NEOSCHWAGERINIDS FROM THE AKASAKA LIMESTONE (A PALEONTOLOGICAL STUDY OF THE AKASAKA LIMESTONE, 1ST REPORT.)

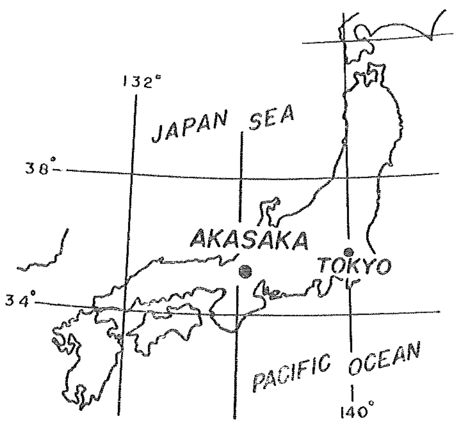
By

Susumu HONJO

Contributions from the Department of Geology and Mineralogy, Faculty of Science, Hokkaido Uuiversity. No. 753

Introduction

Akasaka, Gifu Prefecture, situated in Central Japan, is one of the most classical fields for the Paleozoic stratigraphy in Japan, and it is quite famous the world over owing to the paleontological studies on the fossils derived from the limestone formation developing immediately behind the town of Akasaka. Those works had been carried out by



Text-Fig. 1.

SCHWAGER, YABE, HAYASAKA, DEPRAT, OZAWA, FUJIMOTO, MINATO, MORIKAWA et al., and so forth since as early as the nineteenth century. The history of the Akasaka limestone was also discussed by OZAWA, 1927, and MINATO, 1952, to which readers are referred.

It goes without saying that neoschwagerinids are very important leading fossils of Tethys Permian stratigraphy. In the Akasaka limestone, neoschwagerinids are very abundant and they are generally well preserved. Moreover, one can observe quite long and uninterrupted geologic succession which yields neoschwagerinids from very primitive to much advanced.

OZAWA, 1927, described a number of neoschwagerinids from this limestone and attempted to clarify the phylogeny of them in a preliminary manner. Although his descriptions are excellent, they should be reexamined from the most up-to-date viewpoint. And it is certain that his schema on the phylogeny of neoschwagerinids should be revised in a few important points.

Since 1954, Prof. M. MINATO and others, including the author, of Hokkaido University, have been making investigations hoping to be able to prepare a more reasonable and detailed shema on the phylogeny of the neoschwagerinids which are found in the Akasaka area.

Thirteen species of comparatively less advanced neoschwagerinids which occur from so called *Neoschwagerina* zone, including five new species, are described in detail as the first step of a future comprehensive study of neoschwagerinids.

Acknowledgment

The author wishes to acknowledge the help given him by many persons in the preparation of this work. First of all, he wishes to express the sincerest thanks to Dr. MASAO MINATO, Professor of Hokkaido University, under whose encouragement and guidance this work has been completed. Certain original views, for instance, the expression of the difference of sagittal section, were suggested by him, and he kindly let the author use his valuable literature.

He wishes, further, the express his gratitude to Mr. MATAJIRO KATO, M.S. for his valuable advice, and lending the author his collection of neoschwagerinids from Iwazaki. Also he thanks Mr. YOSHIYUKI HASEGAWA for the critical reading of several portions of the manuscript. He is kindly permitting the author not only to use his vast collections of neoschwagerinids from Akiyoshi, but to reproduce some of his microphotograph of them which have not hitherto been published.

Grateful acknowledgement is also due to Mr. KUSAKABE, Kyoto University, Dr. ISHII, Osaka Municipal University, for kindly permitting the author to refer to their collections.

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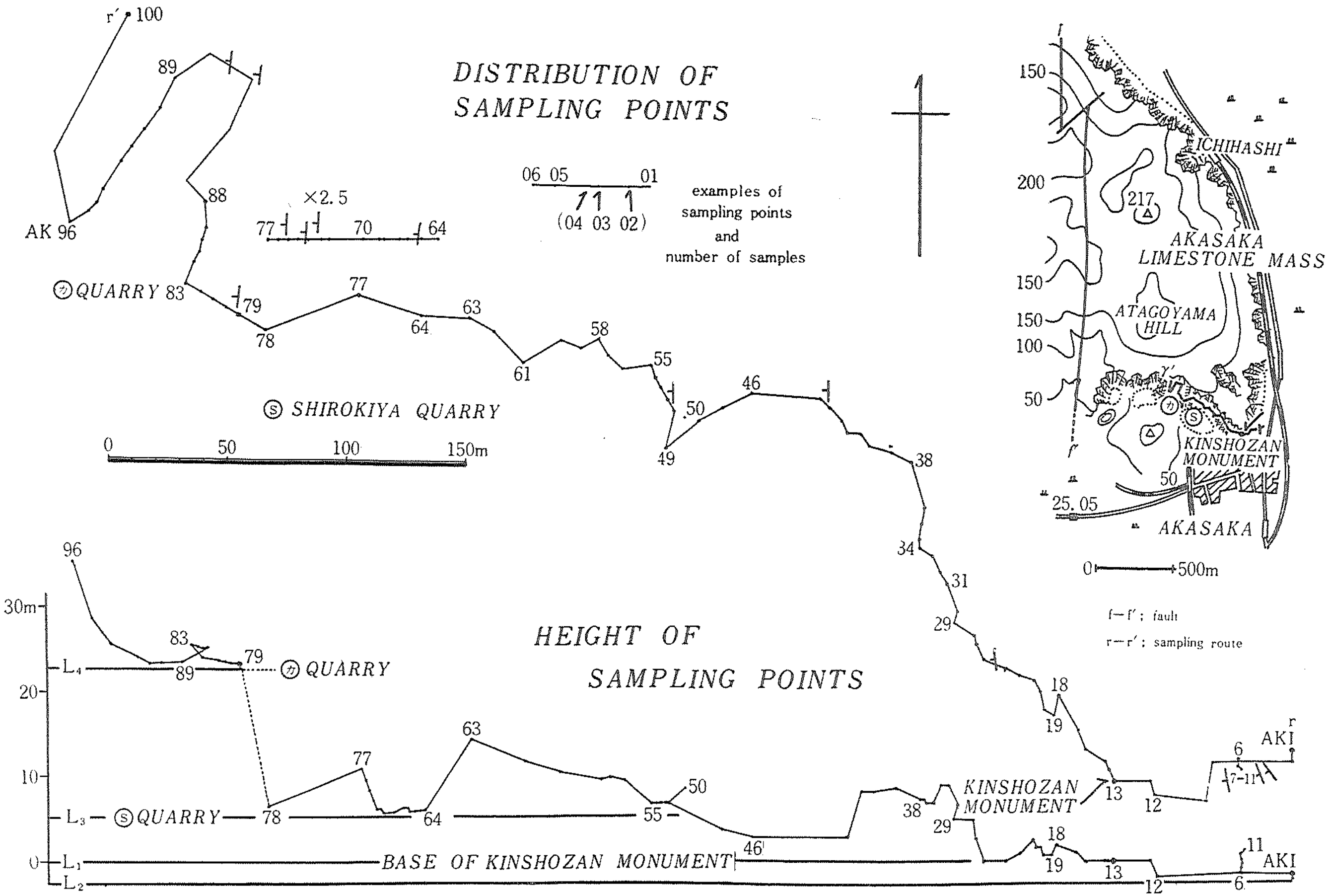

DISTRIBUTION OF SAMPLING POINTS
examples of sampling points and number of samples
06 05 01
(04 03 02)
×2.5
77 70 64
AK 96
QUARRY 83
SHIROKIYA QUARRY
0 50 100 150m
ICHIHASHI
AKASAKA LIMESTONE MASS
ATAGOYAMA HILL
KINSHOZAN MONUMENT
AKASAKA
0 500m
f—f′ ; fault
r—r′ ; sampling route
HEIGHT OF SAMPLING POINTS
30m
20
10
0
L₄
L₃
L₁
L₂
QUARRY
BASE OF KINSHOZAN MONUMENT
KINSHOZAN MONUMENT
AKI

Text-Fig. 2.

in field works.

Biostratigraphy of Neoschwagerina Limestone of Akasaka

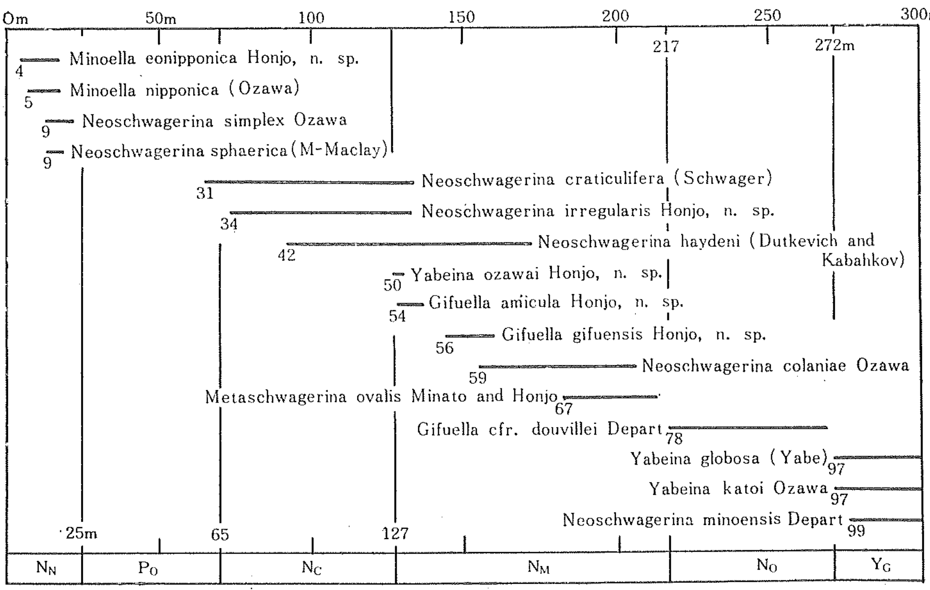
The Akasaka limestone is made up of a lithologically simple mass without intercalations. In the most part of the limestone mass, the stratifications are not clear. Moreover many joints develope to cause much confusion among them.

The south foot of Kinshozan hill has been cut away for limestone quarries, leaving a large comparatively clear cliff, where stratifications generally develope in dip direction. Therefore, a long geologic column is available here.

The cliff generally develops in dip direction. The dip inclines to west, and it changes from 35° to 60°. The structure of the cliff is simple monocline so far as the author observed throughout the foot of the cliff.

The standard route of sampling has been set along the foot of this cliff. This route is named route r-r′. The base point of the route, point 1, has been set at the table like rock tower which supports a water tank in front of the Akasaka kindergarden, Taniyashiki, Akasaka town. The plan of the route and altitude of the sampling points are shown in Fig. 2.

The author selected the sampling point without any consideration



Text-Fig. 3. Ranges of Neoschwagerinids from the Akasaka Limestone, route $r-r$.

except the distance between each point should be constant when he ploted them on the geologic column. Therefore, the points are distributed at intervals of approximately 2.8 m. However, on accounts of unavoidable difficulties, the divergences from the average distance are rather remarkable. The numbers of the localities used in this report are in stratigraphical order throughout the column. Namely, the younger numbers are always representing the lower stratigraphical horizons and vice versa.

The present investigation makes use of hand specimens collected from point 1 to point 96. Those ninty-six localities cover the so-called *Neoschwagerina* zone of the Akasaka limestone. So-called *Yabeina* zone starts from point 97. The observations from the *Yabeina* zone will be published in a succeeding paper.

The ranges of various neoschwagerinids from route r-r′ are shown in Table 1. Among them, six fusulinid subzones[1)] are recognized as follows, in descending order.

TABLE 1

HONJO, nov.				OZAWA, 1927
Yabeina Zonn		app. 200 m	Ng	*Neoschwagerins globosa* zone
Neoschwagerina Zone				
Nd	*Gifuella douvillei* subzone	55 m	Nm	*Neoschwagerina margaritae* zone
No	*Yabeina ozawai* zubzone	90 m		
Nc	*Neoschwagerina craticulifera* subzone	62 m	Nc	*Neoschwagerina craticulifera* zone
Do	*Pseudodolioline ozawai* subzone	40 m		
Nn	*Menoella nipponica* subzone	25 m	Nn	*Cancellina nipponica* zone

NC. *Minoella nipponica* subzone is the lowest of the Akasaka limestone. A massive limestone without fossil remains is developed in the lowest part of the subzone. *Minoella eonipponica* n. sp. first appears at point 4. This is the first appearance of neoschwagerinids in the Akasaka limestone. *Minoella nipponica,* which represents this subzone, appears at a little higher horizon than the first appearance of *Minoella eonipponica*. *Neoschwagerina simplex,* which is the first real neoschwagerinid, appears at the uppermost horizon of this subzone. *Psedoschwagerina* spp. are very abundant throughout the subzone. *Verbeekina minatoi* n. sp. and

1) Each neoschwagerinids subzone starts at the first appearance of a representative species, and closes at the appearance of the subsequent representative species. Generally the former species survives in the later subzone.

2) The mode of occurrence of neoschwagerinids in the Akasaka limestone seems to be fossil enclosures, *s. l.* (IJIRI and FUJITA, 1952, 1958.) The shape of each bioherm has not been clarified. The detail of ranges would be different along a route other than $r-r'$.

Pseudodoliolina ozawa appear from the middle horizon of this subzone.

D$_O$ *Pseudodoliolina ozawai* subzone starts with the sudden disappearance of neoschwagerinids. In this subzone, *Pseudodoliolina ozawai* crowds very dominantly. Sometimes *Pseudoschwagerina* spp. and *Verbeekina verbeeki, V.* cf. *heimi* are found accompanying. Neoschwagerinids are entirely absent for approximately 40 m.

N$_C$ Three species of neoschwagerinid are distinguished in the *Neoschwagerina cratifulifera* subzone. They are *Neoschwagerina craticulifera, N. irregulalis* n. sp. and *N. haydeni.* They are rather close to each other in form.

N$_O$ *Yabeina ozawai* (*Neoschwagerina margaritae* of OZAWA, 1927) subzone occupies the middle horizon of the Akasaka limestone for a thickness of approximately 90 m. Five species of neoschwagerinids, including three new species, are found in this subzone. Their ranges seem to be short except that of *Neoschwagerina colaniae.* Around point 50, there is a comparatively thin layer which is filled with shells or fragments of *Yabeina ozawai,* without other species. It is very interesting that such an advanced neoschwagerinid develops in comparatively lower horizon. *Yabeina ozawai* suddenly disappear, and *Verbeekina sphaera* and *Pseudoschwagerina* spp. occupy the limestone for a few meters. *Gifuella amicula* is rarely found among them. *Gifuella gifuensis* occurs in the layer represented by point 57. Above this layer, secondarily deposited primitive fusulinids occur. *Metaschwagerina ovalis* accompanies with *N. colaniae* in the upper part. This species is rare and sometimes much deformed. From point 60 to 76, fusulinids gradually wane, and sometimes remarkably grown *Bellerophon* sp. occurs.

N$_D$ Near the top of the *Neoschwagerina* zone, ill preserved shells of *Gifuella* cf. *douvillei* appear. They are much deformed and difficult to identify exactly.

Yabeina globosa bioherm is developed above point 97. Microfossils are extremely abundant in the lower *Yabeina* zone. The change of biofacies comes quite suddenly, and offers a sharp contrast to the uppermost *Neoschwagerina* zone which yields poor microfossils. *Neoschwagerina minoensis* occurs in lower *Yabeina* zone.

Morphology of neoschwagerinids

The study of fusulinids requires both a detailed morphologic examination of free solid specimens and sectioned preparations. However, in Akasaka, the limestone is not friable and from it the extraction of solid microfossils by maceration or disintegration has been impossible. This is also true in other localities in Japan, like Akiyoshi, Iwazaki etc., where abundant neoschwagerinids are preserved in limestone mass. GUBLER, J., 1934, illustrated many free solid specimens from Indochina although most foreign students also seem to have studied without free solid specimens.

In this work, the author relies mainly upon random thin sections in indurated rocks. Having approached the problems from this angle, the author has come to believe that some biocharacters should abe examined over again. For instance, the accuracy of measurements of the real size of the proloculus is completely dependent on through where the section is cut through a specimen. An alied problem is the assessment of an equatorial chamberlet. In sectioned preparations, the contours of axial and transverse organs are presented in various states. Therefore if the worker can not restore the solid inside structure, misleading ideas and confusion of taxonomy will be caused.

Other important problems have arisen because of the scantiness of knowledge on the life history[3] of neoschwagerinids. For instance, the volution count of neoschwagerinids has been described by many authors. But as far as scholar have not agreed on what a real adult neoschwagerinid is, the volution count could not have any meaning except that it is presenting a degree of preservation.

In this chapter, not only a brief treatment is given of the terminology, but such problems found in individual characters are discussed. Especially the necessary qualifications for a biocharacter are carefully examined, and the genetic or specific importance of them is discussed.

a) Volution Count

The volution count of neoschwagerinids has been described in previous works. Sometimes this character has been confused with the "size" of neoschwagerinids. But as the author noted above, such properties as volution count, size or external shape should be treated more carefully.

3) The "life history" of the author means not only dimorphism or polymorphism, but includes every process in the ontogeny of neoschwagerinids.

Generally speaking, it seems that the increase and decrease of the number of volutions of neoschwagerinids in the Akasaka limestone is chiefly dependent on what circumstance of sedimentation they had lived in; such variation is not related to the specific specialization.

The author has carefully studied under microscope the margins of specimens in sectioned preparations and also surface of free specimens from Akasaka and several other localities. But the author could not find individuals which are undoubtedly proved to be complete specimens.

Thus, it is supposed that individuals have been peeled of a certain number of their outer volutions during sedimentation, but there is no way to guess this number. In those cases, the number of lost volutions would not be uniform.

Namely, even it would be considered essentially a biocharacter, the volution count of neoschwagerinids in the Akasaka limestone has only been presenting the workers a degree of diagenesis—water wearing etc. —or the resistance to it which is attributed to the inner structure of each species. Therefore, it is difficult to find the biological signicance in this character so far as the present researches are concerned.

Some authors have described the maximum number of volution count among individuals which they treated. But it may biologically be meaningless when they depend on incomplete specimens.

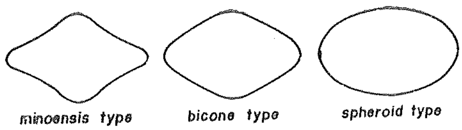
b) External Shape

The contour of axial section of neoschwagerinids is much influenced by even a slight deflection of sectioning plane. It is needful to avoid the confusion of the concept of external shape which is caused by such deflection. The accuracy of the sectioning orientation is indicated by how the axial part is presented in the section. The almost ideal section of bicone shaped neoschwagerinids was presented by Deprat, 1914. His figure will be good standard by which to judge the worth of the axial sections in all workers' sectioned preparations.

Sometimes the shape of neoschwagerinids varies during their life history. As was discussed in the preceding section, the contours of neoschwagerinids in sectioned preparations do not present the outermost shape. Therefore, attention must be paid to what number of volution the worker is basing his remarks upon where he describe the external shape especially when he is depending on such imperfect specimens.

Upon the basis of the study of neoschwagerinids from Akasaka, the shape of the 8th to 10th volution is convenient for the comparative study of external shape of Neoschwagerina, Gifuella or Metaschwagerina, whilst the 15th to 18th volution are for Yabeina.

Generally, the external shape of neoschwagerinids seems to be spheroid. Sometimes, it is elongated and poles are much blunted as in Gifuella. Bicone shape is also common. It is represented by *Neoschwageina craticulifera*. A peculiar external shape is possessed by *Neoschwagerina minoensis*. The lateral slopes of this species in axial section are concave. This type of neoschwagerinids has not been discovered except for *N. minoensis*. Those three types are illustrated in Fig. 4.

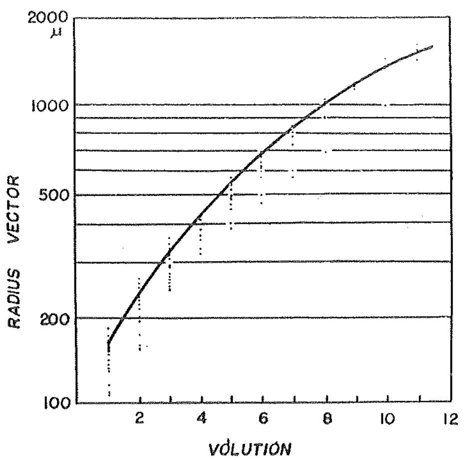


Text-Fig. 4.

c) Form ratio and Growth ratio

The form ratio is defined as the ratio between the length and the thickness of a perfect specimen. In the present work, this character was not accepted.

The growth ratio is taken as the ratio between the radious vector and the half axis length of a volution. The successive growth ratios from the first to outer volutions present to the worker the alteration of shape of a specimen during its ontogeny.



Text-Fig. 5.

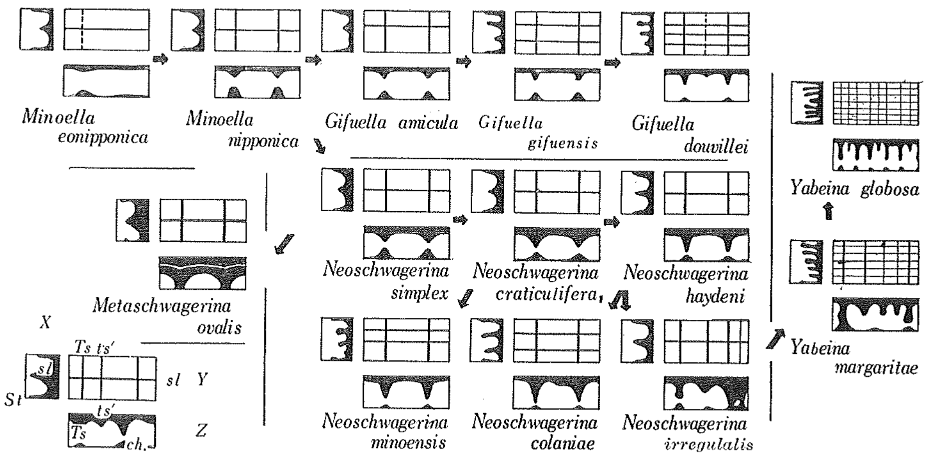
d) Series of radious vector

The rate of expansion of *Neoschwagerina*, *Gifuella* and *Metaschwagerina* is given in Fig. 5. In this figure, ti is impossible to distinguish the different tendencies among the plotted dots for each respective species. No distinguished mutation or variety for different localities has been discovered. The same result has been got whenever measurements were made with different accuracy. One exception is that the radious vectors for each volution of *G. amicula* are generally less than others.

The evidence presented by those tendencies clearly demonstrates that radious vectors or series of radious vectors are almost common throughout the most Noschwagerinids. This character is not suitable to distinguish the genera or species in this case.

e) Size of proloculus

The diameter of megaspheric proloculus has been regarded as an important point for the classification of neoschwagerinids. But it should be remarked that this property is easily influenced by accidental errors[4]. Because, in the first place the proloculus of neoschwagerinis is minute



Text-Fig. 6. Seplular patterns of neoschwagerinids. Allow marks show the course of evolution. See Text-Fig. 8, p. 123.

4) Suppose a sectioning plane cuts a proloculus through a point that is off a certain distance from the center, and the distance is 30 percent of the diameter of the proloculus, then this plane gives a apparent section of proloculus which has approximately 80 percent of the true diameter. Even then this deflection gives only few percent of error on the radious vectors of the eighth to tenth volution. Such slight difference of diameter is generally included within measuring error.

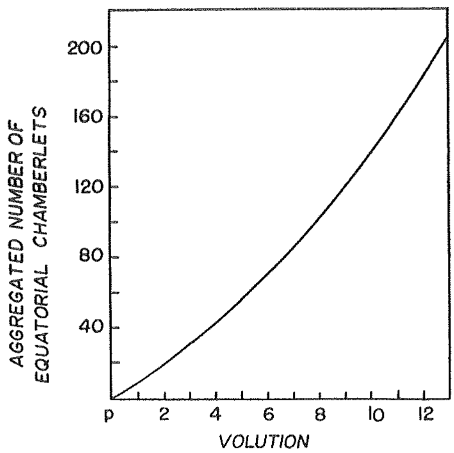
even in megaspheric generation, therefore it is difficult to cut it through the very center. Secondly, the megaspheric proloculus is almost spherical, therefore the contours of sections are always round, then it is imposible to know how deflectively it is cut from the obliquity of the contour of a section.

f) Wall

Wall structure; Properties such as composition of wall, thickness of tectum seem to be common to all neoschwagerinids. Thickness of wall; The thickness of wall is much influenced by axial and lateral organs. If the section cuts the wall through the feet of axial or lateral organs, or both of them, the thickness presents an appearance of being greater than what actually is. As in the case of transverse or axial septula, the worker should be very careful in measuring the thickness of wall.

The thickness of wall of neoschwagerinids should be measured at the center of the parallel crosses of two sets of axial and lateral organs. This part can be called "the center of the vault of a chamberlet." The thickness is minimum in this part of wall. This is explained in Text Fig. 8.

This biocharacter is regarded one of the fundamental genetic properties by the author. It will be explained in detail in the section of genetic diagnoses in this paper. But any way the accuracy of measurement



Text-Fig. 7.

is of limited worth. Therefore this biocharacter is not suitable for delicate classification of neoschwagerinids. And very minute measurement of the thickness of wall is sometimes nonsense.

g) Septular organs.

The author is of the opinion that the evolution and taxonomy of neoschwagerinids are almost entirely depend upon the development or the difference of septular organs in chamberlets.

Sptular organs are wall of fold-like pendants of alveoli which are developed in transverse or parallel direction to the axis of a specimen. Axial organs are septa, axial septula, and so forth. Transverse organs are transverse septula and secondary transverse septula.

Two adjacent septa and a spirotheca from where the septa come out, make a chamber. It is generally long, and both ends are poles of the specimen. The over all shape of chamber is like a cut piece of banana. (AKAGI, S. 1958)

A chamber is separated into many chamberlets by transverse septula. Namely, a part of a chamber which is cut off by two adjacent transverse septula is called a chamberlet. Sometimes an axial septulum or parallel crosses of axial septula and secondary transverse septula are developed in a chamberlet. In other words, septa and transverse septula can be the partitions of a chamberlet, and other septular organs are attached to them. The equatorial chamberlets are especially important for the classification.

Septular pattern; The morphology of the inner structure of a chamberlet is best indicated in septutlar pattern (new term). It means a set of accurate axial and sagittal sections of an equatorial chamberlet.

A succession of septular patterns from the first to outer volutions vividly presents to the worker the ontogeny of a species. (Text-Fig. 6)

The degree of the development of transverse septula of neoschwagerinids has been described by some authors. Especially, DUTKEVICH and KHABAKOV, 1934, were first interested in the taxonomic meaning of this biocharacter; they distinguished *Neoschwagerina craticulifera* var. *haydeni* by the long transverse septula and by the presence of distinct "trabeculas" which are formed by the interlocking between parachomata and long transverse septula of this species.

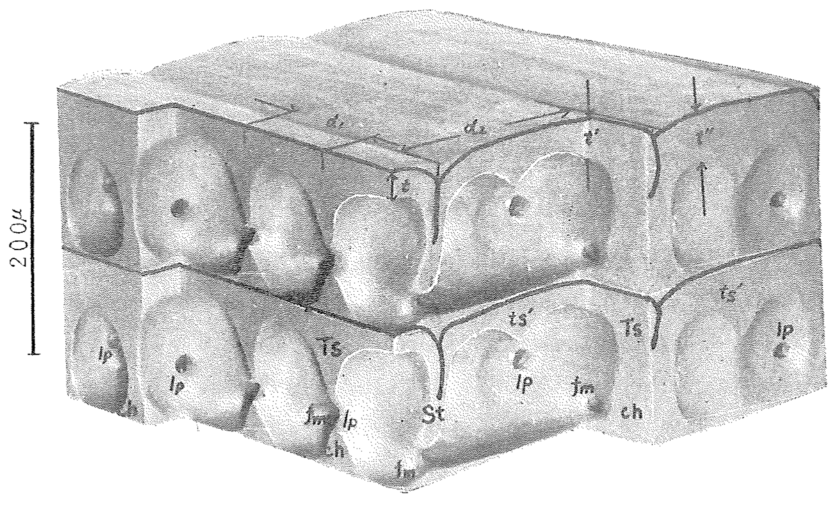
Transverse and axial septula are not simple continuous wall like extentions. The contour of a section is much influenced by the development of lateral passage and axial organs—primary and secondary axial septula etc.—The shape of the axial septula is also closely related with the development of foramina and transverse septula. That is to say, when the transverse septulum is cut through the center of lateral passage in axial direction, the section of it is short, narrow and it does not reach to the top of the corresponding parachomata. On the other hand, when it is cut near the foot of axial section, the section is wide and connections with parachromata and trabeculas are seen in such section. The shape of transverse septula changes between those two extreme condition.

Avoiding the confusion and giving more objectivity to this bio-character, the workers would observe every different shape of transverse and axial septula in both axial and transverse direction, and get a clear idea of the inside of a chamberlet. (Text-Fig. 8)

h) Parachomata and basal deposit

Parachomat adevelop throughout the shell of neoschwagerinids. They are not simple tire-like links which surround the volution. The thickness is much influenced by foramina or especially by lateral passages. In transverse sections, a transverse septulum always corresponds with a parachomatum.

TAN, 1933, studied *Verbeekina* from Sumatra, which has been ranked



Text-Fig. 8. Diagram of inside of chamberlets. t: true thickness of keriotheca. t', t'': wrong measurement of the thickness of keriotheca. d_1: distance between the adjacent transverse septula. d_2: distance between the adjucent septa. d_1 and d_2 make chamberlet." Ts: Transverse septula. ts': axial septula. fm: foramina. lp: lateral passage. ch: parachomata. Those signs are also used in Text-Fig. 6.

the evolutionally nearest relative of neoschwagerinids. He believed that the development of the parachomata is a variable character within the same species or variety, and that the nature of the parachomata is not hereditary. On the other hand, THOMPSON, 1936, believed that the parachomata of *Verbeekina* are probably very similar in degree of development for corresponding volutions. In case of neoschwagerinids, the author believes that the parachomata are an unsettled character especially for the species which occur from lower horizon. The author discovered a specimen of *Minoella nipponica* of which the chamberlets are much narrowed by extremely well developed parachomata and basal deposit. (Plate 6, fig. 1) In some other specimens of the same species, the parachomata are slightly developed. In the species from a higher horizon, they are comparatively less developed as in *N. colaniae*.

The basal deposit seems to be composed of the same material as the parachomata. It covers the surface of the wall except on parachomata. The surface of basal deposit is not consolidated. The degree of development is not similar for every specimen respectively.

i) Number of equatorial chamberlets.

Number of equatorial chamberlets for correspondent volution among neoschwagerinids are quite constant. The aggregated numbers of equatorial chamberlets of various species of neoschwagerinids which are protted on a graph against the volution number are presented almost a single curve. (Text-fig. 7)

DESCRIPTION OF SPECIES

Family *Fusulinidae* MOLLER, 1878

Subfamily *Neoschwagerininae* DUNBER and CONDRA, 1928

Genus *Neoschwagerina* YABE, 1903

Subgenus *Minoella* HONJO, n. subgen.

Type species: *Cancellina nipponica* OZAWA, 1927

Summary diagnosis,—Subgenus *Minoella* seems to be the most primitive neoschwagerind in the Akasaka limestone. It is very interesting that the earlier ontogeny of the subgenus presents more advanced features than the outer volutions.

Misellina claudae or *"Cancellina primigena"* has no transverse septula in any part of the shell. *Minoella* are fundamentally different from them in this point.

Diagnosis,—Shell inflated spheroid, with strongly convex lateral slopes and bluntly rounded poles. Mature specimens have more than twelve volutions. The axis is straight throughout the shell in megaspheric generation.

Megaspheric proloculus medium in size, approximately 0.22 to 0.25 mm in the longest diameter which is composed of tectum and basal deposit covering the outer surface of it. Inner surface of proloculus seems to be smooth. Aperture of proloculus opens to transverse direction of the axis. Around the aperture of proloculus, the spirotheca is slightly depressed, accordingly the proloculus appears to be kidney shape in sagittal section. The shortest diameter of the proloculus is approximately 80% of the longest diameter. Proloculus tube long, the middle part of it is somewhat constricted, the inner end opens. The inner diameter of proloculus tube, measured where it is mostly constricted, is approximately 15 to 20 microns.

The shell expands uniformly in the first five to six volutions. It expands very slowly in the outer volutions, and sometimes it stops expansion.

Growth ratio rapidly increases, especially in the first six volutions. The growth ratio of the tenth volution for this genus is 1.5 to 1.7.

Spirotheca thin in juvenile and medium in adult stage, essentially composed of four layers, namely upper basal deposit, tectum, keriotheca and lower basal deposit.

Tectum approximately 1.8 microns in thickness develops throughout the shell.

Keriotheca develops throughout the shell, except on the wall of proloculus. Keriotheca thin, having an alveolar texture. Each alveoli extends completely to the bottom of keriotheca, vertically uniform from the top to bottom of keriotheca. Alveoli fine, approximately 30 alveoli in 10 square microns of the tangential section of spirotheca. The tangential section of each alveolus looks to be a triangle to a complex polygen. Lower tectorium is distributed near the bottom of keriotheca filling the gap of each alveolus.

Transverse septula appear from the first volution developing at a right angle to the septa. They certainly exists at least in the first six or seven volutions. In early stage, they are broad and short. In outer volutions, they are slight swellings of keriothteca without pointed distal margins.

The vault of chamberlets is flat having angled corners.

Septa are not folded, the shape is uniform throughout the shell.

The space between two adjacent septa expands toward the outer volutions. The total number of equatorial chambers from the first to the end of the tenth volution is about a hundred. The distal margin of septa covered a thick basal deposit.

Axial septula begin in appear in the third equatorial chamberlet of megaspheric generation. They are only a slight swelling of keriotheca and are sporadically distributed in the first and the second volutions. True axial septula appear from the third volution. They are narrow and the two sides run essentially parallel. The distal margin is round and is adhered by thick basal deposit in outer volutions. Accordingly they are sometimes pendant shape in sagittal section.

A second axial septulum per an equatorial chamberlet rarely appears in outermost volutions.

Lateral passage small, short distance above the floor, approximately 15 microns in the fifth volution, and more than 25 microns in the tenth volution.

Parachomata are present throughout the shell, especially well developed in juvenile volutions where they are broad; sometimes individual adjacent parachomata are connected by foot. In the adult stage, parachomata are high and broad. But the degree of development of parachomata for corresponding portions of different specimens of this genus is quite different. Foramina open between two adjacent transverse septula. They are usually roughly circular and located almost directly above the floor.

Discussion,—Since HAYDEN established subgenus *Cancellina* in 1909, there has arisen some confusion in the classification of primitive neoschwagerinids.

According to type description, subgenus Cancellina is a neoschwagerinid which has no axial septula throughout the shell. OZAWA, 1927, first employed the subgenus name in quite different concept from the original diagnosis. He laid much stress on the thinness of wall and septa as the characteristic of the subgenus without giving any remarks on the axial septula. For instance, his "*Cancellina nipponica*" have obviously well developed axial septula from very early equatorial chamberlet to the outer volutions. In 1948, THOMPSON[5)] stated that *Cancellina* is a neoschwagerinid having thick "keriotheca", based on a homoeotype of *Cancellina primigena* from Persia. Thus, his opinion is quite opposite to OZAWA's diagnosis about the thickness of keriotheca of Cancellina. Still more, his *Cancellina primigena* has no axial septula throughout its ontogeny.

Recently, KANMERA re-examined primitive neoschwagerinids in the abundant collections, and reviewed very carefully previous diagnoses of primitive neoschwagerinids. He reached the conclusion that the development of axial and transverse septula is in parallel in *Cancellina* and *Neoschwagerina*. Namely, the two genera can not be distinguished from each other in the development of septular organs. According to him, "the species of *Cancellina* are distinguishable from *Neoschwagerina* in possessing relatively thinner spirotheca and septa, thinner and shorter septula and narrower but higher parachomata." (KAMNERA, K., 1958).

In the paper, KANMERA referred "*Cancellina nipponica*" to *Cancellina* in his sense. The author has a question on this opinion. According to KANMERA, *Cancellina nipponica* has a thin spirotheca. But when the thickness of spirotheca in strict sense in each volution is compared with that of corresponding volution of other typical species of *Neoschwagerina*, remarkable difference is not found. Moreover, observing the ontogeny of the topotype of this species, the transverse septula are well developed in the juvenile volutions. They are quite like the transverse septula of typical species of *Neoschwagerina*.

For those reasons, the author is of the opinion that this species should be referred to *Neoschwagerina*.

In this species the transevrse septula in outer volutions become less proportional to the height of volution; sometimes they vanish. It is true that this tendency is fanintly presented in other neoschwagerinids like *Neoschwagerina craticulifera* s. str., etc. But it is quite remarkable in this species and especially in *Minoella eonipponica* HONJO n. sp. The author believes that this type of ontogeny is very special and it justifies the setting up of a new subgenus *Minoella* distinct from typical species of *Neoschwagerina*.

Besides the subgenotype species, *Minoella eonipponica* is known from the lowest horizon of the Akasaka limestone. Judging from its simple outer volutions, *Minoella eonipponica* seems more primitive than the subgenotype species.

Type species: Subgenoholotype, see the types of *Minoella nipponica* (OZAWA).

Neoschwagerina (*Minoella*) *eonipponica* HONJO, n. subgen., n. sp.

Pl. 1. Figs. 2, 3, 4, 5 and 7

Diagnosis,—*Minoella eonipponica* can be clearly distinguished from

5) He referred only *Neoschwagerina simplex* to *Cancellina* beside the type species.

Minoella nipponica and other primitive neoschwagerinids by the special features of the spirotheca of the outer volutions which have no transverse septula or have only slight swellings of keriotheca without pointed distal margins.

Description, — Shell inflated spheroid. Mature specimens hvae more than ten volutions. Megaspheric proloculus 0.22 to 0.25 mm in longest diameter. The shorter diameter of proloculus approximately 80% of the longer diameter.

Radius vectors of the first to the eighth volution of one of the representative specimens are 96, 125, 173, 221, 300, 407, 525 and 680 microns, respectively.

Spirotheca thin, composed of upper basal deposit, tectum, keriotheca and lower basal deposit. Tectum clear, uniform in thickness which is approximately 1.8 microns. Alveolar texture develops throughout the shell except for proloculus. Thickness of keriotheca in the same specimen of the first to the seventh volution is 4, 5, 9, 10, 11, 11 and 13 microns, respectively.

Transverse septula appear from the first volution of megaspheric generation, and certainly exist in at least six or seven volutions. They are counted as many as 4, 6, 7, 8, 10, (3), (2) and (0), respectively from the first to the ninth volution in one representative specimen. In the first four or five volutions they are broad and short and their axial sections are V shape with pointed distal margins. In outer volutions, the transverse septula are rare, sometimes very slight swellings of keriotheca without pointed distal margin occur. Slight alveolar divergency, which is approximately 15° at the maximum, is seen in juvenile transverse septula.

Septa are not folded. The equatorial chamberlets from the first to the eighth volution in one representative specimen number 7, 12, 11, 11, 13, 15, 18 and 22, respectively.

Axial septula begin to appear in the third equatorial chamberlet of megaspheric generation. Essentially the contour of axial septula is V shape. The distal margin is round and to it adheres unconsolidated basal deposit. Lateral passages are small, approximately 15 microns in the fourth volution. A second axial septulum per each equatorial chamberlet essentially is not present throughout the shell.

Parachomata are present throughout the shell; they develop underneath the transverse septula. In juvenile volutions, they develop beneath the center of swelling of keriotheca in outer volutions. Sometimes parachromata develop above where transverse septula do not exist. The number of parachomata of the seventh and eighth volution in one of the representative specimens is 15 and 15 respectively. The ratio of the width to the height of parachomata in juvenile volutions measured at the point beneath the center of lateral passage is approximately 1:1. Sometimes they touch at their feet. In outer volutions, the space between individual parachomata is irregular. They are high and broad, sometimes the contour of axial section is asymmetric. Foramina small, short distance above the floor.

Discussion, — M-MACLAY, 1955, described extremely primitive neoschwagerinids, *Armenina salgirica,* from Salgile river province of USSR. His illustrated specimen seems to be of the microspheric generation, because the first few volutions are umbilicated and it has a very minute proloculus. At this stage, if no account is taken of the large difference of the size of proloculus, and some difference of radius vectors of corresponding first few volutions between *M. eonipponica* and *Armenina salgirica,* the axial sections of the specimens resemble each other closely. However, the transverse septula in the juvenile volutions of *Minoella eonipponica* are more regularly spaced and better developed than those of *Armenina salgirica.*

Occurence, — *Minoella eonipponica* is abundant in the lowermost horizon of the Akasaka limestone mass, from point 4 to point 7, and at point 9 with some doubt. The occurrence of the specimens ranges approximately within seven meters. The population is highest at point 4. Well preserved specimens are rare throughout the locality; of the most species only inner several volutions remain. The species occur with *Minoella nipponica* (OZAWA) at points 5 to 9, and with *Verbeekina minatoi* HONJO at point 4.

Type level: Lower Middle Permian, MN zone of the Akasaka limestone.

Type locality: The Akasaka limestone, point 4 on route r-r′, about 30 m south of the Akasaka kindergarten, Taniyashiki, Akasaka, Gifu Prefecture.

Type specimens: Holotype, an axial section, pl. 1 fig. 1, 13510, Paratypes, 13355-13364.

Neoschwagerina (*Minoella*) *nipponica* (OZAWA)

Pl. 1, Figs. 6, 7, 8 and 10.
Pl. 2, Pl. 6, Fig. 1.

1927. *Cancellina nipponica* OZAWA. Jour. Coll. Sci., Imp. Univ. Tokyo, sect. 2, vol. 2, pt. 3, pp. 160–161, pl. 34, figs. 12–17, pl. 45, figs. 4–5.

1927. *Neoschwagerina simplex* OZAWA. Ditto pl. 34, fig. 11.
1957. *Cancellina* cf. *nipponica* KOBAYASHI. Sci. Rep. Tokyo Kyoiku Daigaku, sect. C, vol. 5, no. 48, pp. 302-303, pl. 9, fig. 15.

Diagnosis, — *Minoella nipponica* can be easily distinguished from *Neoschwagerina simplex* or *Neoschwagerina craticulifera* by the small transverse septula in the outer volutions. This species differentiated from *Minoella eonipponica* in respect to its outer volutions. Namely the former species clearly has transverse septula which have pointed distal margins throughout the shell even though they are not typical ones, while in the outer volutions of the later species, they are quite lacking.

Description, — Shell inflated spheroid with strongly convex lateral slopes. Mature specimens have more than twelve volutions. Megaspheric proloculus 0.23 to 0.25 mm in the longest diameter. Radius vectors of the first to the twelveth volution, measured in one of the representative specimens are approximately 130, 200, 255, 320, 385, 470, 575, 685, 790, 960, 1085 and 1250 microns, respectively.

Spirotheca is composed of upper basal deposit, tectum, keriotheca and lower basal deposit. Tectum clear, uniform in thickness of approximately 1.8 microns. Alveolar texture develops throughout the shell except for proloculus. Thickness of keriotheca in the first to the twelfth volutions of the specimen noted above are 6.5, 6.5, 6.5, 9, 11, 11, 15, 17, 19, 22, 28 and 28 to 30 microns, respectively.

Transverse septula appear from the first volution of the megaspheric generation. They are developed throughout the shell are regularly spaced. The transverse septula in the first to the twelveth volutions of the specimen noted above number 5, 8, 9, 11, 14, 15, 15, 16, 17, 21, 24 and 29, respectively. In the juvenile volutions, they are broad and extend deeply into chambers, they are essentially V shape in axial section, having alveolar divergency which is approximately 20° at the maximum. In the adult volutions, transverse septula are quite weakly developed. They occur as only slightly swellings of keriotheca with pointed distal margins without alveolar divergency.

Secondary transverse septula are not seen.

Septa are not folded, normal to the spirotheca. The number of equatorial chamberlets from the first to the eleventh volutions in one representative specimen is 4, 7, 9, 11, 11, 15, 15, 20, 22, 21, and 22.

Axial septutla begin to appear in the third equatorial chamberlets. True axial septula appear in the later second volution. A second axial septulum per an equatorial chamberet makes its first appearance at the end of the eighth volution, but it is rare throughout the shell. Lateral passage small, short distance above the floor, approximately 25 microns in diameter measured at the fourth volution.

Parachomata are well developed throughout the shell. The ratio of the width to the height of parachomata of the center of lateral passages for corresponding portions of different specimens of this species is remarkably variant. The diameter of foramina in juvenile volutions is approximately 15 microns.

Discussion, — Previous authors have held the opinion that this species is small in size and has thin spirotheca. But when comparison is made of the radius vectors of each volution of this species with the corresponding volutions of the other neoschwagerinids, large difference can not be found throughout their ontogeny. Also the spirotheca in this species is not thinner than that of the corresponding volution of other species if careful comparison is made. On the contrary, the outermost few volutions of this species have rather thicker spirotheca than the other species.

Occurrence, — *Minoella nipponica* is very abundant in the lowermost horizon of the Akasaka limestone mass, from point 5 to point 10, and at point 12 with some doubt. The occurrence of the species ranges approximately five to seven meters. The population is the highest at point 9, and is best preserved in this locality. The species occurs with *Mincella eonipponica* HONJO n. sp. at points 5 to 9, with *Neoschwagerina simplex* (OZAWA) at point 9 to 12, with *Pseudodoliolina ozawai* YABE & HANZAWA at point 12, and with *Pseudofusulina* spp. at point 11.

Type level: Lower middle Permian, MN zone of the Akasaka limestone.

Type locality: The Akasaka limestone, point 9 on route r-r′, about 30 m south of the Akasaka kindergarten, Taniyashiki, Akasaka, Gifu Prefecture.

Type specimens: Holotype, an axial section pl. 34 fig. 15, OZAWA 1927.

Deposited in the Department of Geology and Paleontology, Faculty of Science, Tokyo University.

Topotypes, 13365-13384.

Genus *Gifuella* HONJO n. gen.[6]

Type species: *Gifuella gifuensis* HONJO n. gen., n. sp.

Summary diagnosis, — *Gifuella* can be distinguished from other allied

6) It was Prof. MINATO who suggested to separate *Gifuella gifuensis* and *G. amicula* from the genus *Neoschwagerina*; he allowed the author to described the genus.

neoschwagerinids by its small transverse septula of which the two sides run parallel in the outer volutions. The axial organs are also finer than in other genera. The external shape of this genus is much elongated—the growth ratio increases very rapidly. The growth ratio for the tenth volution of this genus is more than 1.7.

Diagnosis, — Shell elongate fusiform, with slightly convex lateral slopes and bluntlty rounded poles. The axis of coiling runs straight throughout the shell in megaspheric generation.

Size of megaspheric proloculus variable, small to medium, approximately 0.25 to 0.45 mm in the longest diameter. It is composed of tectutm and basal deposit covering the outer surface of it. Inner surface of proloculus seems to be smooth. Aperture of proloculus opens to transverse direction of the axis. Around the aperture of proloculus, the spirotheca is slightly depressed, accordingly the proloculus appears kidney shape in sagittal section. The shorter diameter of proloculus is approximately 80% of the longest diameter. Proloculus tube long, the middle part of it is somewhat constricted, the inner end opens. The inner diameter of proloculus tube, measured at most constricted part is apprximately 15 to 20 microns.

The shell expands unformly in the first five to six volutions. It expands very slowly in the outer volutions, and sometimes it stops expanding.

Growth ratio very rapidly increases, especially in the first six volutions. The growth ratio of the tenth volution for the genotype is nearly 2.0.

Spirotheca thin in juvenile, medium in adult stage, essentially composed of four layers, namely upper basal deposit, tectum, keriotheca and lower basal deposit.

Upper basal deposit develops throughout the shell. Tectum clear, uniform in thickness throughout the shell at approximately 1.8 microns.

Keriotheca develop throughout the shell, except for the wall of proloculus. Keriotheca thin, having and alveolar texture. Each alveolus extends completely to the bottom of keriotheca, vertically uniform from the top to bottom of keriotheca. Alveoli fine, numbering 20 to 25 in 10 square microns of the tangential section of spirotheca. The tangential section of each alveolus looks triangular to complex polygonal. Lower tectorium seems to be distributed near the bottom of keriotheca filling the gap of each alveolus.

Transverse septula appear from the first volution developing at a right angle to the septa. They are regularly spaced throughout the shell. In juvenile volutions, they are broad and short. In mature stage, they are small being presented as a narrow and short stake in the axial section. They are not pendant shape at an ypoint in the shell. In a transverse septulum each alveolus slightly bends independently toward the outer sides without the additional alveoli. The maximum alveolar divergency in the equatorial chamberlet for the sixth or seventh volution is 15°. The space between two adjacent transverse septutla expands toward the outer volutions.

The ceiling of chamberlets is square and flat havng angular corners.

Septa are not folded, the shape is uniform throughout the shell. The space between two adjacent septa expands toward outer volutions. The total number of equatorial chambers from the first to the end of the tenth volution is approximately a hundred. To the distal margin of septa thick basal deposit adheres.

Axial septula begin to appear in the third equatorial chamberlet of megaspheric generation. They show only as a slight swelling of keriotheca and are sporadically distributed in the first and the second volution. True axial septulum appears from the later second or third volution. The development of axial septula in axial direction is rather constant. They are narrow and both sides of them run essentially parallel. The distal margin is round and adhered to by thick basal deposit in the outer volutions. Accordingly they are pendant shape in sagittal section.

A second axial septulum per an equatorial chamberlet usually first appears at the later third volution, shortly after the first appearance of true axial septula. The occurrence of the equatorial chamberlet which has only one axial septulum is rare after a second axial septulum per chamberlet appears. Outwardly beyond the fourth to fifth volution, every equatorial chamberlet has a second axial septulum. A third axial septulum per an equatorial chamberlet appears at the seventh to ninth volutions. The occurrence of an equatorial chamberlet which has three septula is rather sporadic even in the outermost volutions. Those two or three axial septula in an equatorial chamberlet are different from each other in shape and size. The development of the inner axial septula in an equatorial chamberlet is less than the outer ones. Sometimes it is a slight swelling of keriotheca with pointed distal margin. The axial saction of such axial septulum is not symmetric, the spirally outer side of inner axial septulum makes some angle from the normal spirotheca. While the spirally outer septulum in an equatorial chamberlet is narrow and deep, and its axial section is symmetric, the two sides essentially run parallel or sometimes are pendant in section, with pointed distal margin which is adhered to by consolidated basal deposit. In case of three septula present in an equatorial chamberlet, the middle one has mean properties of the other two. The alveolar divergency is not remarkable; it is about 20° at the maximum measured at both sides of foramina. The increase of width between two adjacent septa is caused by addition of new axial septula.

Lateral passage is a short distance above the floor approximately 15 microns in the fifth volution, and 25 microns in the tenth.

Remarks, — Besides the type specimen, *Gifuella amicula* HONJO n. sp. and *Neoschwagerina douvillei* OZAWA can be classified to this genus. N. douvillei is the most advanced from among them.

Type species: Genoholotype, see the types of *Gifuella gifuensis* HONJO, n. gen., n. sp.

Gifuella gifuensis HONJO, n. subgen., n. sp.

Pl 6, Fig. 7, Pl. 7, Figs. 3, 4, 5, 6 and 7, Pl. 8.

Diagnosis, — *Gifuella gifuensis* can be clearly distinguished from other neoschwagerinids by its much elongated outer volutions and very small transverse septula with cornered feet throughout the ontogeny of the adult volutions. The species is separated from *G. amicula* by its larger radius vectors of the corresponding volutions.

Description, — Shell elongate fusiform, with slightly convex lateral slopes and bluntly narrowed poles. Mature specimens have more than fifteen volutions.

Magaspheric proloculus approximately 0.27 to 0.42 mm in longer diameter. The shorter diameter is approximately 80% of the longest diameter.

Radius vectors of the first to the fifteenth volution measured in one of the representative specimens are approximately 150, 220, 295, 380, 480, 585, 730, 885, 1040, 1370, 1560, 1750 and 1980 microns, respectively.

Growth ratio very rapidly increases; the growth ratio of the same specimen noted above is 1.15, 1.25, 1.50, 1.70, 1.75, 1.85, 2.15, 2.25, 2.35 and 2.45 respectively.

Spirotheca is composed of upper basal deposit, tectum, keriotheca and lower basal deposit.

Tectum clear, uniform in thickness which is approximately 1.8 microns.

Transverse septula appear from the first volution. They are regularly spaced. The number of transverse septula in the first to the twelveth volutions of the specimen used above is, 7, 10, 12, 17, 23, 23, 25, 31, 35, 37, 37 and 35, respectively.

In juvenile volutions, the size of transverse septula increases toward outer volution. While they are uniform throughout the adult volutions. The rought estimation of the ratio of width to the depth of transverse septula measured at a point beneath the center of lateral passage is about 1:1 in outer volutions, and 2:1 in juvenile volutions. In outer volutions, the distal margins of the septula are round and adhered to by lower basal deposit, while in juvenile volutions, margins are pointed and basal deposit is lacking. Alveolar divergency does not occur in juvenile volutions, less than 20° in inner few volutions of adult stage, about 30° in outer volutions of the adult stage at the maximum.

Secondary transverse septula are entirely lacking throughout the shell. Axial septula appear in the third equatorial chamberlet of megaspheric generation. They are narrow and the two sides of them run parallel. The distal margin is round and to it adheres unconsolidated thick basal deposit. A second axial septulum per an equatorial chamberlet first appears at the later third volution, a third axial septulum appears at the seventh volution. Those two or three axial septula in an equatorial chamberlet are different from each other in shape and size. The two sides of an axial septulum run parallel. Sometimes pendant shape in the axial section. The diameter of lateral passage of the fifth and tenth volutions are 15 and 25 microns respectively.

Parachomata present throughout the shell, underneath each transverse septulum. The rough estimation of the ratio of the width to height of parachomata measured beneath the center of lateral passage is 2:1 in juvenile volutions, 1:1 in inner adult stage and 2:3 in outer adult volutions. In juvenile and inner adult volutions, the contour of the axial section of parachomata is essentially V shape with round distal margin, with unconsolidated surface. In the outer volutions, the two sides of parachomata are nearly parallel with consolidated surface. Foramina open between two adjacent transverse septula. The diameter of foramina in juvenile and adult volutions is approximately 12 and 25 microns, respectively.

Occurrence, — *Gufuella gifuensis* HONJO, n. sp. is very abundant in the lower middle horizon of the Akasaka limestone mass, from point 55 to 60. The occurrence of the species ranges approximately through ten meters. The population is the highest at points 56 and 59. Specimens of this species are best preserved at point 56. *Neoschwagerina haydeni* (DUTKEVICH and KHABAKOV) is found in the lowermost and the uppermost part of the range, but the most of *G. gifuensis* colony is composed of the single species.

Type level: Lower Middle Permian, NM zone of the Akasaka limestone.

Type locality: The Akasaka limestone, point 56 on route r-r′, about 120 west of the Nobi-Hakkei Kinshozan monument, about 20 m south of the main building of Kinshozan shrine, Akasaka, Gifu Prefecture.

Type specimen: Holotype, an axial section pl. 7, fig. 3, 13454 Paratypes, 13455-13481.

Gifuella amicula HONJO, n. subgen., n. sp.

Pl. 6, Fig. 2, Pl. 9, Figs. 1, 2 and 4.

Diagnosis, — The radius vectors of the tenth volution of the typical Gifuella amicula are approximately 80% of the *G. gifuensis*. Further, the secondary axial septula of this species are comparatively shorter than those of *G. gifuensis* in the corresponding volution. But there are many specimens which have intermediate characteristics of the two species. The author has not determined how to draw the line between those species more clearly.

Description, — Shell elongate fusiform, with slightly convex lateral slopes and bluntly narrowed poles. Mature specimens have more than eleven volutions.

Megaspheric proloculus approximately 0.40 mm in the longest diameter, while the shorter diameter is approximately 80% of the longest.

Radius vectors of the first to eleventh volutions measured in a representative specimen are approximately 170, 207, 250, 310, 385, 485, 580, 684, 790 and 953 microns, respectively.

Growth ratio very rapidly increases; the growth ratios of the same specimen above noted are 1.03, 1.40, 1.66, 1.81, 1.83, 1.96, 1.93, 1.97 and 2.05, respectively.

Spirotheca is composed of upper basal deposit, tectum, keriotheca and lower basal deposit.

Tectum distinctive, uniform in thickness which is approximately 1.8 microns. Thickness of keriotheca of the specimen noted above is approximately 7, 8, 8, 10, 10, 10, 10, 10, 10 and 10 microns, respectively.

Transverse septula appear from the first volution. They are regularly spaced. Transverse septula of the first to the tenth volutions in the same specimen number 6, 10, 11, 15, 21, 23, 25, 30, 33 and 35, respectively. In juvenile volutions, they are wide V shape with pointed distal margins.

In outer volutions, they are narrow V shape. Alveolar divergency is not presented in the transverse septula of juvenile volutions, less than 25° in the outer volutions.

Secondary transverse septula are entirely lacking in all parts of the shell.

Axial septula appears in the third equatorial chamberlet of megaspheric generation. They are narrow and the two sides run parallel. A second axial septulum per an equatorial chamberlet first appears at the later third volution, a third axial spetula in an equatorial chamberlet are different from each other in shape and size. The two sides of an axial septulum run essentially parallel. Sometimes they are pendant shaped in the axial section.

Parachomata occur throughout the shell. They are poor especially in the outer volutions.

Occurrence, — *Gifuella amicula* HONJO, n. sp. occures beneath the *Gifuella gifuensis* horizon in the Akasaka limestone. The typical specimens of this species were collected from point 48 and point 50. The range of this species is not clear but about five meters. They are not abundant throughout the localities.

Type level: Lower Middle Permian, NM zone of the Akasaka limestone.

Type locality: The Akasaka limestone, point 50 on route r-r′, about 100 m west of the Nobi-Hakkei Kinshozan monument, Akasaka, Gifu Prefecture.

Type specimen: Holotype, an axial section, pl. 7, fig. 1, 13454 Paratypes, 13428-13436.

Genus *Neoschwagerina* s. str., YABE 1903

Type species: *Schwagerina craticulifera* SCHWAGER, 1883

Summary diagnosis, — Transverse septula, axial septula are found throughout the ontogeny. Transverse septula large in the adult volutions, alveolar divergency distinct in them. Sometimes few secondary transverse septula are distributed in an adult volution; they are small swellings of keriotheca with pointed distal margins, without having pendant shape in the axial section. Axial septula in an equatorial chamberlet are less than four at the maximum number. The external form is spheroid, bicone to constricted bicone shape.

Diagnosis, — Shell inflated spheroid, with convex to straight lateral slopes and bluntly rounded poles. Mature specimens have more than ten volutions. The axis of coiling runs straight in all part of the shell in megaspheric generation. The axis of coiling of the inner three volutions of microspheric generation makes some angle to that of other volutions.

Megaspheric proloculus medium in size.

Microspheric proloculus very minute, approximately 0.05 mm in diameter. It is composed of tectum and basal deposit covering outer surface. Proloculus aperture non-existent so far as the author's collections are concerned. The periphery of the first volution is lobulated into eight to ten identations in the wall.

The shell expands uniformly in the first five to six volutions. It expands very slowly in the outer volutions, and sometimes it stops expanding.

Growth ratio rather rapidly increases in the first six volutions. But in the outer volutions, the external shape elongates very slowly or ceases entirely. The growth ratio for tenth volution is approximately 1.5.

Spirotheca is essentially composed of four layers, namely upper basal deposit, tectum, keriotheca and lower basal deposit.

Upper basal deposit develops throughout the shell. Tectum clear, throughout the shell uniform in thickness, which is approximately 1.8 microns.

Keriotheca develops throughout the shell, except for the wall of proloculus. Keriotheca medium in thickness having an alveolar texture. Each alveolus extends completely to the bottom of the keriotheca, vertically uniform from the top to the bottom of the keriotheca. Alveoli fine, numbering 20 to 30 in 10 equare microns of the tangential section of the spirotheca. The tangential section of each alveolus looks triangle to complex polygon. Lower tectorium distributed near the top of keriotheca filling the gaps of each alveolus.

Transverse septula appear from the first volution in megaspheric generation developing at a right angle to the septa. In juvenile volutions, they are broad and short. In adult stage, they are large presenting broad and long V shape with round feet in the axial section. They are not pendant shape at any point in the shell. In a transverse septulum each alveolus is separated from others, and bends independently toward the two sides without additional alveoli. The maximum alveolar divergency in the equatorial chamberlet of the sixth or seventh volution is approximately 40°. The space between two adjacent transverse septula expands toward the outer volutions. Secondary transverse septula are not present at any point of the shell.

The vault of chamberlets are round without having angular corners.

Septa are not folded, essentially normal to the spirotheca, the shape is uniform throughout the shell. The space between two adjacent septa expands toward outer volutions. The total number of equatorial chambers from the first to the end of the tenth volution is approximately one hundred.

Axial septula begin to appear in the third equatorial chamberlet of microspheric generation. They are only slight swellings of keriotheca and are sporadically distributed in the first and the second volutions. True axial septula appear from the later second or the third volution. They broad and essentially V shape in axial section. A second axial septulum per chamberlet makes its first appearance at the tenth to elevent volutions. The occurrence is sporadic even in the outermost volutions. When the two kinds of septula are present in an equatorial chamberlet, they are different from each other in size. The spirally outer axial septulum in an equatorial chamberlet is larger than the inner one. Lateral passage are small, a short distance above the floor.

Parachomata occur throughout the shell just beneath each transverse septulum. They are broad and low in juvenile volutions, and rather slender in outer volutions. Foramina open between two adjacent transverse septula. They are usually roughly circular and located almost directly above the floor. The minimum diameter of foramina observable in juvenile volution is approximately 15 microns, but 30 microns or more in the tenth to twelveth volutions. Trabeculas are sometimes present in outer volutions.

Neoschwagerina simplex OZAWA, 1927

Pl. 3, Figs. 1, 4 and 5, Pl. 4.

1927. *Neoschwagerina simplex* OZAWA. Jour. Fac. Sci., Imp. Univ. Tokyo, Sect. 2, vol. 2, pt. 3, pp. 153–154, pl. 34, figs. 7–10 (non. 11), 22–23, pl. 37, figs. 3a 6a.

?1946. *Neoschwagerina craticulifera haydeni* THOMPSON. Jour. Paleo., vol. 20, no. 2, pp. 155–156, pl. 23, figs. 12–13.

1955. *Neoschwagerina simplex* CHEN. Index Fossils of China, Invertebrata, vol. 1, p. 10, pl. 5, figs. 6 (?7).

Diagnosis, — *Neoschwagerina simplex* can be distinguished from *Neoschwagerina craticulifera* by its wider transverse septula, namely, the transverse septula of the former species are wide V shape with round feet not only in juvenile volutions but in outer volutions, while in the outer volution of the later species they are much narrower and the both sides of them come to run parallel and to have cornered feet. In addition, the maximum alveolar divergency in the former species is larger than in the later species for corresponding volutions.

The lateral slopes of this species are convexed continuously throughout the shell. However, the other allied neoschwagerinids, *Neoschwagerina craticulifera, Neoschwagerina irregulalis* etc., have a straight part of lateral slope between the equator and pole of a specimen. In the former species, the shape of pole is more sharply narrowed than the later ones. That is to say, the lateral slopes of the former species directly meet at the pole, while in the later species, the lateral slopes are more convex near the pole before they meet at the pole forming a bluntly narrowered pole. Furthermore, the ontogeny of external form of the former changes from round juvenile to elongated outer volutions, and external form becomes round again in the outermost volutions, while in the later species, the outermost volutions are also elongated as in their preceeding volutions.

Description, — Shell fusiform, with convex lateral slopes and rather rounded poles. Mature specimens have more than eleven volutions. The axis of coiling of the inner three volutions in microspheric generation makes some angle to that of the outer volutions. Microspheric proloculus very minute in size, approximately 0.05 mm in diameter. Radius vectors of the first to the tenth volutions measured in one of the representative specimen are approximately 100, 180, 280, 380, 510, 685, 865, 1060, 1265 and 1500 microns, respectively.

Growth ratio rather rapidly increases in first five or six volutions, and shape gradually alters into round in outer volutions.

Spirotheca medium in thickness, is composed of upper basal deposit, tectum, keriotheca and lower basal deposit. Tectum clear, uniform in thickness which is approximately two microns. Thickness of keriotheca of the third to the twelfth volutions in the specimen noted above is 3, 5, 6, 9, 10, 13, 16, 20, 28 and 36 microns, respectively.

Transverse septula appear from the third volution in microspheric generation. They are regularly spaced. The number of transverse septula of the third to the tenth volution in the specimen noted above is 6, 8, 12, 13, 14, 17 and 19 respectively. They are broad and extend deeply into chamber with round feet. The alveolar divergency is more than 40° at the maximum. Secondary transverse septula entirely absent.

Septa not folded. The total number of equatorial chamberlets from the first to the end of the tenth volution is approximately a hundred.

Axial septula appear in the third equatorial chamberlet in the microspheric generation. They are slight swellings of keriotheca at the first appearance. Broad and deep axial septula appear in the latter fourth or the eighth volution. Second axial septula per each equatorial chamberlet are rarely fround in the outer most volutions. Lateral passages are small, short distance above the floor, approximately 30 microns in diameter in the tenth volution.

Parachomata are present throughout the shell. Rought estimations of the ratio of the width to the height of parachromata in juvenile volutions and outer volutions are 1:1.5 and 1.2:1. The diameter of foramina in juvenile volutions is approximately 15 microns, while in the tenth volution, it is more than 30 microns.

Discussion,— M. L. THOMPSON, 1946, reported a single axial section of *Neoschwagerina craticulifera* var. *haydeni* from Bamian limestone, Afghanistan. The author is of the opinion that this is a synonym of *Neoschwagerina simplex*. THOMPSON's single axial section has more than thirteen volutions, and the outermost few have narrow transverse septula with cornered feet like those of *Neoschwagerina cratifulifera* s. str. As specimens which have more than eleven volutions have not yet been discovered from Akasaka, slight doubt still remains as to this assessment.

Judging from the description, *Neoschwagerina simplex* (OZAWA) 1923, is a synonym of *Neoschwagerina cratifulifera* var. *rotunda* DEPRAT 1914. But the illustrated figures of the latter are not well oriented and detail of micro-structure is not shown. The author would not discuss further about this nomenclatural problem at this time.

Occurrence, — *Neoschwagerina simplex* is common in the lowermost horizon of the Akasaka limestone mass, from point 9 to point 12. Occurrence of the species ranges through a thickness of approximately six meters. The population is the highest at point 10. Specimens of this species are best preserved at point 9. This species occurs with *Minoella eonipponica* HONJO n. sp. at point 9, with *Minoella nipponica* (OZAWA) throughout the localities, with *Pseudofusulina* spp, at point 11, and with *Pseudodoliolina ozawai* YABE and HANZAWA at point 12.

Type level: Lower Middle Permian, MN zone of the Akasaka limestone.

Type locality: The Akasaka limestone, point 10 on route r-r′, about 30 m south of the Akasaka kindergarten, Taniyashiki, Akasaka, Gifu Prefecture.

Type specimen: Holotype, an axial section pl. 34, fig. 8, OZAWA, 1927. Deposited in the Department of Geology and Paleontology, Faculty of Science, Tokyo University.

Topotype: 13385-13403.

Neoschwagerina craticulifera (SCHWAGER), 1883

Pl. 3, Figs. 6, 8 and 9, Pl. 6, Figs. 5 and 6.

1883. *Schwagerina craticulifera*. SCHWAGER. Richthofen's China, Vol. 4, p. 140, pl. 18, figs. 15-25.
1912. *Neoschwagerina cratifulifera* DEPRAT. Mém. Serv. Géol. Indochine, vol. 1, fasc. 3, pp. 47-49, pl. 2, pp. 47-49, pl. 2, figs. 1-2, 4.
1912. *Neoschwagerina multicircumvoluta* DEPRAT. Ditto pp. 50-51, pl. 2, figs. 7-9, pl. 3, fig. 1.
1912. *Neoschwagerina craticulifera* var. *gradis* DEPRAT. Ditto p. 49, pl. 2, figs. 5-6.
1912. *Neoschwagerina craticulifera* var. *tenuis* DEPRAT. Ditto p. 49, pl. 2, figs. 3.
1913. *Neoschwagerina craticulifera* DEPRAT. Mém. Serv. Géol. Indochine, vol. 2, fasc. 1, p. 56, (without figures)
1914. *Neoschwagerina craticulifera* var. *rotunda* DEPRAT. Mém. Serv. Géol. Indochine, vol. 3, fasc. 1, p. 26, pl. 8, figs. 6-13.
1922. *Neoschwagerina spheroidea* OZAWA. Jour. Geol. Soc. Tokyo, vol. 29, no. 29, no. 348, p. 374, pl. 4, fig. 4.
1925. *Neoschwagerina* cf. *craticulifera* REED. Paraeontologia Indica, n. s. vol. 6, mém. no. 4, p. 95 (without figures)
1925. *Neoschwagerina craticulifera* OZAWA. Jour. coll. Sci., Imp. Univ. Tokyo, vol. 45, art. 6, pp. 54-55, pl. 2, fig. 86, pl. 11, fig. 4.
1927. *Neoschwagerina craticulifera* REED. Palaeontologia Indica, n. s. vol. 10, mém. no. 1, pp. 85-86, pl. 7, figs. 9, 9a.
1927. *Neoschwagerina craticulifera*, and *Neoschwagerina multicircumvoluta* OZAWA. Jour. Fac. Sci., Imp. Univ. Tokyo, sect. 2, vol. 2, pt. 3, pp. 154-156, pl. 40, figs. 1-8, 10, 11a.
1935. *Neoschwagerina craticulifera* GUBLER. Mém. Soc. Géol. France, n. s. Tome 11, Fasc. 4, no. 26, pp. 103-106.
1936. *Neoschwagerina craticulifera* HUJIMOTO. Sci. Rep. Tokyo Bunrika Daigaku, sect. C, vol. 1, no. 2, pp. 112-113, pl. 23, figs. 6, 7.
1937. *Neoschwagerina* sp. aff. *N. craticulifera* Jour. Paleont., vol. 11, pp. 142-143, pl. 25, figs. 7-8.
1942. *Neoschwagerina craticulifera* TORIYAMA. Jap. Jour. Geol. Geogr., vol. 18, no. 4, pp, 244-245, pl. 24, fig. 13.
1944. *Neoschwagerina craticulifera* TORIYAMA. Jap. Jour. Geol. Geogr., vol. 19, nos. 1-4, pp. 81-82, pl. 6, fig. 26.
1947. *Neoschwagerina craticulifera* TORIYAMA. Jap. Jour. Geol. Geogr., vol. 20, nos. 2-4, pp. 76-77, pl. 17, figs. 4-7.
1952. *Neoschwagerina craticulifera* KONISHI. Trans. Proc. Paleont. Soc. Japan, n. s. no. 5, p. 159.
1955. *Neoschwagerina craticulifera* CHEN. Index Fossils of China, Invertebrata vol. 1, p. 10, pl. 5, figs. 4-5.
1957. *Neoschwagerina craticulifera* M-MACLAY. Mem. Leningrad Univ., no. 225, ser. Geol. Sci., part 9, Geology, pp. 125-129, pl. 6, figs. 1-2.
1957. *Neoschwagerina craticulifera* KOBAYASHI. Sci. Rep. Tokyo Kyoiku Daigaku,

sect. C, vol. 5, no. 48, pp. 303–305, pl. 9, fig. 8–13.
1958. *Neoschwagerina craticulifera* TORIYAMA. Mem. Fac. Sci. Kyushu Univ. ser. D, vol. 7, pp. 215–220, pl. 40, figs. 1–22, pl. 41, figs. 1–5.

Diagnosis, — Although *Neoschwagerina craticulifera* is a very important species in the geology of the Permian Tethys sea area, sometimes it has been confused with allied species such as *N. simplex* or *N. haydeni*. The author was able to ascertain the differences of survival ranges for those species in the Akasaka limestone, and found more convenient characteristics to distinguish them. As the differences of primary biocharacter, i.e., the degree of the development of transverse septula, are too delicate among those species, the author wishes to lay stress on the external shape of *N. craticulifera* is typical bicone throughout the adult stage of which the lateral slope has a straight part between the equator and pole. *N. simplex* can be distinguished from this species not only by the less extent of the transverse septula in the outer volutions but also by its spheroid shape. The transverse septula of *N. haydeni* are more extended and have more developed form than those of *N. craticulifera*.

Description, — Shell fusiform, with straight lateral slopes and bluntly narrowed poles. Mature specimens have more than fifteen volutions. The axis of coiling is straight throughout the shell in megaspheric generation. Megaspheric proloculus medium in size, 0.13 to 0.10 mm in the longest diameter.

Growth ratio from the first to the twelfth volution in one of the most representative specimens is 1.00, 1.08, 1.33, 1.57, 1.56, 1.67, 1.75, 1.77, 1.79, 1.77, 1.75, and 1.71, respectively.

Radius vectors of the first to the thirteenth volution in the specimen noted above are 96, 125, 173, 221, 307, 403, 518, 653, 787, 922, 1075, 1229 and 1402 microns, respectively.

Spirotheca medium in thickness, composed of upper basal deposit, tectum, keriotheca and lower basal deposit. The thickness of keriotheca from the second to the thirteenth volution in the same specimen is 6, 6, 9, 9, 9, 12, 12, 12, 12 to 15, 18, 18 and 18 microns, respectively.

Transverse septula appear from the first volution. The numbers of transverse septula from the first to the thirteenth volution in the same specimen are 6, 8, 12, 13, 15, 16, 21, 25, 26, 28, 29, 28, 32, 38 and 37 respectively. They are large and broad and extend deeply into chamber with round feet. The alveolar divergency is more than 42° at the maximum. Secondary transverse septula rarely appear in the volutions beyond the twelfth.

Septa not folded. The total number of equatorial chamberlets from the first to the end of the tenth volution is approximately a hundred.

Axial septula appear in the third equatorial chamberlet in the megaspheric generation. They are slight swellings of the keriotheca at the first appearance. Broad and deep axial septula appear in the later fourth or the eighth volution. Second axial septula per each equatorial chamberlet are rarely found in the outermost volutions. Lateral passage small, short distance above the floor, approximately 30 microns in diameter in the tenth volution.

Parachomata are present throughout the shell. Rough estimations of the ratio of the width to the height of parachomata in juvenile volutions and in outer volutions are 1:1.5 and 1.5:1. The diameter of foramina in juvenile volutions is approximately 15 microns, while in the tenth volution, it is more than 32 microns.

Discussion, — The type illustrations of *Neoschwagerina craticulifera* of SCHWAGER (1883) are handdrawn figures. While those figures have well presented paleozoologists a general conception of the species, there have been found a few problems in them. In the first place, the secondary transverse septula like those Yabeina are seen even in the fifth volution, and they are quite commonly distributed from the seventh to twelfth volution. Especially in the earlier part of the tenth volution, almost every chamberlet has a secondary transverse septulum. Furthermore, second secondary transverse septula per a chamberlet is found in early adult volutions.

In 1935, GUBLER re-examined SCHWAGER's original specimen which had been deposited in the Berlin Museum. On that occasion, he could not find such numerous secondary transverse septula in it. The author has ignored the secondary transverse septula in the original illustration following GUBLER's observation.

The axial part of SCHWAGER's axial section do not have axial substance; this raises doubt as to the accuracy of the orientation.

The last problem is the considerable difference of the radius vectors for the corresponding volutions between illustrated axial and sagittal sections. On this problem, TORIYAMA, 1958, offered detailed discussion. So the author will not discuss this problem further.

DEPRAT, 1914, illustrated a very beautiful axial section of *Neoschwagerina craticulifera* also from Akasaka, which is one of the most well oriented specimens ever to have been published. In this figure, the characteristics of *Neoschwagerina craticulifera* are better presented than in SCHWAGER's original illustration.

There are six known varieties of this species as follows;

Neoschwagerina craticulifera var. *gradis* DEPRAT, 1912
N. craticulifera var. *tenuis* DEPRAT, 1912
N. craticulifera var. *minoensis*, DEPRAT, 1914
N. craticulifera var. *rotunda* DEPRAT, 1914
N. craticulifera var. *spheroidea* OZAWA, 1922
N. craticulifera var. *haydeni* DETKEVITCH and KHABAKOV, 1934

Among them *N. craticulifera* var. *minoensis* was promoted by OZAWA to the rank of an independent species. *N. craticulifera* var. *haydeni* is a more advanced type than *N. craticulifera* s. st., therefore the present author has considered it an independent species.

According to the original description, *N. craticulifera* var. *gradis* DEPRAT is separated from the type species by its considerable size and round poles. The original microphotographs are very oblique, therefore the pole regions seem to become round in shape, and those illustrations tell us no other peculiarities. There being no serial diameters of volutions through the ontogeny of this variety, one is not able to reestimate the size of this variety.

According to the type description, the internal structure of *N. tenuis* DEPRAT, 1912 is absolutely identical to *N. craticulifera,* although it differs from type species by its slightly longer external form, round pole, and not inflated middle part. Those differences may also be attributable to the inaccurate orientation of the specimens.

Neoschwagerina rotunda DEPRAT was included as a synonym of *N. craticulifera* s. str. by OZAWA, 1927. But *N. simplex* seems to be more suitable on the basis of the original description.

A simple axial section of *Neoschwagerina spheroidea* was illustrated by OZAWA, 1925, without description. The illustrated figure is obviously of a typical *N. craticulifera* and it was included as a synonym by OZAWA himself in 1927.

Neoschwagerina multicircumvoluta DEPRAT, 1914, was regarded a synonym of *N. craticulifera* which belongs to another generation. Observing the magnified microphotograph of this species (pl. 3, fig. 1), one is scarcely able to decide that the proloculus is of a microspheric generation, although it is smaller and the heights of the first few volutions are much lower than those of the type species. But other figures (pl. 2, fig. 7 and fig. 9) are identical to *N. craticulifera* s. str.

Occurrence, — *Neoschwagerina craticulifera* s. st. is common in the lower horizon of the Akasaka limestone mass, from point 31 to point 56. It ranges through nearly one hundred meters. In upper horizons, the present species seems to occur in mixture with *N. haydeni.*

Type locality: The Akasaka limestone, point 31, on route r-r′, about 110 m NW of the Nobi-Hakkei Kinshozan monument, Okubo, Akasaka, Gifu Prefecture.

Type specimen: Holotype, an axial section, pl. 18, fig. 17, SCHWAGER, 1883.

Topotypes: 13404-13411.

Neoschwagerina irregulalis HONJO, n. sp.

Pl. 3, Figs. 2 and 7
Pl. 5.

Diagnosis, — Generally speaking, in respect to size the transverse septula on a volution presented in an axial section, are not remarkably different from each other. However, in this species, not only are the sizes quite irregular but the shapes of them are obviously different.

Description, — Shell fusiform, with slightly convex lateral slopes and bluntly narrowed poles. Mature specimen have more than thirteen volutions. Megaspheric proloculus medium in size.

Spirotheca medium in thickness, is composed of upper basal deposit, tectum, keriotheca and lower basal deposit. Tectum clear, uniform in thickness which is approximately 2.0 microns. Alveolar texture developes throughout the shell except for proloculus. Thickness of keriotheca of the second to the eighth volution measured in one of the representative specimen is 7, 7, 9, 10, 10, 12 and 12 microns, respectively.

Transverse septula appear from very early volutions. They are irregularly spaced. The spiral development is also irregular. In juvenile volutions, they are uniform, broad and shallow with pointed distal margins, essentially V shape in axial section. In the outer volutions, in respect to width, the transverse septula are different from each other; sometimes narrow pendant-shaped transverse septula are inserted between two adjacent V-shaped transverse septula. The maximum alveolar divergency is more than 45°.

Septa are not folded. The total number of equatorial chamberlets from the first to the end of the tenth volution is approximately a hundred. A third axial septulum per an equatorial chamberlet can not be discovered at any point in the shell. Lateral passage small. Short distance above the floor.

Parachomata develop throughout the shell. They differ in size with each other. Rough estimation of the width to the height of parachomata in the outer volutions is 2:3. Foramina located short distance above the floor, approximately 30 microns in outer volutions at the maximum.

Discussion, — It has not been without some hesitation that the new specific name is proposed here, because the development of transverse septula of neoschwagerinids in transverse direction is not constant, although they are uniform in well oriente dplane. That is, when an axial section runs through near a septum, the section of transverse septulum is presented as a quite large one. On the contrary, when an axial section is cut through the center of a foramina, the same transverse septula seem narrow and short. In an oblique section, such differences should be distributed following a certain rule. However, in this species, the different sized and shaped transverse septula are mixedly distributed throughout the adult volutions in any kind of orientation. Therefore, the author is of the opinion that those differences are not attributable to the orientation but actually occur in nature.

Occurrence, — *Neoschwagerina irregulalis* is common in the lower horizon of the Akasaka limestone mass, from point 34 to point 58. Occurrence of the species ranges for approximately fifty meters in the Akasaka limestone. The population is the highest at points 34 to 36. This species is co-existent with *N. craticulifera* s. str.

Type level: Lower Middle Permian, NC zone of the Akasaka limestone.

Type locality: The Akasaka limestone, point 34 on route r-r′, about 130 m NW of the Nobi-Hakkei Kinshozan monument, Okuba, Akasaka, Gifu Prefecture.

Type specimen: Holotype, an axial section, pl. 3, fig. 2 Paratypes. 13500-13503.

Neoschwagerina haydeni (DUTKEVITCH and KHABAKOV), 1934

Pl. 3, Figs. 10

1909. *Neoschwagerina craticulifera* HYDEN. Rec. Geol. Surv. India, vol. 38, p. 248–249, pl. 21, fig. 1–7.

?1925. *Neoschwagerina margaritae* OZAWA. Jour. Coll. Sci., Imp. Univ. Tokyo, vol. 45, art. 6, pp. 58–60, pl. 11, figs. 1, 3 (non. 2).

1934. *Neoschwagerina craticulifera* var. *haydeni* DUTKEVITCH and KHABAKOV. Acad. Sci. USSR., Geol. Pamir, vol. 8, pp. 94–99, pl. 2, figs. 6–8, pl. 3 figs. 1–2.

Diagnosis, — The two sides of a septulum in the adult volution of Neoschwagerina haydeni run parallel; it reaches deeply into a chamber. The external shape of this species is spheroid throughout its life history. This species can be distinguished from *N. craticulifera* s. str. by those points.

Description, — Shell fusiform, with slightly convex lateral slopes and bluntly narrowed poles. Mature specimens have more than fourteen volutions. Megaspheric proloculus approximately 0.20 microns in diameter.

Radius vectors of the first to the twelfth volution of one of the representative specimens are 125, 195, 250, 300, 365, 460, 555, 675, 785, 960, 1070 and 1240 microns, respectively.

Spirotheca medium, is composed of upper basal deposit, tectum, keriotheca and lower basal deposit. Tectum clear, uniform in thickness which is approximately 2.0 microns. Alveolar texture developes throughout the shell except for proloculus. Thickness of keriotheca of the first to the tenth volution in one of the representative specimens is 6, 6, 6, 9, 10, 10, 12, 13, 13 and 14 microns, respectively.

Transverse septula appear from the first volution of megaspheric generation. They are regularly spaced. In the juvenile volutions they are low and wide V shape with pointed distal margins in the transverse section. In the outer volutions, the two sides of transverse septula practically parallel. The numbers of transverse septula from the first to the tenth volution of the specimen noted above are, 5, 7, 8, 10, 11, 13, 14, 16, 18 and 22 respectively. The maximum alveolar divergency is approximately 40°. Secondary transverse septula entirely lacking throughout the shell. The ceiling of chamberlets is round.

Septa are not folded. Hollows of the septa between two adjacent joints of transverse septula are deep in the outer volutions. Therefore, trabeculus are easily formed in transverse section of the chamber. The total number of equatorial chamberlets from the first to the tenth volution is approximately a hundred.

Axial septula begin to appear in the third equatorial chamberlet. They are essentially V shape in sagittal section. A second axial septulum per each equatorial chamberlet first appears at the eighth volution. From the ninth volution, the most of the equatorial chamberlets have two axial septula in them. A third axial septulum per equatorial chamberlet can not be discovered at any point in the shell. Lateral passage small, short distance above the floor.

Parachomata develop throughout the shell. In juvenile volutions, they are wide and high. In outer volutions they become narrow. Foramina open between two adjacent septula, short distance above the floor.

Occurrence, — *Neoschwagerina haydeni* is abundant in lower horizon of the Akasaka limestone mass, from point 42 to point 59. It ranges for very long time in the Akasaka limestone, viz., more than seventy meters. This species occurs with *N. craticulifera* s. str. and *N. irregularis* in the earlier half of the range. Those two allied species are completely taken over by this species at the later half of the range. *N. colania* is found with this species in the same sectioned preparations of points 59 and 57.

Level: Lower Middle Permian, upper NC to middle NM zone of the Akasaka limestone.

Specimens: 13449-13452.

Neoschwagerina colaniae OZAWA

Pl. 11, Figs. 5, 6, 7 and 8

1925. *Neoschwagerina colaniae* OZAWA. Jour. Coll. Sci., Imp. Univ. Tokyo, vol. 45, art. 6, pp. 157–158, pl. 40, figs. 9, 12–13, pl. 41, figs. 3, 11.

1957. *Neoschwagerina* cf. *colaniae* KOBAYASHI. Sci. Rep. Tokyo Kyoiku Daigaku, Sect. C, vol. 5, no. 48, pp. 305–306, pl. 10, figs. 1–2.

Diagnosis, — This species resembles *N. haydeni* in its deeply extended transverse septula. But the former has more broad and peculiar V shaped transverse septula. The transverse septula of this species is the largest among the *Neoschwagerina* which have ever been described.

Description, — Shell fusiform, with slightly convex lateral slopes and pointed poles. Mature specimens have more than 12 volutions. Microspheric proloculus is approximately 0.02 mm in diameter.

Radius vectors of the first to the eleventh volution measured in one representative specimen are 60, 96, 136, 180, 240, 316, 420, 536, 690, 828 and 976 microns, respectively.

Growth ratios in the specimen noted above of the first to the eleventh volution are 0.83, 1.15, 1.18, 1.47, 1.43, 1.69, 1.76, 1.76, 1.68. 1.65 and 1.65, respectively.

Spirotheca thin, is composed of upper basal deposit, tectum, keriotheca and lower basal deposit. Tectum clear, uniform in thickness which is approximately 2.0 microns. Alveolar texture develops throughout the shell. Thickness of keriotheca of the specimen noted above in the second to the twelveth volution is 5, 8, 8.5, 8.5, 8.5, 13, 18, 17, 19 to 18, 195 and 19.5 to 17 microns, respectively.

Transverse septula appear from the second volution in microspheric generation. In the juvenile volutions, they are broad and shallow and regularly spaced. In the outer volutions, they are very broad and well proportioned to the height of a chamber, and they are somewhat irregularly spaced. The two sides of transverse septula in the adult volution are not smooth in this species. That is say, a few notches are seen along the contour of the transverse septula in their axial sections. At the point where the transverse septula and parachomata touch, the former is usually much wider them the latter. The numbers of transverse septula of the first to the eighth volutions in the specimen noted above are 5, 6, 10, 12, 15, 19, 22, 24, respectively. The vault of chamberlets are much narrowed by good development of transverse septula. The maximum alveolar divergency in the outer volutions is more than 45°.

Septa are not folded, regularly spaced. The total number of equatorial chamberlets from the first to the end of the tenth volution is approximately a hundred.

Axial septula begin to appear in the third volution of microspheric generation. They are well developed from the first appearance. The two sides of axial septula run parallel with round distal margins to which adhere a consolidated basal deposit. The axial section is pendant in the adult volutions. A second axial septulum per equatorial chamberlet usually makes its first appearance at above the middle of the sixth volution. Such septula are commonly distributed beyond the fifth volution. A third axial septulum per equatorial chamberlet is sporadically found in the outermost volutions.

Parachomata are present throughout the shell. Corresponding to the irregular spacing of transverse septula, they also somewhat irregularly spaced on the spirotheca. They are narrow and high in the adult stage. Rought estimation of the ratio of the width to the height of parachomata is 2:3 in juvenile volutions and 1:2 in outer volutions. Foramina small, a short distance above the floor, approximately 30 microns in the outer volutions.

Discussion, — According to the type description of OZAWA, the present species is rather globular, although his illustrated single axial section is obviously oblique. In a well oriented specimen, the form ratios for each volution increase rather rapidly and its adult shape becomes slightly elongated fusiform.

Occurrence, — *Neoschwagerina colaniae* is rather rare in the middle horizon of the Akasaka limestone mass, from point 59, about to point 70. Occurrence of the species ranges through approximately fifty meters in the Akasaka limestone. The population is the highest at point 61. Generally, the specimens are not well preserved, especially the outer volutions seem to be easily worn. This species seems to co-exist with *Gifuella gifuensis* n. sp. and *Metaschwagerina ovalis* n. gen., n. sp.

Type level: Lower Middle Permian, NM zone of the Akasaka limestone.

Type locality: The Akasaka limestone, point 61 on route r-r′, about 100 m north of Shirakiya Limestone Company's powder magazine, Okubo, Akasaka, Gifu Prefecture.

Type specimen: Holotype, an axial section, OZAWA pl. 41, fig. 11, probably deposited in the Department of Geology and Paleontology, Tokyo University. Topotypes, 13485-13493.

Genus *Metaschwagerina* MINATO and HONJO

Type species: *Metaschwagerina ovalis* MINATO and HONJO

Diagnosis, — Spirotheca essentially composed of four layers, namely upper basal deposit, tectum, keriotheca and lower basal deposit which covers the upper and lower surfaces of them. Keriotheca very thick throughout the shell. In some outer volutions, the keriotheca is differentiated into two layers, namely upper and lower layer. The alveoli of upper layer fine, and some number of alveoli stop extending at a certain horizon developing parallel to the tectum, while the rest of the alveoli extend to the bottom of the keriotheca forming a lower layer. Transverse septula well developed, regularly spaced, formed by the extension of alveoli of lower layer. They are broad and extend deeply into chambers. Secondary transverse septula do not occur. The contours of ceilings and chamberlets in axial section round. Septa not folded, normal to the spirotheca. The space between two adjacent septa expands toward outer volutions. Axial septula present, appear in the comparatively early volutions, simple in shape. Parachomata present; they are not well developed especially in outer volutions.

Metaschwagerina ovalis MINATO and HONJO

Pl. 7, Figs. 1 and 2, Pl. 8.

1958. *Metaschwagerina ovalis* MINATO and HONJO. Earth Science, No. 38, frontispiece.

Diagnosis, — *Metaschwagerina ovalis* MINATO and HONJO can be easily distinguished from other neoschwagerinids by its round external shape, thick keriotheca and poorly developed axial and transverse septula. In well preserved specimens, the special texture of kriotheca, which is separated into two layers, can be observed.

Description, — Shell spheroid, with convex lateral slopes and bluntly rounded poles. Mature specimens have more than 12 volutions. The axis of coiling straight in megaspheric generation. In microspheric generation, the axis of coiling of inner three volutions makes some angle to that of outer volutions.

Microspheric proloculus very minute, approximately 0.03 mm in diameter, composed of tectum, upper basal deposit which covers outer surface. The periphery of the first volution of microspheric generation is strongly lobulated into eight convexes of the wall.

In microspheric generation, the height of the first volution is very small. Radius vectors of the first to the twelfth volution measured in one of the representative specimens are approximately 68, 134, 210, 316, 454, 616, 798, 1016, 1266, 1528, 1742 and 1956 microns, respectively.

Growth ratios of the first to the twelfth volution measured in the specimen mentioned above are 1.12, 1.21, 1.38, 1.44, 1.53, 1.51, 1.49, 1.51, 1.45, 1.41, 1.44 and 1.46, respectively.

Spirotheca practically composed of four layers, namely tectum, keriotheca, and basal deposit which covers their upper and lower surfaces.

Basal deposit on the surface of spirotheca well developed in the first to the 5th or the 6th volution. Toward the outer volutions, it is less well developed. In outer volution beyond the 6th, the basal deposit very thin or entirely lacking. Basal deposit composed of simple black substance which seems to be the same substance as that composing the parachomata.

Tectum distinct, thin, thickness uniform throughout the shell, approximately 1.5 microns.

Keriotheca very thick, developed throughout the shell except in the wall of proloculus and the first volution of microspheric generation. Thickness of keriotheca of the first to the eleven volution measured in one of the representative specimens is approximately 8, 20, 30, 40, 80, 85, 100, 135, 135, 140 and 140 microns respectively. In the keriotheca of the first to the sixth volution, each alveolus extends completely to the bottom of the keriotheca; they are vertically uniform and parallel with each other. Alveoli fine in this stage, approximately 20 alveoli in 10 square microns tangential section of spirotheca. The keriotheca of volutions beyond the seventh volution differentiated into two layers. In this stage, the alveoli of upper layer are fine, approximately 25 in 10 equare microns of the tangential section of this layer of keriotheca. About one-half of the alveoli stop extension at two-thirds of the thickness of keriotheca making a certain horizon developing parallel to the tectum; the rest of the alveoli extend to the bottom of keriotheca, forming a lower laer. In lower layer, the alveolar walls and alveoli themselves becomes thick to lower surface of keriotheca. Approximately 15 alveoli are counted in 10 square microns of the tangential section cut near the upper surface of lower layer. The shape of tangential section of alveoli is generally hexagonal. Alveolar wall has a complex texture.

Transverse septula are regularly spaced in a chamber throughout the shell, formed by the extension of the alveoli of lower layer. Each alveolus is separated from others and bends independently toward both sides without the additional alveoli. Alveolar wall thick lower part of septula. Alveolar divergency in transverse septula is quite distinct especially in outer volutions; it is more than 45° in the seventh volution. Transverse septula appear from the third volution in microspheric generation, right angle to the septa, regularly spaced. The number of transverse septula in the third to the tenth volution of a representative specimen is 4, 6, 7, 9, 13, 13, 16 and 18, respectively. The development of transverse septula in spiral direction is quite regular. They extend broadly and deeply into chambers. The distal margin of transverse septula reaches to the surface of tectum except at the lintel of lateral passage. Two adjacent septula touch at their feet, accordingly the ceilings of chamberlet are quite narrow and round.

Secondary transverse septula are not present at any part of the shell.

Septa not folded, normal to the spirotheca, uniform throughout the shell. The space between two adjacent septa expands toward outer volutions. The total number of chambers from the first to the end of the tenth volution is approximately one hundred.

Axial septula appear in about the 15th equatorial chamberlet in microspheric generation. All equatorial chamberlets of volutions beyond the fourth have pointed distal margins. The development of shape of axial septula in axial direction variable; sometimes only slight swellings of keriotheca with round distal margin are observed in sagittal section. The alveolar divergency in axial septula of the seventh volution is greater than 45°.

Parachomata present throughout the shell, just beneath each transverse septulum. The width and height are in the ratio of 3:1, in rough estimation, measured at the two sides of lateral passage.

In volutions beyond the fifth, the parachomata are very weakly developed, sometimes lacking. Foramina circular, located directly above the floor. In volutions beyond the fifth, the foramina open any place without connection with the location of transverse septula accordingly the number of foramina is greater than the number of transverse septula. The minimum diameters of foramina measured in the fifth and the eighth volution are approximately 15 and 30 microns respectively.

Discussion, — The most important trend in the evolution of the neoschwagerinids seems to be toward the complication and increase of the number of septular organs in the chamberlets. For instance, the transverse septula of *Minoella nipponica* are not well proportioned and few in number, while in the more highly developed species such as *Gifuella douvilei* or *Neoschwagerina colaniae,* better proportioned transverse septula and a greater number of axial septula are found. The other important trend is decrease in the thickness of keriotheca. This is very clear when the thicknesses in *Neoschwagerina simplex* and *Yabeina globosa* are compared.

Toward the upper horizons of *Neoschwagerina* zone of the Akasaka limestone, the primitive type of neoschwagerinids such as *Minoella, Neoschwagerina* or *Gifuella* are gradually replaced by highly organized ones like *Yabeina globosa.* However, one can imagine the presence of relict species such as *Neoschwagerina minoensis.*[7]

The present species occurs from near the uppermost horizon of *Neoschwagerina* zone of the Akasaka limestone. It acquires real interest when one observes that this species possesses primitive biocharacters of the neoschwagerinids throughout the shell except for its special texture of the keriotheca. In other words, some primitive elements of the neoschwagerinids in this species are intensified rather than minimized in the reverse way of evolution. For instance, the axial septula of this species are broad V-shape. They closely resemble those of primitive neoschwagerinids in juvenile volutions. Furthermore secondary transverse septula does not present throughout the ontogeny.

This species is perhaps best characterized by its thick and peculiar keriotheca.

Specifically, the thickness of keriotheca reaches almost three times that of other neoschwagerinids which survive contemporaneously with this species. It is very interesting that this species seems to have special complex two layered keriotheca. Those facts demnostrate that this species is not a simple relict fauna but it had been developed in some a special way of evolution.

In view of these facts, the author is believes that this species should be regarded as a new independent genus separated from other neoschwagerinids.

Occurrence, — *Metaschwagerina ovalis* is rarely found in the middle horizon of the Akasaka limestone. Occurrence of the species ranges from

7) *Neoschwagerina minoensis* OZAWA survives in *Yabeina* zone in Japan. This species close to *N. craticulifera* var. *haydeni* in many respects.

between points 67, and 77, approximately fifteen maters. The population is the highest and the specimens are best preserved at point 68. This species is accompanied by *Neoschwagerina colaniae* at the points 67, 68, and 72 (?).

Type level: Lower Middle Permian, MM zone of the Akasaka limestone.

Type locality: The Akasaka limestone, point 68 on route r-r′, about 10 m north of the Shirokiya Limestone Company's powder magazine, Shirokiya quarry, Okubo, Akasaka, Gifu Prefecture.

Type specimen: Holotype, a part of an axial section, MINATO and HONJO, Earth science, frontispiece. Reg. No. 13494, Paratypes, 13495, 13496.

Yabeina ozawai HONJO, n. sp.

Pl. 11, Figs. 1, 2, 3 and 4, Pl. 12.

?1924. *Neoschwagerina claticulifera* HAYASAKA. Sci. Rep. Tohoku Imp. Univ., Ser 2., vol. 8, no. 1, p. 18, pl. 3, figs. 9 (non 8)

1927. *Neoschwagerina margaritae* OZAWA. (non DEPRAT) Jour. Fac. Sci., Imp. Univ. Tokyo, sect. 2, vol. 2, pt. 3, pp. 158–159, pl. 42, figs. 5, 7.

1935. *Neoschwagerina margaritae* GUBLER. Mem. Soc. Geol. France, n. s. Tomell, fasc. 4, no. 26, pp. 106–108, pl. 7, figs. 1, 4, 6, pl. 8, fig. 4.

1936. *Neoschwagerina margaritae* FUZIMOTO. Sci. Rep. Tokyo Bunrika Daigaku, sect. C, vol. 1, no. 2, pp. 117–118, pl. 22, figs. 16–17, pl. 24, figs. 1–4.

1942. *Neoschwagerina margaritae* TORIYAMA. Jap. Jour. Geol. Geogr., vol. 18, no. 4, pp. 243–244, pl. 24, fig. 9 (?10, ?11, ?12).

1957. *Neoschwagerina margaritae* KOBAYASHI. Sci. Rep. Tokyo Kyoiku Daigaku, Sect. C, vol. 5, no. 48, pp. 305-306, pl. 10, figs. 1–2.

Diagnosis, — *Yabeina ovawai* can be distinguished from *Neoschwaregina* by it numerous axial septula and well developed secondary transverse septula of which both sides are parallel, or of which the axial sections are pendant.

The axial section of *Yabeina cascadensis* is closely like that of *Yabeina ozawai.* According to the original description, the former has only one or two axial septula in an equatorial chamberlet, while more than four axial septula are seen in the later.

Description, — Shell fusiform, with slightly convex lateral slopes and buluntly narrowed poles. Mature specimens have more than fifteen volutions. The axis of coiling straight throughout the shell in megaspheric generation. Megaspheric proloculus small to medium, 0.17 to 0.10 mm in the longest diameter.

Growth ratios from the first to the fourteenth volution in one of the most representative specimens are 1.13, 1.26, 1.33, 1.49, 1.57, 1.62
the most representative specimens are 1.13, 1.26, 1.33, 1.49, 1.57, 1.62,
1.65, 1.58, 1.62, 1.70, 1.68, 1.72, 1.70 and 1.66, respectively.

Radius vectors of the first to the thirteenth volution in the specimen noted above are 106, 172, 242, 304, 400, 406, 614, 764, 926, 1098, 1216, 1332, 1498 and 1690 microns, respectively.

Spirotheca thin, composed of upper basal deposit, tectum, keriotheca and lower basal deposit. The thickness of keriotheca from the fourth to the thirteenth volution in the specimen mentioned above is 9, 11 to 13, 17, 17, 17, 22, 22, 26, 30 and 30 microns, respectively.

Transverse septula appear from the first volution.. The numbers of transverse septula from the first to the fourteenth volution in the same specimen are 6, 8, 12, 13, 16, 20, 21, 24, 26, 24, 28, 29, 33 and 37, respectively. In juvenile volutions, they are V shape with pointed distal margins in the axial section. In outer volutions, the two sides of them run parallel. Sometimes they are pendant. In the outermost volutions, the most of transverse septula take typical pendant shape with round distal margins in axial section. They extend normally from the ceiling of chamberlets with angled feet. The maximum alveolar divergency in transverse septula is approximately 20°.

Secondary transverse septula first appear at the seventh volution, smaller than the adjacent transverse septula. They are bud-like small extensions of keriotheca in the seventh to ninth volutions. In the outer volutions, they are pendant. Distribution of secondary transverse septula is sporadic, approximately four or five for each volution.

Parachomata present throughout the shell; they develop only underneath the transverse septula, and do not occur bellow secondary transverse septula. They are small and sometimes narrower than the corresponding transverse septula.

Axial septula well developed, first appear from the second volution. They are only small swellings of keriotheca in inner few volutions, pendant shape in outer volutions. A second axial septula per each equatorial chamberlet first appears in the fifth volution. A third axial septula, also in the fifth, a fourth in the sixth, a fifth axial septula also first appears in the sixth volution. Rarely six axial septula per an equatorial chamberlet are present in outer volutions. In an equatorial chamberlet, the spirally inner axial septula are longer and more pendant like than the spirally outer axial septula. Lateral passage small, short distance above the floor.

Discussion, — *Neoschwagerina margaritae* has been described by many authors since DEPRAT reported the species from North Annan in 1913. In his report, he did not refer to secondary transverse septula, and it was very strange that he reported the absence of transverse septula although his illustrated sagittal section obviously has well-developed axial septula throughout the ontogeny.

COLANI, 1924, first followed to Deprat. She reported nothing about the axial septula nor secondary transverse septula. Judging from her illustrated sagittal section, the equatorial chamberlet of the adult stage has few axial septula, and the secondary transverse septula are entirely lacking in the axial section.

OZAWA reported *N. margaritae* in 1925 and 1927 from Nagato and Akasaka. The specimens of OZAWA from Nagato are rather like the specimens of Deprat and Colani. But his specimens from Akasaka are very different from previously described ones, i.e., the secondary transverse septula seems to be distributed in the adult volutions of the axial section

TABLE 2.

	Secondary transverse septula in adult volutions		Axial septula in adult volutions	
	Description	Plate	Description	Plate
DEPRAT, 1913 North Annan	non descript.	non	non	2–3
COLANI, 1924	non descript.	non	non descript.	2–3
OZAWA, 1925 Nagato	non descript.	non	1–2	2–3?
OZAWA, 1927 Akasaka	non descript	irregularly inserted	non descript.	3–5?
GUBLER, 1935 Indochina	"present"	irregularly inserted	1–2	2
HUJIMOTO, 1936 Kwanto Mts.	non		"At least 2–4."	
TORIYAMA, 1942 Tosa	non[9]		"Increased in number."	
TORIYAMA, 1947 Tosa	non		1–2	
KOBAYASHI, 1957 Mt. Ibuki	non[10]		1–3	

8) Irregular developmedt of transverse septula as in OZAWA seems to be shown in his fig. 9, pl. 24.

9) Also seen in fig. 5, pl. 10. The author has discussed their publishec photomicaographs.

10) GUBLER did not include OZAWA's *N. Margaritae* from Akasaka amongst his synonyms.

and the number of axial septula in the adult volutions is much larger than in the younger ones. GUBLER first reported the presence of secondary transverse septula in his specimens under the name of *N. margaritae*. It can be easily re-examined in his excellent photomicrograph. However, according to his description and photomicrograph, the present species has only two, rarely three axial septula in an equatorial chamberlet of the adult volutions. GUBLER's specimens are also different from those of OZAWA from Akasaka in this point[11].

After those authors, *N. margaritae* has been described by a few Japanese authors, viz., HUJIMOTO, 1936, TORIYAMA, 1942 and 1947, KOBAYASHI, 1957. But the confused definitions of on this species have not been clarified yet. The definitions are summarized in the following table.

The author is of the opinion that a line should be drawn between the specimens of DEPRAT and COLANI, and of OZAWA from Akasaka. The development of secondary transverse septula is not clearly shown in OZAWA's microphotograph of axial section. But OZAWA's specimens are salfly comparable to the specimens collected by the author which have secondary transverse septula. Furthermore, OZAWA's specimens and the author's topotype specimens have more than four axial septula in an adult equatorial chamberlet. In view of these facts, the author proposes a new species based on OZAWA's specimens from Akasaka, and assigns the species to the genus *Yabeina* following previous authors' diagnoses.

Occurrence, — *Yabeina ozawai* makes dencely crowded layer which develops for three to five meters. It is composed of single species. The population is extremely high throughout the range. The species occurrs relatively lower horizon in Akasaka; around point 51.

Type level: Lower Middle Permian, NM zone of the Akasaka Limestone.

Type locality: The Akasaka Limestone, point 51 on route r-r′, about 110 m north east of the Shirokiya Limestone Company's powder magazine, Okubo, Akasaka, Gifu Prefecture.

Type specimen: Holotype, an axial section, OZAWA 1927, pl. 42, fig. 7.

Topotypes, Reg. No. 13412-13427.

11) GUBLER did not include OZAWA's *N. Margaritae* from Akasaka amongst his synonyms. His specimens are closely similar to *Yabeina packardi* THOMPSON and WHEELER.

Addendum

After this work was finished, very round neoschwagernid was discovered among the author's collection from lower horizon of the Akasaka limestone. This species can be salfly comparable to Cancellina sphaerica M-Maclay.

Neoschwagerina sphaerica (M-MACLAY)

Pl. 3, Fig. 3.

1957. *Cancellina sphaerica* M-MACLAY. Mem. Lenigrad Univ., no. 225, ser. Geol. Sci., part 9, Geology, pp. 122-125, pl. 5, fig. 1.

Diagnosis, — The growth ratio of this species is almost 1 especially in the outer volutions. But other biocharacters, development of transverse septula and axial septula etc., are very similar to those of *Neoschwagerina simplex*. Therefore, the author is a opinon that the present species should be included to genus *Neoschwagerina*.

Occurrence, — *Neoschwagerina sphaerica* occurr with *N. simplex*. This species is not rare at point 9. This species occurrs with *Minoella eonipponica* HONJO n. sp. and *M. nipponica* (OZAWA).

Specimens: Reg. No. HU. 13511.

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Nov. 1958

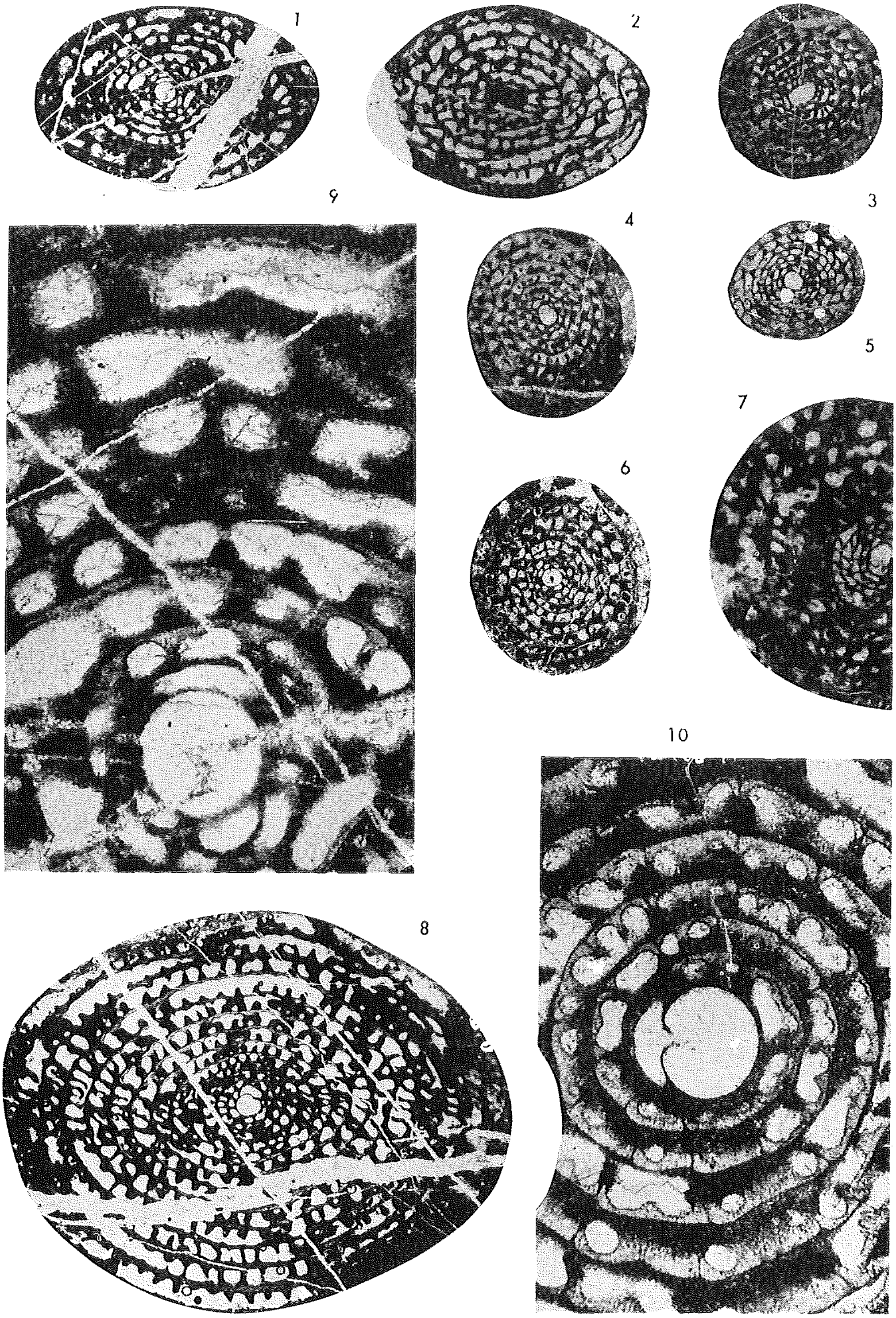
Explanation of Plate 1

Plate 1

All figures are unretouched photographs.
All specimens in Hokkaido Univeristy.
X15, except for Figs. 9 and 10.

Neoschwagerina (*Minoella*) *eonipponica* HONJO, n. subgen., n. sp. Holotype: Fig. 1, Part of Fig. 1: Fig. 9, Paratypes: Figs. 2, 3, 4 and 5.
Neoschwagerina (*Minoella*) *nipponica* (OZAWA) Topotypes: Figs. 6, 7, 8 and 10.

Fig. 1. Axial section of *Minoella eonipponica* ×15. collected from point 7. Reg. No. HU 13510.
Fig. 2. A tangential section of *Minoella eonipponica*, ×15. point 4. Reg. No. HU 13356.
Fig. 3. Sagittal section of *Minoella eonipponica*, ×15. point 5. Reg. No. HU 13357.
Fig. 4, Ditto. point 5. Reg. No. HU 13358.
Fig. 5. Ditto. point 4. Reg. No. HU 13364.
Fig. 6. Sagittal section of *Minoella nipponica* ×15, point 8, Reg. No. HU 13366.
Fig. 7. Ditto. collected from point 9, Reg. No. HU 13380.
Fig. 8. Axial section of *Minoella nipponica*, point 8, Reg. No. HU 13365.
Fig. 9. Part of Fig. 1,
Fig. 10. Part of sagittal section of *Minoella nipponica* (OZAWA) Reg. No. HU 13372.



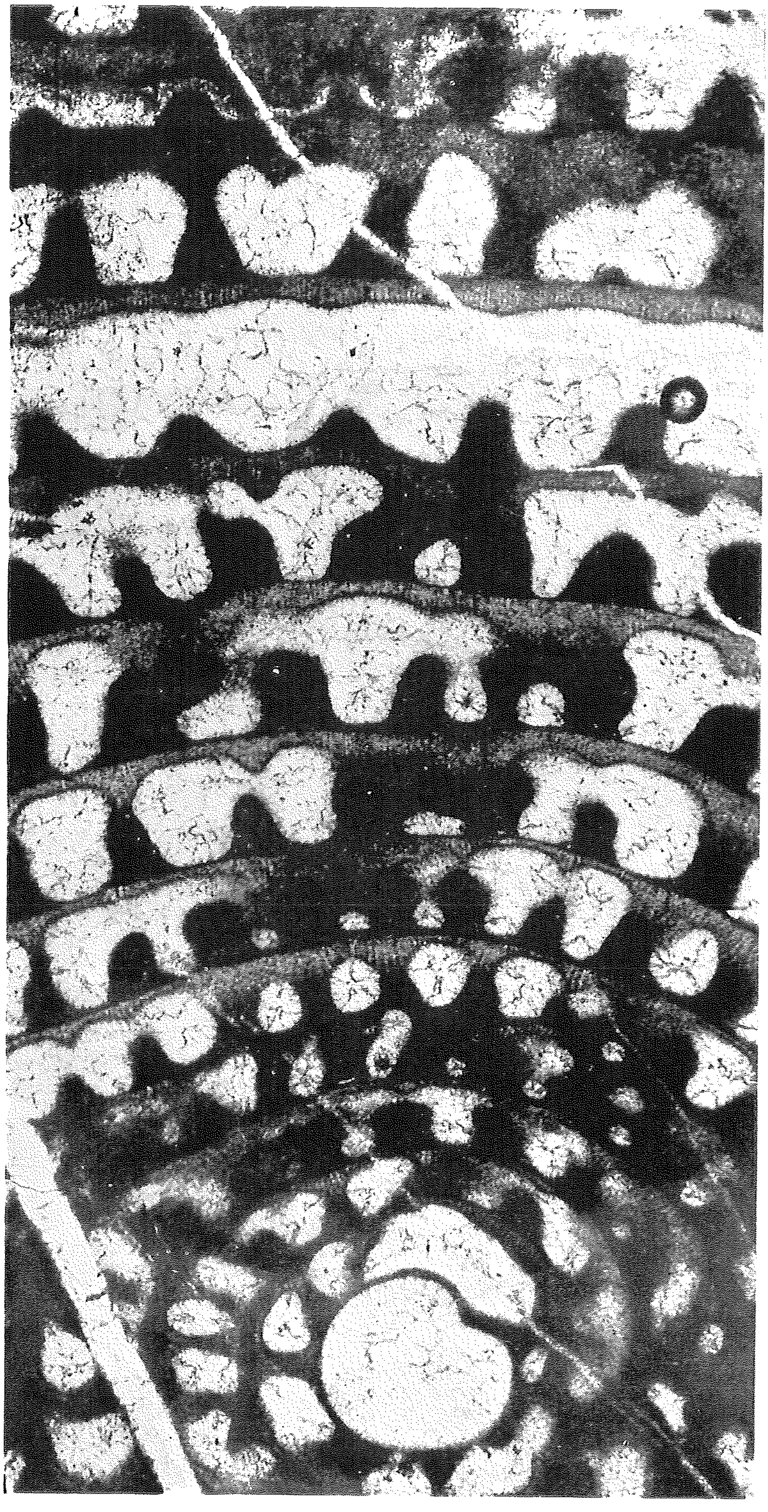
S. HONJO: Neoschwagerinids from AKASAKA. Photo. S. HONJO

Explanation of Plate 2

Plate 2

Unretouched photograph.

Part of the axial section of *Minoella nipponica* (OZAWA), Plate 1, Fig: 8. ×150.



HONJO: Neoschwagerinids from AKASAKA. Photo. S. HONJO

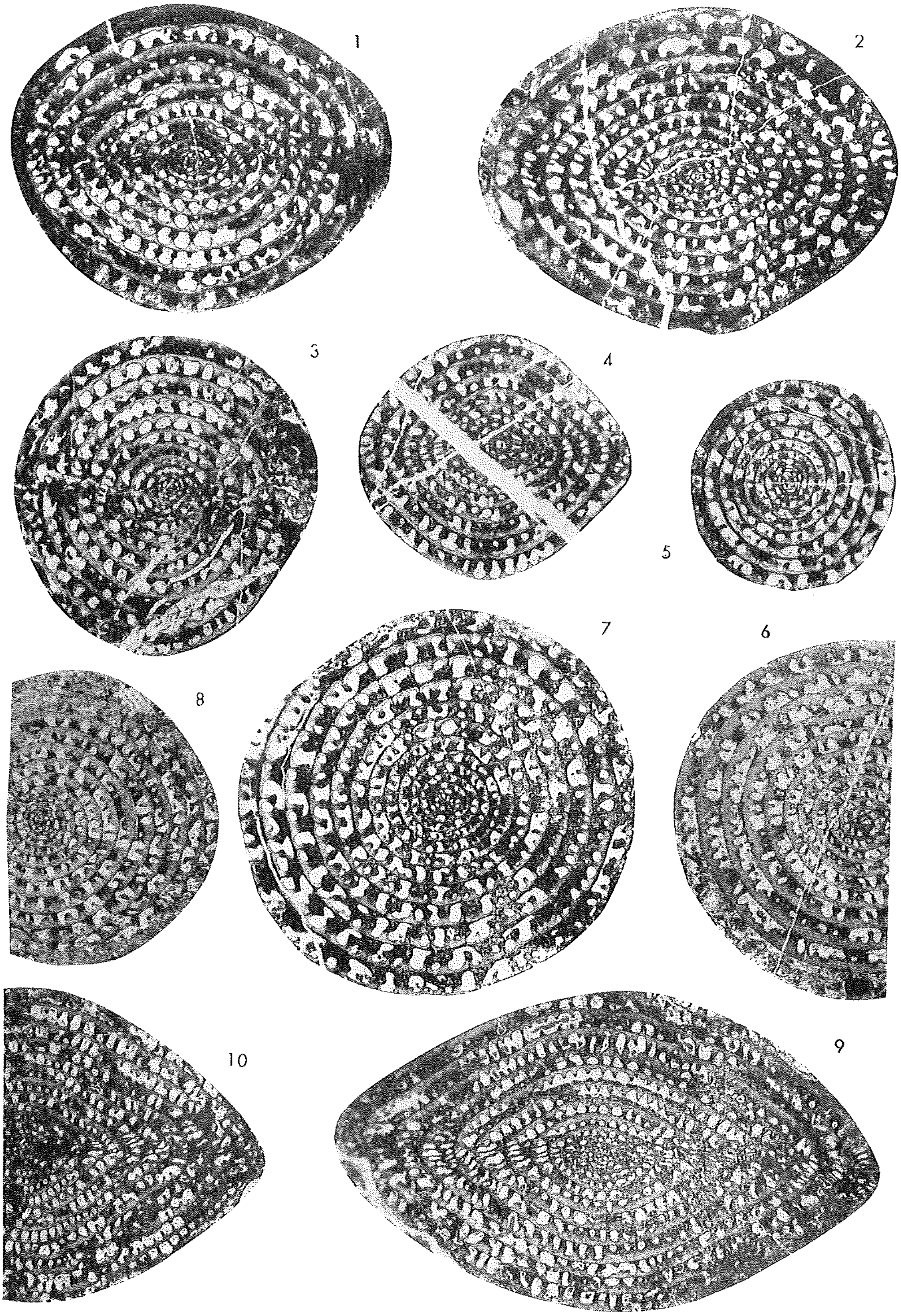
Explanation of Plate 3

Plate 3

All figures are unretouched phtographs.
All specimens in Hokkaido University.
All figures are ×15.

Neoschwagerina simplex OZAWA, Topotypne: Figs. 1, 4 and 5.
Neoschwagerina sphaerica (M-MACLAY), Fig. 3.
Neoschwagerina irregularis HONJO, n. sp. Holotype: Fig. 2, One of the paratypes; Fig. 7.
Neoschwagerina craticulifera (SCHWAGER), Fig. 6, 8, 9
Neoschwagerina haydeni (DUTKEVICH and KABAKHOV) Fig. 10.

Fig. 1. Axial section of *Neoschwagerina simplex*, ×15, collected from point 10. Reg. No. HU 13385.
Fig. 2. Axial section of *Neoschwagerina irregularis*, ×15, Reg. No. HU 13512.
Fig. 3. Axial section of *Neoschwagerina sphaerica*, ×15, point 9, Reg. No. HU 13511.
Fig. 4. Axial section of *Nioschwagerina simplex*, ×15, Reg. No. HU 13522.
Fig. 5. Sagittal section of *Neoschwagerina simplex* OZAWA, ×15, Reg. No. HU 13523.
Fig. 6. Sagittal section of *Neoschwagerina craticulifera* (SCHWAGER) ×15, point 35, Reg. No. HU 13405.
Fig. 7, Sagittal section of *Neoschwagerina irregularis* HONJO, n. sp. ×15 collected by Y. HASEGAWA from Kaerimizu, Akiyoshi, Reg. No. HU 13530.
Fig. 8. Sagittal section of *Neoschwagerina craticulifera* (SCHWAGER), ×15, Reg. No. HU 13524.
Fig. 9. Axial section of *Neoschwagerina haydeni* ×15, collected by Y. HASEGAWA from Kaerimizu, Akiyoshi, Reg. No. HU 13531.



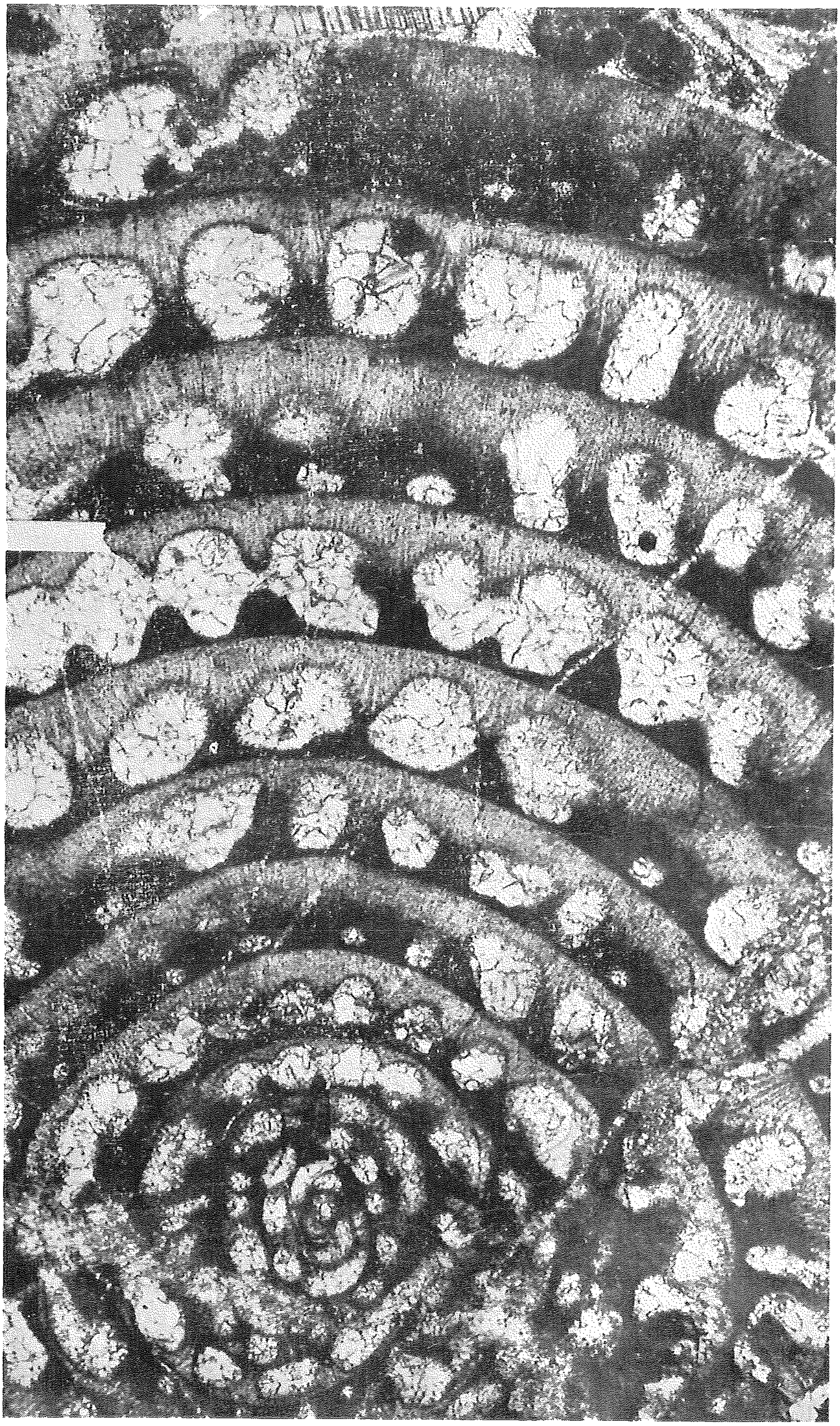
S. HONJO: Neoschwagerinids from AKASAKA. Photo. S. HONJO

Explanation of Plate 4

Plate 4

Unretouched photograph

Neoschwagerina simplex OZAWA, Plate 3, Fig. 1. ×110.



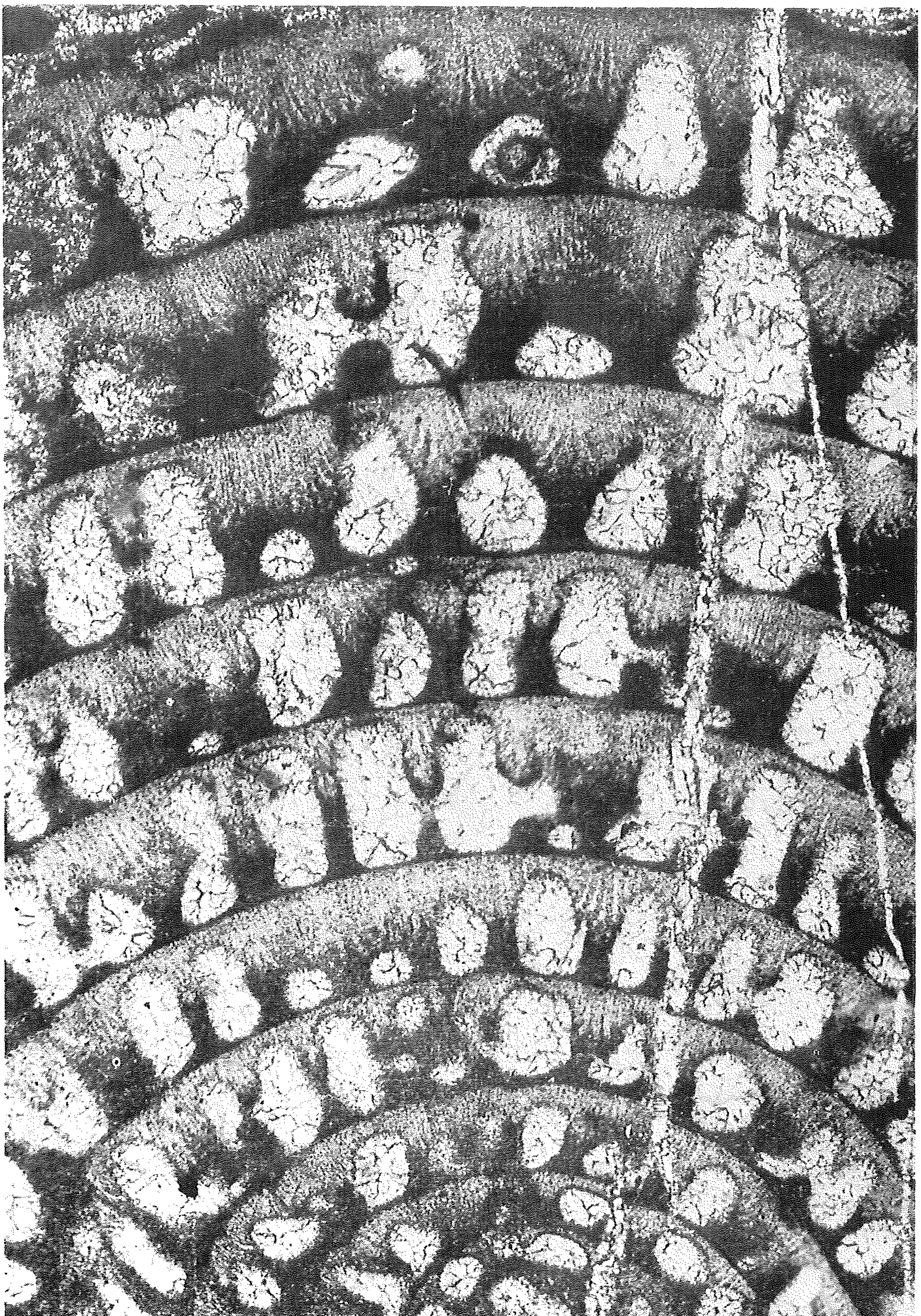
S. HONJO: Neoschwagerinids from AKASAKA. Photo. S. HONJO

Explanation of
Plate 5

Plate 5

Unretouched photograph

Part of a paratype axial tangential section of *Neoschwagerina irregularis* HONJO, n, sp. ×110 collected from point 36. Reg. No. HU 13513. whole figure of ihis specimen is not illustrated in this paper.



S. HONJO: Neoschwagerinids from AKASAKA.

Photo. S. HONJO

Explanation of
Plate 6

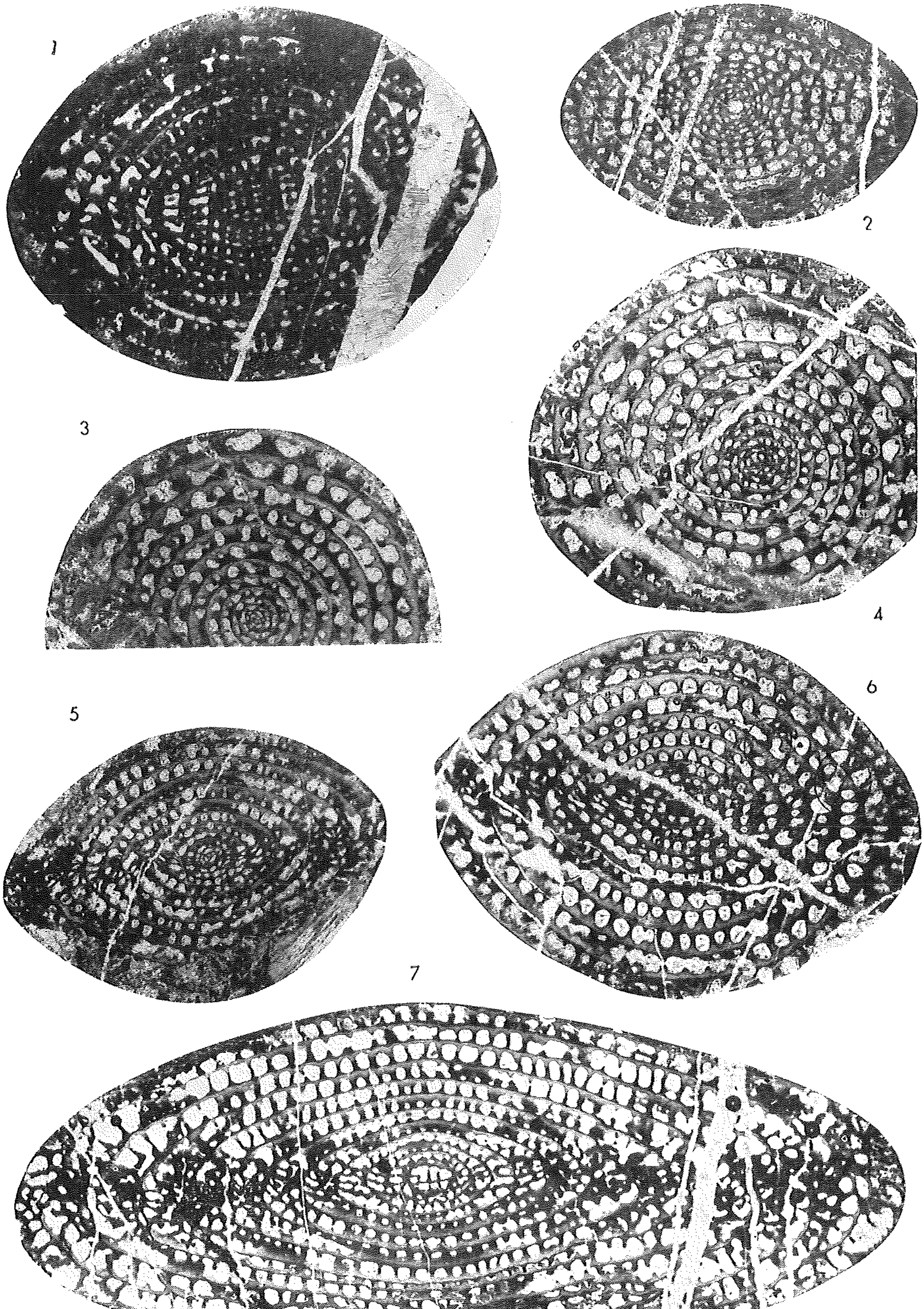
Plate 6

All figures are unretouched photographs.
All figures are X15.

Minoella nipponica (OZAWA), Topotype: Fig. 1.
Neoschwagerina simplex OZAWA, Topotypes: Fig. 2 and 4.
Neoschwagerina craticulifera (SCHWAGER), Figs. 5 and 6.
Gifuella amicula HONJO, n. gen., n. sp., Paratype: Fig. 2.

Gifuella gifuensis HONJO, n. gen., n. sp., Paratype: Fig. 7.

Fig. 1. Tangential section of *Minoella nipponica* ×15, collected from point 9, Reg. No. HU 13365, Remark on well developed parachomata, see p.
Fig. 2. Oblique section of *Gifuella amicula*, ×15, point 56. Reg. No. HU 13429.
Fig. 3. Tangential section of *Neoschwagerina simplex*, ×15, point 9. Reg. No.
Fig. 4. Ditto.
Fig. 5. Axial section of *Neoschwagerina craticulifera*, ×15, point 31. Reg. No. HU.
Fig. 6. Tangential section of *Neoschwagerina craticulifera*, ×15, point 36. Reg. No. HU.
Fig. 7. Tangential section of *Gifuella gifuensis*, point 54, Reg. No.



S. HONJO: Neoschwagerinids from AKASAKA. Photo. S. HONJO

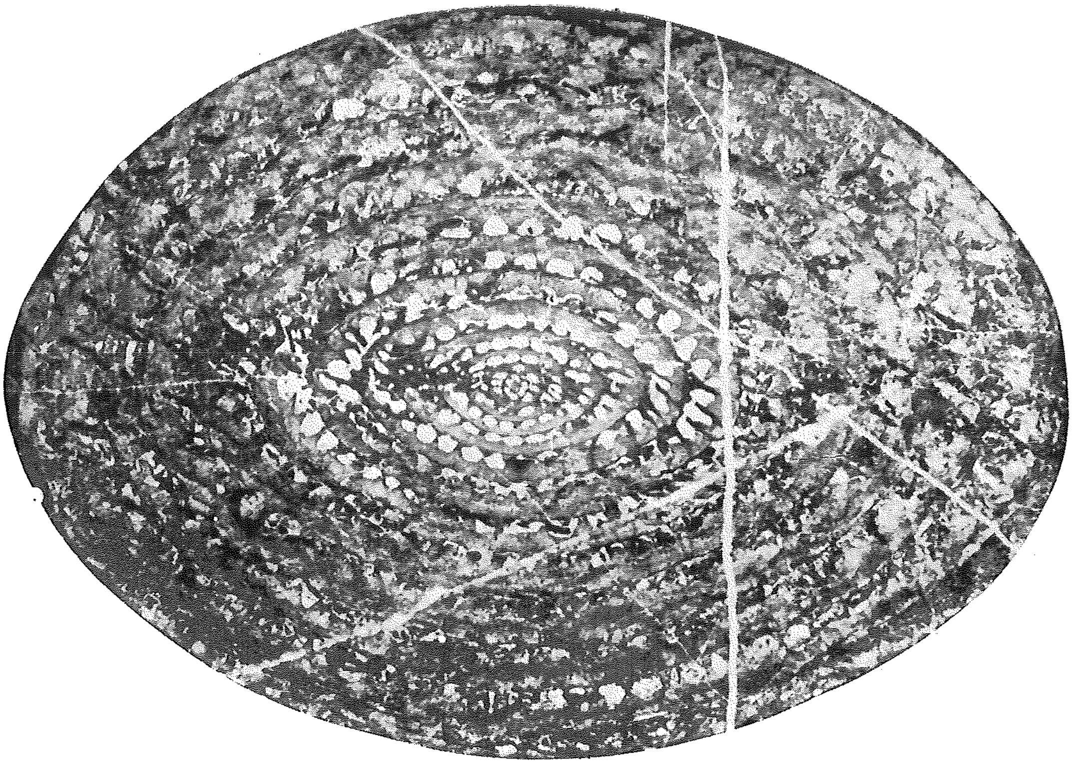
Explanation of Plate 7

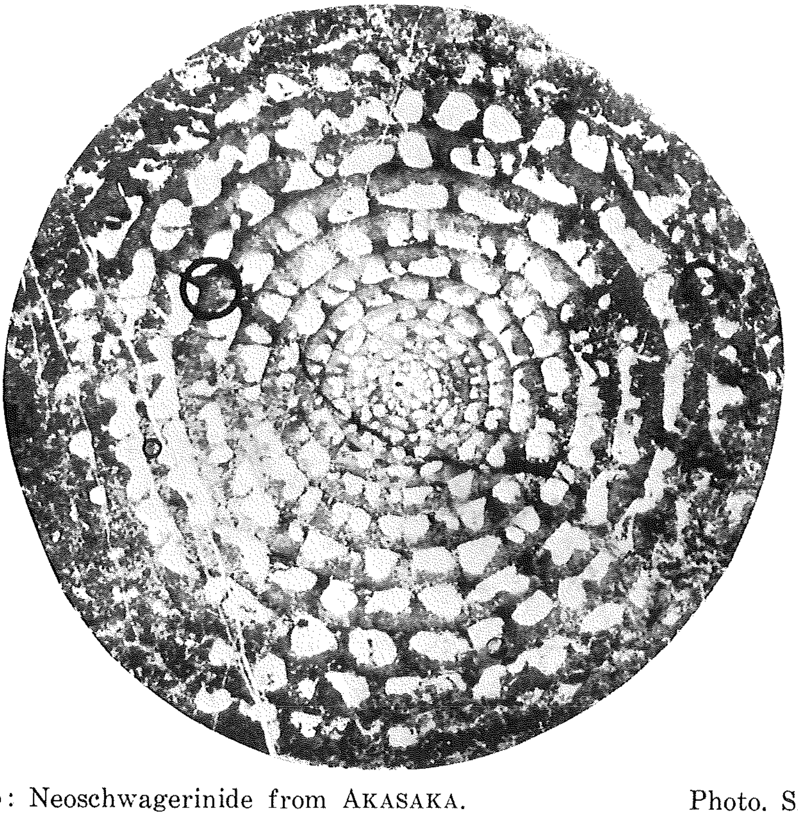
Plate 7

All figures are unretouched photographs.
All specimens are in Hokkaido University.

Metaschwagerina ovalis MINATO and HONJO, Holotype: Fig. 1, One of paratypes: Fig. 2.

Fig. 1. Axial section of *Metaschwagerina ovalis*, ×25, Reg. No. HU 13494.
Fig. 2. Sagittal section of *Metaschwagerina ovalis*, ×25, Reg. No. HU 13495.





S. HONJO: Neoschwagerinide from AKASAKA. Photo. S. HONJO

Explanation of Plate 8

Plate 8

Unretouched photograph.

Part of the axial section of *Metaschwagerina ovalis* MINATO and HONJO, Plate 10, Fig. 1. X.

S. HONJO: Neoschwagerinids from AKASAKA. Photo. S. HONJO

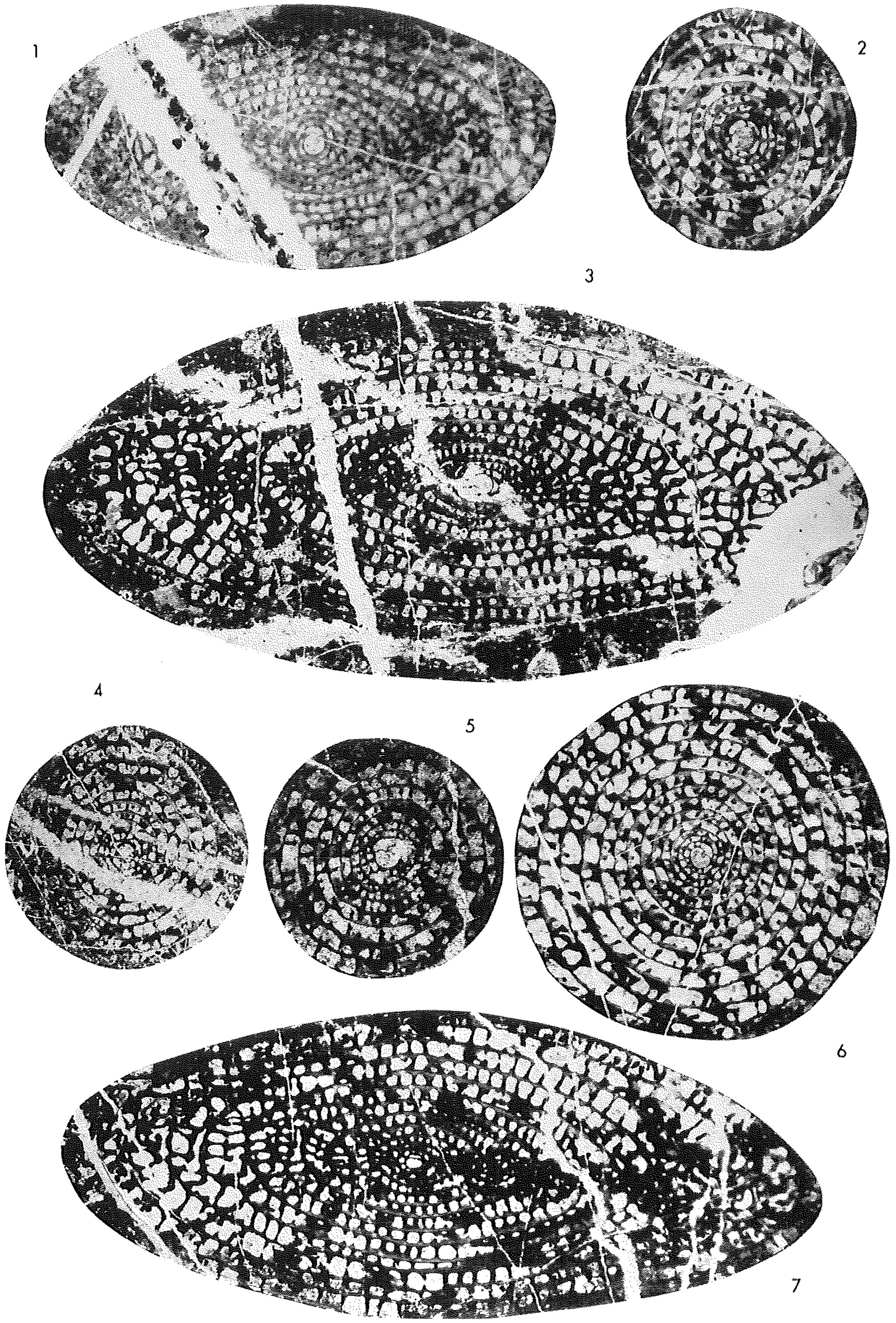
Explanation of Plate 9

Plate 9

All figures are unretouched photographs.
All figures are X15, except for Fig. 1 and 2.

Gifuella amicula HONJO, n. gen., n. sp. Holotype ; Fig. 1, One of the paratypes : Fig.
Gifuella gifuensis HONJO, n. gen., n. sp. Holotypes : Fig. 3, Paratypes : Figs. 4, 5, 6 and 7.

Fig. 1. Axial section of *Gifuella amicula*, $\times 20$, point 51. Reg. No. HU 13453.
Fig. 2. Sagittal section of *Gifuella amicula*, $\times 20$, point 51, Reg. No. HU 13428.
Fig. 3. Axial section of *Gifuella Gifuensis*, $\times 15$, point 55. Reg. No. HU 13454.
Fig. 4. Sagittal section of *Gifuella amicula*, $\times 15$, point 51, Reg. No. 13577.
Fig. 5. Ditto. point 58. Reg. No. 13455.
Fig. 6. Ditto. point 55. Reg. No. 13460.
Fig. 7. Axial tangential section of *Gifuella gifuensis*, point 55, Reg. No. 13480.



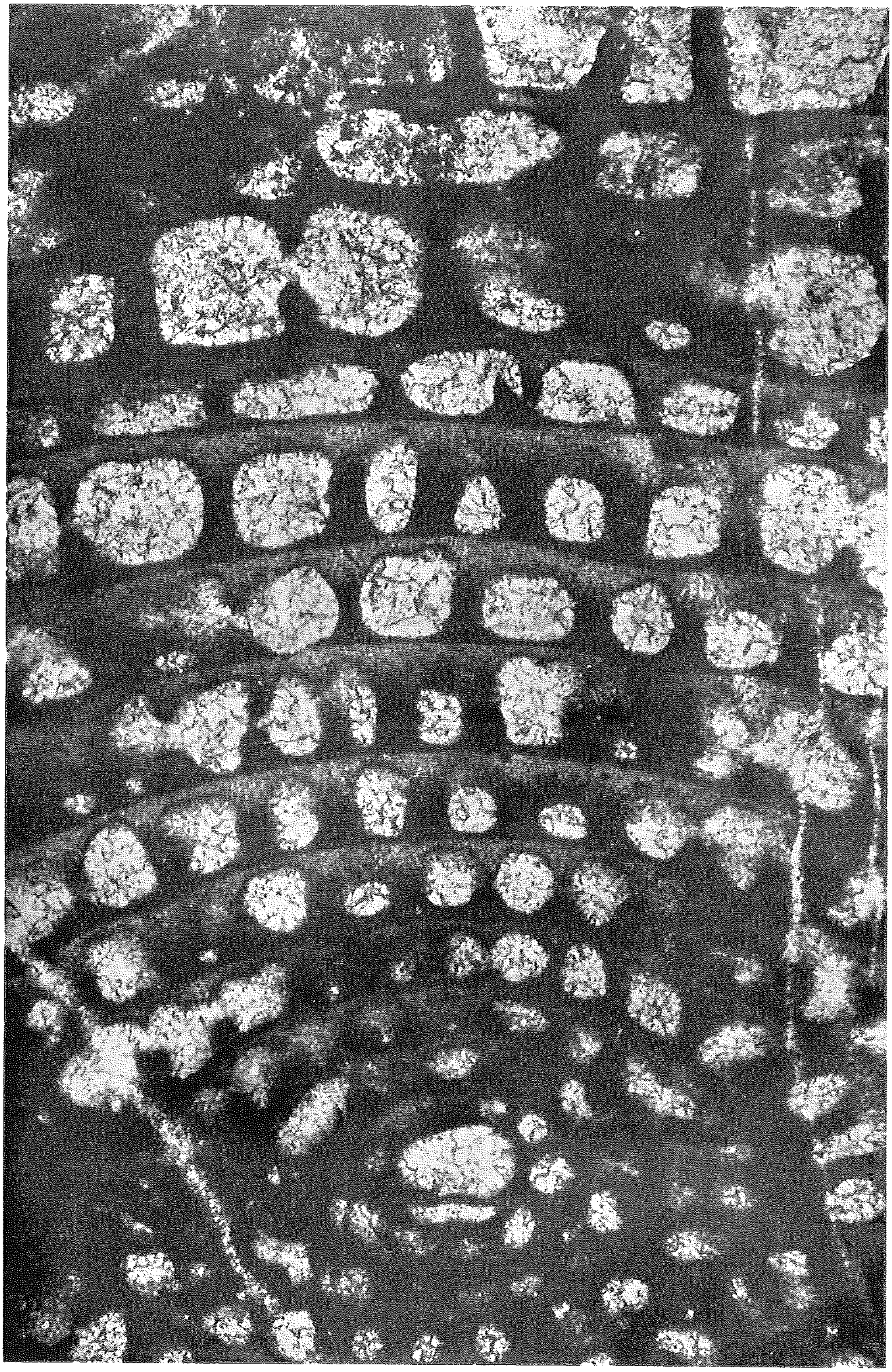
S. HONJO: Neoschwagerinids from AKASAKA. Photo. S. HONJO

Explanation of
Plate 10

Plate 10

Unretouched photograph

Part of anaxial tangential section of *Gifuella gifuensis* HONJO, n. gen., n. sp., Plate 7, Fig. 7, ×110.



S. HONJO: Neoschwagerinids from AKASAKA. Photo. S. HONJO

Explanation of
Plate 11

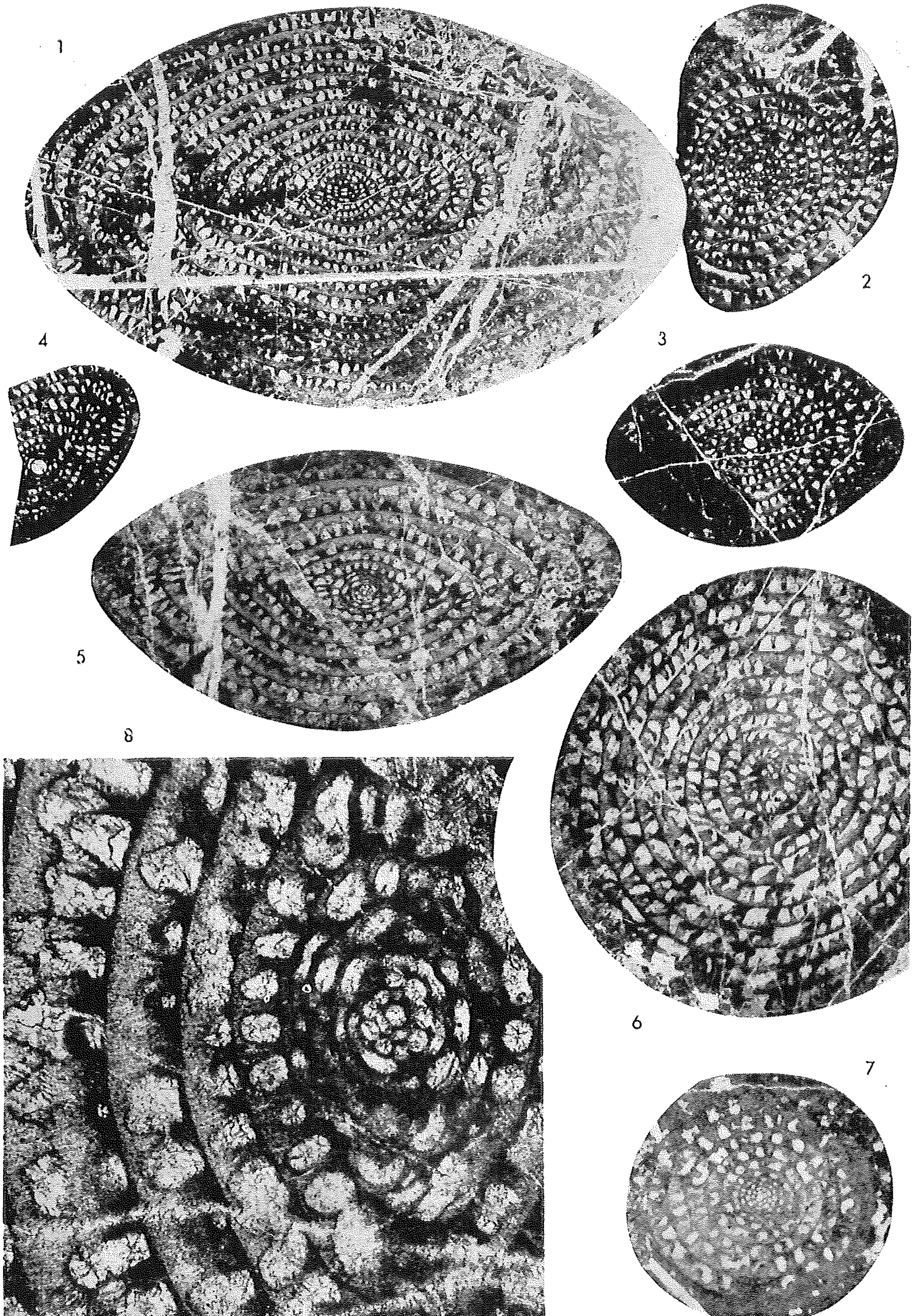
Plate 11

All figures are unretouched photographs.
All specimens are in Hokkaido University.

Yabeina ozawai HONJO, n. sp., Topotypes; Fig. 1, 2, 3 and 4.
Neoschwagerina colaniae OZAWA, Topotypes; Fig. 5, 6 and 7. Part of Fig. 1; Fig. 8.

Fig. 1. Tangential section of *Yabeina ozawai*, ×15, collected from point 50, Reg. No. 13412.
Fig. 2. Sagittal section of *Yabeina ozawai*, ×15, point 50, Reg. No. 13413.
Fig. 3. Axial section of *Yabeina ozawai*, ×15, point 50, Reg. No. 13414.
Fig. 4. Ditto. Reg. No. 13415.
Fig. 5. Axial section of *Neoschwagerina colaniae*, point 62, ×20, Reg. No. 13485.
Fig. 6. Tangential section of *Neoschwagerina colaniae*, ×20, point 60, Reg. No. 13489.
Fig. 7. Axial section *Neoschwagerina colaniae*, ×20, point 61, Reg. No. 13486.
Fig. 8. A part of Fig. 5.

Plate XI



S. HONJO: Neoschwagerinids from AKASAKA.

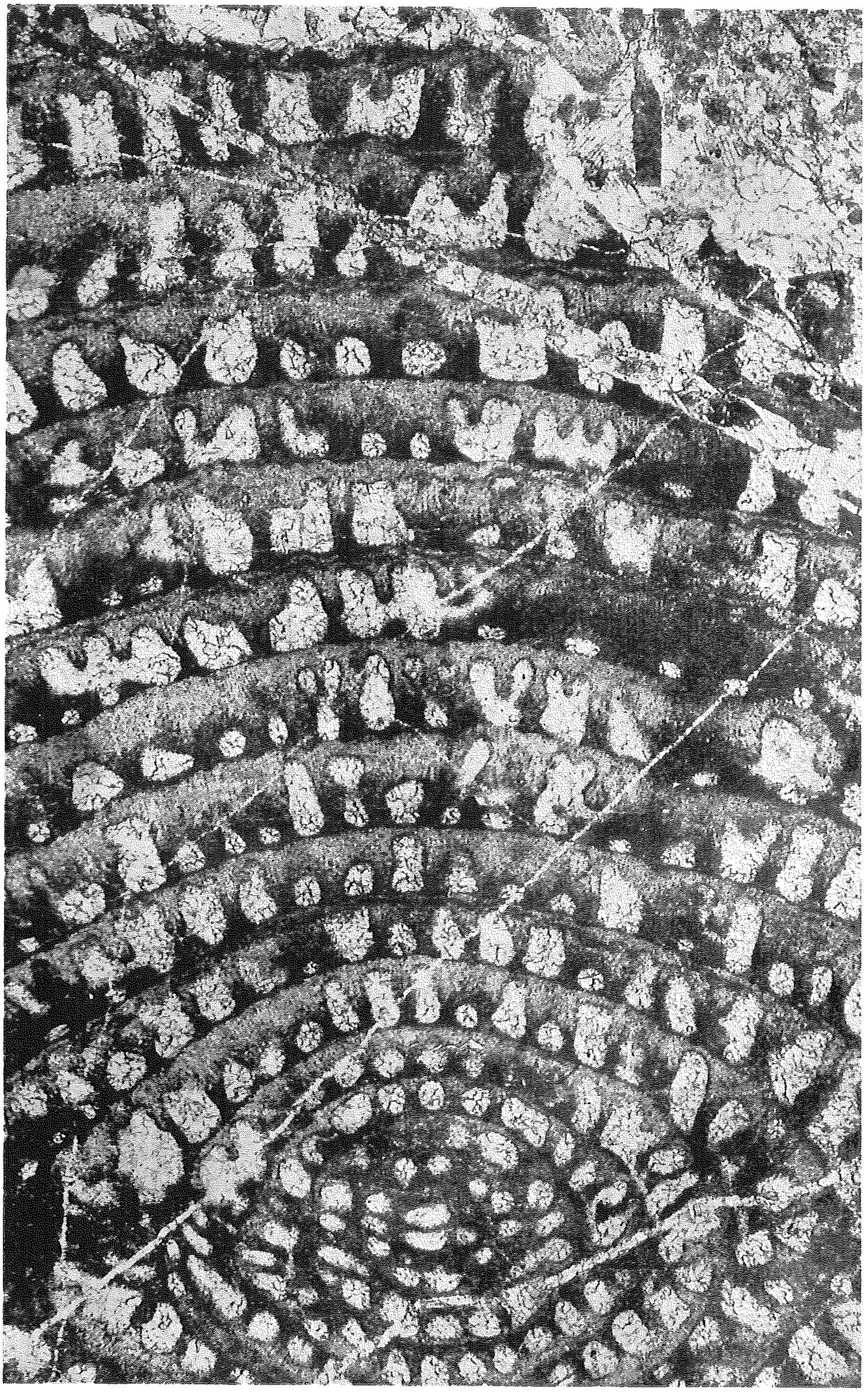
Photo. S. HONJO

Explanation of Plate 12

Plate 12

Unretouched photograph

Part of the axial tangential section of *Yabeina ozawai*, n. sp. Plate 11, Fig. 1, ×80.



S. HONJO: Neoschwagerinids from AKASAKA. Photo. S. HONJO