THE AXIAL SEPTULA OF SOME JAPANESE NEO-SCHWAGERININAE WITH SPECIAL REMARKS OF THE PHYLOGENY OF THE SUBFAMILY NEOSCHWAGERININAE DUNBAR AND CONDRA, 1928

By

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(With 2 text-figs., 7 tables and 6 plates)
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Introduction

As is well known, fusulinid foraminifera belonging to the subfamily Neoschwagerininae DUNBAR and CONDRA, 1928 are especially characteristic in having seputla as well as septa.

Transverse septula are to be found in all genera belonging to this subfamily, although they are weakly developed in the genus *Cancellina*.

Secondary transverse septula are abundantly found in those species belonging to the genera *Yabeina, Lepidolina, Afghanella, Sumatrina* and *Gublerina,* gen. nov. and they are also sometimes found in most species belonging to those genera such as *Minoella**) *Neoschwagerina* and *Gifuella,* although they are entirely lacking in the genera *Metaschwagerina* and *Cancellina.*

The axial septula are also developed in all species of neoschwagerinids having been reported by many palaeontologists up to the present, although there are observable only incipient "*axial septula*" in the genus *Cancellina.*

Most palaentologists who have ever studied fusulinid fossils have been accustomed to pay little attention to the nature of the axial septula. The senior author has long believed, however, that the axial septula may be a quite useful biocharacter to aid in classification of neoschwagerinids more in detail, whereas they have been apt to be little investigated by most scientists according to hitherto published works. Anyhow, the senior author tried to give special attention to the axial septula in the

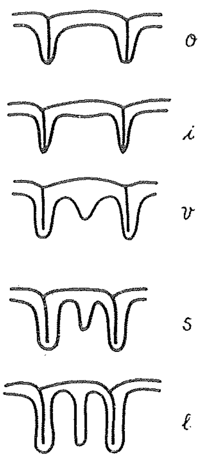
*) A very few and short secondary transverse septula can be found in *Minoella nipponica* (OZAWA).

course of his study regarding Japanese neoschwagerinids.

The most important results of that study will be here briefly presented.

1 Four types of axial septula.*

The axial septula are a kind of ridges that hang down into the chamber from the spirotheca being parallel to the axis of coiling and situated between the septa. They are continuous long plates resembling septa, so they are well observable only in the sagittal thin sections, although the presence of such structures is occasionally indicated by a slight swelling of the inner margin of some part of the spirotheca, even in the axial section.



Text.-Fig. 1. Type of axial septula

In well-oriented sagittal thin sections, there are distinguishable at least four types of axial septula among the Japanese neoschwagerinids in respect to their outer forms. Of them, the most simple one is here designated as *i* type, which is presumed to be incipient or more primitive in form than any other types. They look mere swellings of the spirotheca between each pair of septa. Secondly, there is a type showing *v* form in its outer configuration, so it is here designated as *v* type. In general, the axial septula of *i* type are very low in comparison with broad bases, while those of *v* type are higher than the preceding ones.

The third and fourth types are here designated as *s* and *l* type respectively, both are found in species seemingly of more advanced forms among neoschwagerinids. The outer configurations of them show lath like shape, with parallel sides, instead of *v* shape; but they are still distinguishable from each other owing to the difference of their length or height; the *s* type here designated is shorter than the *l* type.

In observing carefully types and number of those septula found between the pair of septa and also the sequence of appearance of each

*) Formerly, the terms "primary" or "secondary septula" have been used among palaeontologists. The *i*, *v*, and probably *s* types of axial sepula may be comparable to the so-called "secondary septula", while *l* may be nearly equivalent with the so-called "primary axial septula".

To tell the truth, the so-called secondary septula appear earlier than the so-called primary axial septula. Accordingly, the terms primary or secondary would be best abandoned. This is one of the reasons why the authors do not like to apply here the older usage of those terms and newly propose the terms of *i*, *v*, *s* and *l* types of axial septula.

type for each volution, the authors learned that the septula are rather constant for each species, so they are now in belief, that the axial septula are quite useful criteria in specific distinction of neoschwagerinids.

For instance, in the sagittal section of the representative specimens of *Minoella eonipponica* HONJO,*) no axial septula are observable in the several chambers in the first volution counted from the proloculus, then *i* type of septula appears first in the later stage of the first volution; this type of septula is also occasionally found in the later volutions of some specimens, for example, in the third, sixth or seventh volutions. On the other hand, *v* type of septula are distributed in the volutions ranging from the second to the tenth.

Besides, there are also to be found such interspace between the septa, where no kind of septula is found. So the septula distribution in this species may be tabulated as below:

TABLE 1.

Volution	Type of septula	
I	?	*i*
II	?	*o*, *v*
III	?	*i*, *v*
IV	*o*, *v*	*v*
V	*v*	?
VI	*i*, *v*	?
VII	*i*, *v*	?
VIII	*v*	?
IX	*v*	?
X	*v*	?

o means without any kind of septula between the septa.

Thus, *Minoellea eonipponica* HONJO shows *v* type of septula as the most advanced form among the axial septula, through the ontogeny of this species.

Similar observations on the axial septula have been applied to the other species, and the authors found that *Neoschwagerina simplex* OZAWA has almost the same septula as those observed in the preceding species. However, they became aware that very complicated axial septula are observable in other species.

There are not seldom found combinations of some types of septula in advanced species besides the four types above enumerated. For instance, the following combinations have been detected up to the present day from various kinds of species belonging to the Japanese Neoschwagerininae.

* Honjo, 1959.

TABLE 2.

$v+i$, $2v$, $2v+i$
$s+i$, $s+v$, $2s$, $2s+v$, $3s$, $4s$, $5s$, $6s$
$l+i$, $l+v$, $l+s+v$, $l+2s$, $l+3s$, $l+4s$, $l+5s$
$2l$, $2l+v$, $2l+s$, $2l+2s$, $2l+3s$, $2l+4s$
$3l$, $3l+v$, $3l+2s$, $3l+3s$, $3l+4s$, $3l+5s$
$4l$, $4l+v$, $4l+s$, $4l+2s$, $4l+3s$
$5l$, $5l+s$, $5l+2s$
$6l$, $6l+s$

Of the symbols above enumerated, $v+i$ means that there are one v type and one i type septulum between two septa, $2v$ means that there are to be found two v type axial septula between two septa; those that follow are the same.

Table 3* partly shows the results of observation for each species regarding the distribution of the types of axial septula at each volution of the representative specimens.

As is clearly shown in table 2, i and v types of axial septula are especially prevalent in the early stage of ontogeny for each species, while s and l types together with their more complicated combination of various types of axial septula are usually appearing in still later volutions.

Nevertheless, the fact must not be overlooked that there can be seen considerable individual variations either regarding the first appearance of any of the types of axial septula for each volution or their distribution throughout the ontogeny of the animal. However, the authors cannot but admit that the most advanced form in respect to the type of axial septula including their combinations is rather constant for each species.

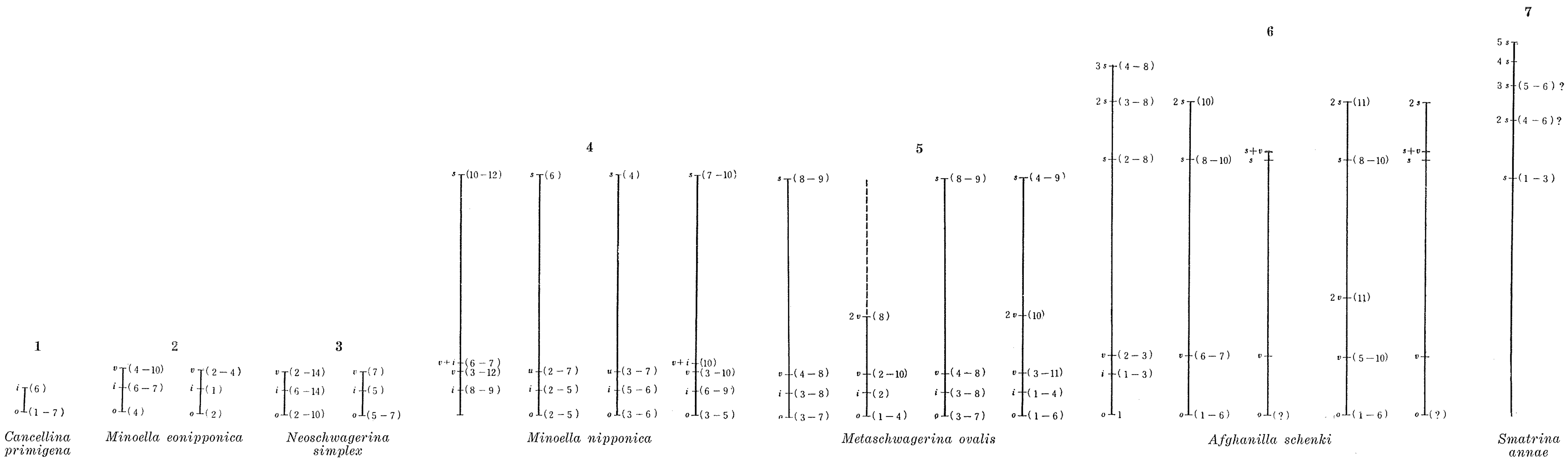
That is to say, there may be indeed recognized either slight or considerable individual variations in what number of volution a definite type of axial septulum appears for each species, but the occurrence of highest or most specialized form of axial septula is quite constant for each species.

For instance, *Minoella eonipponica* as well as *Neoschwagerina simplex* have v type of axial septula as the most specialized form throughout their ontogeny, *Minoella nipponica* and *Metaschwagerina ovalis* show s type, *Neoschwagerina irregularis* $l+v$, and such species as *Neoschwagerina craticulifera* have $2l+v$.

Further, it must be noted that there are species showing not always the same ontogeny regarding the development of axial septula, even though they have a similar type of axial septula as the most advanced form.

*) Numbers in ( ) show the volution number.

TABLE 3. 1—20.


1
2
3
4
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7
Cancellina primigena
Minoella eonipponica
Neoschwagerina simplex
Minoella nipponica
Metaschwagerina ovalis
Afghanilla schenki
Smatrina annae

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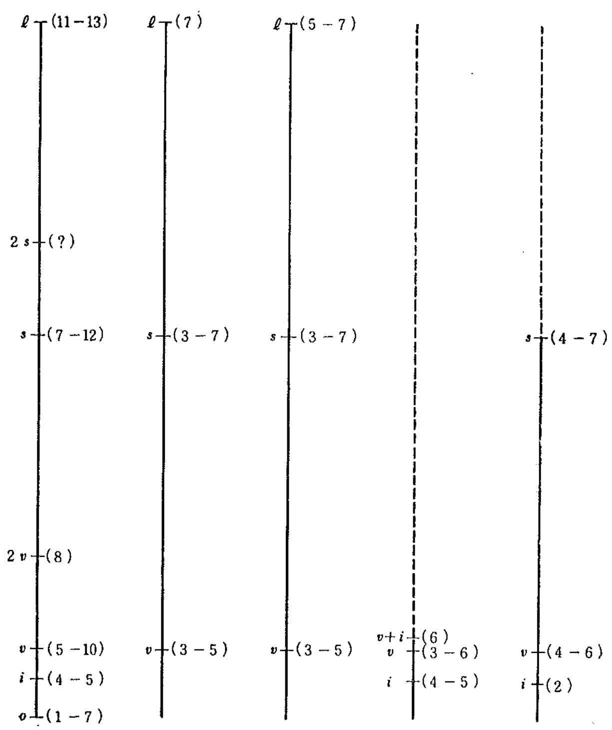
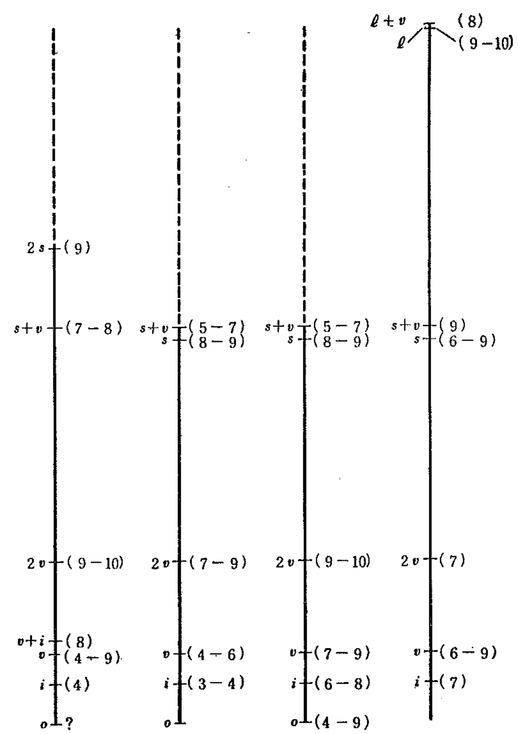


Gifuella amicxla

9



Neoschwagerina irregularis

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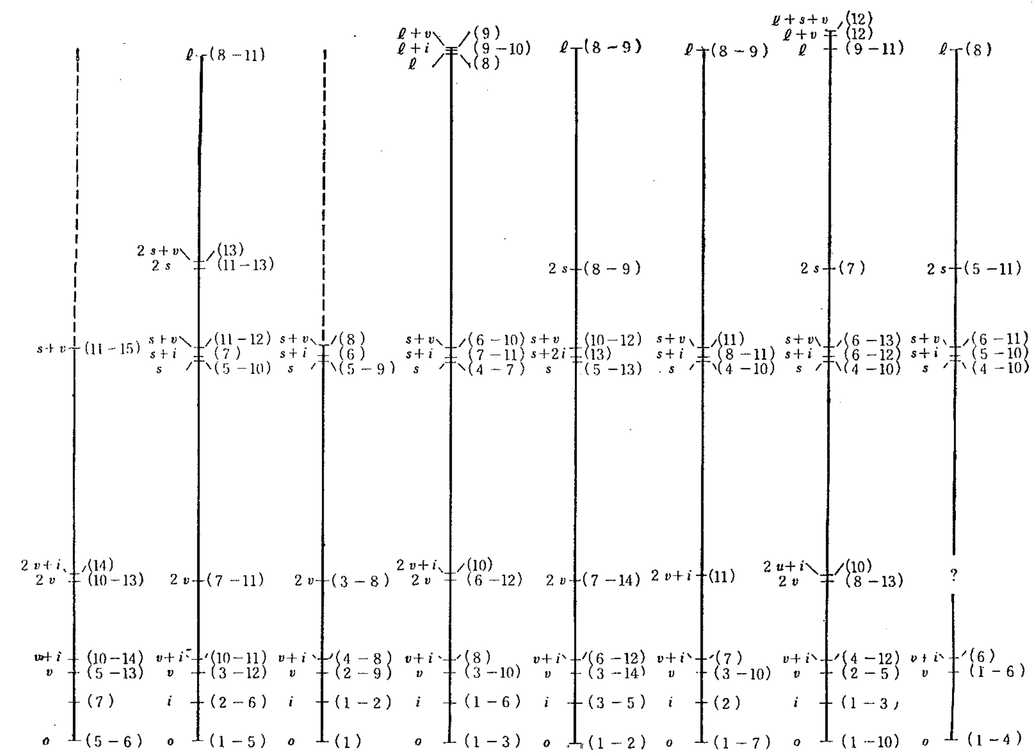

Gifuella gifuensis

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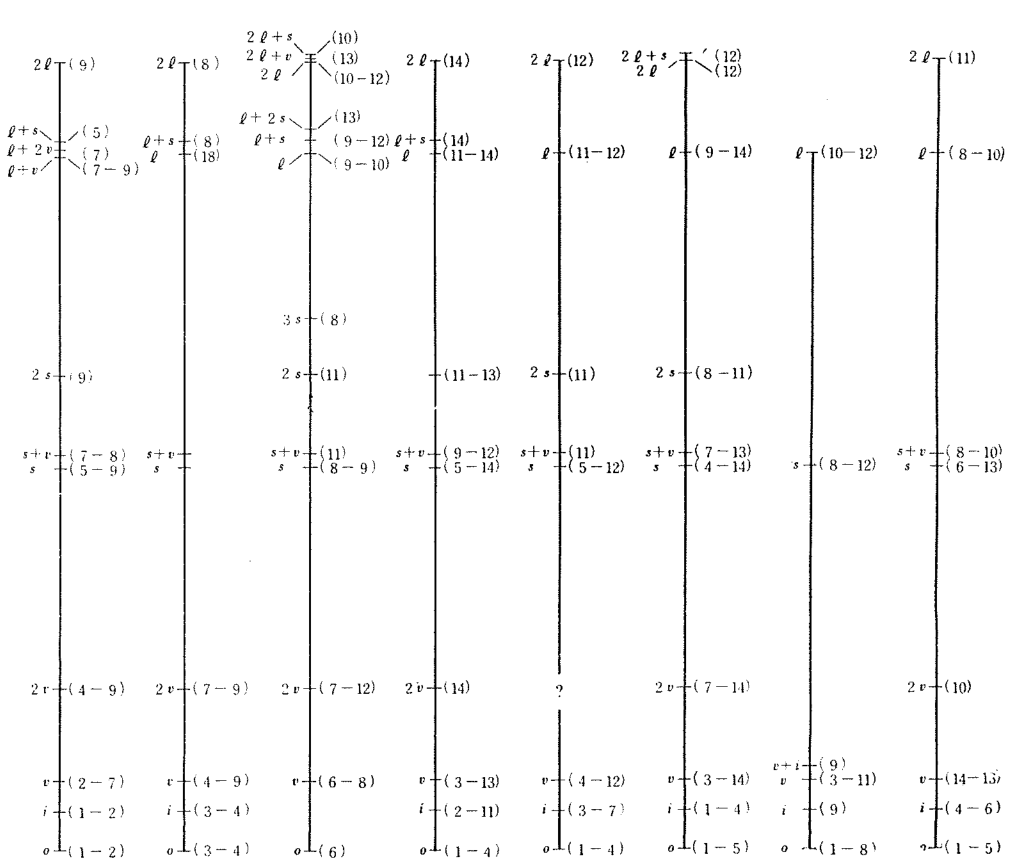

Neoschwagerina craticulifera
* *N. haydeni*

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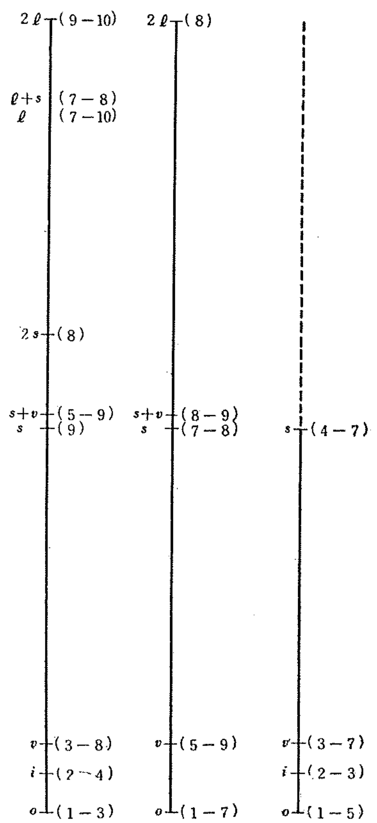

Neoschwagerina colaniae

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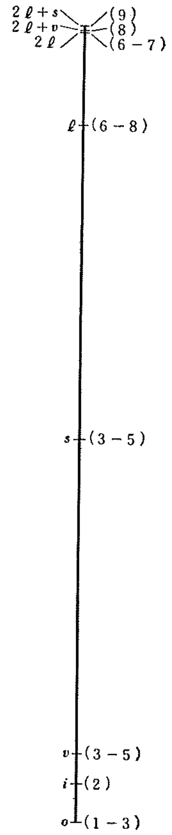

Neoschwagerina minoensis

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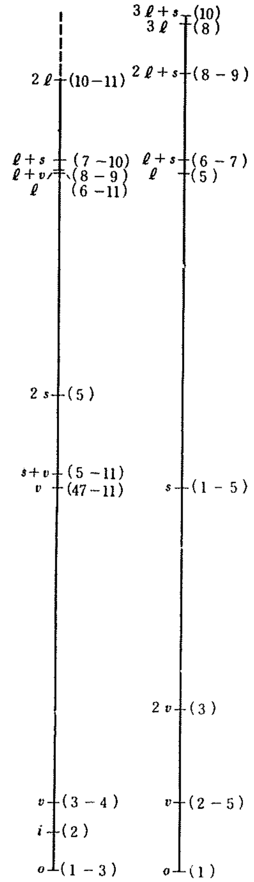

Gifuella douvillei

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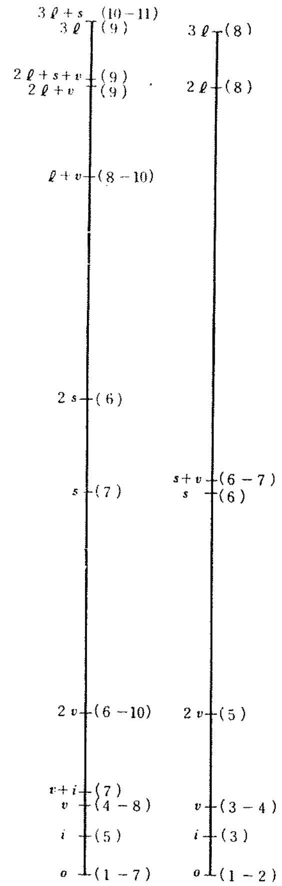

Yabeina texana

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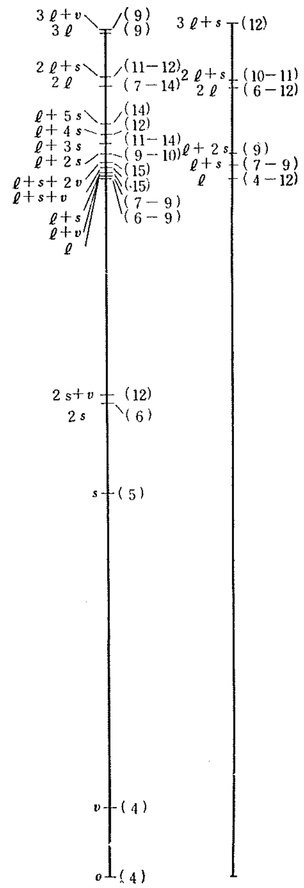
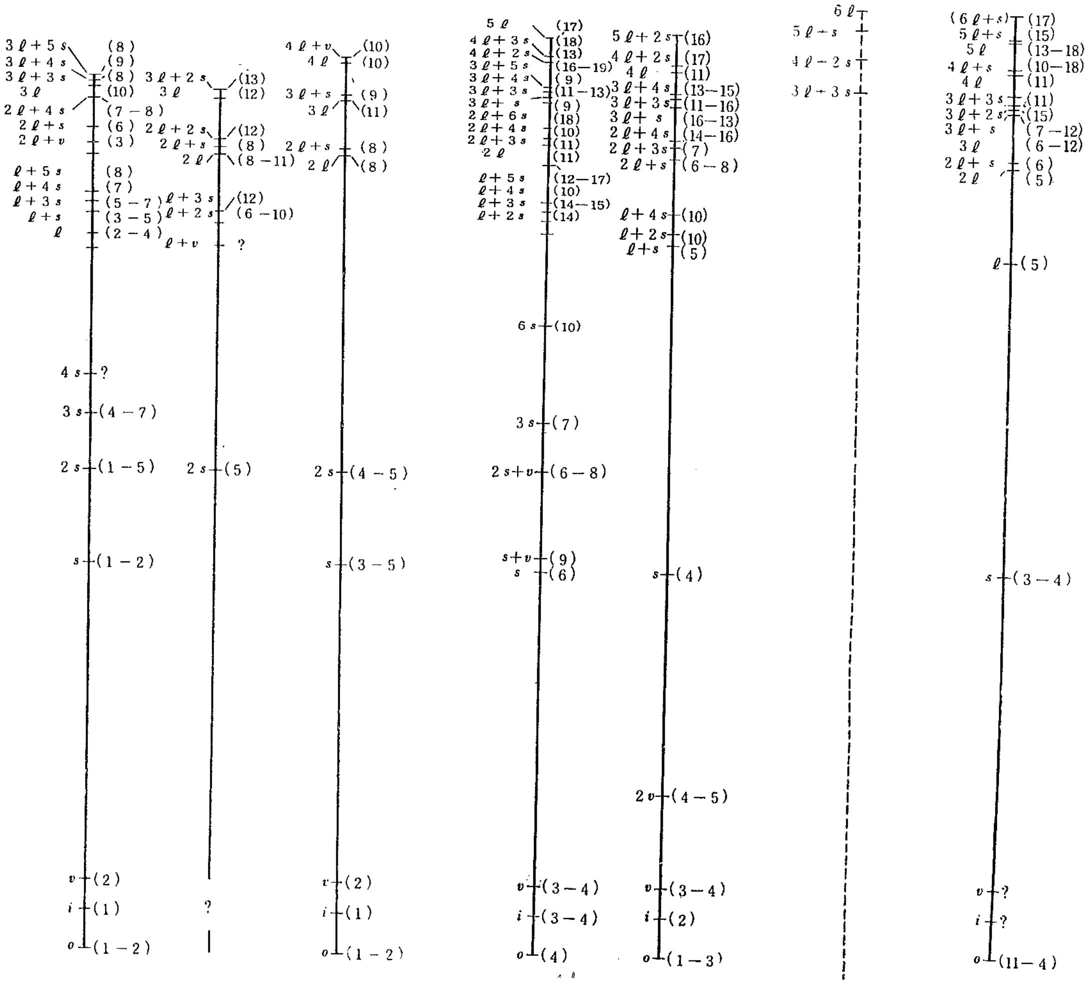


Yabeina ozawai

17 18 19 20



Lepidolina multiseptata *Yabeina globosa* *Gublerina elongata* *Yabeina katoi*

For instance, both *Minoella nipponica* and *Metaschwagerina ovalis* have *s* type of axial septulum as the most advanced form through their ontogeny. However, the former shows such a ontogeny from *o*, through *i*, *v* and $v+i$ to *s* type in respect to the ontogenical development of the axial septula, while the latter shows a series of *o*, *i*, *v*, 2*v* and *s*; thus there is found a slight difference in respect to the ontogeny of these two species regarding the development of the axial septula, whereas they have a similar type of axial septulum as the most advanced form. Similar cases are also observable in other species.

Following table shows the result of observation for each species regarding the most advanced types of axial septula.

TABLE 4.

Cancellina primigena HAYDEN	*i*
Minoella conipponica HONJO	*v*
Neoschwagerina simplex OZAWA	*v*
Minoella nipponica (OZAWA)	*s*
Metaschwagerina ovalis MINATO and HONJO	*s*
Afghanella schencki THOMPSON	3*s*
Sumatrina annae VOLZ	5*s*
Gifuella amicula HONJO	*l*
Neoschwagerina irregularis HONJO	$l+v$
Gifuella gifuensis HONJO	$l+s$
Neoschwagerina craticulifera (SCHWAGER)	2*l*
Neoschwagerina colaniae OZAWA	2*l*
Neoschwagerina haydeni DOUTKEVICH and KABHAKOV	$2l+s$
Neoschwagerina minoensis OZAWA	$2l+s$
Gifuella douvillei (OZAWA)	$3l+s$
**Yabeina texana* SKINNER & WILD	$3l+s$
Yabeina ozawai HONJO	$3l+s$
Lepidolina multiseptata DEPRAT	$4l+v$
Yabeina globosa (YABE)	$5l+2s$
Gublerina elongata (DEPRAT)	6*l*
Yabeina katoi OZAWA	$6l+s$

For the sake of convenience, logarithmic section paper will be here used in Table 3 to represent the distribution of types of axial septula for each volution of each representative specimen; the purpose is that the maximum development or the ontogeny regarding the axial septula for each species may be more easily understood.

If, $i=10$, $v=10^2$, $s=10^3$ and $l=10^4$,
$\log i=1$, $\log v=2$, $\log s=3$ and $\log l=4$
Plot those values on logarithmic section.

* This species is here treated for the sake of convenience of camparison, although if has been not yet found in Japan.

2 Phylogeny of the subfamily Neoschwagerininae

§ 1. Summary of the more important biocharacters of some neoschwagerinids.

The nature of the axial septula having been reviewed in detail, together with the more important biocharacters represented by the shape of the shell, size of proloculus, form of the transverse septula and the structure of the spirotheca, the authors became aware that the former views regarding the phylogeny of Neoschwagerininae held by various scientists should be revised in many important points.

For instance, *Lepidolina multiseptata* (DEPRAT) has been viewed to be a more specialized form than any other species belonging to the genus *Yabeina* s. 1., but that may be not true according to their recent observation on the axial sepula and their stratigraphical position.

Study of the stratigraphy in respect to the horizon of *Lepidolina multiseptata* has also proved that this species is decidedly much older than *Yabeina* globosa, as will be explained later in detail.

Further, *Neoschwagerina simplex*,→*N. craticulifera*,→*N. colaniae*,→ so called *N. margaritae* (=*Yabeina ozawai* HONJO),→*N. katoi* and *Yabeina globosa* bioseries having been established by OZAWA seems to have been long accepted to reconstruct the phylogeny of neoschwagerinids by various palaeontologists. Their views may be untrustworthy, because the stratigraphical distribution of that species can never justify such conclusion. The sequence of the first appearance of each species in the stratigraphical order, has been proven to be quite different from the one once supposed by OZAWA.

Besides, such species having been treated by such Japanese palaeontologists as OZAWA, FUJIMOTO, TORIYAMA and others as *Neoschwagerina margaritae* is never conspecific with the species first established by DEPRAT based upon the specimens of Indo-China; for the former species, the junior author proposed lately the new name *Yabeina ozawai* HONJO. Further, *Neoschwagerina cratifulifera* begin to appear at nearly the same horizon as *yabeina ozawai* at the strip of Akasaka; instead of that, OZAWA formerly stated it to be higher than *N. craticulifera* regarding the stratigraphical position. Such being the situation, the phylogeny having been presented until present day, must be revised in various points, for which the authors will later state their views.

Before going into the matter further, however ,all those biocharacters above enumerated should be tabulated in a concise form, for the sake of convenience. Most of those data shown in the table herewith are based on present writers' own observations on a number of representative specimens for each species, so far as they are available at presnt. †)

Cancellina primigena; After HAYDEN, collected from Afghanistan. after THOMPSON from Persia and after HUJIMOTO from Kwanto mountains.
* *Minoella eonipponica;* The author's collection from Akasaka.
* *Neoschwagerina simplex;* The author's, form Akasaka.
* *Neoschwagerina irregularis;* The author's form Akasaka.
* *Metaschwagerina ovalis;* The author's from Akasaka.
* *Giffuella amicula;* The author's from Akasaka.
* *Gifuella gifuensis;* The author's from Akasaka.
* *Neoschwagerina craticulifera;* After DEPRAT and OZAWA from Akasaka, and the author's collection from Akasaka.
* *Neoschwagerina colaniae;* The author's collection from Akasaka.
* *Neoschwagerina haydeni;* The author's collection from Akasaka, and after Doutkevich and Kabhakov.
* *Neoschwagerina minoensis;* After OZAWA from Akasaka, and the author's collection from Akasaka.
Gifuella douvillei; After GUBLER from Yunnan.
Yabeina texana; After SKINNER and WILD from Texas.
* *Yabeina ozawai;* The author's collection from Akasaka.
Lepidolina multiseptata; After DEPRAT from Indo-China.
* *Yabeina globosa;* The author's collection from Akasaka.
** *Gublerina elongata;* KATO's collection from Iwaizaki, and after GUBLER from Yunnan.

§ 2. Brief note on the former views of the phylogeny of neoschwagerinids and allied forms.

Much diverse views have been held among the paleontologists for the phylogeny of neoschwagerinids and allied forms. It may be necessary to use too much space to refer to all of them. The authors wish to refer only some of them tabled in concise form for the sake of convenience; these views seem to be more important. (Table 7, 1–7)

Comparing with those former views referred to here, everybody must be surprised how diverse views have been held until the present day.

†) Of them, an asterisk* means the species dealt with the specimens collected by the junior author at Akasaka, Central Honshu, two asteriska,** specimens collected by MATAJIRO KATO, Hokkaido Univ., at Iwaizaki, Kitakami mountains; all of them are now stored at the Department of Geology and Mineralogy, Hokkaido University; other data concerning the biocharacters for other species listed are based on the illustrations accompanied by references which have been published by OZAWA, DEPRAT, GUBLER, HAYDEN, THOMPSON, and SKINNER and WILD, which are sufficient enough to be available for the present writers' purpose.

TABLE

	Cancellina primigena HAYDEN	*Minoella eonipponica* HONJO	*M. nipponica* OZAWA	*Metaschwagerina ovalis* MINATO and HONJO
form	spheroidal	spheroidal	spheroidal	spheroidal
proloculus	medium	medium	medium	medium
spirotheca	moderate keriotheca	moderate keriotheca	moderate keriotheca	thick double keriotheca
transverse septula	—	low, V (in juvenile)	low, V	low, V
secondary transverse septula	—	—	—	—
axial seplula	*o* *i*	*o* *i* *v*	*o* *i* *v* *v*+*i* *s*	*o* *i* *v* 2*v* *s*

	Neoschwagerina irregularis HONJO	*Neoschwagerina haydeni* (D. and K.)	*Neoschwagerina colaniae* OZAWA	*Neoschwagerina minoensis* DEPRAT
form	bicone	bicone	bicone	constricted bicone
proloculus	minute	minute	minute	minute
spirotheca	moderate keriotheca	moderate keriotheca	moderate keriotheca	moderate rather thick keriotheca
transverse septula	nigh, V, or short I	long, V	large, V	large, I
secondary transverse septula	rare	rare	rare	—
axial seplula	*v* *i* *v*, 2*v* *s*+*v* 2*s*	*o* *i* *v*, 2*v* *s*, *s*+*v*, 2*s* *l*, *l*+*s* 2*l*, 2*l*+*s*	*o* *i* *v* *s*, *s*+*v*, 2*s* *l*, *l*+*s* 2*l*	*o* *i* *v* *s* 2*l* 2*l*+*v* 2*l*+*s*

5

Gifuella amicula HONJO	*Gifuella gifuensis* HONJO	*Gifuella douvillei* (DEPRAT)	*Neoschwagerina simplex* OZAWA	*Neoschwagerina craticulifera* (SCHWAGER)
elongate spheroidal	elongate spheroidal	elongate spheroidal	spheroidal	bicone
medium	medium	medium	medium	medium
moderate keriotheca	moderate keriotheca	moderate keriotheca	moderate keriotheca	moderate keriotheca
high, I	high, I	high, I	high, V	high, V
rare	rare	common	very rare	rare
o *i* *v* *v+i* *s* *2s* *l*	*o* *i* *v, v+i, v+s* *2v, 2v+i* *s, s+v 2s,* *s+i, 2s+v* *l, l+i, l+v*	*o* *i* *v* *s, 2s, s+v* *l, l+s* *l+v 2l*	*o* *i* *v*	*o* *i* *v, 2v* *s, s+v, 2s, s+2v,* *3s* *l, l+v, l+s, l+2v* *l+2v* *2l, 2l+s, 2l+v*

Yabeina ozawai HONJO	*Yabeina katoi* OZAWA	*Yabeina globosa* DEPRAT	*Sumatrina annae* VOLZ	*Afghanella schenki* THOMPSON	*Lepidolina multiseptata* (DEPRAT)
bicone,	spheroidal	bicone	fusiform	fusiform	bicone
spheroidal medium	minute	minute	medium large	minute (micro.)	large
moderate keriotheca	thin	moderate	thin	thin	thin no keriotheca
long	long, narrow	long, narrow	long	small V pendant	long
irregular	abundant	abundant	pendant	abundant	very abundant
3l, 3l+v, 3l+s	*v+s, 2v+s, v+s* *l+2s, 2l+2s, 3l* *3l+s, 3l+2s* *4l+s, 5l* *6l, 6l+5*	*o, i* *v, s* *s+v, 2s+v, 5s, 6s* *l+2s, l+3s, l+4s* *l+5s* *2l, 2l+3s, 2l+4s* *2l+6s* *3l, 4l, 5l, 5l+2s*	*3s* *4s* *5s*	*o* *v* *s* *2s* *3s* *4s*	*l+5l* *2l+s, 2l+v, 2l* *3l* *3l+2s, 3l+s* *3l+5s, 3l+4s* *4l+v, 4l*

Most workers, however seem to have agreed with each other in the point that they have viewed the genus *Lepidolina* to be the direct decendant of the genus *Yabeina*.

Excepting this point, they did not agree with each other. They held quite diverse views, even though they could agree on the common ancestral form of neoschwagerinids.

One of the main causes why such different opinions have been held seems to have been based upon the fact not only, how to see the bio-characters, but also in the ambiguity as to the stratigraphical distribution of species or genus belonging to Neoschwagerininae. So the authors wish briefly to present a summary in respect to the geological range of neoschwagerinids, found in Japan.

§ 3. Brief note on the stratigraphical distribution of some neoschwagerinids in Japan

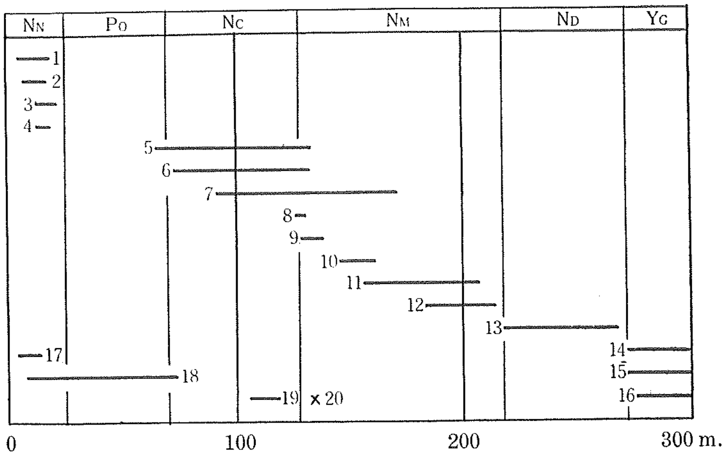
At the serior author's request a detailed stratigraphical survey has been made at Akasaka by the junior author with the purpose of determining the stratigraphical distribution there of each species belonging to Neoschwagerininae; the result has already been given by him in 1959.

However, he tried to check the geological range for each species, along only one route, chosen so as to settle the sequence of the beds. Accordingly, there may be still left some possibilities that the geological range of each species may be more extensive both downwards and upwards than he has reported.

Nevertheless, his observations may be far more reliable than any others, concerning the stratigraphical distribution of neoschwagerinids at Akasaka, because he tried to get specimens for each 0.5 to 2.5 m thickness along the long route carefully selected to give a perfect geological section without any interruption or repeating by faulting, folding or other disturbances.

His excellent results are concisely graphed in Table 6. Next, how to correlate the biozone of *Lepidolina multiseptata* (DEPRAT) to the geological section of Akasaka must be explained. According to the junior author, *Verbeekina verbeeki* (GEINITZ) seems to be very prevalent between the horizons indicating by the first appearance of *Neoschwagerina simplex*, and the horizon of the earlist stage of *N. craticulifera*, while *Verbeekina sphaera* first appears and distributes until the middle range of *Neoschwagerina craticulifera*. On the contrary, MORIKAWA and others who studied the fusulinid remains of the same place at the same time, held a view that *V. sphaera* has the geological range from

TABLE 6.



1. *Minoella eonipponica* HONJO
2. *Minoella nipponica* (OZAWA)
3. *Neoschwagerina simplex* (OZAWA)
4. *Neoschwagerina sphaerica* (M-MACLAY)
5. *Neoschwagerina craticulifera* (SCHWAGER)
6. *Neoschwagerina irregularis* HONJO
7. *Neoschwagerina haydeni* (DOUTKEVICH and KABAHKOV)
8. *Yabeina ozawai* HONJO
9. *Gifuella amicula* HONJO
10. *Gifuella gifuensis* HONJO
11. *Neoschwagerina colaniae* OZAWA
12. *Metaschwagerina ovalis* MINATO and HONJO
13. *Gifuella* cfr. *douvillei* DEPRAT
14. *Yabeina globosa* (YABE)
15. *Yabeina katoi* OZAWA
16. *Neoschwagerina minoensis* DEPRAT
17. *Verbeekina minatoi* HONJO (M. S.)
18. *Verbeekina verbeeki* (GEINITZ)
19. *Verbeekina sphaera* (OZAWA)

(20. *Lepidolina multiseptata* DEPRAT and *Gublerina elongata* (DEPRAT))

N_N : *Minoella nipponica* zone
P_O : *Pseudodoliolina ozawai* zone
N_C : *Neoschwagerina craticulifera* zone
N_M : *Yabeina ozawai* zone
N_D : *Gifuella douvillei* zone
Y_G : *Yabeina globosa* zone

the pre-*N. simplex* to the horizon of the first appearance of the same species, whilst *V. verbeeki* is distributed in the next zone higher than that of *N. cratifulifera* and at the same time, *V. verbeeki* first appears at the lowest horizon of *Yabeina ozawai.* (=so-called *N. margaritae* of MORIKAWA, non DERAT).

Thus among the scientists very diverse views are now held in respect to the geological distribution of *Verbeekina verbeeki* in the same strip of Akasaka. They agree with each other, however, in viewing the geological range of *Verbeekina verbeeki* to be lower than *Yabeina ozawai* (=so-called *Neoschwagerina margaritae* of OZAWA). Meanwhile MORIKAWA and others listed *Lepidolina multiseptata* as found at a horizon a little higher than the lowest zone of *Yabeina ozawai* at Akasaka. The present authors are now wondering whether or not the species called under the name of *Lepidolina multiseptata* by MORIKAWA and others may be entirely conspecific with DEPRAT's species.

Further, in the Iwaizaki district, specimens referable to *Lepidolina multiseptata* DEPRAT are to be found with certainty in the horizon immediately above the *Verbeekina verbeeki* limestone; there is only a few meter's thickness between the lowest horizon of *Lepidolina multiseptata* and uppermost horizon of *Verbeekina verbeeki.* So the stratigraphical position of *Lepidolina multiseptata* must be surely concluded to be in nearly the same horizon as *Yabeina ozawai,* instead of that horizon being much a higher zone of *Yabeina globosa,* as many palaeontologists have formerly held.

Also, it must be noted, *Gublerina elongata* (GUBLER) is to be found at Iwaizaki in association with *L. multiseptata* and *Verbeekina verbeeki.* Then, the biozone of *Cancellina primigena* must be taken into consideration.

According to HUZIMOTO, *Cancellina primigena* was found somewhere around the Kwanto mountains in Japan, in association with a species referable to *Pseudofusulina ambigua* DEPRAT.

On the other hand this species was already reported having been found in Afghanistan in association with *Neoschwagerina-Verbeekina* fauna.

Accordingly, the geological range of the genotype of the genus *Cancellina* should be shown as in Text-Fig. 2, which may surely be a range from the *Parafusulina* zone to the lower half of the *Neoschwagerina* zone.

Meanwhile, so-called *Lepidolina? gigantea* TORIYAMA has been newly settled in respect to the stratigraphical horizon, which should be regarded to be surely higher than at least the upper boundary of *Neoschwagerina* zone and may be nearly equivalent to the horizon of *Yabeina globosa* zone in rough estimation.

There is no possibility that this species is stratigraphically situated

TABLE 7, 1 DEPRAT, 1912

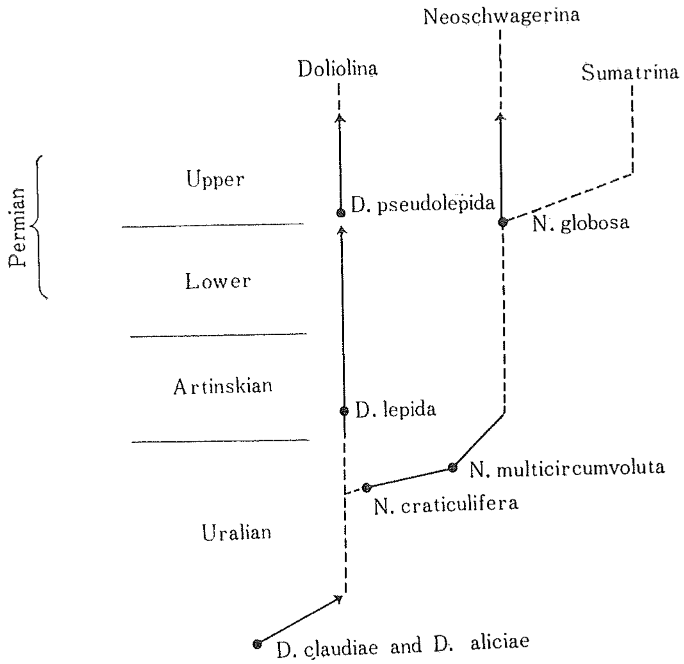


TABLE 7, 2 OZAWA, 1925

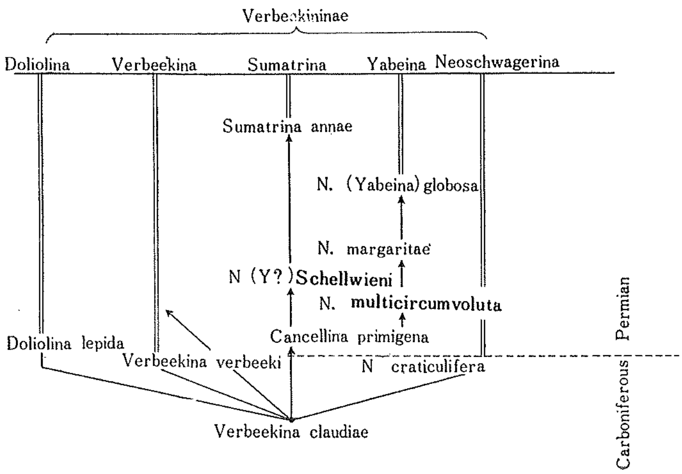


TABLE 7, 3 OZAWA, 1927

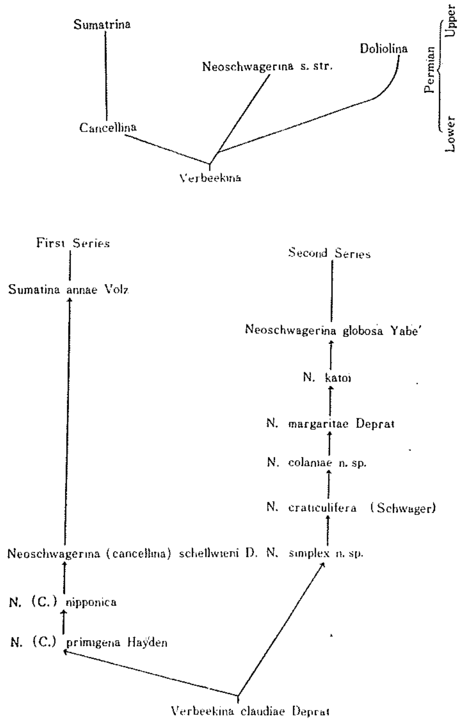


TABLE 7, 4 LEE, 1934,

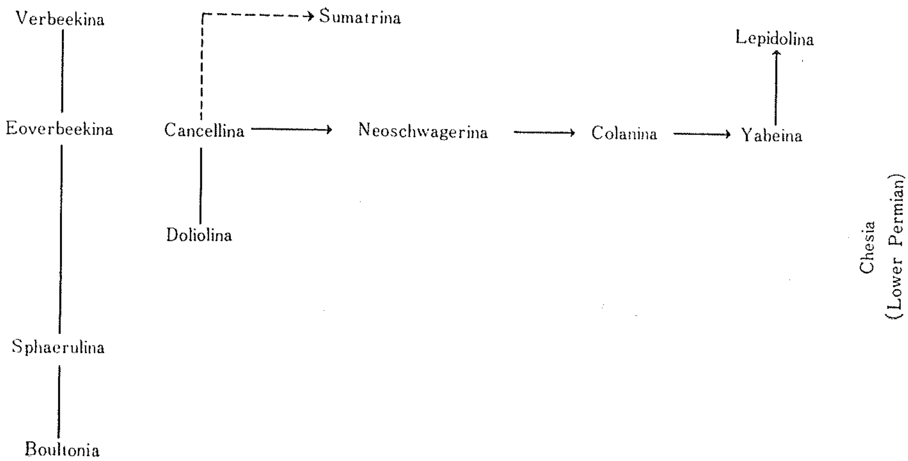


TABLE 7, 5 THOMPSON, 1948

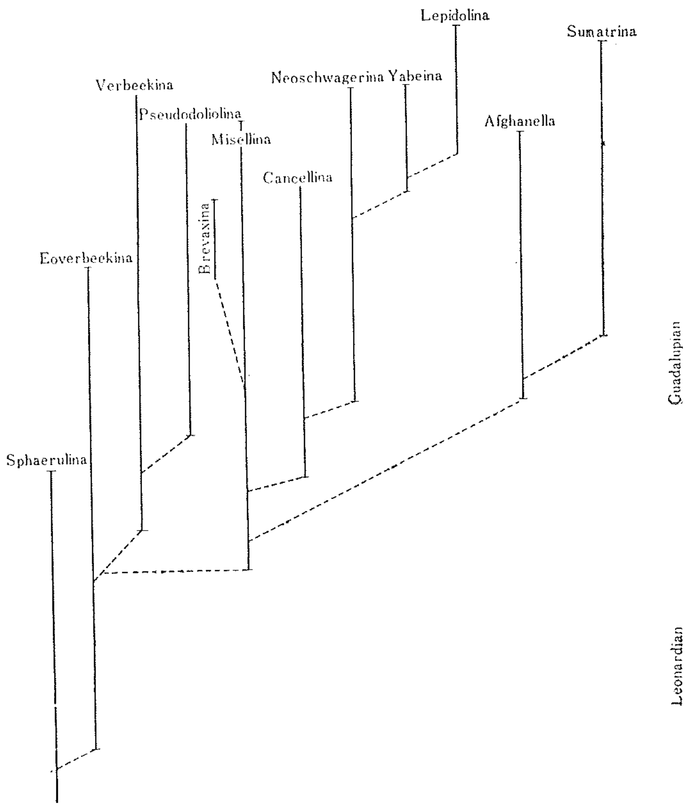


TABLE 7, 6 YABE, 1948

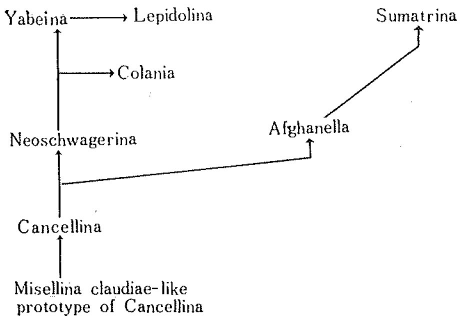
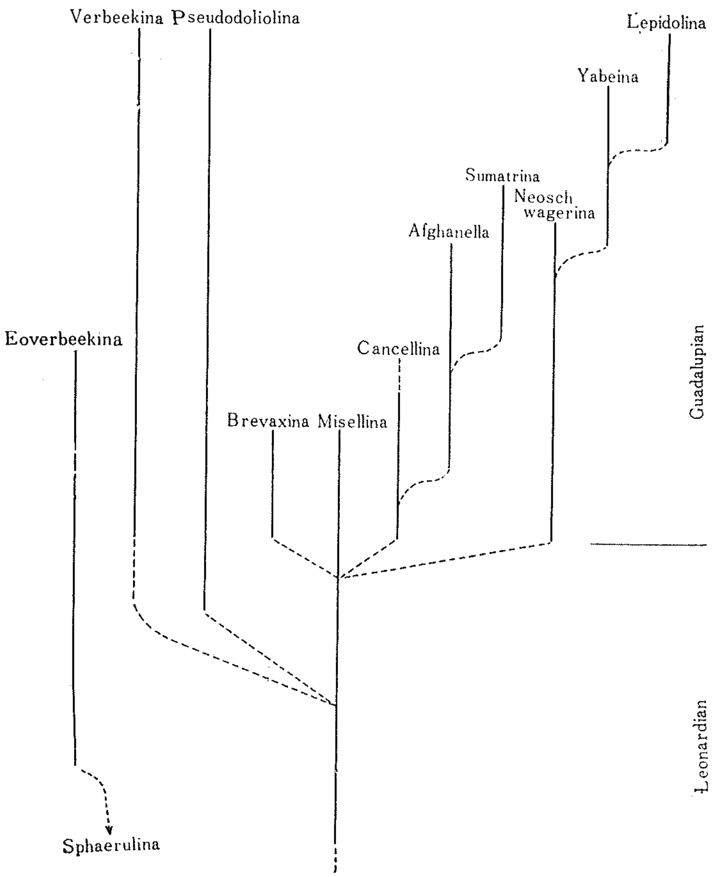


TABLE 7, 7 KANMERA, 1957



in horizon higher than that of *Yabeina globosa.*

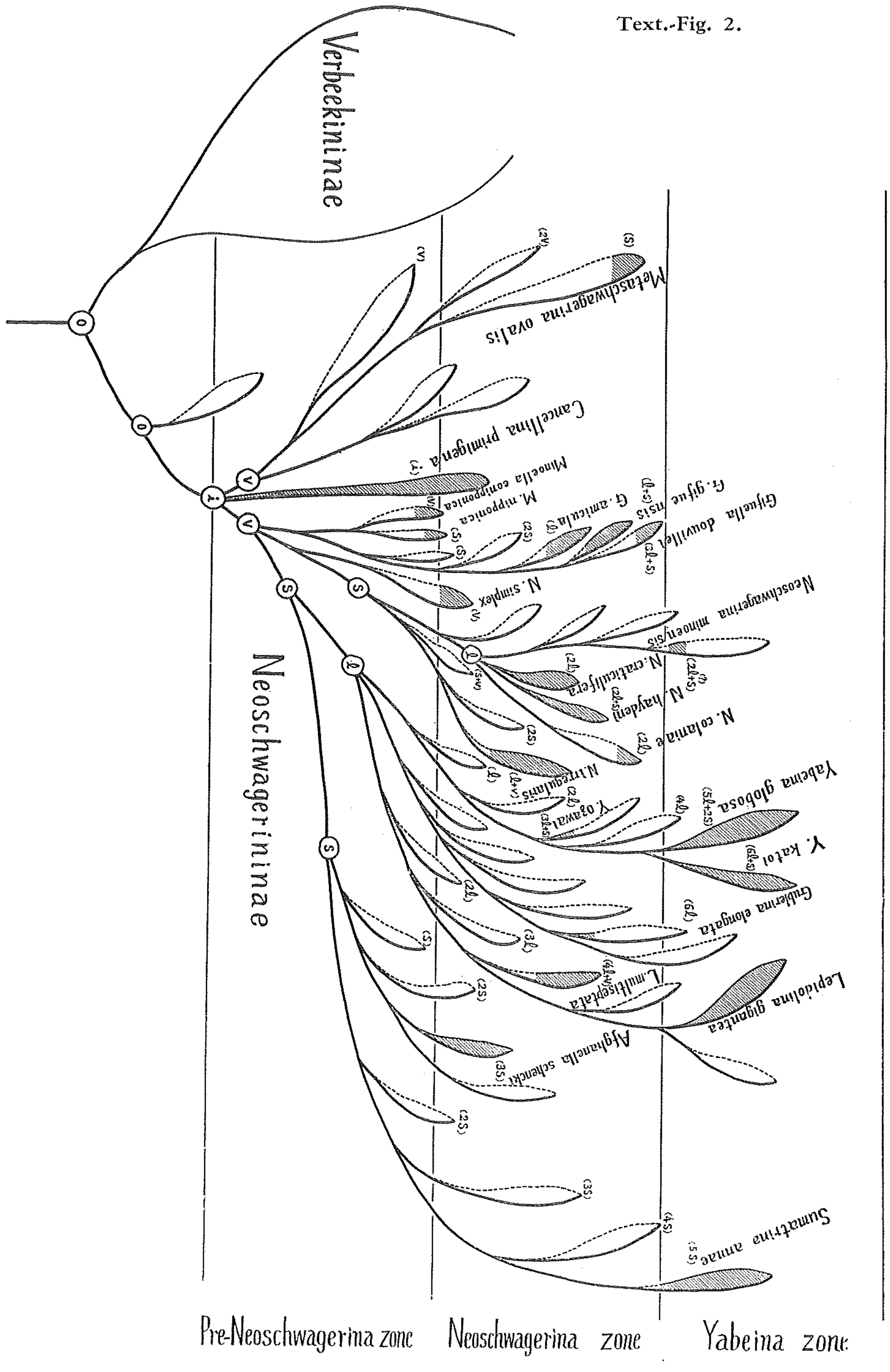
§ 4. Phylogeny of Neoschwagerininae newly compiled

The phylogeny of Neoschwagerininae newly compiled is here shown in Text-Fig. 2.

This has been done on the basis of the stratigraphical data in respect to the geological distribution combined with the bio-characters of each species.

In this case, the bio-characters for each species are fully taken into consideration not only in respect to the mature stage, but also to their ontogeny. Especially, much attention has been paid by the present writers

Text.-Fig. 2.


Verbeekininae
Neoschwagerininae
Metaschwagerina ovalis
Cancellina primigena
Minoella conipponica
M. nipponica
G. amicula
Gr. gifuensis
Gifuella douvillei
N. simplex
Neoschwagerina minoensis
N. craticulifera
N. haydeni
N. colaniae
N. irregularis
Y. ogawai
Yabeina globosa
Y. katoi
Gubleria elongata
L. multiseptata
Lepidolina gigantea
Afghanella schencki
Sumatrina annae
Pre-Neoschwagerina zone
Neoschwagerina zone
Yabeina zone

to the ontogenical development of the axial septula.

Needless to say, the size of shell, form of shell, size of proloculus, nature of transverse septula, secondary septula, their frequency of appearance throughout their development, appearance of pendant-shaped septa, the structure of spirotheca, etc. have also been fully taken in consideration.

In short, Neoschwagerininae must be separated into two major divisions based upon the different evolutional trends. One of the divisions might show a trend for their spirotheca to increase in thickness, while the reverse is the situation in the other group. The former is represented by the *Metaschwagerina* bioseries, which has finally a double keriothea in mature stage. The latter is represented by all species belonging to Neoschwagerinae except *Cancellina,* which may be regarded as presumedly like the imaginary common ancestral form of Neoschwagerininae except for slight differences.

The latter may be again branched into many different bio-series, which will be later considered more in detail.

Subfamily

Neoschwagerininae DUNBAR and CONDRA, 1928

The subfamily Neoschwagerininae DUNBAR and CONDRA, 1928 includes some of the most highly complex of the fusulinids.

Members of the subfamily are found from the upper zone of the so-called *Parafusulina* zone to the uppermost known fusulinid zone.

Mature specimens of the subfamily have a range in maximum diameter from about 3 mm to more than 22 mm. The largest one which has ever been found in Japan is *Lepidolina gigantea* TORIYAMA, collected by the senior author from the highest fusulinid zone in the Kitakami district, northern Honshu, Japan; its length reaches more than 20 mm. The maximum diameter of all forms is along the axis of coiling.

Shell may be inflated fusiform in either with short or long axis, while there may be such forms as spheroidal, spherical, biconical and constricted biconical. The spirotheca of primitive genera is composed of a tectum and lower thick layer composed of distinct keriotheca. More advanced forms have rather thinner spirotheca and are apt to lack keriothecal structure at least in the later volutions. Also such forms can be found among the highly specialized species whose alveoli become much thinner in the outer volutions, so that they (the alveoli) are apt to be misunderstood as having been lost. The finer the alveoli may be, the more compact the keriotheca become, so that the keriotheca are sometimes misunderstood to be free from alveoli.

The most characteristic feature of this subfamily is in having septula besides septa. There are two kinds of septula: axial septula and transverse septula. Foraminina and parachomata are present in all genera.

The subfamily Neoschwageriniae is distinguishable from the subfamily *Verbeekininae* by the presence of septula in the former.

The former is also distinguished from the latter in having more fine alveoli than the latter. The subfamily *Neoschwagerininae* includes the following genera: *Cancellina, Minoella, Metaschwagerina, Neoschwagerina, Gifuella, Yabeina, Gublerina, Afghanella, Sumatrina* and *Lepidolina*. *Neoschwagerininae* are confined to the Tethys sea area of northern Africa, southern Europe, southeastern, southern and eastern Asia, the east Indies, Japan and northwestern North America. The most primitive genus, *Cancellina*, appeared in the middle Permian as stated already, and advanced forms occur in the later half of the middle Permian.

Genus *Cancellina* HAYDEN, 1909

Until the present, only one species which can be belonged to this genus has been ever reported in Japan; it is the species identified by FUZIMOTO, 1936, to the genotype of this genus. He described this species on the basis of materials derived from the limestone outcrops in some places of the Kwanto mountain. From the figures presented by him, as fig. 8 in plate 10, the authors agree with him in specific identication.

According to FUZIMOTO, his specimens were found in association with a species referable to *Pseudofusulina ambigua* (DEPRAT) with slight doubt. So he believed that *Concellina primigena* (HAYDEN) of Japan may be "Uralian" in age. His view regarding the stratigraphical position of this species however, must be somewhat revised.

It seems very probable that this species was found in the limestone to be correlated to the *Parafusulina* zone instead of the "Uralian".

Neoschwagerina simplex (OZAWA), *Minoella nipponica* (OZAWA) etc, were commonly assigned into the genus *Cancellina* by a few Japanese palaeontologists, but it may not be correct. So far as the genotype of this genus is concerned, the transverse septula are only weakly developed in *Cancellina*.

Further, there are neither secondary transverse septula nor any specialized axial septula excepting that the axial septula such as *i* type are occasionally to be found.

Parachomata are numerous in the genus *Cancellina* and sometimes become relatively high. But the genotype, whose inner volutions are very tightly coiled, is sometimes lacking or at least indistinct in parachomata, even in the early volutions.

Form, spheroidal in the axial section in this genus. The genus is also quite characteristic in having rather smaller shell than most members of the subfamily *Neoschwagerininae.*

Axial septula; *o,* and *i.*

Genotype: *Neoschwagerina primigena* HAYDEN, 1909, Geol. Surv., Records, vol. 39, p. 249, pl. 22, figs. 1-7. Holotype was designated by THOMPSON as the specimen illustrated by HAYDEN as fig. 1, pl. 22.

Remarks: From the smaller size of shell, sheroidal form, weak development of transverse septula, this species must be regarded to be the most primitive form belonging to *Neoschwagerininae* known until the present day. The authors do not know the exact geological range of this genus. So far as the genotype of this genus is concerned, however, it has been found in Japan at a horizon somewhat lower than the *Neoschwagerina-Verbeekina* zone. In Afghanistan, the genotype was found, according to THOMPSON, from the Bamian limestone in association with *Yanchienia haydeni, Schwagerina furoui, Polydiexodina afghanensis, Verbeekina verbeeki, Neoschwagerina cratifulifera haydeni* and *Afghanella schenki.*

Of those fusulinid remains above listed, however, the neoschwagerinid called by THOMPSON under the name of *Neoschwagerina cratifulifera haydeni* may not belong to the species, but may be *N. simplex.*

Accordingly, the genotype of this genus seem to have a long geological range extending from the *Parafusulina* zone to the lowest part or lower half of the so-called *Neoschwagerina-Verbeekina* zone. Anyhow, the genus should be regarded to be one of the most primitive forms among neoschwagerinids known until present. And it seems highly probable that this form might be first among neoschwagerinids, even though the geological range of some species belonging to this genus is more extensive towards a higher horizon as so-called *Neoschwagerina-Verbeekina* zone.

The genus *Cancellina* seems to have evolved from such ancestral form which might have no transverse septula nor axial septula, and at the same time whose alveoli might be very coarse like common species belonging to *Neoschwagerininae,* including *Cancellina* itself. Further there might be such a thing as an ancestral form of the genus *Cancellina* which might have no septula but possess rather coarse alveoli like the genus *Cancellina* itself.

Besides, there might be also another form whose alveoli might be as coarse as the *Cancellina*, but possess transverse septula, even though it lacked any type of axial septula.

Of them, the first mentioned form is nothing but *Misselina*. Speaking in general, there might be yet a common ancestor between Verbeekininae and Neoschwagerininae, besides *Misselina* itself. (see Text-Fig. 2)

Genus *Minoella* HONJO, 1959

Minoella has low transverse septula in the early stage of ontogeny, but those septula show inclination to decrease in height in the later volutions. Finally the septula become absent in most outer volutions. Secondary transverse septula are very seldom to be found. Form spheroidal. Shell small.

Axial septula are only represented by *o*, *i* and *v*.

Genotype: *Cancellina nipponica* OZAWA, 1927.
Horizon: Uppermost *Parafusulina* Zone.

Remarks: The difference between *Minoella* and *Neoschwagerina* is this, that the former has more primitive and simple axial septula, besides the former has transverse septula which are very low and apt to decrease in height or to be lost towards the outer volutions.

At present, only two species are known which may be assignable into the genus *Minoella*, including the genotype. Both of them are to be found at a little lower horizon than that of *Neoschwagerina simplex*, at least in respect to the horizon of the first appearance, although the upper range of *Minoella* extends as far as the lower half of the range of *Neoschwagerina simplex*.

From the common ancestor between *Metaschwagerina* series and another series including all neoschwagerids except for *Cancellina*, two main branches might have existed during the time represented by the lowest or lower *Parafusulina* zone in age.

The branching seems to have been occurred in a form whose axial septula were *v* form.

The next branching might have occurred in one of them and may have evolved towards *Minoella* and *Gifuella* series. *Minoella* bio-series shows an evolutional trend, in which the specialization gradualy accelerates in degeneration of transverse septula.

Genus *Metaschwagerina* MINATO and HONJO, 1958

This genus is quite characteristic in having thick spirotheca from the inner volutions, which possess rather coarse alveoli. The keriotheca become separated into two layers in the outer volutions; the upper of them has relatively fine alveoli in contrast to rather coarser ones of the lower layer.

The transvers septula of this form resemble the ones found in *Neoschwagerina simplex.* Secondary transverse septula are entirely lacking in this genus.

Axial septula are as follows: *i, v, 2v,* and *s.*

Genotype: *Metaschwagerina ovalis* MINATO et HONJO, Frontispiece of "Earth Science" (Chikyu Kagaku), no. 38, 1958.

Horizon: The upper half of the *Neoschwagerina* zone.

Remarks: At present, this genus is monotypic; its stratigraphical position is slightly higher than *Neoschwagerina haydeni* zone and subequal with the upper half of *Neoschwagerina colaniae* zone. This species has rather simple and primitive axial septula, although it is stratigraphically situated in comparatively higher horizon as a member of neoschwagerinids.

In this regard, this form may be a more advanced form than *Cancellina, Minoella,* and most primitive species of *Neoschwagerina* as *N. simplex* OZAWA, but must be decidedly regarded to be a rather more primitive form than any other known species belonging to the genus *Neoschwagerina,* except for *N. simplex.*

So, this genus seems to have evolved with an evolutional trend that the alveoli become always coarser instead of the axial septula becoming complicated.

As is known, all the species belonging to Neoschwagerininae have coarser alveoli in their spirotheca than that of Verbeekininae; the genus *Metaschwagerina* may exhibit the most specialized form in this trend. It is the form that finally came to have double layers of keriotheca.

In the course of the evolution of this species, there might be perhaps those forms which had a single layer of keriotheca, whose alveoli were yet very coarse, and which possessed at the same time such axial septula as *i* or *v* types.

Also, the direct ancestor of the genotype of the genus *Metaschwagerina* might be a form whose axial septula might be *2v*, and whose spirotheca might be composed of double layers of keriotheca besides tectum, at least in the outer volutions.

This is suggested sufficiently in the ontogeny of this species. In future, all those species above noted may be found and their geological distribution may be roughly expected as is schematically given in Text-Fig. 2, showing the phylogeny of Neoschwagerininae.

Probably, this bio-series may be branched from the common ancestor between *Minoella*, *Gifuella* and *Metaschwagerina* itself in the Pre-*Neoschwagerina* stage. The age might be represented by the *Parafusulina* zone.

Genus *Gifuella* HONJO

Form elongate spheroidal, that is to say, spheroidal with comparatively long axis.

Transverse septula abundant throughout the life history. Secondary transverse septula are also present, although they are only few. Axial septula are the following: *i, v, v+i, 2v, s, s+v, l* and *l+s*.

Genotype: *Gifuella gifuensis* HONJO, 1958, plate 7, fig. 3.
Horizon: Upper *Neoschwagerina* Zone.

Remarks: At present, three species have been found in Japan which should be surely assinged into this genus: *Gifuella amicula* HONJO, *G. gifuensis* HONJO and *Gifuella douvillei* (DEPRAT).

Their geological distribution at Akasaka is shown in Table 6. According to this Table, one becomes aware of the fact that the lower the stratigraphical hozion may be, the more primitive the forms appear in respect to the axial septula.

As will be later stated in detail, the authors are of the opinion that from the ancestral form which might be much like *Neoschwagerina simplex* whose most advanced axial septula is *v*, many branchings might have occurred before the dawn of the *Neoschwagerina-Verbeekina* age.

Prior to such branching, however, another branching might have already occurred from the common ancestral form which might have axial septula of *v* type, too; one which must be regarded to be represented by *Minoella-Gifuella* bioseries, and yet another one which may be represented by most other *neoschwagerinids* as is shown in Text-Fig. 2.

Gifuella series seems to have been evolved trends for their outer form to become more elongate, their transverse septula higher, and the axial septula to be more complicated and specialized. The secondary transverse septula begin to appears, too. Probably, the branching towards the *Minoella* and *Gifuella* bio-series might have happened prior to the age of the first appearance of *Minoella*.

Genus *Neoschwagerina* YABE, 1903

The genus *Neoschwagerina* YABE is the oldest generic name in the subfamily *Neoschwagerininae*.

The shells are small, but larger than those of *Cancellina* and *Minoella*. Sometimes they are elongate spheroidal in form, having a straight axis of coiling, steep convex lateral slope, and bluntly pointed to narrowly rounded poles, and sometimes constricted bicone.

The transverse septula develop throughout the shell, but the secondary transverse septula are rather seldom to be found, especially in the outer volutions.

The highly specialized form may have axial septula a little more complicated than those of *Gifuella* but not so complicated as those found in *Yabeina* and *Lepidolina*.

The axial septula are as follows: *i, v, 2v, s+v, s+2v, 2s, l, l+v, l+2v, l+s, 2l, 2l+v*.

Genotype: *Schwagerina craticultifera Schwager*, 1883 (in von *Richthofen's* China, Bd. 4, p. 140-143, pl. 18, figs. 15-20. Holotype was designated by THOMPSON as the specimen illustrated by SCHWAGER as fig. 17 in pl. 18.

Horizon: *Neoschwagerina* zone.

Remarks: As already stated, many branchings seem to have been already occurred from such form as a common ancestor whose axial septula might be *v*, like *Neoschwagerina simplex*.

From this common ancestor, *Neoschwagerina simplex* might have first branched. Then the groups of *Neoschwagerina cratifulifera,* and *Neoschwagerina irregularies* might be branched.

Naturally there might have occurred many branchings to bring into existence many other different species, even though they have not yet been found. So, the authors wish to trace those two branches represented by *N. craticulifera* and *N. irregularis*. *Neoschwagerina craticulifera* which seem to have been branched into at least three forms; one of them is *N. haydeni* whose axial septula became slightly more advanced in form than the preceding species, although no marked specialization can be perceived in other biocharacters, except that the transverse septula show a tendency to be longer and narrower.

Another branch might be evolved to show a trend in which the shell form become changing. Such a species as *Neoschwagerina minoensis* may be one highly specialized in this trend whose shell is constricted bicone in outline, being quite different from *Neoschwagerina cratifulifera*, although no marked changes have occurred in the axial septula of this species.

It must be noted, there may perhaps be many species surely linking *N. simplex* to *N. craticulifera*, or *N. craticulifera* to *N. minoensis*, although their existence has unfortunately not been proved until the present day.

This is, moreover suggested not only by the facts of the geological distribution of each species above noted, but also from the ontogeny. *Neoschwagerina colaniae* may nearly resemble *N. haydeni;* but the branching of those two might be held to have occurred from the common ancestor of *N. curaticulifera* and *N. haydeni.* The transverse septula of *N. colaniae* are as narrow as these of *N. haydeni*, but there are customary to be perceived a few notches of special form in the former, especially in the outer volutions. *N. irregularis* bio-series is represented by only one species of *N. irregularis* at present, which might be a little later branched from the common ancestor whose shell might be much like that of *Neoschwagerina simplex*, but might have *s* type of axial septula. *N. irregularis* is characteristic in having mixed transverse septula of *Neoschwagerina* and *Yabeina* type, especially in outer volutions; also its axial septula are less complicated than those specialized species belonging to *Neoschwagerina* as *N. craticulifera, N. craticulifera var. haydei, N. colaniae* and *N. minoensis.*

The difference between the three genera, *Yabeina, Lepidolina* and *Gublerina* and the genus *Neoschwagerina* is this; the latter has constantly rather thicker spirotheca than the former three, the former three ganera have more numerous secondary transverse septula than *Neoschwagerina*; further those secondary transverse septula can be seen even in the inner volutions in the genera *Yabeina, Lepidolina* and *Gublerina*, whereas they are confined to the outer volutions of the genus *Neoschwagerina.* The axial septula are more complicated in the former three than in the latter. Further, pendant form septa are seldom to be found in the three genera *Yabeina, Lepidolina* and *Gublerina*, while they are completely lacking in the genus *Neoschwagerina.*

Genus *Yabeina* DEPRAT, 1914

This genus is different from the genus *Neoschwagerina* in having more numerous *l* type of axial septula than the latter, besides, the former has thinner and lath shaped transverse septula, while they are very broad at their base in the genus *Neoschwagerina*. In the genus *Yabeina*, the transverse septula become far narrower than those found in the *Neoschwagerina*; this is especially true in the later volutions. Moreover, the secondary transverse septula appear in earlier volutions compared with *Neoschwagerina*. Besides, the transverse septula are found to be more numerous in *Yabeina*. Of course, the axial septula are quite different between *Neoschwagerina* and *Yabeina*, in their types and number regarding which the authors intend to write later more in detail.

As has already been stated, the spirotheca of *Yabeina* may be thin in some forms. A form such as *Yabeina katoi* shows an inclination for the spirotheca to become thin already in the inner volutions. On the contrary, the spirotheca of *Y. globosa* seem to be thin towards the outer volutions. Anyhow, it is quite true, that *Yabeina* has spirotheca somewhat thinner than that of *Neoschwagerina*. However *Yabeina* has spirotheca which are never free from keriotheca at every volution.

Even in *Yabeina globosa* whose spirotheca has been believed to loose alveoli in the last volution, the spirotheca is, however observed to keep alveoli through the life history of the creature. The authors have tried to make certain about this point by careful observation based upon perfect specimens in excellent preservation. In *Yabeina ozawai*, the spirotheca is not distinguishable from that of common species of *Neoschwagerina*, whose alveoli are rather coarse throughout its ontogeny. On the contrary in such species as *Yabeina globosa* and *katoi*, it is quite true that the spirotheca sometimes becomes thinner and the alveoli become finner, especially in the outer volutions. But if one observes them carefully under high magnification, can surely ascertain the presence of alveoli in *Yabeina* throughout its ontogeny, although they become much thinner towards the outer volutions; such fact must have led the former scientists to misunderstand them to be a compact layer, instead of keriotheca.

As will be later stated, *Yabeina, Gublerina, Lepidolina, Afghanella* and *Sumatrina* bio-series have a common ancestor whose shell may be very much like *Neoschwagerina simplex*. In what age this branching might have occurred is presumed in Text-Fig 2. From this common ancestor whose most advanced axial septula might be *v*, two branchings might occurred at first. One of them might be branched into *Yabeina, Gublerina* and *Lepidolina*-group, the other one into *Afghanella* and *Sumatrina*-group. *Yabeina* bio-series might have evolved showning a trend in which axial septula became complicated, although the shell form did not greatly change.

Genotype: *Yabeina inouyei* DEPRAT, 1914, Indochina Service Géol. mém., vol. 3, fasc. 1, pp. 30-34, text. 6, 7a, pl. 6, figs. 4-10, pl. 7, figs. 1, 2. Holotype, pl. 6, figs. 4.

Genus *Gublerina* nov.

So-called *Yabeina elongata* GUBLER has usually been believed to be a more advanced form than *Yabeina globosa*.

However, the stratigraphical horizon, especially in respect to that of the first appearance of *Gublerina elongata* (GUBLER) is surely far lower than that of *Yabeina globosa*. *Gublerina elongata* (GUBLER) may be nearly as low as *Lepidolina multiseptata* or *Yabeina ozawai* HONJO in respect to the horizon of the first appearance.

The early ontogenical stage of *Gublerina elongata* is closely resemble to *Neoschwagerina simplex*, in septa, septula, and spirotheca, but not in the form of shell. The early stage of *G. elongata* has a biconical shell whose lateral slope is rather straight like *N. craticufera*, besides the pole regions are rather pointed.

On the contrary, *N. simplex* has a shell rather spheroidal in form, whose pole region is rounded. Anyhow, *Gublerina* bio-series seems to have been branched from the common ancestor which resembled *N. simplex* in much earlier age than *Yabeina globosa*.

Through careful observation of each stage of ontogeny regarding *Gublerina elongata*, the authors cannot but help come to the view that *Gublerina* bio-series might not have branched from such a highly specialized form as *Yabeina globosa*.

Surely, *Gublerina* bioseries might be branched from the common ancestor between *Yabeina* and *Lepidolina*, in the earlist stage of *Neoschwagerina* zone or a little earlier age than that.

Genus *Gublerina* is characteristic in having much elongated shell in the mature stage, although it is spheroidal with rather short axis in the early stage. This genus* is also characteristic in having spirotheca with alveoli throughout its life history and possessing axial septula of highly complicated combinations.

The axial septula of the genotype of this genus became very complicated, which are: $3l+3s$, $4l+2s$, $5l+s$, $6l$.

In this regard this species may be comparable to a highly specialized form such as *Yabeina globosa*. However, the genotype has the shell far

* It is quite true, if it would be observed in high magnification.

more elongated than such species, as *Yabeina globosa* or *katoi*, or *ozawai*. Further the proloculus of this species is very large, like common species belonging to *Lepidolina*.

There may be at least a few species which should be assigned into the genus *Gublerina* besides the genotype. Of those species having been described from the Japanese Permian under the generic name of *Yabeina* or *Lepidolina*, there may certainly to be found species which are surely congeneric with *Gublerina elongata*.

But the authors would be offering conclusive remarks on this matter until the time when more detailled study will have been finished on more perfect specimens of each species.

Genotype: *Yabeina elongata* GUBLER 1935, pl. 8, figs. 1, 2, 5, and 12.

Gnus *Lepidolina* LEE, 1933

The genus *Lepidolina* has customary been considered the most highly evolved from being derived from *Yabeina*. Is there any sure indication that the genus *Lepidolina* should be regarded to be a direct decendant of such highly specialized forms of the genus *Yabeina* as *globosa* or *katoi*?

Yabeina globosa, whose spirotheca becomes thin towards the outer volutions, is apt to be misunderstood to be free from keriotheca at least in the last volution. In the genus *Lepidolina*, the spirotheca is thin and is composed of dense opaque material being quite free from alveoli, in the outer volutions, although the keriothecal structure can be clearly observable in the inner volutions.

In this regard, the genus *Lepidolina* must be generically distinguished from both *Yabeina* and *Gublerina*, putting aside the problem for a while, whether or not the genus *Lepidolina* should be regarded as a more advanced form than the latter.

In the genus *Lepidolina* the transverse septula are very thin, and the secondary transverse septula first appear in the inner two or three volutions. Also pendant-shaped septa are seldom to be found. The axial septula are as follows: *o, i, v, s, 2s, 3s, 4s, l, l+v, l+s, l+2s, l+3s, l+4s, l+5s, 2l, 2l+v, 2l+2s, 2l+4s, 3l, 3l+s, 3l+2s, 3l+4s, 3l+5s, 4l, 4l+v*.

Genotype: *Neoschwagerina (Sumatrina) multiseptate* DEPRAT, 1912. Indochina Service Géol. Mém., vol. 1, fasc. e, pp. 53-55, pl. 3, figs. 2-8. (Holotype was designated by THOMPSON as the specimen illustrated by DEPRAT fig. 3 in pl. 3)

Genus *Afghanella* THOMSON, 1946

In Japan, there have been found at least two species belonging to the genus *Afghanella,* one of which may be entirely conspecific with the genotype of this genus, while the other one is *A. ozawai* HANZAWA.

The shell of the genus *Afghanella* THOMPSON is rather small.

The shell may be ellipsoidal in form.

These spirotheca is very thin, and is composed of tectum and a lower thin layer possessing of fine alveoli. But such keriothecal structure is apt to be hardly observable in some parts of the shell. Secondary transverse septula occur from the inner volutions, except for the first to third volutions.

In the outer volutions, they become pendant-shaped and uniform in length. Axial septula are pendant-shaped and uniform in length, too. In respect to the length, they may be grouped into *s* type. Axial septula of *Afghanella schenki* THOMPSON are as follows: *i, v,* 2*v, s,* 2*s,* and 3*s.* Genus *Afghanella* might be branched from the common ancestral form from which numerous bio-series represented by such genera as *Yabeina, Gublerina, Lepidolina, Afghanella* and *Sumatrina* might have been seprated. The branching having resulted in many bio-series as above enumerated might have happened a little later than the older branching between *Neoschwagerina* and other specialized forms of neoschwagerinids.

The common ancestor of the older branching might have axial septula as *v* type as the most specialized forms, while the newer common ancestor may have possessed *s* type of axial septula.

In the possession of pendant-shaped septa, thin spirotheca, the genus *Afghanella* seems to be more nearly allied to *Yabeina, Gublerina* and *Lepidolina* than to *Neoschwagerina.* It must be worthy of note, that most highly specialized species belonging to *Yabeina, Gublerina,* and *Lepidolina* have such axial septula as *2s, 3s, 4s, 5s,* in their early stage of ontogeny, and those kind of axial septula are also frequently to be found in the bio-series of *Afghanella* and *Sumatrina.*

In Japan until the present day, no specimens have been found having axial septula of *l* type, which may be surely assignable into the genera *Afghanella* and *Sumatrina.*

Genotype: *Afghanella schencki* THOMPSON, 1946. Jour. Palaeont. vol. 20, pp. 153-155, pl. 25, figs. 1-12.

Holotype: Fig. 2, pl. 25.

Genus *Sumatrina* VOLZ, 1904

The genus *Sumatrina* VOLZ has a small elongated shell. The foramina are numerous and subcircular in cross section like the preceding genus.

The spirotheca is very thin and is composed of a single layer which seems to be quite free from alveoli.

The septa are pendant shaped, although they are rather thin in the earlist stage of ontogeny. The secondary transverse septula are short and uniform in length throughout the shell.

They increase in number towards the outer volutions.

The axial septula of *S. annae* are as follows: *s, 2s, 3s, 4s* and *5s*. All those septula are pendant shape, except for them found in the first or second volution. At present no available specimen being assignable into this genus are in the authors' hands. So the data are necessarily based upon the illustrations given by HANZAWA, 1954.

Sumatrina can be easily distinguished from *Afghanella* by the more elongate shell, more specialized axial septula (?), presence of secondary transverse septula in the innermost volutions and thin spirotheca without alveoli. Anyhow, *Sumatrina* may be regarded to be a more advanced and specialized form than *Afghanella*. But the branching which brought about these two bio-series might be held to have occurred in the age of the Pre-*Neoschwagerina* zone.

Genotype: *Sumatrina annae* VOLZ, 1904, Geol. u. Palaeont. Abhand. Neue Foige, Bd. 6 (Ganz Band 10), Heft 2, p. 98-100, text-figs. 27-31. Holotype was designated by THOMPSON as the specimen illustrated by VOLZ as text fig. 28.

On *Lepidolina? gigantea* TORIYAMA

TORIYAMA once described a gigantic neoschwagerinid from the Permian of the Kitakami mountains, which was called by him under the name of *Lepidolina? gigantea* TORIYAMA.

The specimen assigned into this species was unexpectedly found by one of the writers (M.M.) from a thin limestone, which may be stratigraphically situated at little higher horizon than *Neoschwagerina* zone and may be correlated to the so-called *Yabeina* zone.

This species is the largest neoschwagerinid ever to have been found in Japan. The volution number more than 28, attaining at least a length of 21 mm and a width 15 mm.

The spirotheca is apparently thin throughout the shell, but is surely composed of tectum and keriotheca, except for a few outer volutions, where the alveoli can hardly be seen. Although TORIYAMA stated that the spirotheca seems to consist of only a single homogeneous layer, the presence of alveoli, together with so-called divergent alveoli of septa are clearly recognizable at least until the 24th or 25th volutions from the inner volutions, when the thin section was observed in high magnification.

Even though the material is unfortunately not in good state of preservation, the structure of alveoli can be surely observed.

However, there are unfortunately no well oriented thin sections, and they are not suitable for more detailed observation.

Especially, the nature of the axial septula cannot be observed yet in detail.

As TORIYAMA assigned this species into the genus *Lepidolina* with slight doubt, it may be not fully congeneric with *Lepidolina* and may be rather near to the genus *Yabeina*.

However, so far as the specimens examined by the writers which should be surely placed in the genus *Yabeina* are concerned, they possess always alveoli in the spirotheca at any volutions, though they sometimes become so thin that the spirotheca may be misunderstood to be a compact layer free from keriothecal structure.

In this regard, this species would be better assigned into the genus *Lepidolina* than into *Yabeina*, because it has spirotheca seemingly free from alveoli in the outer two or three volutions.

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Nov. 1958

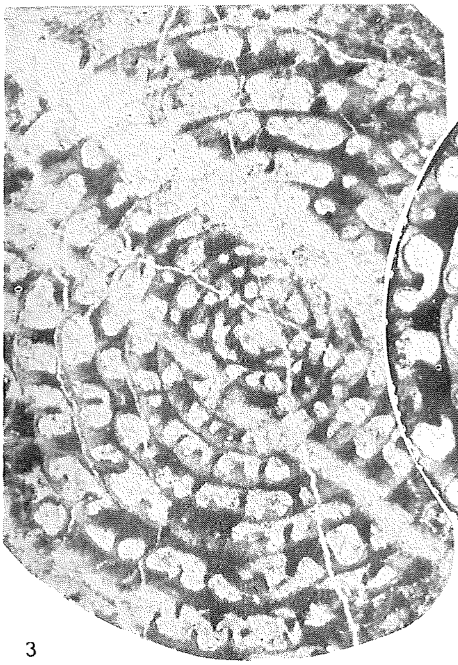
Explanation of
Plate 1

Explanation of Plate I.

Fig. 1. *Gifuella amicula* HONJO ×40, Reg. No. HU 13577.

Fig. 2. *Neoschwagerina simplex* OZAWA ×40, Reg. No. HU 13523.

Fig. 3. *Minoella eonipponica* (OZAWA) ×app. 120. Reg. No. HU 13366.



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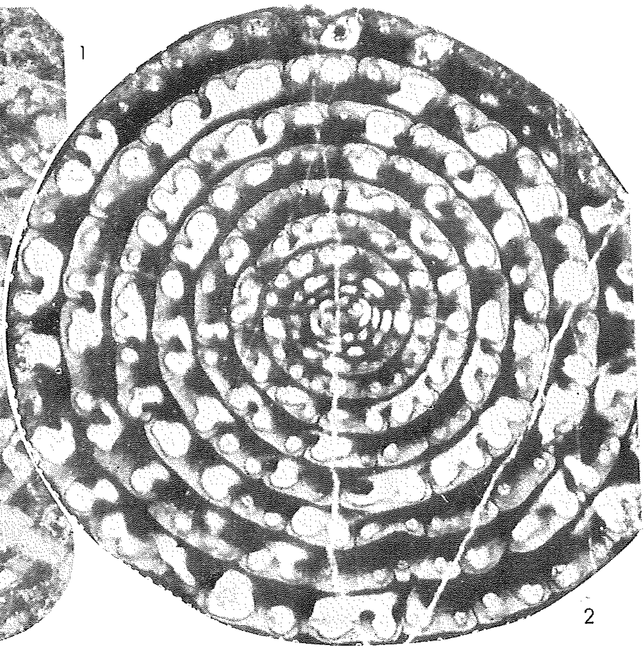

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MINATO and HONJO: Axial Septula Photo. S. HONJO

Explanation of Plate 2

Explanation of Plate II.

Gifuella gifuensis HONJO ×app. 120. Reg. No. HU 13460.

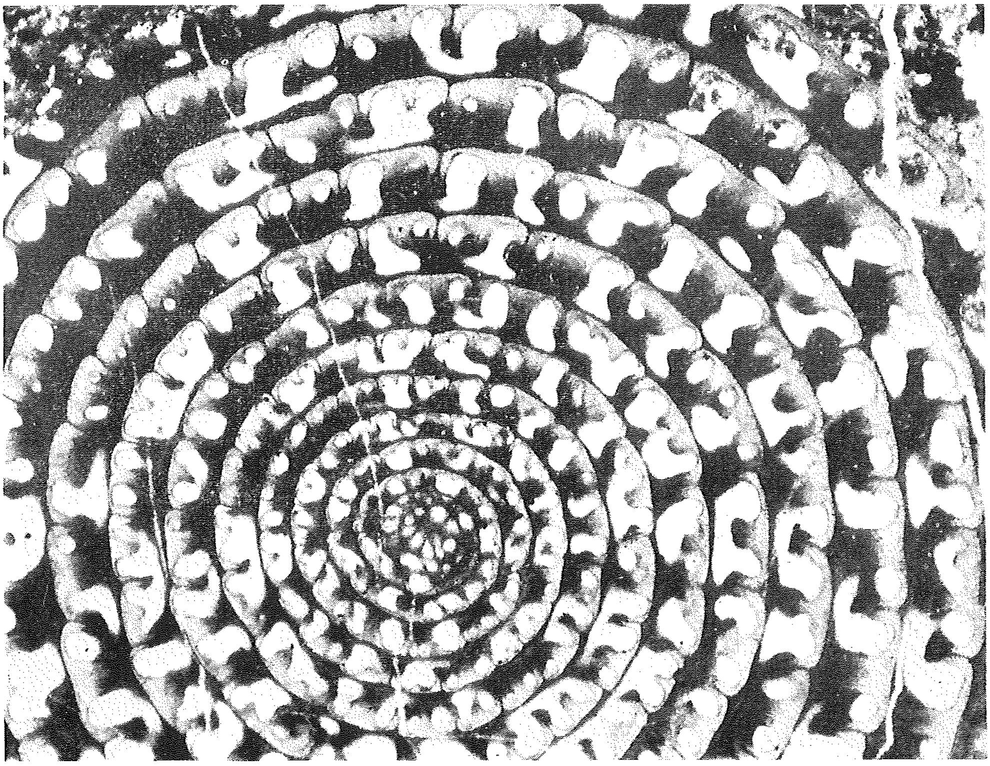
MINATO and HONJO: Axial Septula Photo. S. HONJO

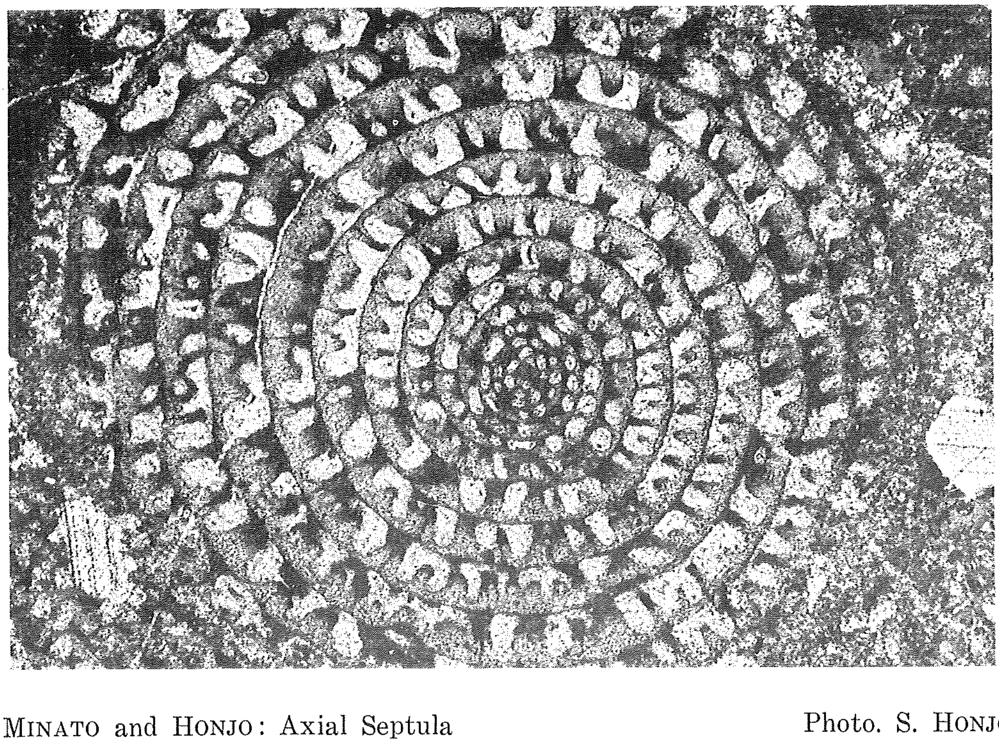
Explanation of Plate 3

Explanation of Plate III.

Fig. 1. *Neoschwagerina irregularis* HONJO ×40, Reg. No. HU 13530.

Fig. 2. *Neoschwagerina haydeni* DOUTOKEVICH and KABHAKOV ×40, Reg. No. HU 13534.





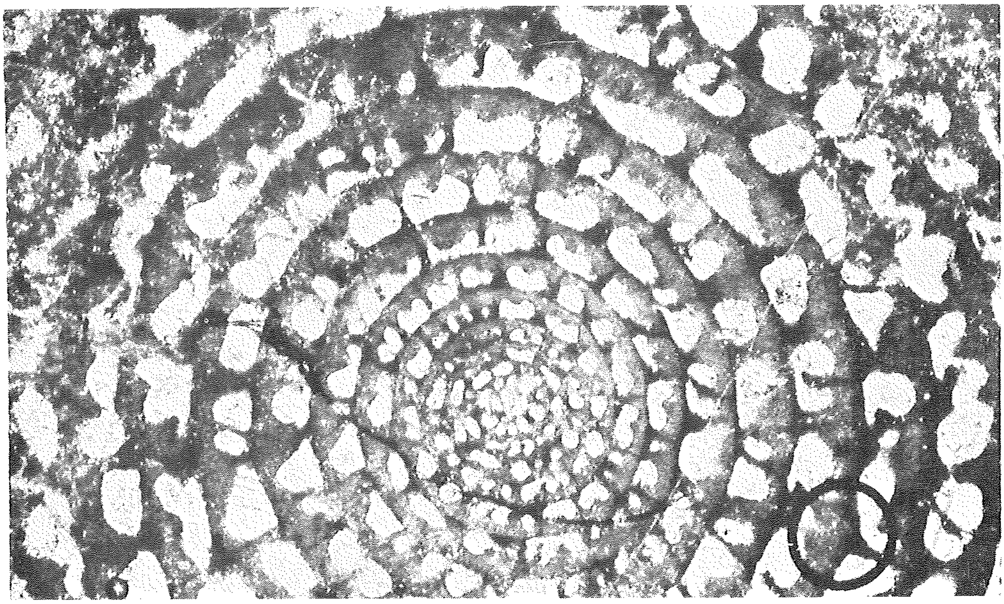
MINATO and HONJO: Axial Septula Photo. S. HONJO

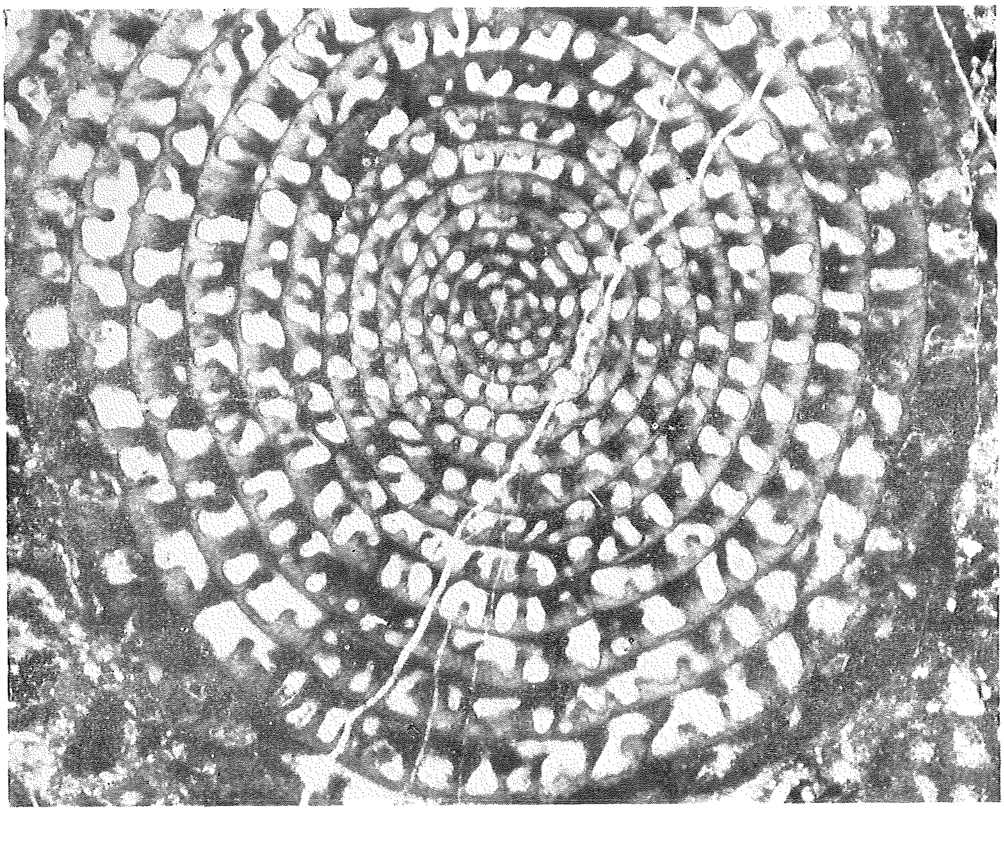
Explanation of
Plate 4

Explanation of Plate IV.

Fig. 1. *Metaschwagerina ovalis* MINATO and HONJO $\times 40$, Reg. No. HU 13495.

Fig. 2. *Neoschwagerina craticulifara* (SCHWAGER) $\times 40$, Reg. No. HU 13516.





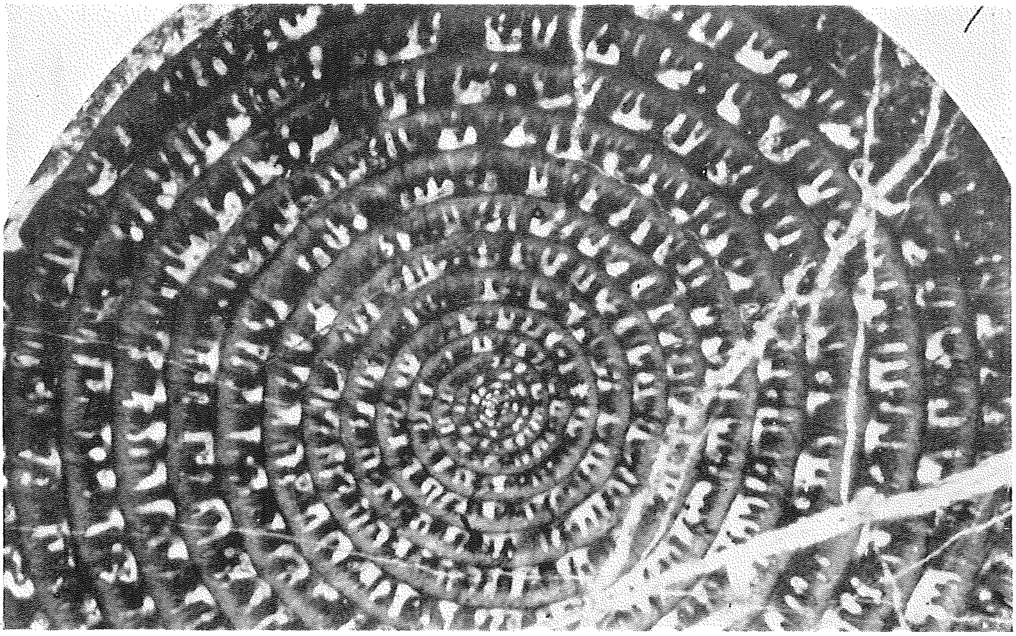
MINATO and HONJO: Photo. S. HONJO

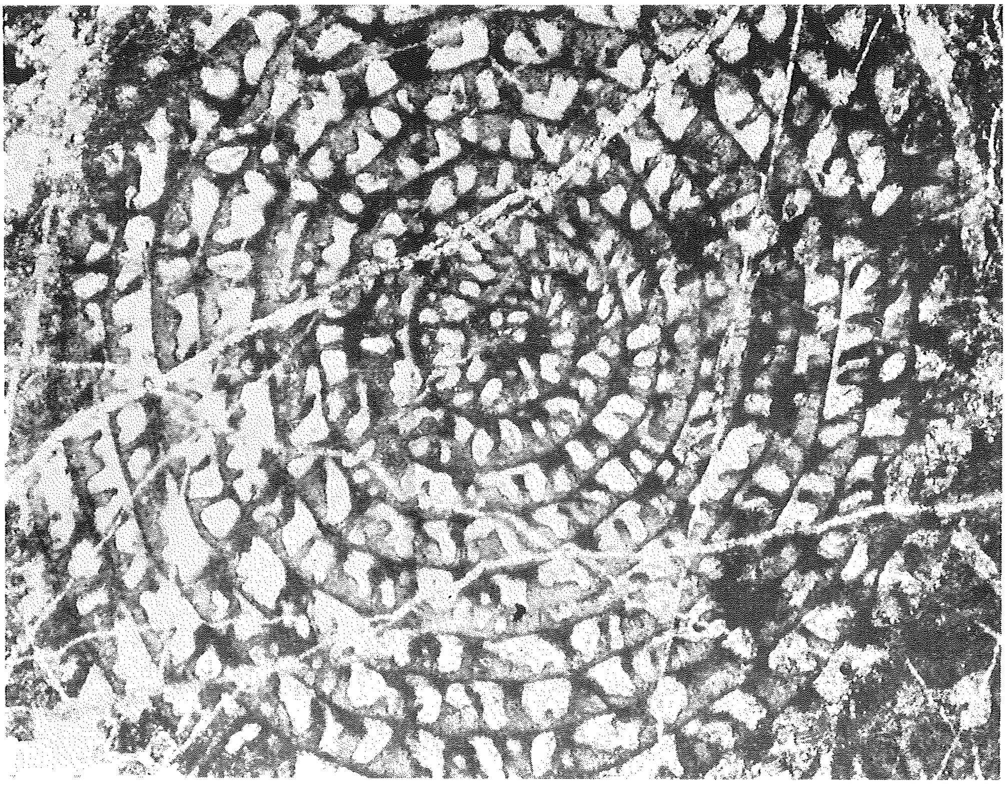
Explanation of
Plate 5

Explanation of Plate V.

Fig. 1. *Yabeina globosa* (YABE) ×25, Reg. No. HU 13527.

Fig. 2. *Neoschwagerina colaniae* OZAWA ×40, Reg. No. HU 13489.



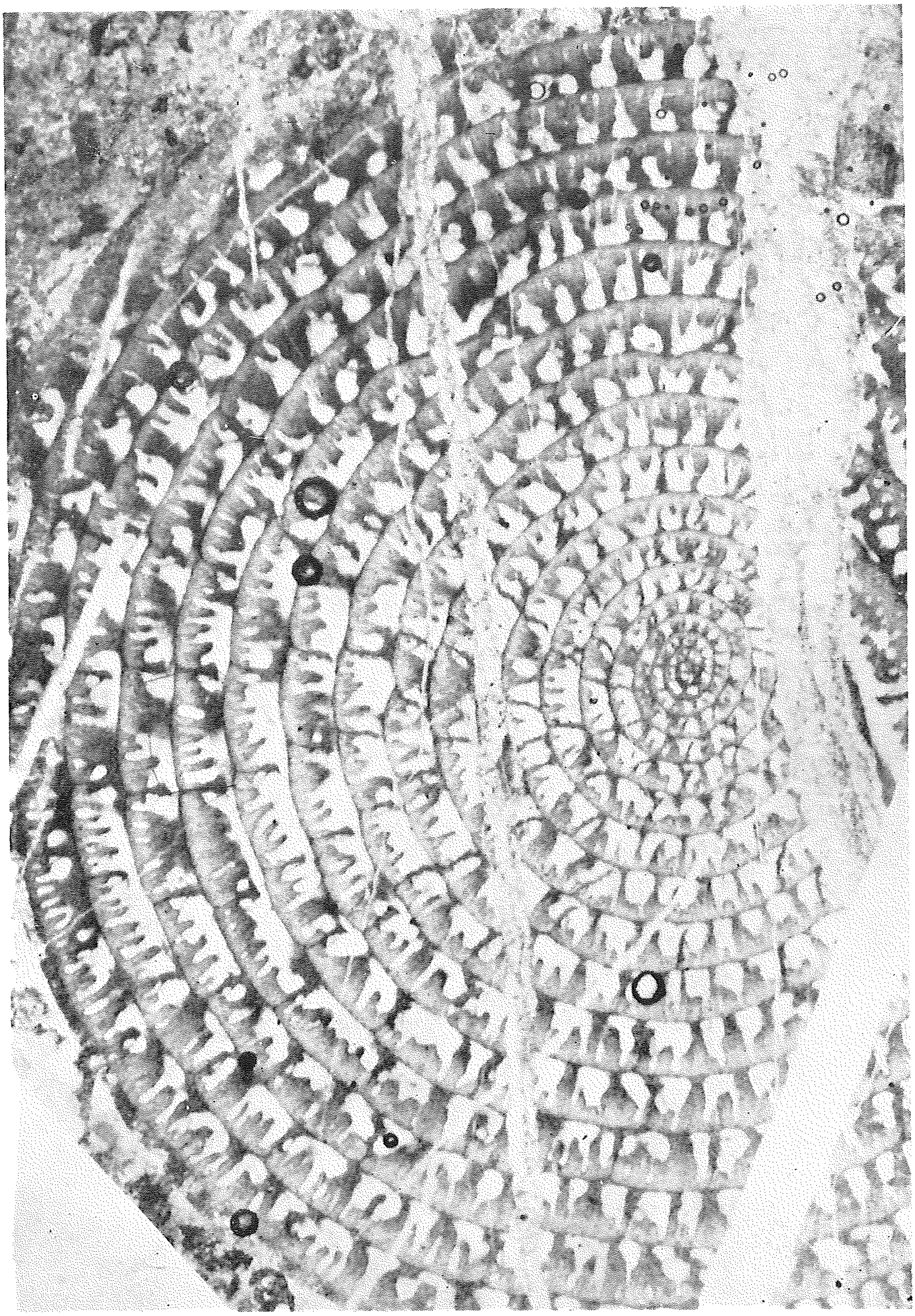


MINATO and HONJO: Axial Septula Photo. S. HONJO

Explanation of
Plate 6

Explanation of Plate VI.

Yabeina katoi OZAWA ×25, Reg. No. HU 13521.



MINATO and HONJO: Axial Septula Photo. S. HONJO