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Contributions to the Geology and Paleontology of Cambodia. Part 1. Permian Fusulinids*

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(With 5 Textfigures and 8 Plates)

1. Introduction

This paper is based on the collection and data gathered during the scientific expedition from Osaka City University and University of Kyoto to Cambodia on Oct., 1962 ~ Feb., 1963. The geological observation and fossil-collection were made by the leader of the expedition, K. ISHII and a member, Y. NOGAMI.

During the scientific trip, our members had the opportunity to visit classical Permian fossil-localities and ISHII & NOGAMI reexamined GUBLER's geological and paleontological works of Cambodia (1935a, b).

We collected many fossils of fusulinids, corals and brachiopods from many limestone-hills distributed on the plain of northwestern Cambodia, that is to say, Phnom Kang Var, Phn. Dong Preas, Phn. Lang K. Tom, Phn. Svai, Phn. Bak and Phn. Ancheang near Sisophon, Phn. Banteai Neang beside the railway in the south part of Mongkol Borey, Phn. Thom and Phn. Tauch on the route between Battambang and Sisophon, Phn. Sampou, Phn. Krapou, Phn. Takream and Phn. Doumeay between Battambang and Pailin, Phn. Sâ of the north part of Kampot.

Although we examined also the biostratigraphy of these places (hills), these works will be reported by us in the other papers. In this paper we intend to restudy the fusulinids described by GUBLER and discuss the genus *Lepidolina* and its type-species, *Neoschwagerina multiseptata* DEPRAT, 1912.

In this opportunity we wish to express our hearty thanks to the Government of Cambodia who gave us the permission of the survey and collections and to the

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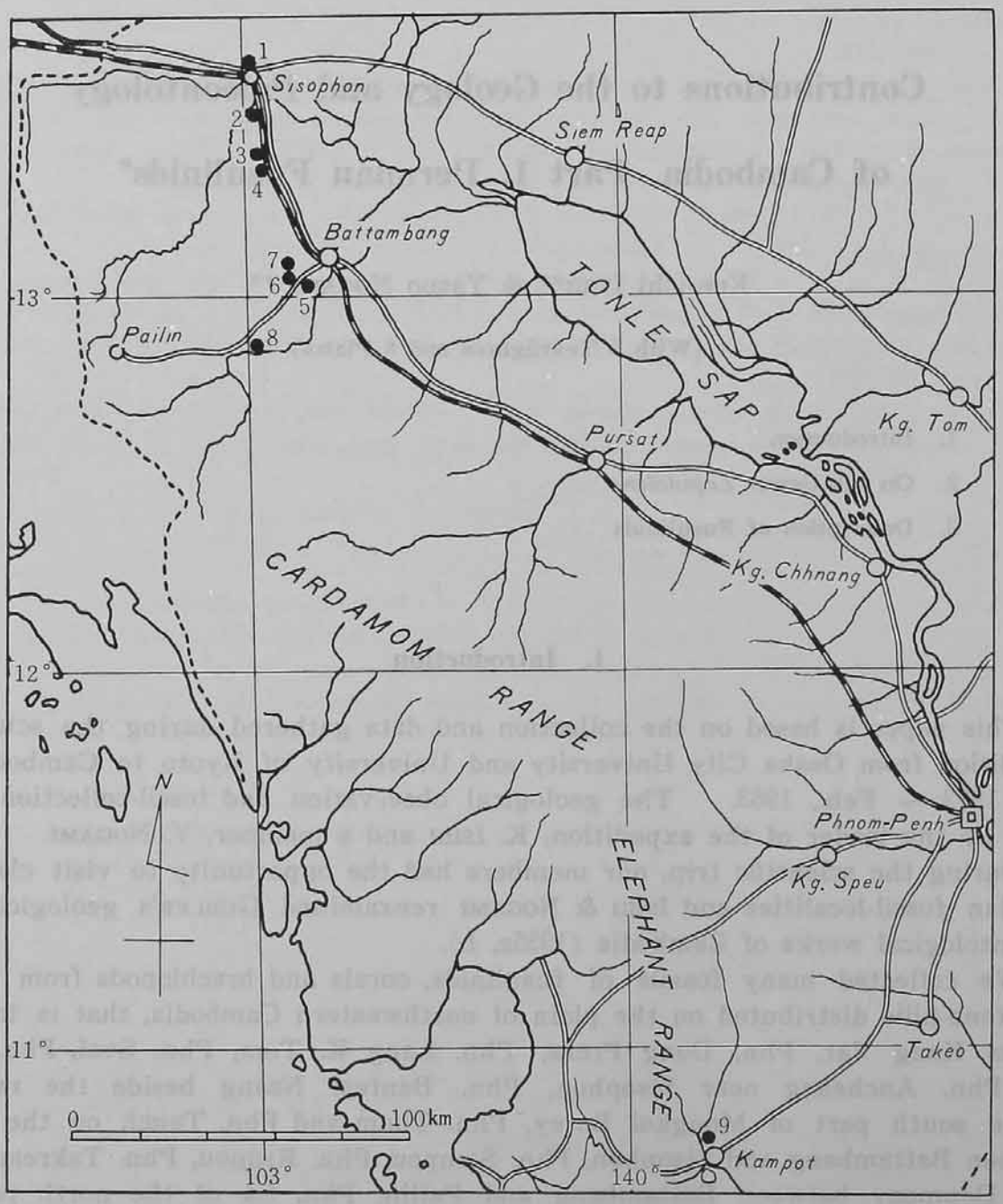
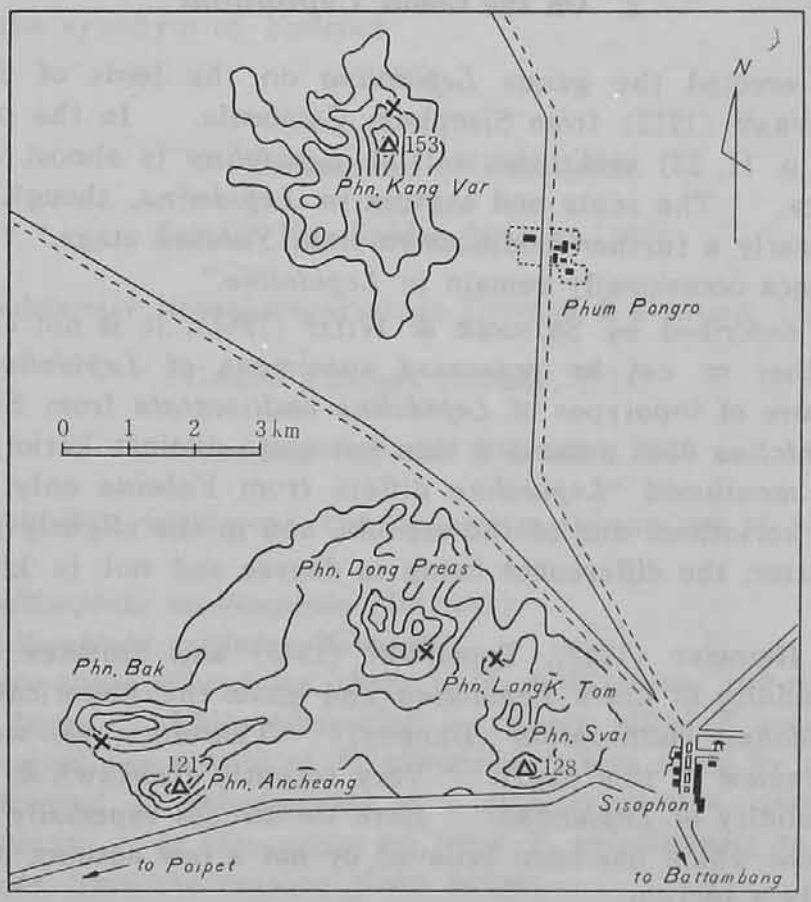


Textfigure 1. Index map of limestone-hills from which Permian fossils were collected by us. 1 : Sisophon, 2 : Phnom. Banteai Neang, 3 : Phn. Thom, 4 : Phn. Tauch, 5 : Phn. Sampou, 6 : Phn. Krapou, 7 : Phn. Takream, 8 : Phn. Doumeay, 9 : Phn. Sâ.

Ministry of National Education that favoured us with kind assistance during our survey. Furthermore, we must mention our heartfelt gratitude to Mr. Chea Boun Eng, the officer of the Ministry of National Education for guiding and translating through all period of our trip. We wish to add that he was not only an able guide but was a good collaborator of our scientific trip.

We appreciate the help Prof. N. Ikebe, Prof. K. Fujita, Prof. T. Kira (Osaka City Univ.), Prof. S. Matsushita, Prof. T. Shidei and Prof. K. Nakazawa (Univ. Kyoto) have given to our scientific expedition. We are much indebted to Assist.



Textfigure 2. Index map of limestone-hills in the Sisophon area (Loc. 1 of textfiig. 1). Height in m. × : localities from which fusulinids were collected.

Prof. K. KANMERA (Kyushu Univ.) for the kind advices and the opportunity of reexamining the specimens of *Lepidolina toriyamai*. We wish to express our gratitude also to Prof. K. ICHIKAWA (Osaka City Univ.) who gave kind advices and read the manuscript.

In this paper, the following species and subspecies are described:

Yabeina multiseptata multiseptata (DEPRAT), 1912
Yabeina multiseptata gigantea (GUBLER), 1935
Yabeina elongata (GUBLER), 1935
Yabeina minuta THOMPSON & WHEELER, 1942
Verbeekina verbeeki (GEINITZ), 1876
Pseudofusulina sp. cfr. *Pseudofusulina crassa padangensis* (LANGE), 1925
Chusenella cambodgiensis (GUBLER), 1935
Chusenella? sp.

These species indicate the upper part of the Middle Permian or Upper Permian. Details of the biostratigraphic distribution of these species will be discussed in another paper. Among these species *Yabeina multiseptata* occurs most abundantly. Because its study involves the general discussion about the validity of the genus *Lepidolina*, it will be treated separately in the following chapter, while other species will be treated in the third chapter.

2. On the Genus *Lepidolina*

LEE (1933) erected the genus *Lepidolina* on the basis of *Neoschwagerina multiseptata* DEPRAT (1912) from Sisophon, Cambodia. In the original description, LEE (1933, p. 11, 23) said, "the wall of *Lepidolina* is almost entirely devoid of the keriotheca. The septa and septula in *Lepidolina*, though perfectly consolidated, are clearly a further modification from *Yabeina* stage." "Vestiges of the alveolar keriotheca occasionally remain in *Lepidolina*."

As already described by SKINNER & WILD (1954), it is not clear from LEE's discussion whether or not he possessed specimens of *Lepidolina multiseptata*. The wall structure of topotypes of *Lepidolina multiseptata* from Sisophon clearly shows that *Lepidolina* does possess a thin but quite distinct keriotheca. Therefore, they have mentioned "*Lepidolina* differs from *Yabeina* only in the extreme thinness of the keriotheca and of the septula, and in the slightly greater consolidation of the latter, the differences being in degree and not in kind." (S. & W., 1954, p. 450)

DUNBAR & HENBEST (1942), THOMPSON (1948) and SKINNER & WILD (1954) discussed the validity of LEE's *Lepidolina* and gave the historical review of the studies of *Lepidolina multiseptata* (DEPRAT). Therefore, we would not repeat the historical review in this paper. Very recently HANZAWA & MURATA (1963) discussed the validity of *Lepidolina*. Here we discuss especially the wall structure of *Lepidolina* which has been believed by not a few authors to have the wall composed of only a tectum.

According to our observation on the Cambodian specimens collected by us, the spirotheca of "*Lepidolina*" *multiseptata* is composed of a tectum and a keriotheca with fine alveoli as in the case of *Yabeina globosa* (=*Y. inouei*), the type-species of *Yabeina*. However, spirotheca, septa, axial septula and transverse septula of *Y. globosa* are thicker and stronger than those of "*L*". *multiseptata* (see Pl. I–IV). In *Y. globosa*, thickness of spirotheca, septa and transverse septula have a tendency becoming thick beyond the middle stages of individual. In "*L*". *multiseptata*, on the other hand, the increase of the thickness of the spirotheca and septulal structure is not very distinct, and they are generally thin in all stages of ontogeny. After HANZAWA & MURATA (1963, p. 4), "In the *Yabeina globosa* group, the secondary transverse septula are wide and about of the same width being one half of the primary transverse septula or a little more and sometimes irregular in width in the same whorls. In the *Yabeina multiseptata* group, the secondary transverse septula have a tendency that they are almost uniform in width in the same whorl and they do not exceed one half of the width of the primary transverse septula. But the secondary transverse septula of the second group are not exactly uniform in width, therefore it is practically difficult to distinguish the two groups from each other by the septal feature mentioned above."

In some specimens of "*L.*" *multiseptata* and even in some specimens of *Y. globosa*, spirotheca becomes very thin and looks as if it is composed of only a tectum, but this feature can be observed only on spirotheca of outer one or two volutions of adult specimens.

In short, there is no sufficient diagnostic feature, which enables one to separate *Lepidolina* generically from *Yabeina*, except for a minor difference in the degree

of development of the spirotheca and septulal structure. *Lepidolina* may be suppressed as the synonym of *Yabeina*.

3. Description of Fusulinids

Family **Fusulinidae** MÖLLER, 1878

Subfamily Neoschwagerininae DUNBAR & CONDRA, 1928

Genus *Yabeina* DEPRAT, 1914

Yabeina multiseptata (DEPRAT), 1912

In the Cambodian specimens the following subspecies of this species are discriminated:

Yabeina multiseptata multiseptata (DEPRAT)

Yabeina multiseptata gigantea (GUBLER).

In addition to these subspecies, there is *Y. multiseptata shiraiwensis* occuring abundantly in Japan. This subspecies is closely allied *Y. multiseptata multiseptata*. A detailed description of *Y. shiraiwensis* was made by us in 1962. At that time we treated *Y. shiraiwensis* as a distinct species, closely allied to *Y. multiseptata*, GUBLER. In this paper we treat *Y. shiraiwensis* as the subspecies of *Y. multiseptata*, from the reasons given below.

Description: —— Shell large, inflated fusiform or slightly elongated fusiform. First 2 or 3 volutions subsperical, and beyond 5th volution shell assumes its mature shape. Mature specimens of 15th volution are 5.8 to 13.6 mm long and 3.7 to 6.1 mm wide, giving form ratio 1.3 to 2.6.

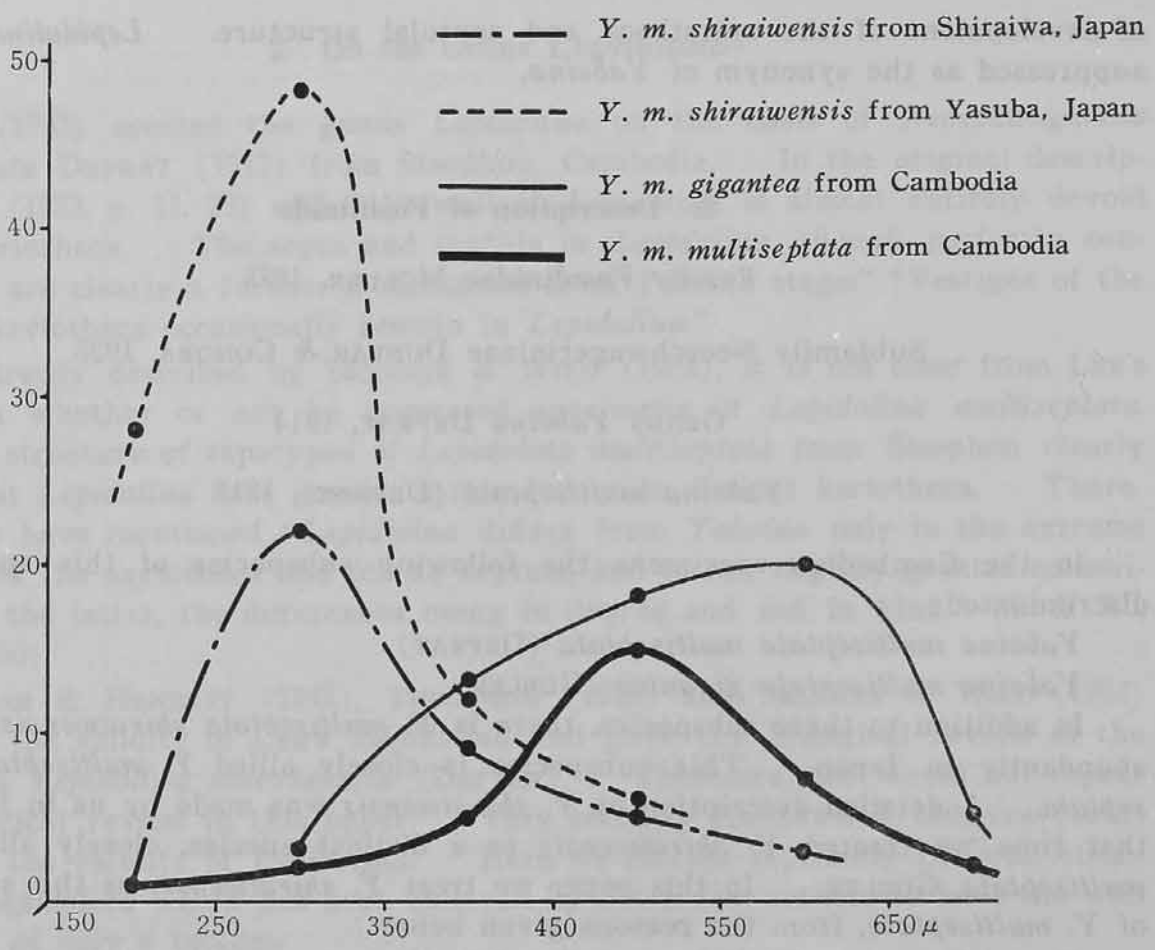
Proloculs large; its outside diameter 170 to 745 microns. Height of voution increasing rather rapidly.

Spirotheca relatively thin, composed of a tectum and a very thin keriotheca with very fine alveoli. Thickness of spirotheca 5 to 10 microns in all stage of individual.

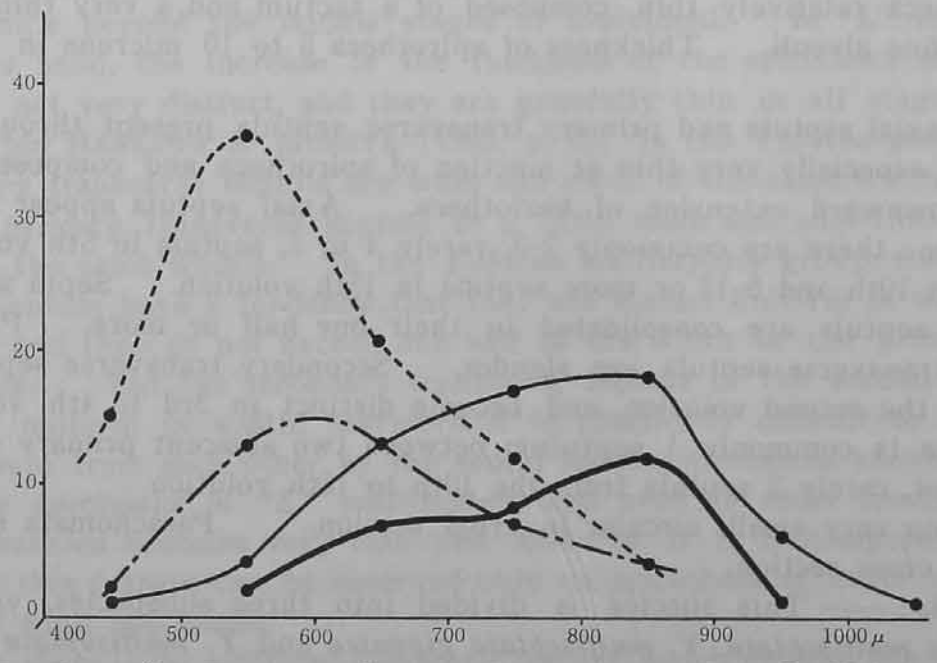
Septa, axial septula and primary transverse septula present throughout shell. Septa thin, especially very thin at junction of spirotheca and composed of a tectum and downward extension of keriotheca. Axial septula appear from 1st or 2nd volution; there are commonly 2-3, rarely 4 or 5, septula in 5th volution, 6 or 7 septula in 10th and 8-12 or more septula in 15th volution. Septa and primary transverse septula are consolidated in their one half or more. Primary and secondary transverse septula are slender. Secondary transverse septula appear often from the second volution and become distinct in 3rd to 4th volution outward; there is commonly 1 septulum between two adjacent primary ones; there are, however, rarely 2 septula from the 10th to 15th volution.

Foramina very small, circular in cross section. Parachomata small, semicircular in cross section.

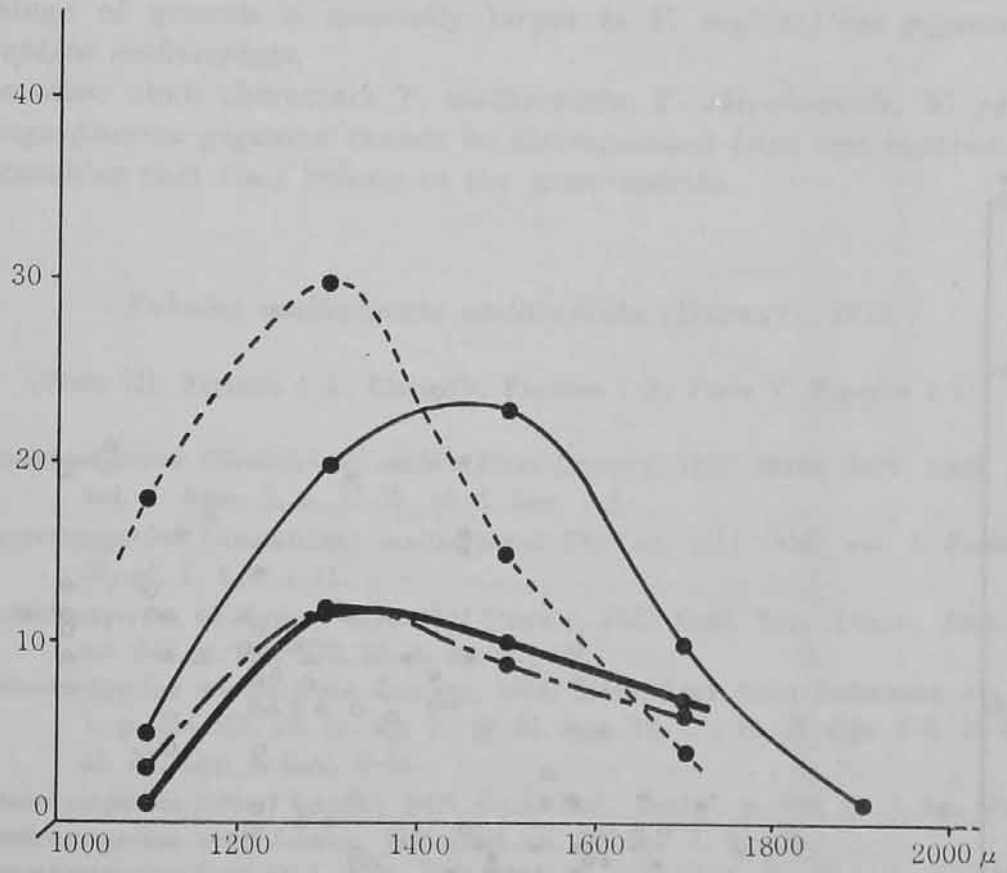
Remarks: —— This species is divided into three subspecies, viz. *Yabeina multiseptata multiseptata*, *Y. multiseptata gigantea* and *Y. multiseptata shiraiwensis* by the differences in growth shown on the textfigures 3-4. The differences



Textfigure 3a. Frequency Curve of Proloculus-size (abscissa). Ordinate in Figs. 3a, b, c shows individual number.



Textfigure 3b. Frequency Curve of Radius Vector of the 5th Volution



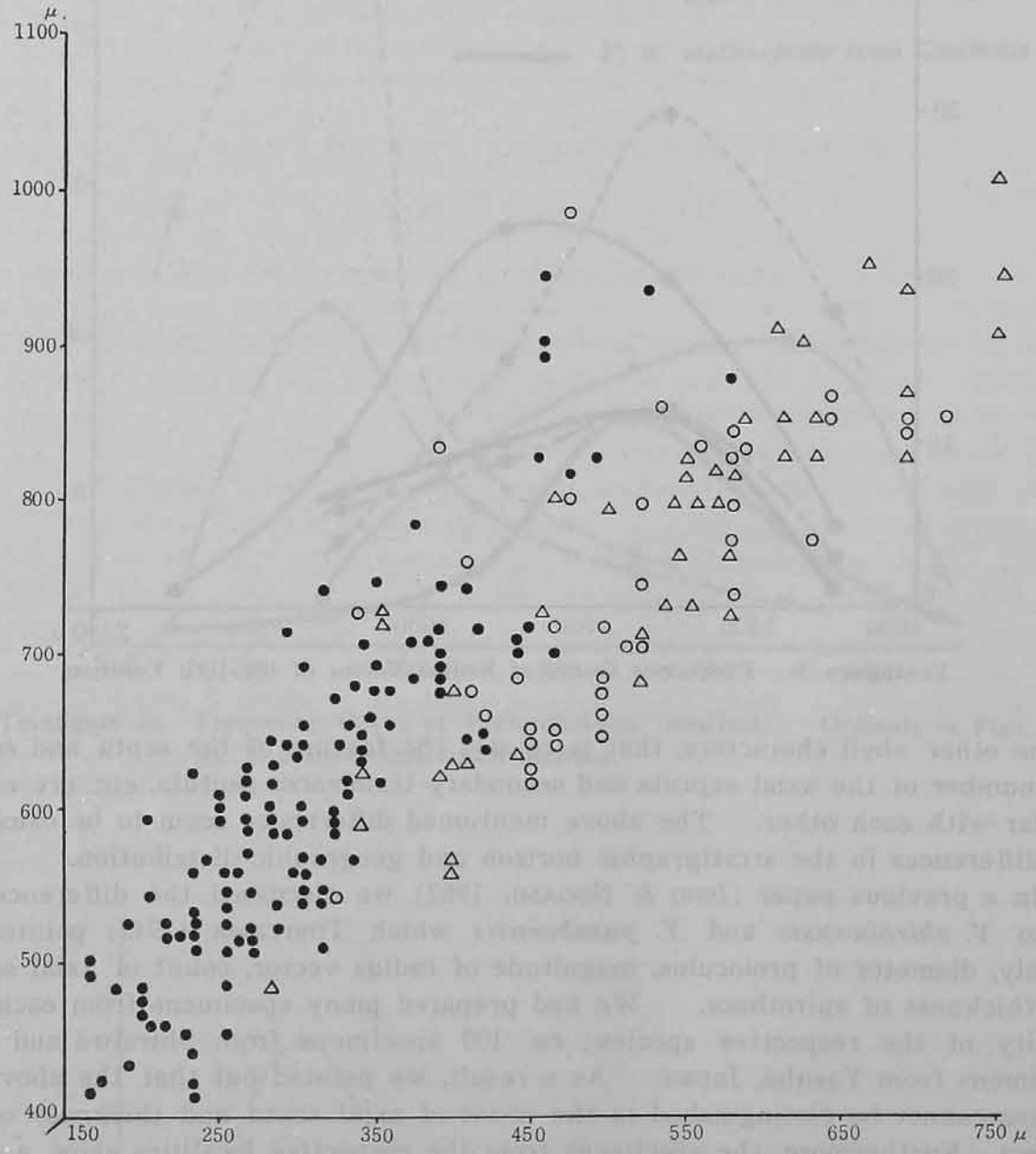
Textfigure 3c. Frequency Curve of Radius Vector of the 10th Volution

of the other shell characters, that is to say, the feature of the septa and septula and number of the axial septula and secondary transverse septula, etc. are entirey similar with each other. The above mentioned differences seem to be caused by the differences in the stratigraphic horizon and geographic distribution.

In a previous paper (ISHII & NOGAMI, 1962) we discussed the differences between *Y. shiraiwensis* and *Y. yasubaensis* which TORIYAMA (1942) pointed out, namely, diameter of proloculus, magnitude of radius vector, count of axial septula and thickness of spirotheca. We had prepared many specimens from each type locality of the respective species; ca. 100 specimens from Shiraiwa and ca. 50 specimens from Yasuba, Japan. As a result, we pointed out that the above two species cannot be distinguished in the count of axial septa and thickness of spirotheca. Furthermore, the specimens from the respective localities show a single unimodal curve of proloculus-size and radius vector. The curves from the two localities have the same maximum point. So, we confirmed that *Yabeina yasubaensis* is synonymous with *Y. shiraiwensis*.

We dropped measured values of size of proloculus, radius vector of the 5th and 10th volution of specimens from Cambodia on the graphs for *Y. shiraiwensis* presented in our paper 1962.

Consequently, the two curves of Cambodian specimens overlap those of *Y. multiseptata shiraiwensis*. On the other hand, the value of proloculus and radius vector of the type specimen of *Y. yasubaensis* which dropped on the right fringe of the unimodal curve of *Y. shiraiwensis*, lie in the overlapped part of the curves for Cambodian specimens (*Y. multiseptata multiseptata* and *Y. multiseptata gigan-*



Textfigure 4. Correlation between Proloculus-size (abscissa) and Radius Vector of the 5th Volution (ordinate). ○: *Yabeina multiseptata multiseptata*, △: *Y. m. gigantea*, ●: *Y. m. shiraiwensis*.

tea) and for *Y. multiseptata shiraiwensis*.

In *Y. multiseptata multiseptata* and *Y. multiseptata gigantea* the frequency curves of proloculus show the allied single unimodal curve. The frequency curves of radius vector show likewise the same character. The two subspecies have the similar tendency of the growth as shown by the frequency distribution of form ratio of the 5th, 10th, 12th and 15th volution (see textfigures 5a, b, c, d). However, it is evidently understood from the same figures that the form ratio

in each stage of growth is generally larger in *Y. multiseptata gigantea* than in *Y. multiseptata multiseptata.*

In the other shell characters *Y. multiseptata, Y. shiraiwensis, Y. yasubaensis* and *Y. megaspherica gigantea* cannot be distinguished from one another. Therefore, we consider that they belong to the same species.

Yabeina multiseptata multiseptata (DEPRAT), 1912

(Plate III, Figures 1-3; Plate IV, Figures 1-3; Plate V, Figures 1-4)

Neoschwagerina (Sumatrina) multiseptata DEPPAT, 1912, Mém. Serv. Géol. Indochine, vol. 1, Fasc. 3, p. 53-55, pl. 3. figs. 2-8.

Neoschwagerina (Sumatrina) multiseptata, DEPRAT, 1914, ibid., vol. 3, Fasc. 1, p. 34-35, pl. 5, figs. 7-11.

Neoschwagerina (Yabeina) hayasakai OZAWA, 1922, Geol. Soc. Tokyo, Jour., vol. 29, no. 348, p. 369, 370, pl. 4, fig. 2.

Neoschwagerina multiseptata, COLANI, 1924, Mém. Serv. Géol. Indochine, vol. 11, Fasc. 1, p. 154-155, pl. 15, fig. 1; pl. 24, figs. 12, 13; pl. 25, figs. 1-8, 10-12, 14, 15; pl. 26, figs. 1, 2, 4, 6-18.

Neoschwagerina tobleri LANGE, 1925, Geol. Ser., Deel 7, p. 209, pl. 4, fig. 69a, b, c, d.

Neoschwagerina staffi LANGE, 1925, ibid., p. 266, pl. 3, fig. 70.

Neoschwagerina buxtorfi LANGE, 1925, ibid., p. 211, pl. 4, fig. 74.

Neoschwagerina sumatrensis LANGE, 1925, ibid., p. 213, pl. 4, fig. 72a, b.

Neoschwagerina multiseptata, GUBLER, 1935, Mém. Soc. Géol. France, Nov. Sér. T. 11, Fasc. 4, p. 119-123, pl. 3, fig. 5; pl. 6, figs. 1, 3, 8-10; pl. 7, fig. 5.

Neoschwagerina megasphaerica, GUBLER, 1935, ibid., p. 114-116, pl. 7, fig. 3; pl. 6, fig. 4.

Lepidolina multiseptata, THOMPSON, 1948, Protozoa, Art. 1, Univ. Kansas, p. 66, 67, pl. 20, figs. 5, 6; pl. 22, figs. 1-5.

Lepidolina multiseptata, SKINNER & WILD, 1954, Jour. Paleon., p. 449-450, pl. 52, figs. 1-5.

Yabeina khmeriana SAURIN, 1958, Ann. Fac. Sci. Saigon, p. 226, 227, pl. 1, figs. 6-11.

Yabeina johannis SAURIN, 1958, ibid., p. 228, 229, pl. 2, figs. 1-8.

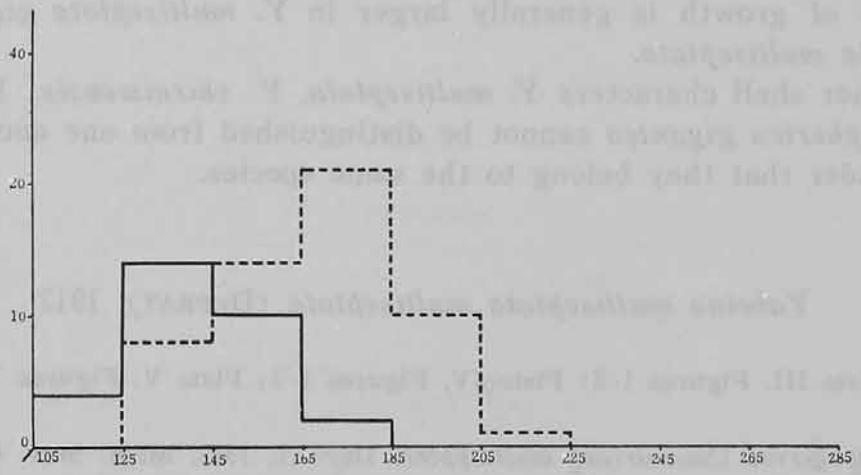
Lepidolina multiseptata, SAURIN, 1958, ibid., p. 229, 230, pl. 1, fig. 13; pl. 2, figs. 9, 10.

non *Yabeina* cfr. *multiseptata*, MORIKAWA, 1961, Sci. Rep. Saitama Univ., ser. B, vol. B, no. 1, p. 66, pl. 9, fig. 4; pl. 14, fig. 10.

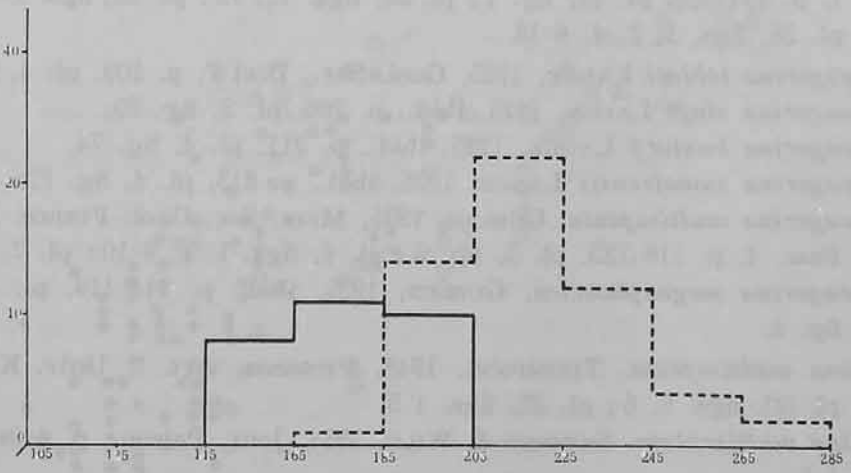
Description: —— Shell large, inflated fusiform. Inner 2 or 3 volutions subspherical, and beyond 5th volution shell form resembles its mature shape. Size of matured specimens cannot be measured, because a few outer volutions are missing. Shell at 15th volution are 6.7 to 9.6mm long and 4.2 to 5.5mm wide; form ratio 1.5 to 2.0.

Proloculus large; its outside diameter 245 to 710 microns, mainly 350 to 705 microns. Height of volution increasing rather rapidly.

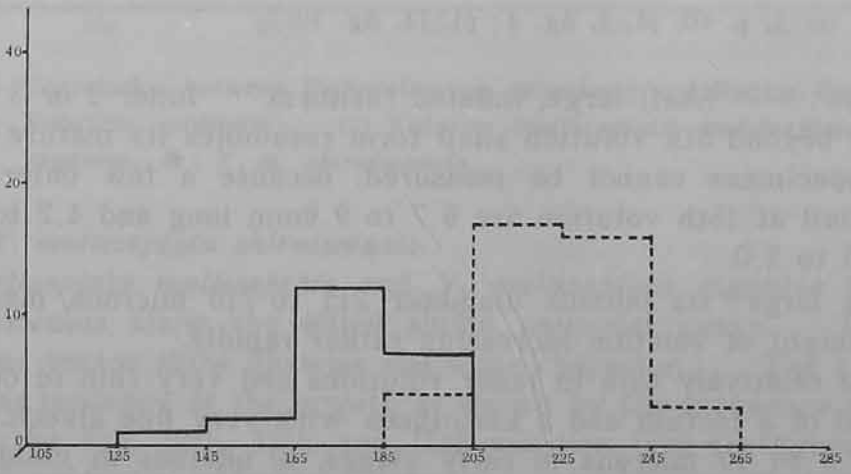
Spirotheca relatively thin in inner volutions and very thin in outer volutions. It is composed of a tectum and a keriotheca with very fine alveoli. Thickness of spirotheca 5 to 10 microns in early stages, 10 microns in middle stages, 5 to 10 microns in later stages.



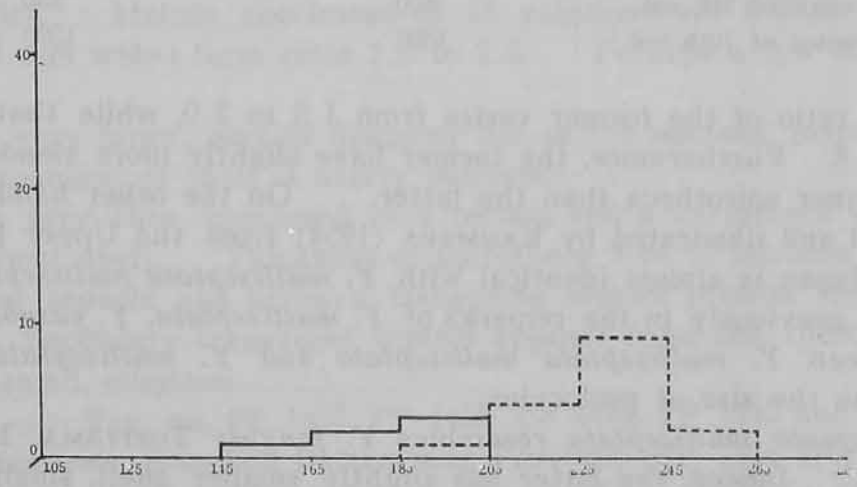
Textfigure 5a. Frequency distribution of Form Ratio of the 5th Volution (in micron: abscissa). Ordinate in Figs. 5a-d shows individual number. Solid line: *Yabeina multiseptata multiseptata*, dotted line: *Y. m. gigantea*.



Textfigure 5b. Frequency distribution of Form Ratio of the 10th Volution



Textfigure 5c. Frequency distribution of Form Ratio of the 12th Volution



Textfigure 5d. Frequency distribution of Form Ratio of the 15th Volution

Septa, axial septula and primary transverse septula present throughout shell and slender. Secondary and primary transverse septula appear first in 1st to 2nd volution. Number of axial septula 2 to 12. Consolidation of septa and septula is only half.

Foramina small, circular in cross section.

Material: —— Reg. no. PF 1419 and PF 1420 from Phnom Bak limestone, Sisophon, Battambang Province; PF 1414, PF 1416, PF 1425, PF 1437 and PF 1442 from Phn. Sampou limestone, Battambang Province; PF 1429 and PF 1430 from Phn. Takream limestone, Battambang Province, Cambodia. All specimens are deposited in Department of Geosciences, Osaka City Univ.

Remarks: —— The specimens in our collection resemble DEPRAT's and GUBLER's specimens of *Neoschwagerina multiseptata* from Cambodia in many important characters, so that a specific identify is undoubted.

Neoschwagerina megaspherica reported by DEPRAT (1913) from Lang-Nac in Indochina seems to have highly evolved spirotheca and septula for a species of *Neoschwagerina*. However, our Cambodian specimens and GUBLER's and COLANI's specimens of *Y. multiseptata* (including GUBLER's *N. megaspherica*) have more evolved spirothecal structure and better developed secondary transverse and axial septula than *N. megaspherica* DEPRAT. As pointed out by KANMERA (1954, p. 21), we also consider that GUBLER's and COLANI's specimens of *N. megaspherica* may not be identical with *N. megaspherica* DEPRAT. Though GUBLER's *N. megaspherica* is feebly distinguished from the same author's *N. multiseptata* in the size of proloculus, the proloculus size of the former lies in the frequency curve of those of Cambodian specimens of *Y. multiseptata multiseptata* collected by us.

Y. multiseptata multiseptata is much allied to *Y. multiseptata shiraiwensis* from the Middle Permian formation in Akiyoshi, Japan, but the former differs slightly from the latter in some respects. As shown in textfigures 3, 4, the frequency curves of the two indicate the following maximum value:

	Y. m. multiseptata	*Y. m. shiraiwensis*
diameter of proloculus	500	300
radius vector of 5th vol.	850	550
radius vector of 10th vol.	1300	1300

The form ratio of the former varies from 1.5 to 2.0, while that of the latter from 1.3 to 1.8. Furthermore, the former have slightly more slender septula and somewhat thinner spirotheca than the latter. On the other hand, *Y. shiraiwensis* described and illustrated by Kanmera (1954) from the Upper Permian Kuma formation in Japan is almost identical with *Y. multiseptata multiseptata.*

As stated previously in the remarks of *Y. multiseptata, Y. yasubaensis* is intermediate between *Y. multiseptata multiseptata* and *Y. multiseptata shiraiwensis* with respect to the size of proloculus.

Y. multiseptata multiseptata resembles *Y. pinguis* Toriyama, 1958 from Akiyoshi district. Indeed, the latter has slightly smaller shell, smaller proloculus, thicker spirotheca and more primitive septula than the former. However, we think it is better not to separate them specifically, because *Y. pinguis* is associated with *Y. multiseptata shiraiwensis* in Akiyoshi and the both species lie in same frequency curve of the shell character.

Unfortunately, *Y. hayasakai, Y. tobleri, Y. buxtorfi, Y. staffi and Y. sumatrensis* are not described sufficiently in original papers. However, these species may be synonymous with *Y. multiseptata multiseptata* judging from the original illustrations.

Occurrence: —— This species occurs abundantly in Phnom Kang Var, Phn. Dong Preas, Phn. Lang K. Tom, Phn. Svai and Phn. Bak from Sisophon, Battambang Province; Phn. Banteai Neang beside the railway of the south part of Mongkol Borey, Battambang Province; Phn. Sampou, Phn. Takream and Phn. Doumeay between Battambang and Pailin; Battambang Province, Cambodia. Upper part of Middle Permian to Upper Permian.

Yabeina multiseptata gigantea (Gubler), 1935

(Plate VI, Figures 1-4)

Neoschwagerina megaspherica var. *gigantea* Gubler, 1935, Mém. Soc. Géol. France, Nov. Sér., T. 11, Fasc. 4, p. 116-118, pl. 3, figs. 6, 8, 10?

Neoschwagerina douvillei, Gubler, 1935, ibid., p. 111-113, pl. 7, figs. 7, 8; pl. 8, fig. 6; pl. 6, fig. 2?; pl. 7, fig. 10?; pl. 8, fig. 10?

Yabeina gubleri Kanmera, 1954, Mem. Fac. Sci. Kyushu Univ., Ser. D, vol. 4, no. 1, p. 19-21, pl. 4, figs. 1-13.

Yabeina gubleri, Nogami, 1958, Mem. Coll. Sci. Univ. Kyoto, Ser. B, vol. 25, no. 2, p. 103, 104, pl. 1, figs. 5, 6.

Lepidolina kumaensis, Nogami, 1958, ibid. p. 104, 105, pl. 2, figs. 8, 9.

Yabeina gubleri, Chisaka, 1960, Jour. Coll. Art, Sci. Chiba Univ., vol. 3, no. 2, p. 250, 251, pl. 6, figs. 1-4; pl. 7, figs. 1-6; pl. 8, figs. 1-5.

Lepidolina kumaensis Kanmera, 1954, Mem. Fac. Sci. Kyushu Univ., Ser. D. vol. 4, no. 1. p. 22-24, pl. 5, figs. 1-13.

Description: —— Shell large, inflated fusiform, inner 3 volutions subspherical, following 3 volutions highly inflated fusiform, and beyond 7th or 8th volution shell elongated fusiform with inflated central part, concave lateral slope and bluntly pointed poles. Mature specimens of 15 volutions are 8.6 to 13.6 mm long and 3.8 to 5.6 mm wide; form ratio 2.0 to 2.6. Perhaps a few outer volutions are missing.

Proloculus very large; outside diameter 345 to 745 microns, mainly 450 to 650 microns. Expansion of shell is nearly uniform.

Spirotheca very thin, composed of a tectum and a keriotheca with very fine alveoli throughout shell. Thickness of spirotheca 5 to 10 microns in all stages.

Septa, axial septula and primary transverse septula present throughout shell and slender. Secondary transverse septula appears from 2nd volution.

Foramina small, elliptical.

Material: —— Reg. no. PF 1412, PF 1415, PF 1423, PF 1440 and PF 1441 from Phnom Bak limestone, Sisophon Battambang Province; PF 1424 from Phn. Bantei Neang, of the south part of Mongkol Borey, Battambang Province, Cambodia. All specimens are deposited in Department of Geosciences, Osaka City Univ.

Remarks: —— The present form was first described by GUBLER (1935) as *Neoschwagerina megaspherica* var. *gigantea*.

The radius vector of *N. douvillei* by GUBLER falls within the frequency curve of *Y. multiseptata gigantea*. The form ratio of the former is also within the variation of the latter. Also in other shell characters the former cannot be distinguished from the latter. Therefore, *N. douvillei* by GUBLER should be considered as *Y. multiseptata gigantea* rather than *N. douillei* OZAWA which latter has more primitive shell characters.

The present specimens are closely allied to *Y. multiseptata multiseptata*. Indeed, there is no difference between the two forms in many shell characters, as far as the inner 7 or 8 volutions are concerned. But beyond the 8th volution the shell of the former becomes elongated fusiform with convex lateral slopes and bluntly pointed polar ends.

The form ratio of *Y. multiseptata gigantea* varies from 1.8 to 2.7, mainly 2.0 to 2.4 at the 10th volution and 2.0 to 2.6, mainly 2.2 to 2.4 at the 15th volution, while those of *Y. multiseptata multiseptata* does not exceed 2.1 even in the most elongated form. Furthermore, the former is slightly more evolved in the structure of septa and septula in the outer volutions. Judging from the above mentioned features *Y. multiseptata gigantea* seems to be a slightly advanced form of *Y. multiseptata*.

The present form very closely resembles *Y. gubleri* KANMERA (1954, pl. 6, figs. 7-11, Pl. 8, fig. 3) from the Kuma formation of Kyushu, Japan. The former is, however, different from the latter in having only smaller proloculus, smaller shell and less inflated central portion. Namely, the former is 6.6 to 9.1 mm long and 2.9 to 4.3 mm wide at the 12th volution, and form ratio is 2.0 to 2.6, mainly 2.2 to 2.4, while the latter is 9.0 to 10 mm long and 3.8 to 4.5 mm wide, and form ratio 2.0 to 2.3. But in the other important characters two forms are closely allied with each other. Therefore *Y. gubleri* should be considered as a synonym of *Y. multiseptata gigantea*.

Occurrence: —— This species occurs in Phnom Kang Var, Phn. Dong Preas,

Phn. Lang K. Tom, Phn. Svai and Phn. Bak from Sisophon, Battambang Province; Phn. Banteai Neang beside the railway of the south part of Mongkol Borey, Battambang Province; Phn. Sampou on the route between Battambang and Pailin, Cambodia. Upper part of Middle Permian to Upper Permian.

Yabeina minuta THOMPSON & WHEELER, 1942

(Plate IV, Figures 4-7)

Yabeina minuta THOMPSON & WHEELER, 1942, Jour. Paleont. vol. 16, p. 707, 708, pl 106, figs. 6-9, 10?

Description: —— Shell small, inflated to slightly elongated fusiform. Inner 2 or 3 volutions subspherical, and beyond 5th volution shell takes its mature shape. Mature specimens have at least 13 to 15 volutions, however, outer few volutions may be missing subsequently. Shells of 15th volution are 5.8 to 7.7mm long and 3.2 to 4.1 mm wide, giving form ratio of 1.5 to 2.0.

Proloculus small: outside diameter 150 to 215 microns. Height of volution increases slowly toward outside.

Spirotheca thin, composed of a tectum and a keriotheca with fine alveoli.

Primary transverse septula present throughout shell. Secondary transverse septula appear first in 7th to 9th volution.

Foramina are numerous and occur throughout shell. About 3-5 axial septula occur in 11th volution. Primitive axial septula first appear in later chambers of 1st volution.

Material: —— Reg. no. PF 1408, PF 1409, PF 1413, PF 1418, PF 1432, PF 1434 and PF 1438 from Phnom Bak limestone, Sisophon, Battambang Province, Cambodia They are deposited in Department of Geosciences, Osaka City Univ.

Remarks: —— The present specimens are well identical with the type specimen from the Marble Canyon limestone, Southern British Columbia. Though a few outer volutions in the present specimens are generally missing, the present form is identical with *Y. minuta* better than with *Y. columbiana* THOMPSON & WHEELER because of its smaller shell size and a smaller number of foramina for corresponding volutions, for instance, there are about 32 to 37 foramina in the 12th volution of the present specimens, while there are 39 to 44 foramina in the 12th volution of *Y. columbiana* THOMSON & WHEELER.

The present specimens resemble closely *Neoschwagerina margaritae* DEPRAT reported by GUBLER from Cambodia in all essential shell characters except in having more inflated shell, larger size of shell and larger number of volution. Specifically speaking, these two forms may be related with each other. Neither the present specimens nor GUBLER's specimens can be identical with *N. margaritae* DEPRAT which has more globular form, smaller proloculus and less developed secondary transverse septula.

Occurrence: —— The species occurs commonly and are collected from the same limestones yielding *Y. multiseptata*. Upper part of Middle Permian to Upper Permian.

Yabeina elongata (GUBLER), 1935

(Plate VII, Figures 1-3)

Neoschwagerina elongata GUBLER, 1935, Mém. Soc. Géol. France, Nov. Sér. T. 11, Fasc. 4, p. 108-111, pl. 8, figs. 1, 2, 5, 12.

Description: —— Shell large, highly elongated fusiform to subcylindrical, with straight to broadly curving axis of coiling, flat to gently concave lateral slopes and narrowly rounded polar ends. Mature specimens contain as many as 20 volutions. Specimens of 15 volutions 12 to 15 mm long and 4.6 to 5.7 mm wide; form ratio 2.5 to 3.1. Inner 2 volutions lenticular, with short axis of coiling and umbilicated polar ends, following 3 volutions inflated fusiform, beyond 6th volution shell increases rapidly in length.

Proloculus minute; outside diameter 25 to 35 microns. Expansion of shell very slow and generally uniform.

Spirotheca very thin, composed of a tectum and a keriotheca with very fine alveoli. Beyond 13th volution spirotheca becomes exceedingly thin and looks as if it were composed of only a thin single layer under low magnitude, but under high magnitude faint vestiges of keriotheca are observed.

Septa, axial septula and primary transverse septula present throughout shell and slender. Secondary transverse septula appear first in 3rd to 4th volution, there is one septulum between adjacent primary one in the inner volutions and there are 2 septula in outer volutions.

Material: —— Reg. no. PF 1403 and PF 1411 from Phnom Bak limestone, Sisophon, Battambang Province; PF 1407 from Phn. Sampou limestone, Battambang Province, Cambodia. They are deposited in Department of Geosciences, Osaka City Univ.

Remarks: —— The specimens in our collection are somewhat smaller than GUBLER's specimens. Namely, after his figure 46, in which the result of measurment is given, the specimens are 1.0 to 1.2 mm long and 0.6 mm wide at the 15th volution, 2.8 to 3.3 mm long and 1.5 to 1.8 mm wide at the 10th, 6.0 to 8.5 mm long and 3.0 to 3.5 mm wide at the 15th volution and 4.6 to 5.6 mm wide at the 20th volution, while the present specimens are 0.5 to 0.8 mm long and 0.3 to 0.5 mm wide at the 5th volution, 2.3 to 3.9 mm long and 1.1 to 1.4 mm wide at the 10th volution, 6.0 to 7.5 mm long and 2.3 to 2.9 mm wide at the 15th volution and 11 to 13 mm long and 3.8 to 4.3 mm wide at the 20th volution. In the other important features the present specimens are almost identical with the type ones.

In the present species proloculus-size is no more than 40 microns. Number of volutions does not exceed 20 and shell is elongate, but in the other shell characters it resembles *Y. multiseptata*. The species is associated with *Y. multiseptata* and number of this species does not exceed one percent of *Y. multiseptata*.

Yabeina elongata may be a microspheric form of *Y. multiseptata*.

Occurrence: —— This species occurs rather rarely, associated *Y. multiseptata*. They occur in the same limestones. Upper part of Middle Permian to Upper Permian.

Subfamily **Verbeekininae** Staff & Wedekind, 1910

Genus *Verbeekina* Staff, 1909

Verbeekina verbeeki (Geinitz), 1876

(Plate VIII, Figures 4-6)

Fusulina verbeeki Geinitz, 1876, Palaeontographica, Bd. 22, p. 399, 400

Verbeekina verbeeki, Staff, 1909, Neues Jahrb. Min., Geol. Palaönt., Beil. -Bd. 27, pl. 7, figs. 5, 7

Verbeekina verbeeki, Thompson, 1936, Jour. Paleont., Vol. 10, No. 3, p. 197-200, pl. 24, figs. 1-8

Verbeekina verbeeki, Nogami, 1961, Mem. Coll. Sci. Univ. Kyoto, Ser. B, vol. 28, no. 2, p. 167-169, pl. 2, figs. 1-4

For further references see Thompson (1936) and Nogami (1961)

Description: —— Shell large and almost spherical. Mature specimens having 15 volutions or more, 5.9 to 7.2 mm in diameter. Inner 2 or 3 volutions lenticular, with short axis of coiling.

Proloculus minute; outside diameter 30 to 45 microns. Height of volutions gradually increasing until 5th or 6th volution, then rapidly increasing until 10th volution, remaining nearly epual in mature 3 volutions.

Spirotheca thin, composed of a tectum, keriotheca-like layer and inner thin layer.

Septa almost flat. Parachomata are rarely present in early and middle stages of growth, but become relatively numerous in later stages.

Material: —— Reg. no. PF 1422, PF 1426 and PF 1428 from Phnom Bak limestone, Sisophon, Battambang Province, Cambodia. They are deposited in Department of Geosciences, Osaka City Univ.

Remarks: —— The specimens from Cambodia are almost identical with the topotype specimens described and illustrated by Thompson (1936) from Padang Highlands in Sumatra, so there is no question in identifying the present form as *Verbeekina verbeeki*.

Occurrence: —— The specimens are common and coexist with many specimens of *Yabeina multiseptata*. Upper part of Middle Permian to Upper Permian.

Subfamily **Schwagerininae** Dunbar & Henbest, 1930

Genus *Chusenella* Hsü, 1942 emend. Chen, 1956

Chusenella cambodgiensis (Gubler), 1935

(Plate VII, Figure 6)

Fusulina exillis, Deprat, 1912, Mém. Sery. Géol. Indochine, vol. 1, Fasc. 3, p. 24, pl. 8, figs. 13, 14; pl. 7, fig. 16

Pseudofusulina cambodgiensis Gubler, 1935, Mém. Soc. Géol. France, Nov. Ser. T. 11, Fasc. 4, p. 86, 87, pl. 3, not figs. 2, 3

Chusenella deprati, Chen, 1956, Palaeont. Sinica, New Ser. B, no. 6, p. 42, pl. 2, figs. 16-18

Chusenella sinensis SHENG, 1963, ibid., no. 10, p. 209, pl. 23, figs. 7-18

Description: —— Shell typically fusiform with bluntly pointed poles. Number of volutions is 7. Mature shells are 4.48 to 6.23 mm long and 1.97 to 2.34 mm wide; form ratio 2.5 to 2.7. Inner 3 or 4 volutions coil tightly, while later ones coil rather loosely.

Spirotheca very thin in inner 4 volutions but beyond 4th volution it becomes thick rather rapidly. Outer surface of shell has slight rugosity. Alveolar structure distinct from 4th volution. Alveoli rather coarse and pronouncedly thickened downward. Septa of inner 3 or 4 volutions unfluted in central regions but beyond these volutions septal fluting becomes intense and somewhat regular. Especially septal fluting of last volution is high troughout length of shell, often forming chamberlets.

Tunnel narrow, but rather high, being 1/2 as high as chamber. Chomata undeveloped.

Axial fillings deposited only in polar regions of inner volutions as narrow bars.

Proloculus small; outside diameter 11 microns.

Material: —— Reg. no. PF 1406, PF 1431 and PF 1436 from Phnom Bak limestone, Sisophon, Battambang Province, Cambodia. They are deposited in Department of Geosciences, Osaka City Univ.

Remarks: —— The present species was included in the genus *Pseudofusulina* by GUBLER. However, this species does not show the distinct shell character of *Pseudofusulina* which has phrenotheca and thick spirotheca. In this paper this species is classified under the genus *Chusenella* on account of the inner shell characters. SAURIN (1958) described this species under the genus *Schwagerina*. *Chusenella* HSÜ was reexamined in detail by CHEN (1956). Very recently, SHENG (1963) discussed the difference between *Schwagerina* and *Chusenella*. After SHENG *Chusenella* differs distinctly from *Schwagerina* in its almost unfluted septa of the tightly coiled juvenarium. In this respect the present species should be referred to *Chusenella*.

DEPRAT reported *Fusulina exilis* SCHWAGER from Tonkin in 1912. DEPRAT's specimen is inflated fusiform with bluntly pointed poles. It is tightly coiling in inner volutions. In these characters it does not agree with SCHWAGER's original specimen of *Fusulina exilis* from Akasaka which is loosely coiling from inner volutions and has cylindrical form. Furthermore, description by DEPRAT does not coincide with his illustration. In 1925 OZAWA pointed out this problem and he proposed a new species *Schellwienia deprati* on the basis of specimens from Nagato. *Fusulina exilis* of DEPRAT was referred to *S. deprati* by OZAWA*. Unfortunately, OZAWA's original specimens are represented by a tangential section and a sagittal section. Therefore, it is not warranted whether DEPRET's *F. exilis* can be safely referred to OZAWA's species or not. In the meanwhile, GUBLER (1935) proposed a new name *Pseudofusulina cambodgiensis* for *F. exilis*,

* From the specific name, *deprati*, one might interprete OZAWA's *Schellwienia deprati* as a substitute name for *F. exilis*, DEPRAT non SCHWAGER. Since, however, it was proposed as new species, not as a new name, and since the description of the new species is based on Nagato specimens, we conclude that the type *S. deprati* should be the Nagato specimen as interpreted GUBLER (1935).

DEPRAT, 1912 non SCHWAGER.

The identification concerning *F. exilis* of DEPRAT is further complicated. GUBLER (1935), when he proposed a new name for *F. exilis* of DEPRAT, illustrated two specimens under this new name. Certainly, GUBLER's specimens resemble DEPRAT's in the tight coiling of inner volutions. Judging from GUBLER's illustration, however, his specimens differ from DEPRAT's original in the following important points.

1) GUBLER's illustrations show cylindrical form with rounded polar region, while DEPRAT's is inflated fusiform with bluntly pointed poles.

2) The axial fillings are heavy in the former, but are weak in the latter.

The present specimens are more closely allied to *F. exilis*, DEPRAT (=*Pseudofusulina cambodgiensis*) (1912, pl. VII, fig. 16; Pl. VIII, figs. 13, 14) than to GUBLER's specimens.

The present specimens resemble *Schwagerina multialveola* CHEN, 1956 in shell form and feature of the growth, but the former is distinguishable from the latter by more tight coiling and weaker axial fillings.

Ch. cambodgiensis is very similar to *Ch. sinensis* SHENG, 1963 from the upper part of the Maokou limestone of Kwangsi, South China in important shell characters. Probably they are synonymous each other.

Occurrence: —— This species occurs rather rarely from the same limestone yielding *Y. multiseptata*. Upper part of Middle Permian to Upper Permian.

Chusenella ? sp.

(Plate VII, Figures 4, 5)

Description: —— Shell fusiform with pointed poles. Number of volutions at maturity 9. Axial length 7.09 to 7.26 mm, median width 2.54 to 2.62 mm; form ratio about 2.6 to 2.9. Inner 3 volutions tightly coiled, while beyond 4th volution shell coils rather loosely.

Proloculus small, its outside diameter 131 to 180 microns.

Spirotheca particularly thin in inner 3 volutions, but becomes rather rapidly thick from next one. Spirotheca of especially outer 6 volutions composed of a tectum and a keriotheca with coarse alveoli.

Tunnel low and narrow in inner volutions and gradually increasing in width in outer volutions.

Chomata weakly developed and discontinuous in inner volutions, but in outer volutions completely absent.

Axial fillings very heavy except last volution.

Septal fluting narrow and irregular, but often absent in central part of outer volutions.

Material: Reg. no. PF 1417 and PF 1421 from Phnom Bak limestone, Sisophon, Battambang Province, Cambodia. They are deposited in Department of Geosciences, Osaka City Univ.

Remarks: —— The characters of juvenarium of this species is not well observable owing to heavy axial fillings developed in polar regions. Therefore, it is not certain whether this species belongs the genus *Schwagerina* or *Chusenella*.

This species closely resembles *Ch. cambodgiensis* in shell form. However, the former may be distinguished from the latter in its heavier axial fillings and slightly weaker septal fluting.

This species is comparable with *Ch. schwagerinaeformis* SHENG, 1963, *Ch. tingi* CHEN, 1956 and *Schwagerina tienchaensis* CHEN, 1956. However, this species can be distinguished from *Ch. schwagerinaeformis* and *Ch. tingi* by its larger size, larger form ratio and larger proloculus. Furthermore this species can be distinguished from *S. tienchiaensis* by its larger shell, larger number of volutions and weaker septal fluting.

Occurrence: —— The present specimens occur rather rarely from Phnom Bak, Sisophon, Battambang Province, Cambodia. They coexist with many specimens of *Y. multiseptata*. Upper part of Middle Permian to Upper Permian.

Genus *Pseudofusulina* DUNBAR & SKINNER, 1931

Pseudofusulina sp. cfr. *Pseudofusulina crassa padangensis* (LANGE), 1925

(Plate VIII, Figures 1-3)

Description: —— Shell elongate fusiform with bluntly pointed poles. Shell coiling uniformly and loosely. Number of volutions at maturity 6 to 7. Mature shells are 7.09 to 9.88 mm long and 2.17 to 2.95 mm wide; form ratio 3.0 to 3.7.

Proloculus large, its outside diameter 246 to 311 microns. Spirotheca composed of a tectum and a keriotheca with coarse alveoli. It is thin in inner 3 volutions and becomes thick beyond 3rd volution.

Tunnel low and irregular. Chomata weakly developed in inner 2 or 3 volutions, but completly absent in outer volutions.

Axial fillings generally narrow at polar regions, but in some specimens wide in outer volutions.

Septa narrowly, highly and irregularly fluted throughout shell. Fluting often weak in last volution.

Material: —— Reg. no. PF 1404, PF 1405, PF 1410, PF 1433, PF 1439 and PF 1435from Phnom Bak limestone, Sisophon, Battambang Province, Cambodia. They are deposited in Department of Geosciences, Osaka City Univ.

Remarks: —— The present specimens closely resemble *Pseudofusulina crassa* var. *padangensis* in GUBLER's collections from Cambodia. However, our specimens have slightly larger length and larger form ratio than GUBLER's specimens.

As GUBLER pointed out, this species resembles *Pseudofusulina japonica* (GÜMBEL). In general the latter has larger size, larger number of volutions and larger proloculus than the former.

OZAWA considered *P. padangensis* (LANGE) as synonym of *P. japonica*. They may eventually turn out to be conspecific through a future study of additional material. For the present, however, they are distinguished from each other by the above-mentioned characters and our specimens are referred to *P. crassa padangensis*.

Occurrence: —— The present specimens occur commonly from Phnom Bak, Sisophon, Cambodia. They coexist with many specimens of *Y. multiseptata*. Upper part of Middle Permian to Upper Permian.

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Table 1. Measurements of *Yabeina multiseptata multiseptata* (DEPRAT)

Yabeina multiseptata multiseptata (DEPART)

Specimen	Pl. Fig.	P.	Radius vector (mm)									
			V 1	2	3	4	5	6	7	8	9	10
PF 1420	V, 5	.570	.400	.515	.600	.730	.830	.970	1.115	1.255	1.400	1.560
PF 1416	V, 7	.575	.405	.485	.585	.710	.830	.965	1.100	1.230	1.425	1.600
PF 1414	V, 6	.520	.395	.510	.610	.725	.845	.965	1.120	1.240	1.365	1.485
PF 1419	III, 2	.555	.355	.455	.575	.700	.825	.975	1.140	1.310	1.500	1.685
PF 1425		.470	.340	.430	.495	.580	.685	.790	.910	1.030	1.170	1.315
PF 1430		.495	.340	.430	.540	.665	.800	.925	1.055	1.200	1.355	1.545
PF 1442	III, 8	.705	.410	.510	.620	.720	.820	.950	1.065	1.310	1.435	1.600

Specimen	Form ratio of volutions												
	V 1	2	3	4	5	6	7	8	9	10	11	12	13
PF 1420	1.0	1.0	1.0	1.2	1.2	1.4	1.5	1.7	1.7	1.8	1.8	1.9	1.9
PF 1416	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1.9	1.9	—
PF 1414	1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.7
PF 1419	1.1	1.1	1.2	1.2	1.2	1.3	1.4	1.5	1.6	1.6	1.6	1.7	1.7
PF 1425	0.8	1.0	1.1	1.1	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.5
PF 1430	1.0	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	—
PF 1442	1.1	1.1	1.1	1.1	1.1	1.2	1.3	1.3	1.3	1.3	1.3	1.4	1.4

Table 2. Measurements of *Yabeina multiseptata gigantea* (GUBLER)

Yabeina multiseptata gigantea (GUBLER)

Specimen	Pl. Fig.	P.	Radius vector (mm)									
			V 1	2	3	4	5	6	7	8	9	10
PF 1424	—	.685	.455	.570	.685	.805	.945	1.100	1.255	1.390	1.545	1.715
PF 1440	VI, 2	.555	.360	.475	.590	.705	.820	.900	1.065	1.190	1.355	1.475
PF 1415	VI, 1	.455-	.315	.400	.515	.625	.740	.860	1.000	1.125	1.275	1.410
PF 1441	VI, 3	.575	.410	.510	.605	.720	.835	.950	1.105	1.270	1.435	1.600
PF 1412	VI, 4	.540	.370	.455	.570	.665	.755	.885	1.000	1.115	1.255	1.420
PF 1423	—	.515	.340	.430	.515	.610	.715	.815	.925	1.055	1.200	1.340

Specimen	Form ratio of volutions												
	V 1	2	3	4	5	6	7	8	9	10	11	12	13
PF 1424	1.1	1.2	1.3	1.6	1.6	1.6	1.7	1.7	1.8	1.9	2.2	2.3	2.4
PF 1440	1.1	1.2	1.2	1.5	1.6	2.0	2.0	2.1	2.1	2.3	2.3	2.4	2.3
PF 1415	1.0	1.4	1.6	1.7	1.9	1.8	1.8	1.8	2.1	2.3	2.3	2.3	2.3
PF 1441	1.0	0.9	1.1	1.1	1.2	1.4	1.6	1.8	1.9	2.1	2.3	2.4	2.4
PF 1412	1.0	1.1	1.1	1.3	1.6	1.8	1.9	2.1	2.3	2.4	2.4	2.5	2.5
PF 1423	1.2	1.5	1.7	1.8	1.9	2.1	2.2	2.4	2.5	2.6	2.7	2.6	2.6

11	12	13	14	15	16	17
1.745	1.915	2.085	2.290	2.515	—	—
1.745	1.930	—	—	—	—	—
1.645	1.795	1.955	2.130	2.310	2.520	2.730
1.880	2.010	2.285	2.515	—	—	—
1.455	1.610	1.765	1.955	2.120	2.340	—
1.715	1.915	—	—	—	—	—
1.720	1.885	2.090	2.295	2.460	—	—

14	15	16	17
1.8	1.8	—	—
—	—	—	—
1.8	1.7	1.7	1.7
1.7	—	—	—
1.6	1.6	1.6	—
—	—	—	—
1.4	1.3	—	—

11	12	13	14	15	16	17
1.885	2.060	2.255	2.430	2.630	—	—
1.640	1.845	2.050	2.255	—	—	—
1.585	1.770	1.965	2.135	2.380	2.615	?
1.765	1.925	2.130	2.355	—	—	—
1.600	1.790	2.020	2.230	2.455	2.685	—
1.505	1.695	1.885	2.075	2.285	2.515	—

14	15	16	17
2.4	2.4	—	—
2.3	—	—	—
2.4	2.3	—	—
2.4	—	—	—
2.4	2.4	?	—
2.6	2.7	?	—

Table 3. Measurements of *Yabeina minuta* Thompson & Wheeler

Yabeina minuta Thompson & Wheeler

Spacimen	Pl.	Fig.	Length	Weidth	Ratio	Prol.	Radius vector (mm)			
							V 1	2	3	4
PF 1413	IV	5	5.986	3.485	1.7	.164	.114	.164	.230	.295
PF 1434	—		?	?	?	.148	.114	.148	.213	.279
PF 1408	IV	7	7.544?	4.018	1.9	.180	.148	.213	.295	.377
PF 1418	IV	4	5.371	3.362	1.6	.246	.164	.230	.295	.410
PF 1438	—		6.642	2.993?	2.2	.164	.131	.180	.246	.328
PF 1409	IV	6	5.986	3.304	2.0	.197	.131	.180	.246	.328
PF 1432	—		6.068	2.289?	2.1 ?	.148	.131	.180	.246	.311

Specimen	Form ratio of volutions														
	V 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PF 1413	1.1	1.0	1.1	1.4	1.4	1.6	1.5	1.5	1.6	1.6	1.6	1.7	1.8	1.7	—
PF 1434	1.0	1.2	1.4	1.4	1.7	1.9	2.1	2.1	2.1	2.0	2.1	—	—	—	—
PF 1408	1.1	1.5	1.4	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.8
PF 1418	1.2	1.3	1.4	1.4	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	—	—	—
PF 1438	1.0	1.3	1.5	1.8	2.0	2.3	2.2	2.1	2.2	2.0	2.2	2.2	2.1	—	—
PF 1409	1.1	1.4	1.5	1.7	1.7	1.9	1.9	2.1	1.9	2.1	2.0	2.0	1.9	—	—
PF 1432	1.0	1.1	1.2	1.6	1.8	1.9	2.0	2.2	2.3	2.3	2.3	2.1	—	—	—

Table 4. Measurements of *Yabeina elongata* (Gubler)

Yabeina elongata (Gubler)

Specimen	Pl.	Fig.	Length	Weidth	Ratio	Prol.	Radius vector (mm)					
							1	2	3	4	5	6
PF 1403	VII	2	?	4.663	?	?	.098	.131	.164	.230	.311	.410
PF 1407	VII	3	16.302?	5.002	3.5	.049	.082	.082	.114	.164	.213	.262
PF 1411	VII	1	?	?	?	.033	.066	.098	.148	.197	.262	.344

Specimen	Form ratio of volutions												
	V 1	2	3	4	5	6	7	8	9	10	11	12	13
PF 1403	1.0	1.0	1.5	1.9	2.1	2.3	2.2	2.3	2.4	2.6	2.9	3.1	3.3
PF 1407	0.8	0.9	1.0	1.3	1.4	2.0	2.3	2.2	2.3	2.4	2.5	2.5	2.6
PF 1411	0.8	1.3	1.6	2.2	2.3	2.6	2.7	2.8	2.9	—	—	—	—

Specimen	Height of volutions (mm)															
	V 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PF 1403	?	.033	.033	.033	.066	.082	.098	.082	.114	.098	.098	.114	.148	.148	.164	.180
PF 1407	.049	.033	.049	.049	.049	.066	.082	.098	.082	.131	.114	.114	.114	.148	.148	.148
PF 1411	.033	.033	.049	.049	.066	.082	.082	.098	.098	.098	.114	.131	.114	.130	.164	.197

5	6	7	8	9	10	11	12	13	14	15
.393	.475	.590	.705	.836	.984	1.131	1.295	1.426	1.607	—
.361	.458	.574	.689	.820	.984	1.115	—	—	—	—
.475	.574	.689	.836	.967	1.131	1.311	1.492	1.681	1.886	2.091
.508	.607	.738	.885	1.033	1.197	1.344	1.525	?	—	—
.410	.508	.622	.738	.902	1.033	1.172	1.361	1.557	—	—
.426	.508	.622	.738	.885	1.016	1.116	1.311	1.473	—	—
.410	.508	.622	.754	.902	1.033	1.197	1.377	—	—	—

Specimen	Height of volutions (mm)														
	V 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PF 1413	.033	.049	.066	.066	.098	.082	.114	.148	.131	.148	.148	.164	.131	.180	—
PF 1434	.033	.033	.066	.066	.082	.098	.114	.114	.131	.164	.131	—	—	—	—
PF 1408	.066	.066	.082	.082	.098	.098	.114	.148	.131	.164	.180	.180	.197	.197	.197
PF 1418	.066	.066	.066	.066	.066	.066	.131	.148	.148	.164	.148	.181	—	—	—
PF 1448	.049	.049	.066	.082	.082	.098	.114	.114	.164	.131	.148	.180	.197	—	—
PF 1409	.033	.049	.066	.082	.098	.082	.114	.114	.148	.131	.148	.148	.164	—	—
PF 1432	.049	.049	.066	.066	.098	.098	.114	.131	.148	.131	.164	.148	—	—	—

7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
.492	.607	.705	.705	.803	.918	1.066	1.213	1.377	1.557	1.722	1.968	2.214	2.624	—	—	—
.328	.410	.508	.590	.721	.836	.951	1.066	1.213	1.361	1.508	1.672	1.852	2.016	2.229	2.442	2.672
.426	.525	.622	.721	.836	.967	1.082	1.213	1.344	1.508	1.705	—	—	—	—	—	—

14	15	16	17	18	19	20	21	22
3.3	3.3	3.2	3.0	3.0	2.9	2.7	—	—
2.7	2.7	2.9	2.9	3.0	3.1	3.1	3.2	3.2
—	—	—	—	—	—	—	—	—

17	18	19	20	21	22
.180	.230	.246	.213	—	—
.164	.180	.164	.213	.213	.230
—	—	—	—	—	—

Table 5. Measurements of *Verbeekina verbeeki* (GEINITZ)

Verbeekina verbeeki (GEINITZ)

Specimen	Pl. Fig.	P.	Radius vector (mm)										
			V 1	2	3	4	5	6	7	8	9	10	11
PF 1422	VIII 4	.035	.045	.090	.135	.180	.255	.410	.615	.915	1.255	1.630	2.035
PF 1426	VIII 5	.040	.055	.090	.135	.195	.280	.475	.770	1.115	1.606	2.010	2.420
PF 1428	VIII 6	.040	.045	.085	.125	.185	.235	.380	.610	.915	1.200	1.510	1.800

Specimen	Form ratio of volutions															
	V 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PF 1422	0 4	0.5	0.6	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PF 1426	0.5	0.4	0.6	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	—	—	—

Table 6. Measurements of *Chusenella cambodgiensis* (GUBLER)

Chusenella cambodgiensis (GUBLER)

Specimen	Pl. Fig.	Length	Weidth	Ratio	Prol.	Radius			
						V 1	2	3	4
PF 1406	VII 6	6.231	2.337	2.7	.148	.114	.164	.246	.361
PF 1431	—	5.658	2.131	2.7	.098	.066	.066	.148	.230
PF 1436	—	4.477	1.968	2.6	?	.082	.131	.180	.295

Specimen	Height of volutions (mm)									
	V 1	2	3	4	5	6	7	8	9	
PF 1406	.049	.049	.082	.114	.213	.328	.311	—	—	
PF 1431	.033	.033	.049	.082	.114	.164	.246	.246	.246	(8½v)
PF 1436	—	.049	.049	.114	.131	.262	.328	—	—	

Specimen	Tunnel angle								
	V 1	2	3	4	5	6	7	8	9
PF 1406	—	23	25	30	43	43	—	—	—
PF 1431	—	30	30	30	26	—	47	—	—
PF 1436	—	30	29	30	36	36	—	—	—

12	13	14	15	16	17
2.400	2.740	3.390	3.085	3.655	—
2.790	3.155	—	—	—	—
2.140	2.420	2.710	3.025	3.280	3.570

Specimen	Septal count																
	V 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
PF 1428	4	8	10	16	14	12	9	9	11	19	20	31	31	43	?	?	?

vector (mm)				
5	6	7	8	9
.574	.902	1.213	—	—
.344	.508	.754	1.000	1.098(8½v)
.426	.689	1.016	—	—

Specimen	Thickness of spirotheca (mm)								
	V 1	2	3	4	5	6	7	8	9
PF 1046	.008	.016	.016	.033	.053	.070	.082	—	—
PF 1431	.008	.008	.020	.020	.033	.062	.053	.074	.070
PF 1436	.012	.016	.020	.029	.041	.074	.094	—	—

Table 7. Measurements of *Chusenella ?* sp.

Chusenella ? sp.

Specimen	Pl. Fig.	Length	Weidth	Ratio	Prol.	Radius			
						V 1	2	3	4
PF 1417	VII 5	7.257 ?	2.542	2.9	.131 .180	.114	.164	.230	.328
PF 1421	VII 4	7.093 ?	2.624	2.7	.131	.114	.164	.213	.311

Specimen	Height of volutions (mm)									Tunnel angle								
	V 1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
PF 1417	.049	.049	.066	.098	.148	.180	.246	.246	.279	—	14	26	26	24	26	27	—	—
PF 1421	.049	.049	.049	.098	.098	.164	.213	.279	.295	—	—	17	29	26	28	26	25	?

Table 8. Measurements of *Pseudofusulina* sp. cfr. *Pseudofusulina crassa padangensis* (LANGE)

Pseudofusulina sp. cfr. *Pseudofusulina crassa padangensis* (LANGE)

Specimen	Pl. Fig.	Length	Weidth	Ratio	Vol.	Prol.	Radius		
							V 1	2	3
PF 1404	VIII 1	8.979	2.952	3.0	7	.295	.213	.295	.377
PF 1405	VIII 3	7.262	2.378 ?	3.2	7	.295	.197	.262	.344
PF 1433	—	9.881	2.665	3.7	7	.262	.098	.246	.361
PF 1435	—	7.093	2.173	3.3	6	.295	.180	.246	.361
PF 1439	—	5.945	1.927 ?	3.1	6	.246	.148	.246	.328
PF 1410	VIII 2	?	?	?	5	.311	.197	.328	.492

Specimen	Tunnel angles							Thickness		
	V 1	2	3	4	5	6	7	V 1	2	3
PF 1404	29	23	31	33	39	39	—	.020	.029	.029
PF 1405	17	23	25	32	37	34	—	.016	.033	.033
PF 1433	—	27	30	31	33	31	—	.012	.029	.045
PF 1435	—	—	49	49	51	64	—	.029	.029	.041
PF 1439	22	19	—	—	—	—	—	.016	.025	.020
PF 1410	31	32	30	33	—	—	—	.025	.037	.041

vector (mm)				
5	9	7	8	9
.475	.656	.902	1.148	1.426?
.410	.574	.787	1.066	1.361?

Specimen	Thickness of spirotheca (mm)								
	V 1	2	3	4	5	6	7	8	9
PF 1417	.004	.012	?	.029	.049	.082	.082	.082	?
PF 1421	.004	?	.012	.020	.020	.049	.082	.148	.094

vector (mm)				Height of volutions (mm)						
4	5	6	7	V 1	2	3	4	5	6	7
.574	.787	1.082	1.443	.066	.082	.082	.197	.213	.295	.361
.508	.705	.951	1.197?	.049	.066	.082	.164	.197	.262	.246
.574	.836	1.130	1.475	.049	.082	.114	.213	.262	.311	.328
.492	.689	.951	—	.066	.066	.114	.131	.213	.262	—
.458	.689	.918	—	.049	.114	.066	.148	.213	.230	—
.721	.951	—	—	.066	.114	.164	.213	.230	—	—

of spirotheca (mm)			
4	5	6	7
.070	.090	.103	.108
.053	.057	.082	.082
.062	.078	.107	.070
.070	.066	.082	—
.057	.074	.074	—
.066	.074	—	—

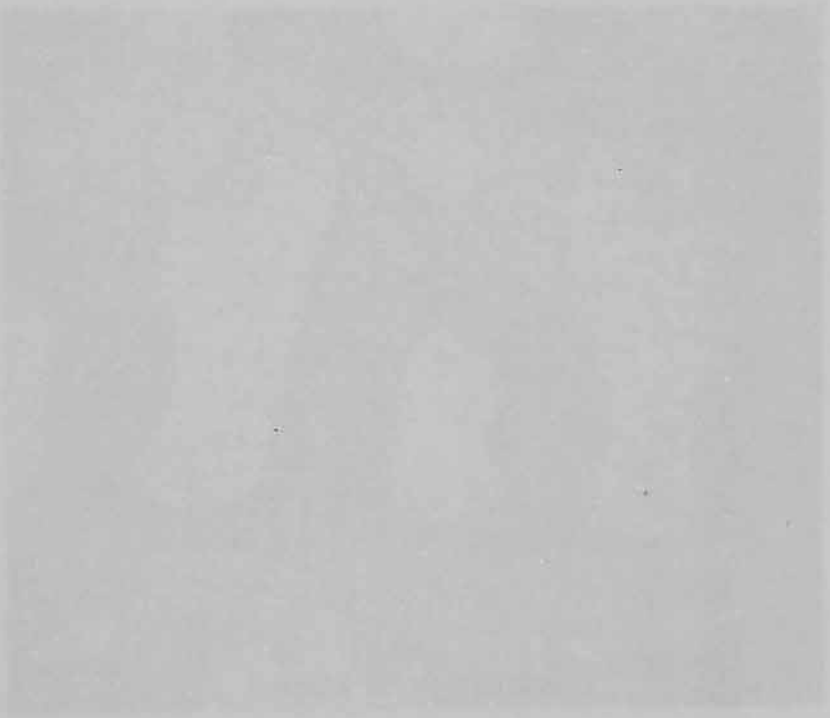


Plate I

Explanation of Plate I

Yabeina globosa (YABE), 1906

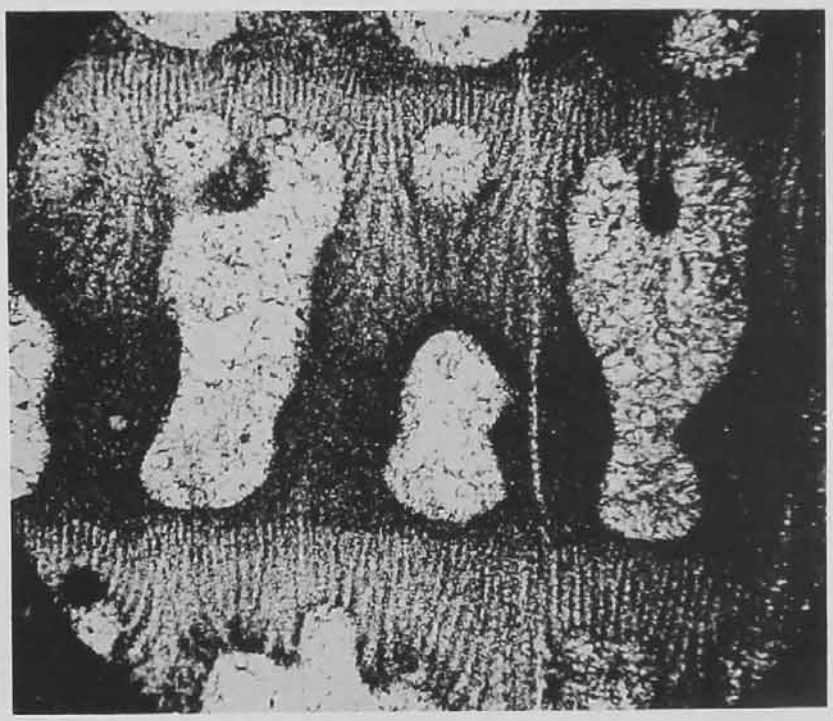
Fig. 1. Enlarged part of Fig. 2, showing the adult stage (17th volution). × 100

Fig. 2. Axial section of a topotype, loc. OZAWA's Mameishi limestone, Akasaka, Gifu Prefecture, Japan (see also OZAWA, 1927), Reg. no. PF 1443. × ca. 8

Fig. 3. Enlarged part of Fig. 2, showing the younger stage. × 100

Specimens illustrated in Plates I-VIII are deposited in the Department of Geosciences, Osaka City University, except otherwise mentioned.

Photos by ISHII



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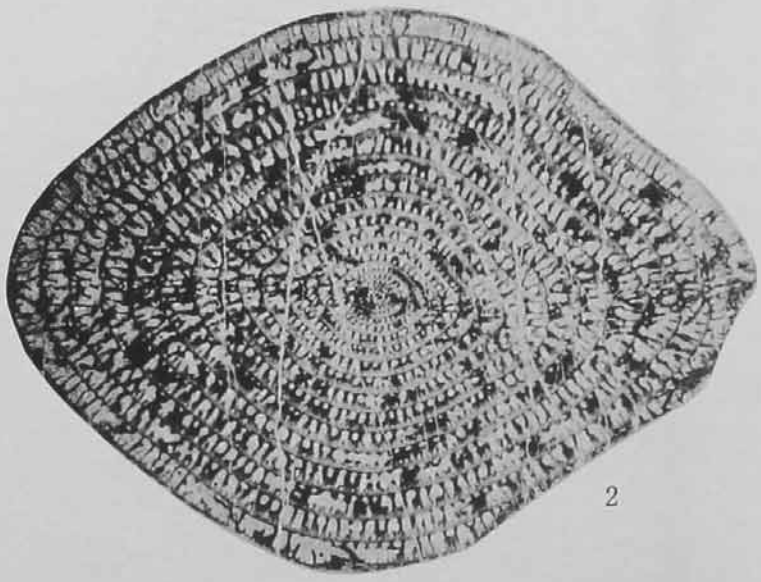

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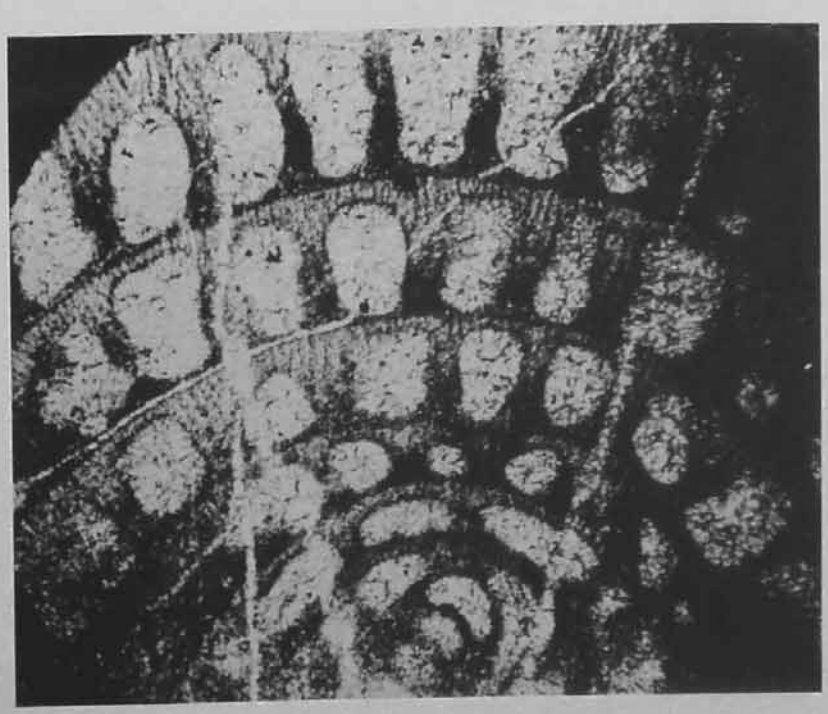

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Plate II

Explanation of Plate II

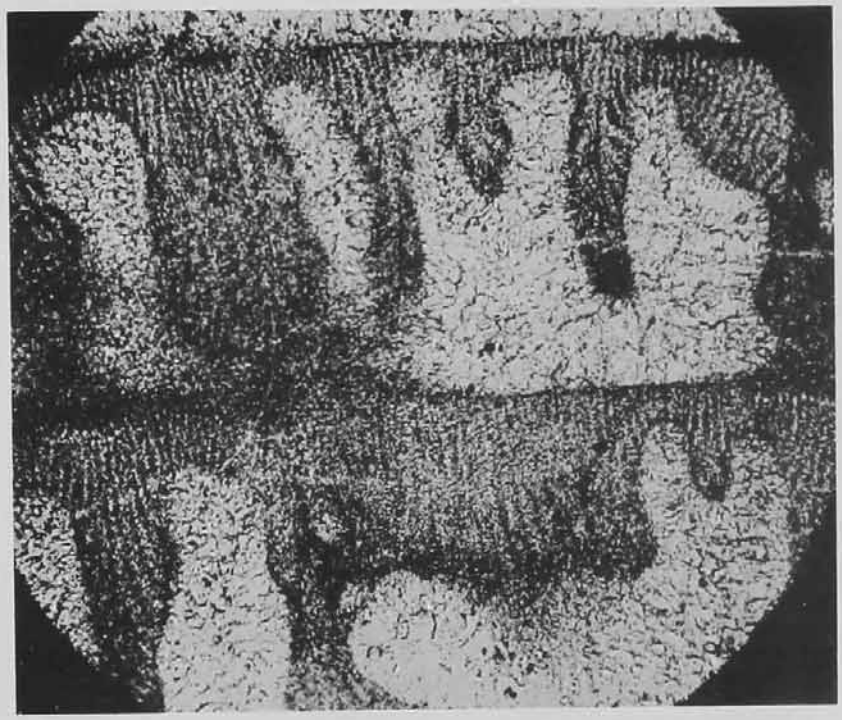
Yabeina globosa (YABE), 1906

Fig. 1. Enlarged part of Fig. 2, showing the adult stage (20th volution). × 100

Fig. 2. Sagittal soction of a topotype, loc. OZAWA's Mameishi limestone, Akasaka, Gifu Prefecture, Japan, (see also OZAWA, 1927), Reg. no. PF 1444. × ca. 8

Fig. 3. Enlarged part of Fig. 2, showing the younger stage. × 100

Photos by ISHII



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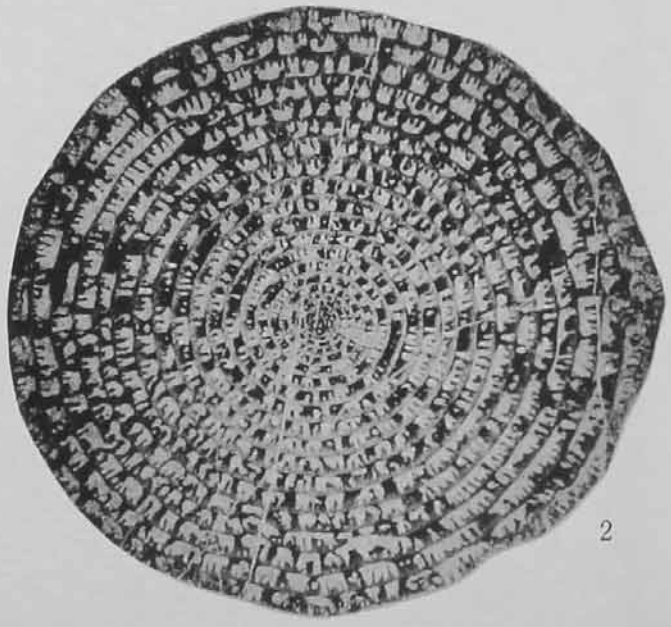

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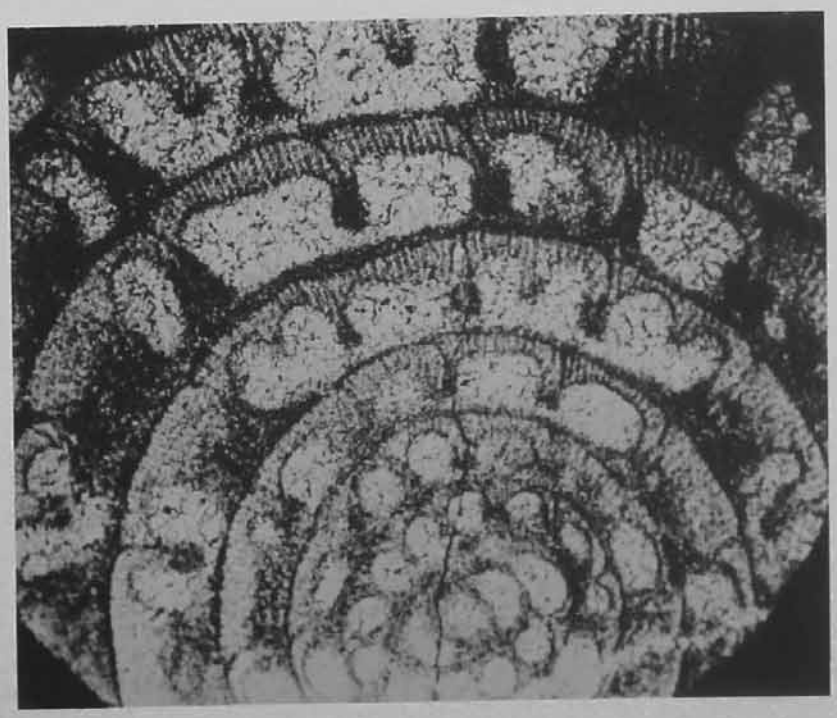


3

Plate III

Explanation of Plate III

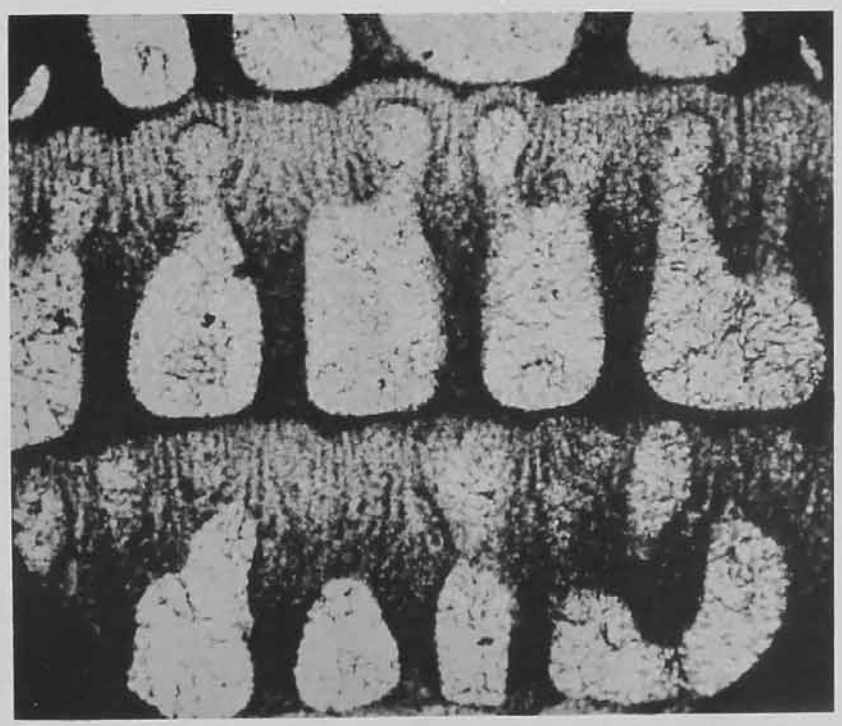
Yabeina multiseptata multiseptata (DEPRAT), 1912

Fig. 1. Enlarged part of Fig. 2, showing the adult stage (12th to 13th volution). × 100

Fig. 2. Axial section of a specimen, from Phnom Bak, Sisophon, Cambodia, Reg. no. PF 1419. × ca. 10

Fig. 3. Enlarged part (1st to 3rd volution) of Fig. 2, showing the younger stage. × 100

Photos by ISHII



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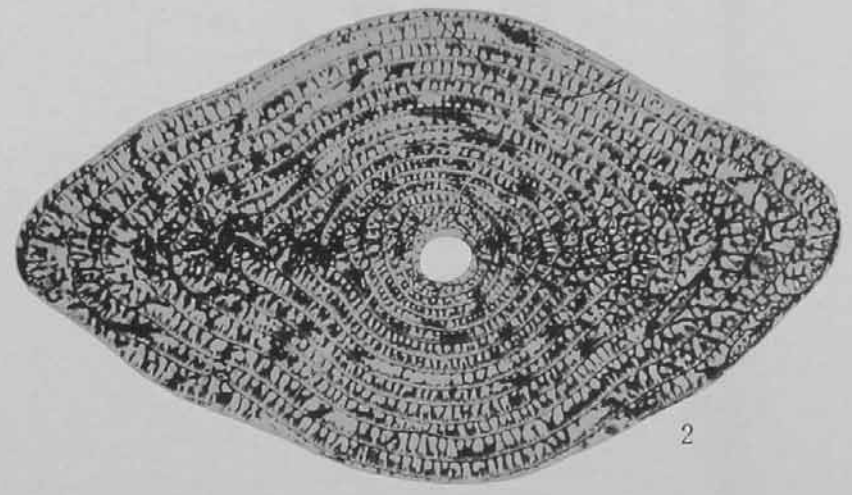

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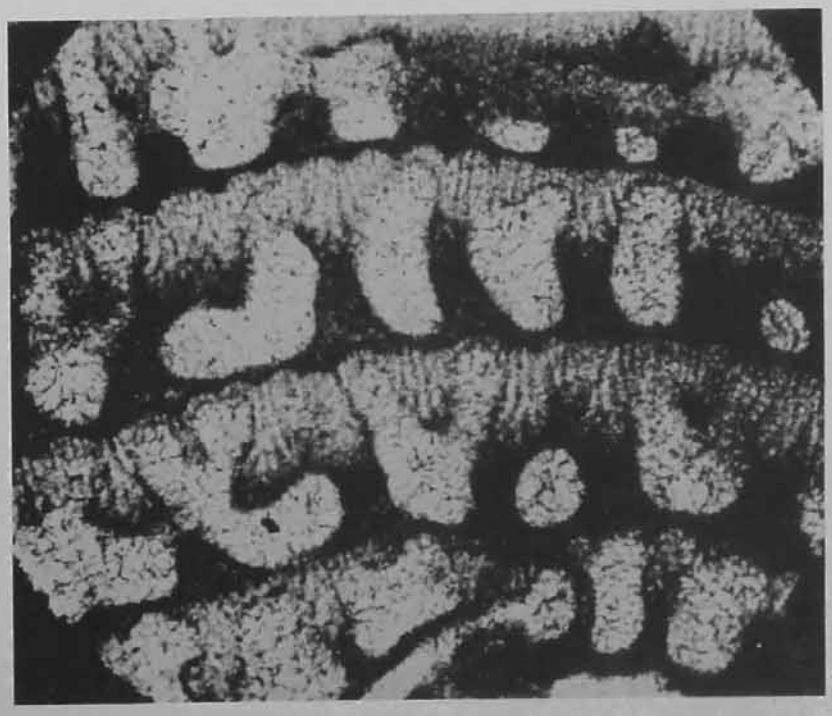

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Plate IV

Explanation of Plate IV

Yabeina multiseptata multiseptata (DEPRAT), 1912

Fig. 1. Enlarged part of Fig. 2, showing the adult stage (9th to 11th volution). × 100

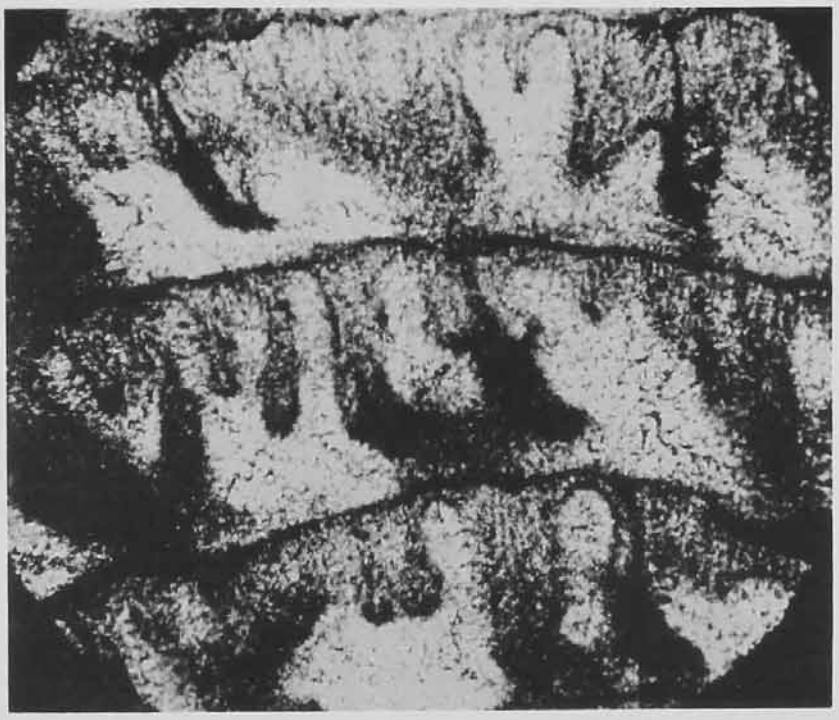
Fig. 2. Sagittal section of a specimen, from Phnom Takream, Battambang Province, Cambodia, Reg. no. PF 1429. × ca. 10

Fig. 3. Enlarged part of Fig. 2, showing the younger stage (1st to 4th volution). × 100

Yabeina minuta THOMPSON & WHEELER, 1942

Figs. 4-7. Axial sections of specimens, from Phnom Bak, Sisophon, Cambodia, 4; Reg. no. PF 1418, 5; PF 1413, 6; PF 1409, 7; PF 1408, all specimens. × ca. 10

Photos by ISHII



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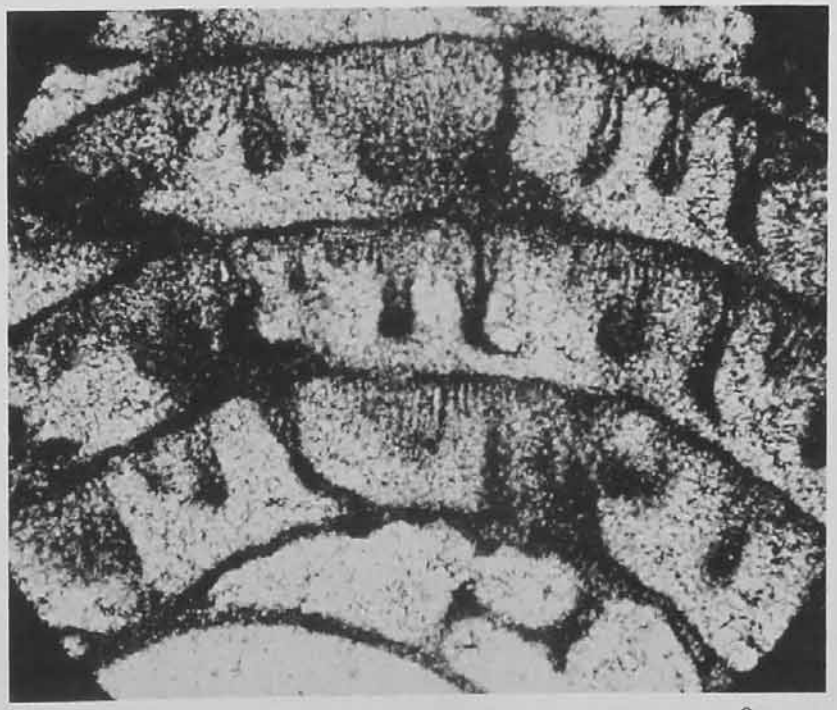

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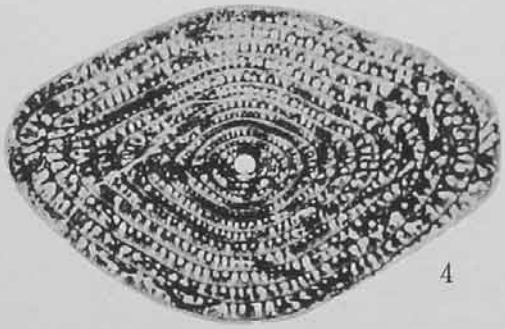

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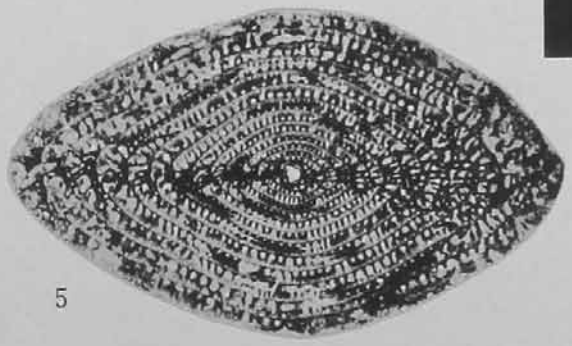

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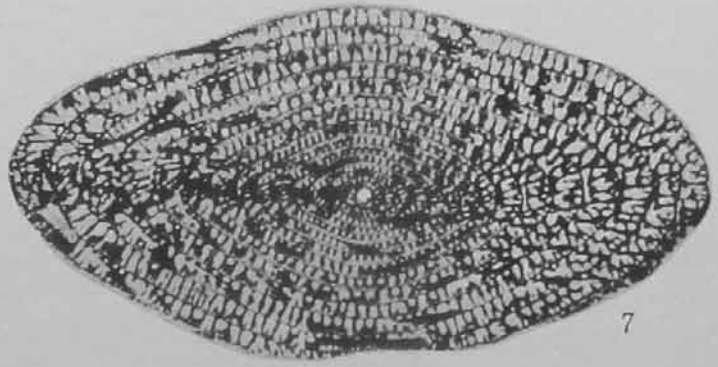

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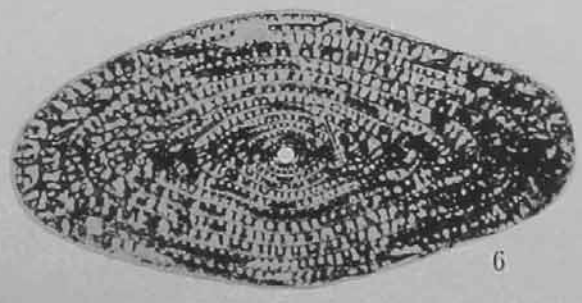


6

Plate V

Explanation of Plate V

All figures × ca. 10

Yabeina multiseptata shiraiwensis OZAWA, 1925

Fig. 1. Lectotype, from Shiraiwa, Yamaguchi Prefecture, Japan, Section no. I-14 (Geol. Inst. Univ. Tokyo) ; This specimen was originally illustrated byOZAWA (1925, pl. 10, fig. 2).

Fig. 2. Lectotype of *Yabeina yasubaensis*, from Yasuba, Kochi Prefecture, Japan, Section no. 1335-39 (Geol. Inst. Univ. Tokyo) ; This specimen was originally illustrated by TORIYAMA (1942, pl. 25, fig. 13).

Fig. 3. Mature specimen, from Shiraiwa, Reg. no. JPF-10309 (Geol. Miner. Inst., Univ. Kyoto) ; This specimen was illustrated by ISHII & NOGAMI (1962, pl. 1, fig. 2).

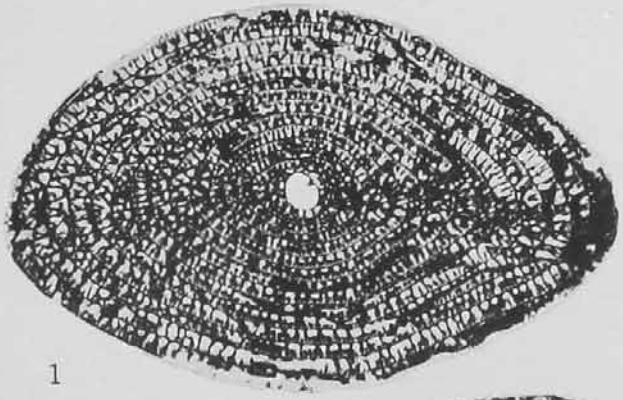
Yabeina multiseptata multiseptata (DEPRAT), 1912

Fig. 4. Sagittal section, from Phnom Sampou, Battambang Province, Cambodia, Reg. no. PF 1437.

Fig. 5. Axial section of a specimen, from Phnom Bak, Sisophon, Reg. no. PF 1420.

Fgs. 6-8 Axial sections of specimens, from Phnom Sampou, Battambang Province, Cam bodia, 6 ; Reg. no. 1414, 7 ; PF 1416, 8 ; PF 1442.

Photos by ISHII, except for figs. 2 which was kindly sent by Prof. TORIYAMA (Kyushu Univ.)



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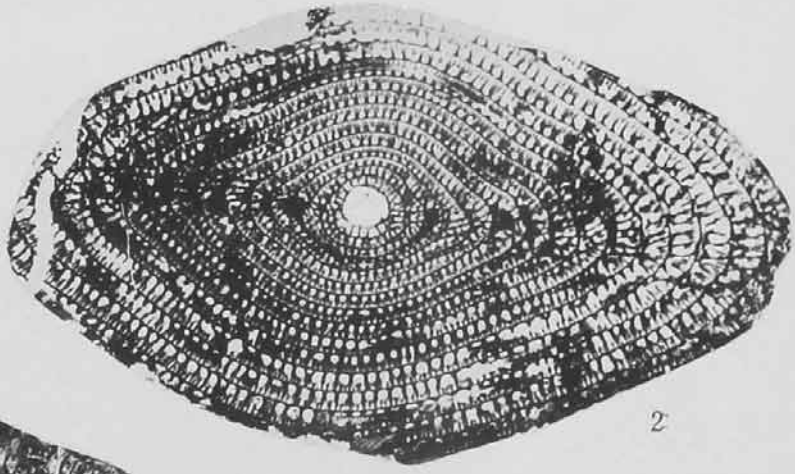

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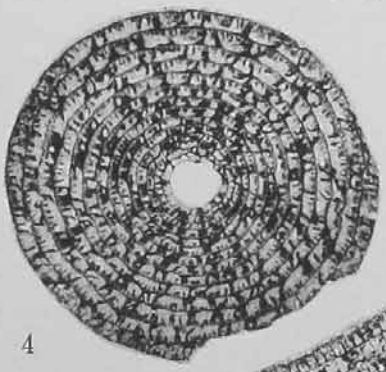

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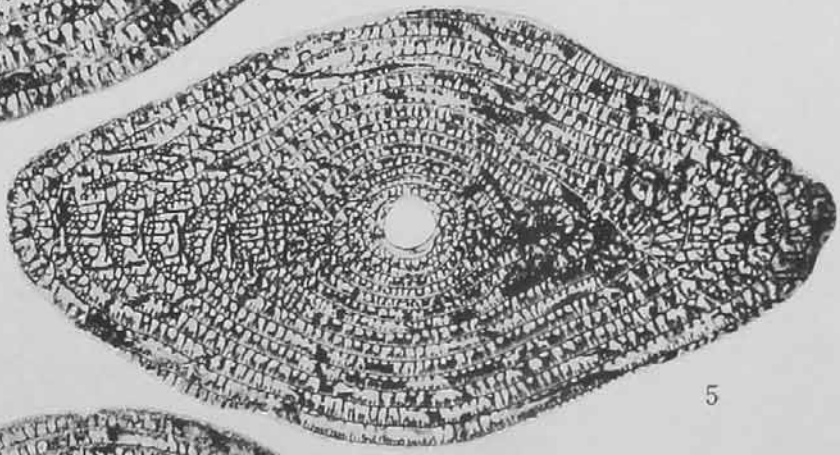

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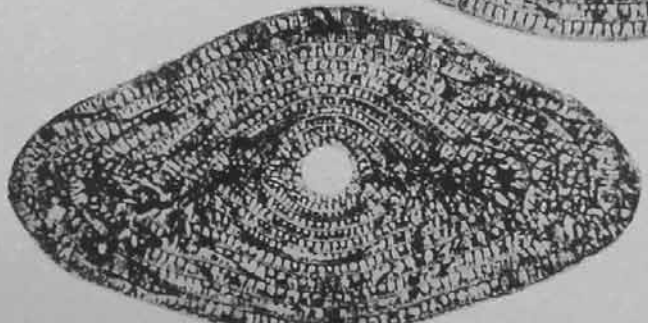
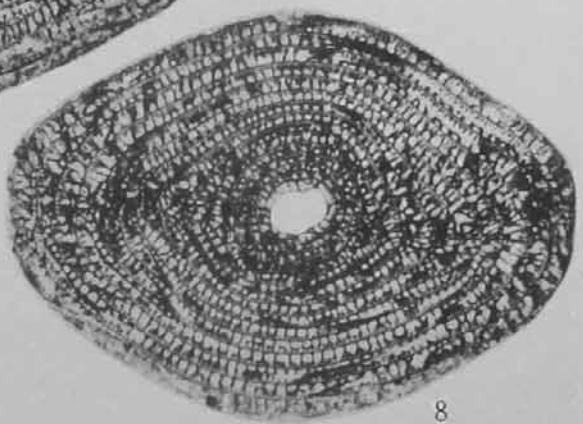




8

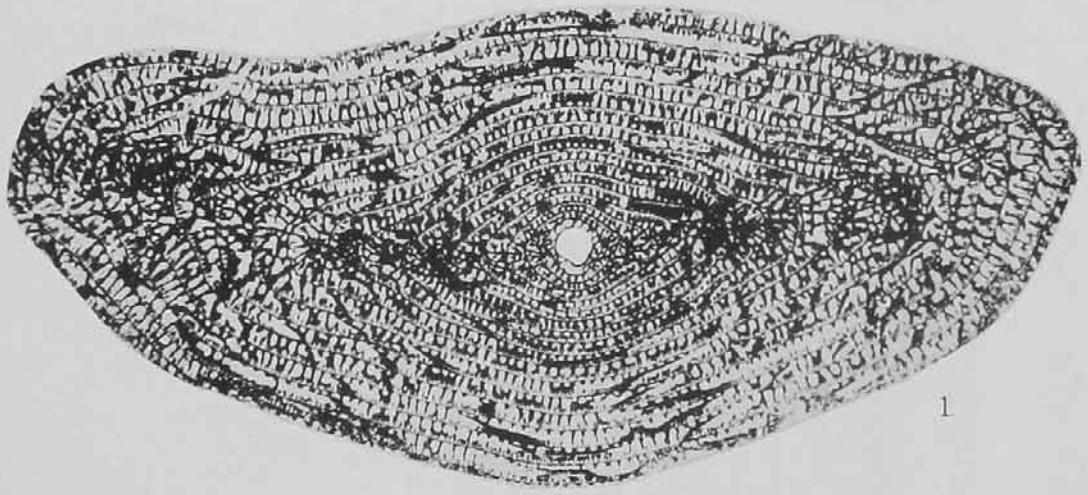
Plate VI

Explanation of Plate VI

Yabeina multiseptata gigantea (GUBLER), 1935

Figs. 1-4. Axial sections of specimens from Phnom Bak, Sisophon, Cambodia, 1; Reg. no. PF 1415, 2; PF 1440, 3; PF 1441, 4; PF 1412, all figures × ca. 10

Photos by ISHII



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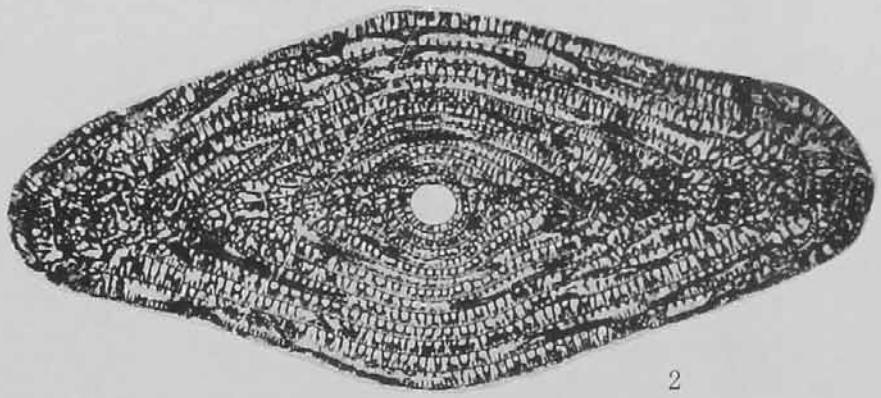

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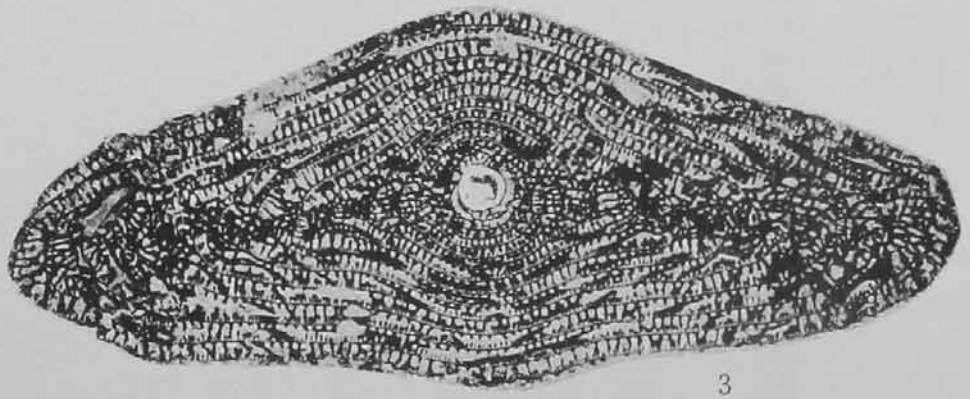

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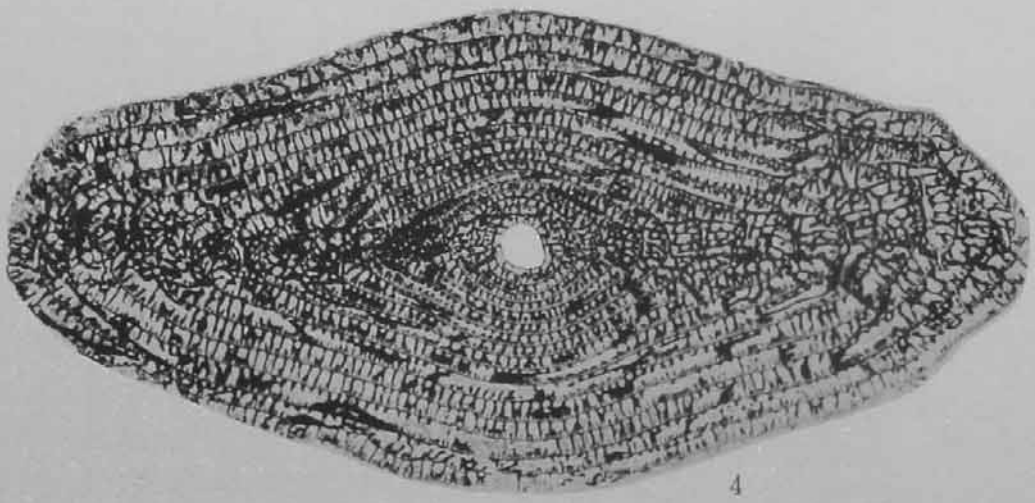

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Plate VII

Explanation of Plate VII

All figures × ca. 10

Yabeina elongata (GUBLER), 1935

Figs. 1, 2. Axial sections of specimens, from Phnom Bak, Sisophon, Cambodia, 1; Reg. no. PF 1411, 2; PF 1403.

Fig. 3. Axial sections of an elongate specimen, from Phnom Sampou, Battambang Province, Cambodia, Reg. no. PF 1407.

Chusenella ? sp.

Figs. 4, 5. Axial sections of specimens, from Phnom Bak, Sisophon, Cambodia, 4; Reg. no. PF 1421, 5; PF 1417.

Chusenella cambodgiensis (GUBLER), 1935

Fig. 6. Axial sections of a specimen, from Phnom Bak, Sisophon, Cambodia, Reg. no. PF 1406.

Photos by ISHII


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Plate VIII

Explanation of Plate VIII

All figures × ca. 10

Pseudofusulina sp. cfr. *Pseudofusulina crassa padangensis* (LANGE), 1925

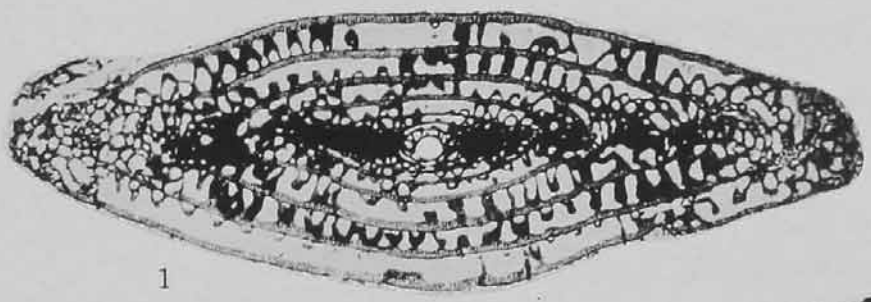
Figs. 1-3. Axial sections of specimens, from Phnom Bak, Sisophon, Cambodia, 1; Reg. no. PF 1404, 2; PF 1410, 3; PF 1405.

Verbeekina verbeeki (GEINITZ), 1876

Figs. 4, 5. Axial sections of specimens, from Phnom Bak, Sisophon, Cambodia, 4; Reg. no. PF 1423, 5; PF 1426.

Fig. 6. Sagittal section of a specimen, from Phnom Bak, Sisophon, Cambodia, Reg. no. PF 1428.

Photos by ISHII



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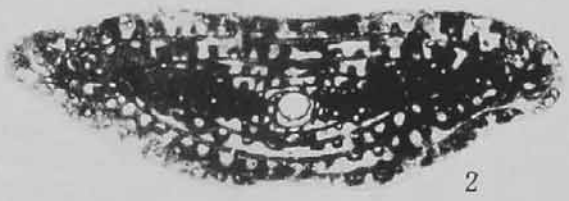

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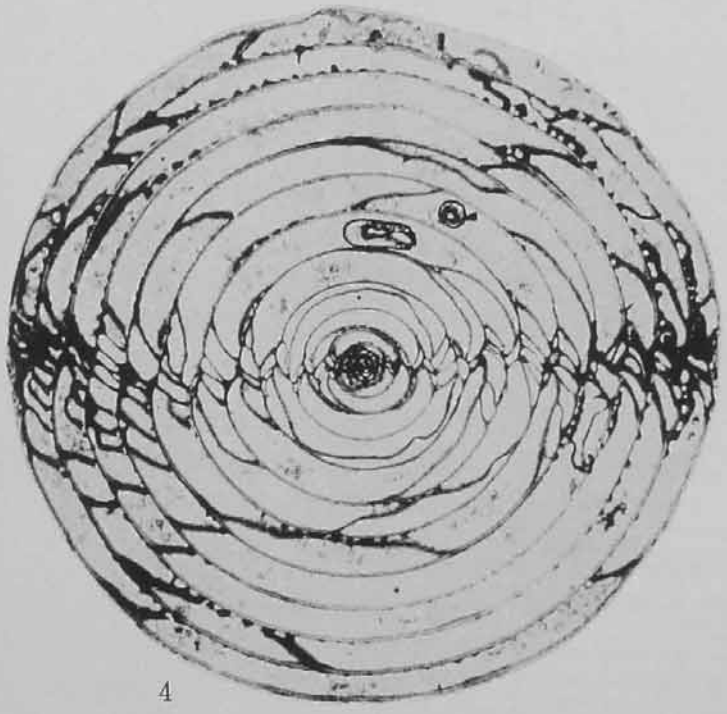

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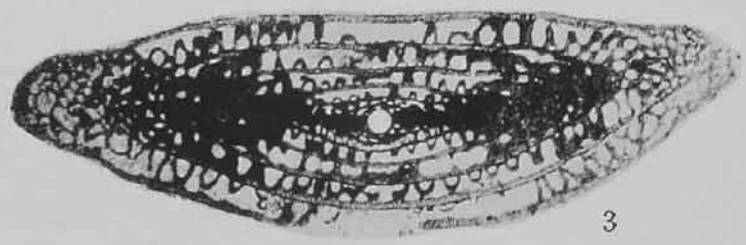

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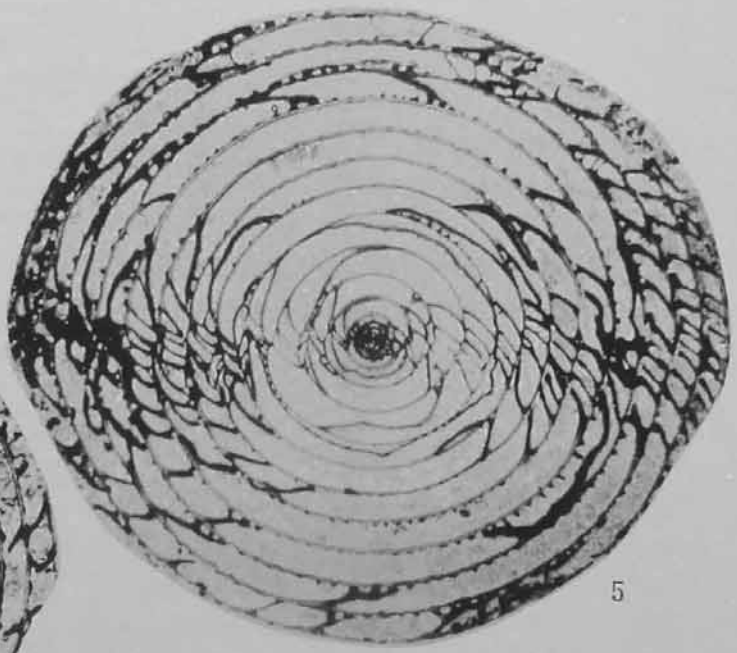

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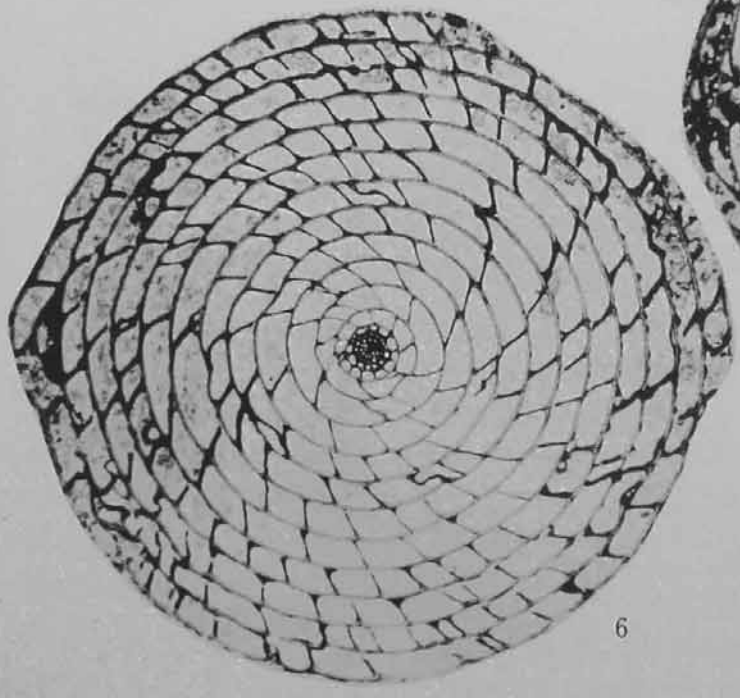

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