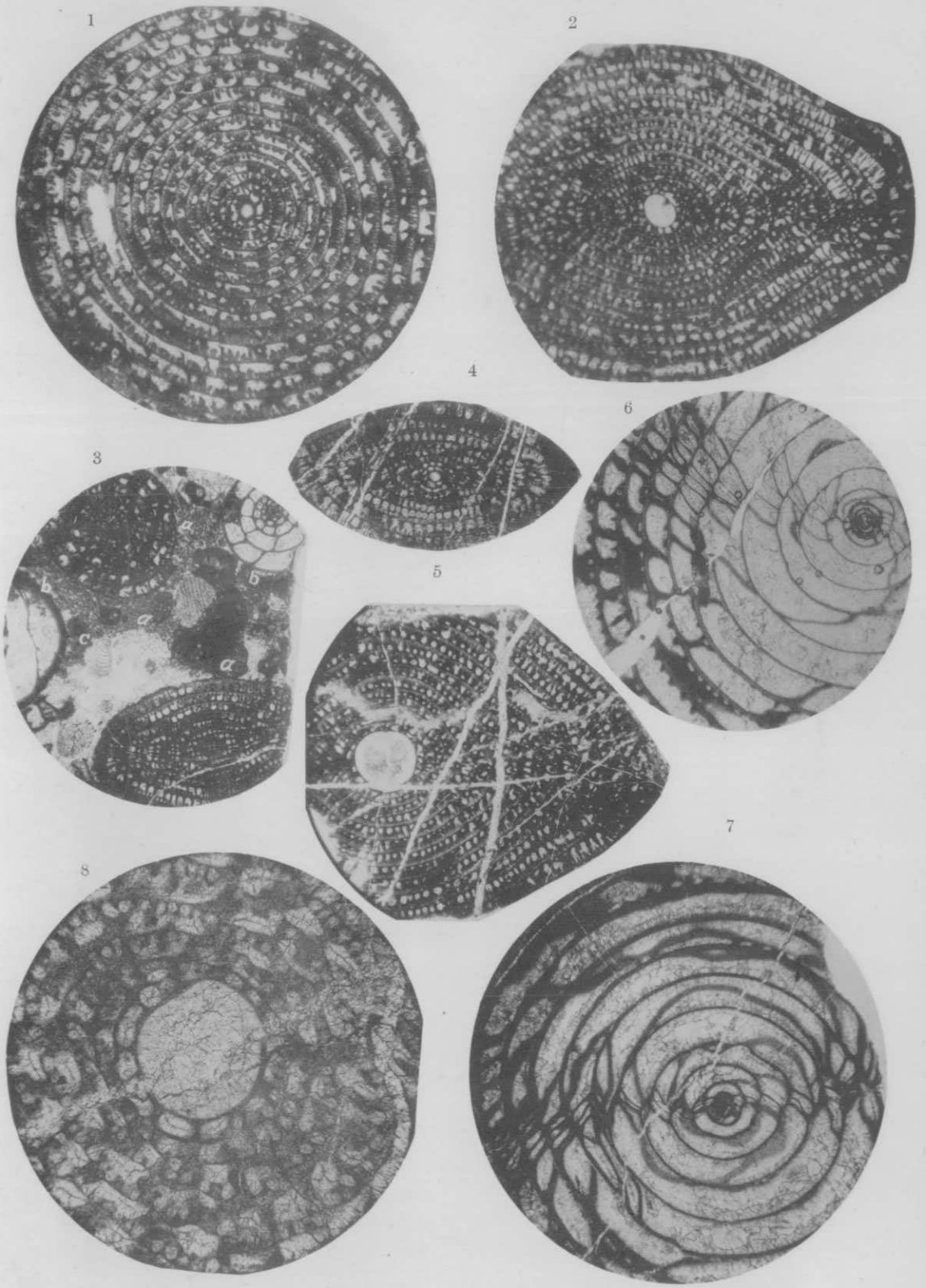
Fig. 3c. Textularia cf. jonesi Brady. ×12. p. 8.

Fig. 3b. Verbeekina verbeeki (Geinitz). ×15. p. 51.

Fig. 5. Yabeina hayasakai Ozawa. ×12. p. 61.

Figs. 6,7. Verbeekina verbeeki (Geinitz). ×15. p. 48.

Fig. 8. Sumatrina annæ Volz. ×45. p. 64.



Y. Ozawa: Paleontological Studies on the Limestone of Nagato.

PLATE XI.

Plate XI.

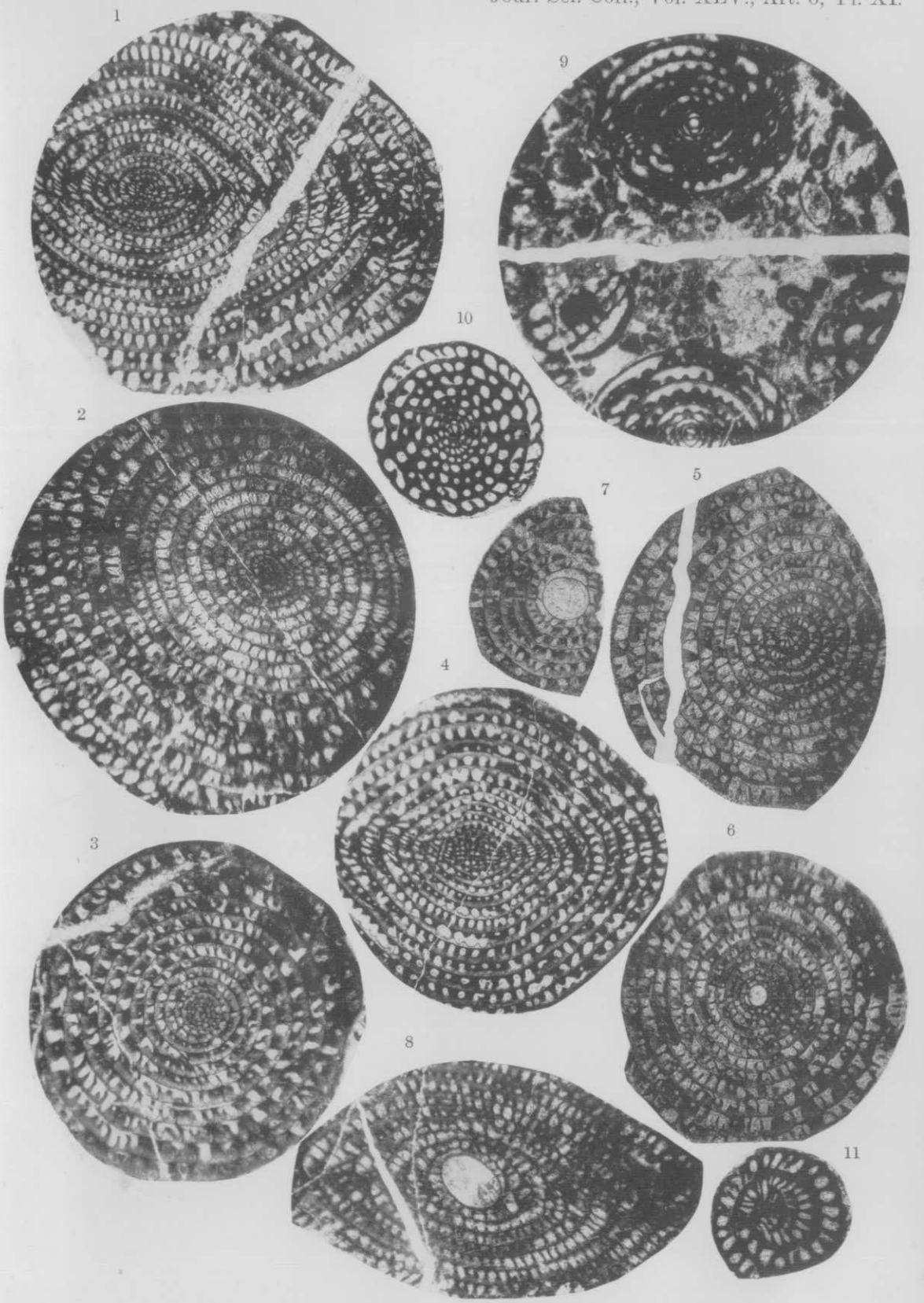
Figs. 1,2,3. Neoschwagerina margaritae Deprat. ×15. p. 58.

Fig. 4. Neoschwagerina craticulifera Schwager. ×12. p. 54.

Figs. 5,6,7. Neoschwagerina douvillei Ozawa. ×15. p. 55.

Fig. 8. Neoschwagerina megasphaerica Deprat. ×15. p. 58.

Figs. 9,10,11. Verbeekina claudiae (Deprat). ×15. p. 52.



Y. Ozawa : Paleontological Studies on the Limestone of Nagato.

PLATE XII.

Plate XII.

Figs. 1,2,3,4,5. Nagatophyllum satoi n. gen. et n. sp. 1,4 ca. ×2.5 2,3,5. ×2. p. 79.

Figs. 6,7. Dibunophyllum rugosum var. ofukensis n. var. ×2.5. p. 77.

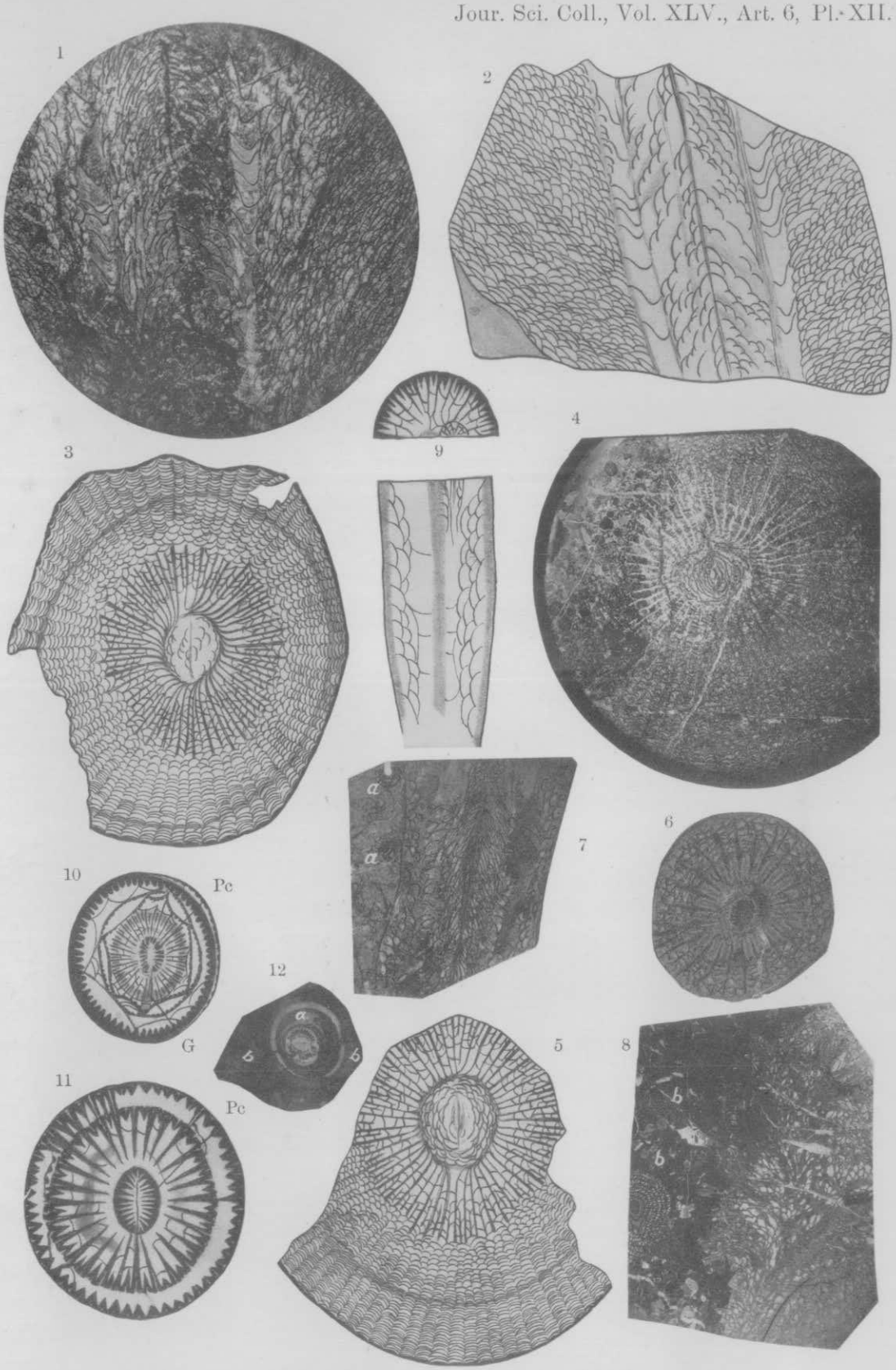
Fig. 7a. Fusulinella biconica (Hayasaka). p. 18.

Figs. 8. Lonsdaleia (Waagenophyllum) frechi Volz. ×2.5. p. 72

Fig. 8b. Neoschwagerina douvillei Ozawa.

Fig. 9,10,11,12a. Lonsdaleia gerthi n. sp. 9,10 ×2. 11 ×3. 12. Natural size. p. 73.

Fig. 12b. Chaetetes sp. p. 81.



Y. Ozawa: Paleontological Studies on the Limestone of Nagato.

PLATE XIII.

Plate XIII.

Fig. 1. Lonsdaleia floriformis crassiconus M'Coy. ×2.5. p. 69.

Figs. 2,3,4,11. Lonsdaleia katoi n. sp. p. 70.

2. Longitudinal section of lower portion. ×4.5.

3. Middle portion. ×4.5.

4. Upper portion showing gemmation. ×4.5.

11. Longitudinal section showing gemmation. Natural size.

Fig 2b. Endothyra sp. p. 8.

Fig 2c. Fusulinella itoi n. sp. p. 19.

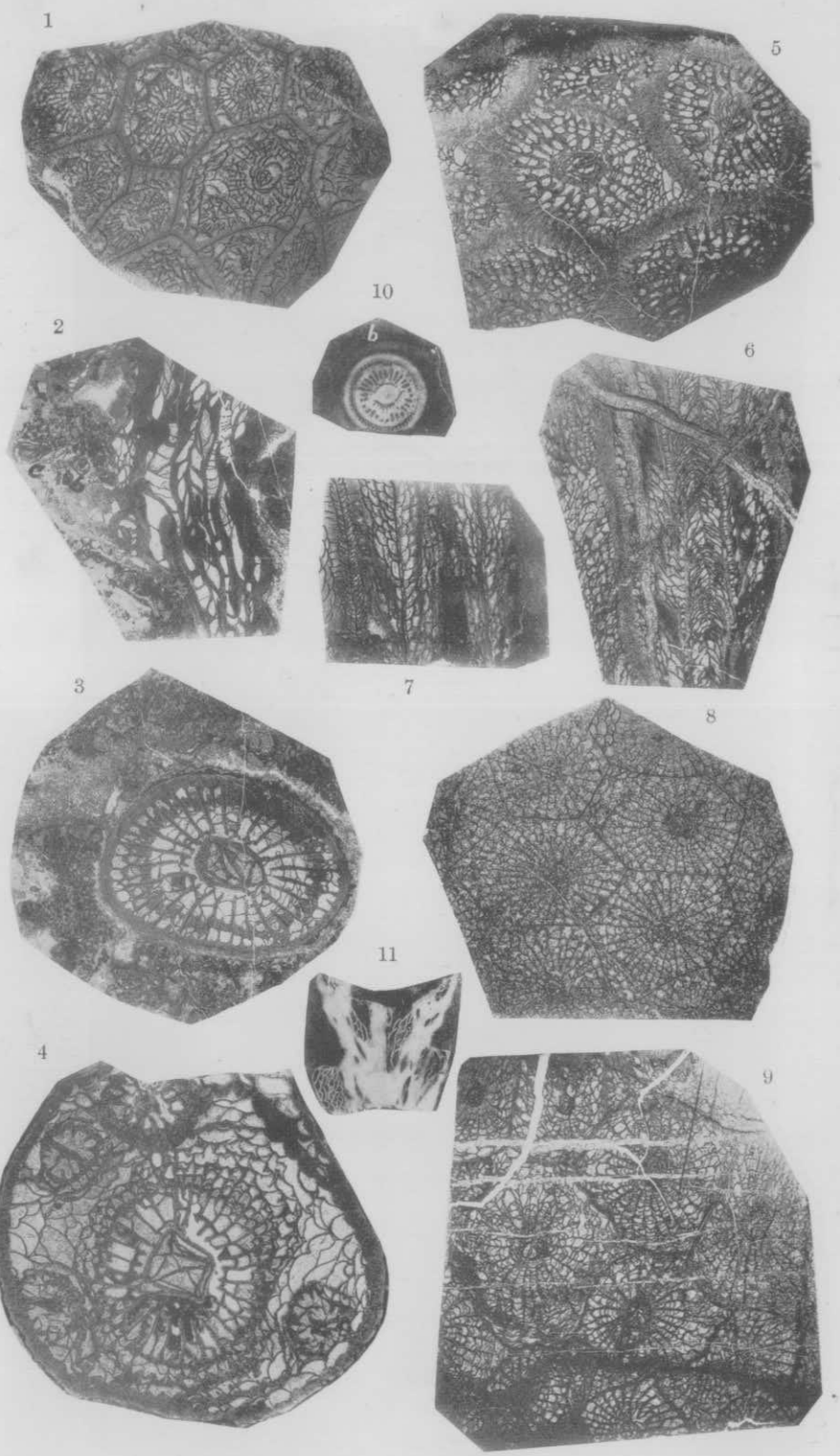
Figs. 5,6. Lonsdaleia (Waagenophyllum) yokoyamai n. sp. ×2.5. p. 72.

Figs. 7,8,9. Lonsdaleia (Waagenophyllum) timorica Gerth ×2.5. p. 74.

7. reversed.

Fig. 10. Lonsdaleia gerthi n. sp. Natural size. p. 73.

Fig. 10b. Chaetetes sp. p. 81.



Y. Ozawa : Paleontological Studies on the Limestone of Nagato.

PLATE XIV.

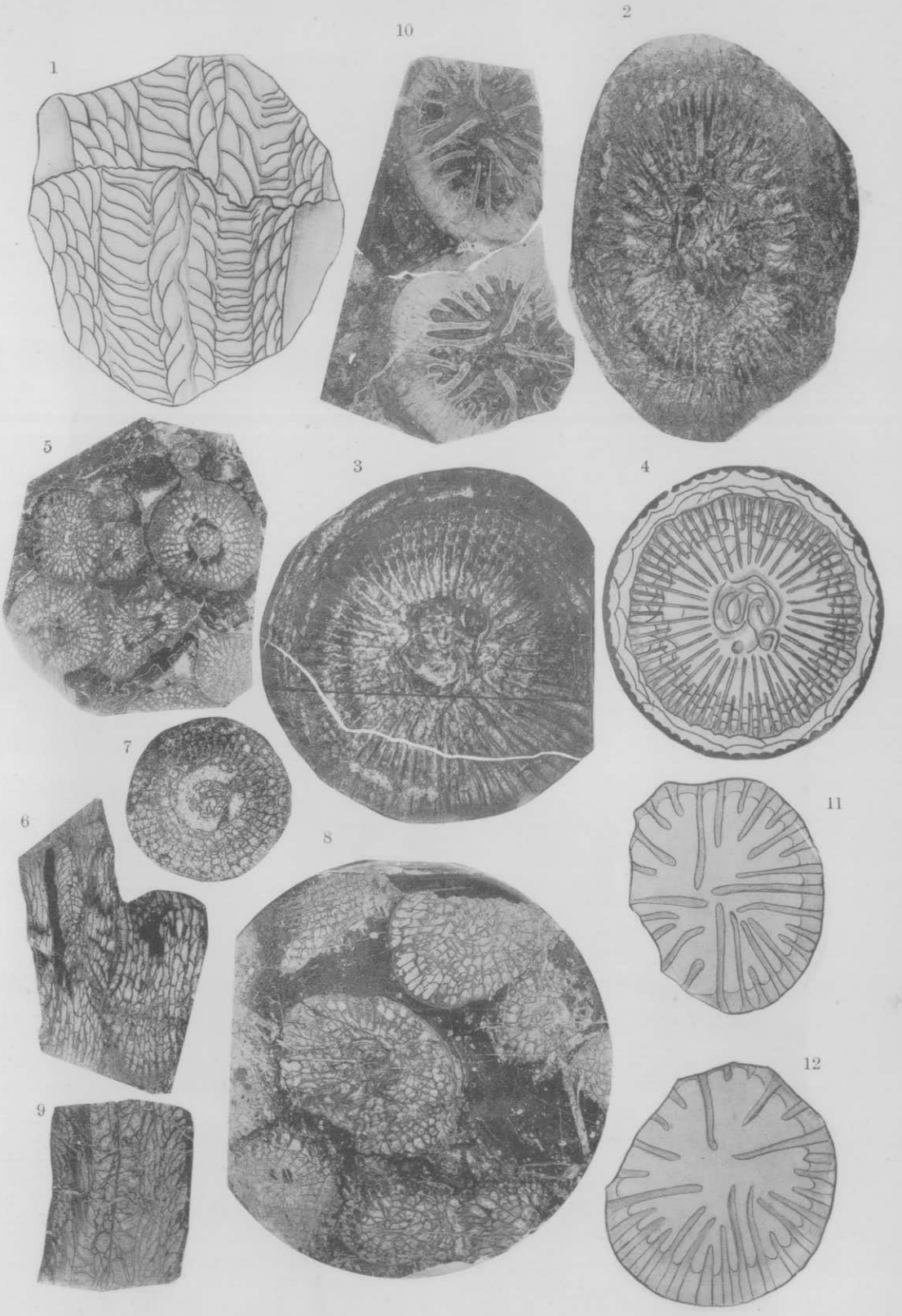
Plate XIV.

Figs. 1,2,3,4. Lonsdaleia enormis n. sp. 2,3 ×2.5. 4,5 ×2.

Figs. 5,6. Lonsdaleia (Waagenophyllum) akasakensis Yabe. ×2.5. p.75.

Figs. 7,8,9. Lonsdaleia (Waagenophyllum) indica var. akagoensis n. var. ×2.5. p. 76.

Figs. 10,11,12. Polycoelia japonica n. sp. 10 ×2.5. 11, 12 ×4. p. 80.



Y. Ozawa: Paleontological Studies on the Limestone of Nagato.

ERRATA FOR VOL. XLV., ART. 6.

Page 4, lines 12, 13. Read '*Neoschwagerina margaritae*' instead of '*Neoschwagerina margaritae* var. *nipponensis*.'

Page 4, line 32. Read '*akagoensis*' instead of '*akagoense*.'

„ „ 34. Read '*ofukuensis*' instead of '*ofukense*.'

Page 31, line 5 from bottom. Read '*kaerimizensis*' instead of '*Kaerimizensis*.'

„ 74, „ 9. Read 'lamellae' instead of 'tabellae.'

„ 77, „ 15. Read 'shows' instead of 'sohws.'

24. Read '*ofukuensis*' instead of '*ofukuense*.'

„ 78, „ 11. Read '*Dibunophyllum*' instead of '*Dibunophpllum*.'

„ 82, „ 7. Read 'distinguished' instead of 'distingulished.'

Explanation of Pl. X., fig. 3b. Read '×12' instead of '×15.'

„ „ „ figs. 6, 7. Read '6. ×12. 7. ×15.' instead of '×15.'

„ „ Pl. XIII., fig. 11. Read 'rejuvenation' instead of 'gemmation.'